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The number of leisure-time activities and risk of functional disability among Japanese older population: the JAGES cohort

Yoshihiro Fuji [a,b], Ryoto Sakaniwa [a], Kokoro Shirai [a], Tami Saito [c], Shigekazu Ukawa [d], Hiroyasu Iso [a,*], Katsunori Kondo [e,f]

[a] Public Health, Department of Social Medicine, Graduate School of Medicine, Osaka University, Osaka, Japan, 2-2 Yamadaoka, Suita-shi, Osaka 565-0871 Japan
[b] Department of Rehabilitation, Osaka General Medical Center, Osaka, Japan, 3-1-56, Sumiyoshi-ku, Osaka-shi, Osaka 558-8558, Japan
[c] Department of Social Science, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Aichi, Japan, 7-430, Morioka-cho, obu-shi, Aichi 474-8511, Japan
[d] Osaka City University Graduate School of Human Life Science, Osaka, Japan, 3-3-138, Sugimoto, Sumiyoshi-ku, Osaka-shi, Osaka 558-8585, Japan
[e] Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, Chiba, Japan, 1-8-1, Inohana, Chuo-ku, Chiba-shi, Chiba 260-0856, Japan
[f] Department of Gerontological Evaluation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Aichi, Japan, 7-430, Morioka-cho, obu-shi, Aichi 474-8511, Japan

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ABSTRACT

Evidence-based prevention of functional disability is a pressing issue for the health among the older population, due to the rapidly global aging. This study aimed to examine the association between leisure-time activities and the risk of functional disability. In a longitudinal prospective cohort study, we recruited 50,286 Japanese men and women aged ≥ 65 years who did not have functional disability at the baseline in 2010–2011, with a median follow-up of 5.8 years. We examined the association between 24 leisure-time activities and the risk of developing functional disability. Cox proportional hazards regressions were used to examine the hazard ratios (HRs) and 95% confidence intervals (95% CIs) for functional disability. A total of 10,631 persons (4,497 men and 6,134 women) newly developed functional disability. The number of leisure-time activities was inversely associated with the risk of functional disability. With reference to no activity, the multivariable HRs (95% CIs) were 0.89 (0.82–0.97) for one activity, 0.72 (0.67–0.78) for two to four activities, and 0.66 (0.58–0.74) for five or more activities (*P* for trend, <0.001) for men, and for women, the corresponding HRs were 0.84 (0.78–0.90), 0.77 (0.72–0.82), and 0.70 (0.62–0.79), (*P* for trend, <0.001). Further, even lower-loading leisure-time activities such as computer for men and handicrafts for women, were also associated with a reduced risk of functional disability. Our study suggests the importance of engaging in various leisure-time activities among the older population.

1. Introduction

Functional disability are not a natural consequence of aging and could be prevented in primary healthcare settings (Yates and Muchisky, 1997; WHO, 2008). Evidence-based prevention of functional disability is a pressing issue for the health among the older population, particularly due to the rapidly aging population in several Asian countries (WHO, 2017; eurostat Statistics Explained). In Japan, the annual medical costs for managing patients with functional disability are expected to increase from US $ 100 billion in 2018 to US $ 150 billion by 2025 (Ministry of Health, Labour and Welfare). Worldwide, the number of years lived with disability doubled from 17.7 million in 1990 to 34.4 million in 2019 (Vos et al., 2020).

The association of leisure-time activities and health benefits among the older population has been described based on the levels of physical activity (Corbett et al., 2018; Chen et al., 2016). For instance, within a median follow-up of 11.6 years, the New Integrated Suburban Seniority Investigation (NISSIN) of 2,888 Japanese men aged ≥ 65 years showed that leisure-time activity with ≥ 18 metabolic equivalent (MET) hours/week of leisure-time activities was associated with a

* Corresponding author. Tel.: +81-6-6879-3911.
E-mail addresses: jzx90.mark23669@gmail.com (Y. Fuji), r.sakaniwa@pbhel.med.osaka-u.ac.jp (R. Sakaniwa), kshirai@pbhel.med.osaka-u.ac.jp (K. Shirai), t-saito@ncgg.go.jp (T. Saito), ukawa@life.osaka-cu.ac.jp (S. Ukawa), iso@pbhel.med.osaka-u.ac.jp (H. Iso), kkondo@kkondo.net (K. Kondo).

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reduced risk of functional disability compared with no leisure-time activities (multivariable hazard ratio [HR]: 0.48; 95% confidence interval [CI]: 0.25–0.94) (Matsunaga et al., 2017). A 10-year follow-up prospective study of 2,456 Finnish men and women aged ≥ 65 years showed that participation in intensive sports and training for ≥ 3 h/week were associated with a reduced risk of incident cardiovascular disease (coronary heart disease and stroke) compared with non-intensive leisure-time activities (HR: 0.55, 95% CI: 0.38–0.79) (Barengo et al., 2017).

The Bronx aging study of 469 English men and women aged ≥ 75 years reported that many of the older adults participated two or more types of leisure-time activities such as playing board games (22.6%), reading books (81.4%), writing (18.6%), performing housework (77.4%), walking (86.1%), climbing the stairs (67.4%), and participating in group exercise (30.0%) (Verghese et al., 2003). Therefore, the impact of the number of various leisure-time activities on the risk of functional disability should be taken into account.

Previous studies reported the benefit of the number of leisure-time activities on the risk of all-cause mortality (Kobayashi et al., 2021), dementia (Xu et al., 2017; Ling et al., 2020), and cognitive impairments among individuals aged ≥ 65 years (Doi et al., 2017; Sugita et al., 2020). Other studies reported that the number and frequency of social participations in leisure-time activities were associated with a lower risk of functional disability (Kanamori et al., 2014; Komatsu et al., 2019). However, the association between the number of different types of leisure-time activities such as walking/running, and gardening, traveling and the risk of functional disability has not been investigated.

This prospective cohort study aimed to examine the association between the number of various leisure-time activities and the risk of functional disability in 50,286 Japanese individuals aged ≥ 65 years.

2. Methods

2.1. Study population

We used the data from the JAGES (Japan Gerontological Evaluation Study) cohort. The study profile has been described elsewhere (Kondo, 2016; Kondo and Rosenberg, 2018). In brief, the baseline mail survey was conducted in 2010–2011 using a self-administered questionnaire. A total of 54,539 people (25,146 men and 29,393 women) aged ≥ 65 years without functional disability from 31 municipalities in Japan were enrolled in our study. We excluded 48 individuals who did not respond to our survey and 4,204 individuals with missing data on leisure-time activities. Finally, 50,286 (23,103 men and 27,183 women) individuals were included in the current study. Data on the incidence of functional disability from 2010 to 2016 were obtained from municipal public long-term care insurance (LTCI) system databases, and we identified people who were newly eligible for the LTCI benefit considered as those with functional disability.

This study was ethically approved by the institutional review boards (no. 10–05, no. 1777). All respondents were informed that participation in this study was absolutely voluntary and that completing and returning the questionnaires via mail indicated their consent to participate.

2.2. Definition for functional disability

The follow-up period started from August 2010 until April 2016, with the longest being 2,070 days. Older adults in Japan with functional disability were certified for LTCI database (Ministry of Health, Labour and Welfare). A formal evaluation was conducted to determine the level of LTCI services for older adults with functional disability (Tsutsui and Muramatsu, 2005; Tsutsui and Muramatsu, 2007). This system was applied as public and social welfare services throughout Japan and covers aged ≥ 65 years with limitations in performing ADL and/or instrumental ADL (IADL) regardless of their income status. The levels of functional disability were assessed by certified interviewers through home-visited and based on written opinions from a primary physician, including a physician's examination and evaluation of physical and cognitive functions (Tsutsui and Muramatsu, 2005). Functional disabilities were assessed with seven levels: support needed (levels 1 to 2), care needed (levels 1 to 5), or no functional disability (independent). All registered individuals who were identified with functional disability received public and social welfare services for adult day care, home-visit care, day-visit services, short-stay services, residential services, and/or in-facility services, depending on the degree of functional disabilities from local government (Ministry of Health, Labour and Welfare). These LTCI's criteria are widely adopted in previous epidemiological studies (Kanamori et al., 2014; Ukawa et al., 2020; Hikichi et al., 2015; Ashida et al., 2016; Aida et al., 2013). In each, local Japanese government, the applicants for the LTCI are asked to fill out a basic application form (Ministry of Health, Labor and Welfare, 2013).

Information on all-cause mortality was obtained from the LTCI database system of the participants' municipality office. Those who died from any cause, moved out from their original community, or had no data on the last follow-up, whichever came first, were censored.

2.3. Definition of the number of leisure-time activities

At baseline, all participants were asked the following question: "Do you currently have any leisure-time activities?" When the participants responded "yes," they were asked to provide the different types of leisure-time activities that they engaged in.

According to physical activities tracking guide, the amount of time spent (in METs) in performing leisure-time activities were as follows: for example walking/running: 2.3/6.0, gardening: 3.3, traveling: 2.5, reading: 1.3, computer: 1.5, and handicrafts: 1.3 (Ainsworth et al., 2011). The types of leisure-time activities were classified as: higher-loading leisure-time activities (METs ≥ approximately 2.5: walking/running, gardening, traveling, cultivation of agricultural crops, karaoke, fishing, golf, photography, grand golf, exercise/tai chi, mountain climbing, instrument performance, gate ball, dance, and chorus/folk song) and lower-loading activities (METs < 2.5: reading, computer, igo/shogi/mahjong, pachinko, painting/picture letter, calligraphy, haiku/tanka/senryu, handicrafts, and tea ceremony/flower arrangement), and other non-specified activities.

We counted the total number of leisure-time activities performed by each individual (from 0 to 24 points). All participants were divided into four groups according to the number of leisure-time activities (zero, one, two to four, and ≥ five or more types).

2.4. Covariates

The sociodemographic variables (sex, age, and marital status), socioeconomic status (educational level, occupational status, and equivalized income), health-related behaviors (smoking status, IADL status, and walking hours), and histories of comorbidities (diabetes mellitus, hypertension, stroke, heart disease, mental disorder, and hearing loss), engagement in social activities (political groups/organizations, volunteer groups, sports groups/clubs, neighborhood associations, and senior clubs), and frequency of meeting friends were included as covariates for multivariate-adjusted examinations. These variables were divided into the following categories: sex (men or women), age (65–69, 70–74, 75–79, 80–84, or ≥ 85 years), educational level (<10 or ≥ 10 years), occupational status (employed or not employed), equivalized income (<200, 200–399, or ≥ 400 × 10,000 JPY; 100 JPY≒1 USD), marital status (married, widowed, divorced, or never married), smoking status (yes or no), IADL status (independent; 5 points out of 5 or not-independent; <5 points) (Koyano et al., 1991), walking hours (<30, 30–59, 60–89, ≥90 min/day), and histories of comorbidities (diabetes mellitus, hypertension, stroke, heart diseases, mental disorder, and/or hearing loss), social activities (political groups/organizations, volunteer groups, sports groups/clubs, neighborhood associations, and/or senior clubs), and frequency of meeting friends (≥four or more times/week,

Table 1
Sex-specific baseline characteristics according to the number of leisure-time activities

		Men				Women			
		Number of leisure-time activities (%)				Number of leisure-time activities (%)			
		0	1	2–4	≥5	0	1	2–4	≥5
Number at risk, n*		6,503	3,848	9,429	3,323	9,071	4,591	10,491	3,030
		(28.2)	(16.6)	(40.8)	(14.4)	(33.4)	(16.9)	(38.6)	(11.2)
Age, years**		74.2	74.7	73.6	73.0	75.1	75.2	73.5	72.3
		(6.4)	(6.3)	(5.7)	(5.3)	(6.7)	(6.3)	(5.7)	(5.0)
Educational level, years**	≥10	1,797	1,000	3,270	1,201	2,409	1,318	3,961	1,363
		(27.6)	(26.0)	(34.7)	(36.1)	(26.6)	(28.7)	(37.8)	(45.0)
Occupational status**	Not employed	3,886	2,387	6,313	2,422	5,586	2,857	7,281	2,343
		(59.8)	(62.0)	(67.0)	(72.9)	(61.6)	(62.2)	(69.4)	(77.3)
Equivalized income, 10,000 JPY*	<200	1,395	832	1,388	309	2,012	990	1,662	329
		(21.5)	(21.6)	(14.7)	(9.3)	(22.2)	(21.6)	(15.8)	(10.9)
	200–399	3,483	1,980	5,559	2,082	3,883	1,899	5,114	1,596
		(53.6)	(51.5)	(59.0)	(62.7)	(42.8)	(41.4)	(48.8)	(52.7)
	≥400	652	425	1,516	728	712	434	1,561	664
		(10.0)	(11.0)	(16.1)	(21.9)	(7.9)	(9.5)	(14.9)	(21.9)
Marital status*	Married	5,416	3,187	8,170	2,991	4,892	2,501	6,299	1,904
		(83.3)	(82.8)	(86.7)	(90.1)	(53.9)	(54.5)	(60.0)	(62.8)
	Widowed	589	370	776	223	3,265	1,626	3,318	931
		(9.1)	(9.6)	(8.2)	(6.7)	(36.0)	(35.4)	(31.6)	(30.7)
	Divorced	201	122	209	61	389	168	397	92
		(3.1)	(3.2)	(2.2)	(1.8)	(4.3)	(3.7)	(3.8)	(3.0)
	Never married	131	63	117	23	190	113	270	79
		(2.0)	(1.6)	(1.2)	(0.7)	(2.1)	(2.5)	(2.6)	(2.6)
Smoking status*	Current	1,417	834	1,658	417	383	164	248	55
		(21.8)	(21.7)	(17.6)	(12.6)	(4.2)	(3.6)	(2.4)	(1.8)
	Former	2,405	1,409	4,161	1,693	334	154	369	97
		(37.0)	(36.6)	(44.1)	(51.0)	(3.7)	(3.4)	(3.5)	(3.2)
	Never	1,488	954	2,237	826	6,860	3,529	8,661	2,621
		(22.9)	(24.8)	(23.7)	(24.9)	(75.6)	(76.9)	(82.6)	(86.5)
Instrumental activities of daily living (IADL) status**	Independent; 5 points out of 5	3,597	2,254	6,626	2,724	6,274	3,474	9,180	2,892
		(55.3)	(58.6)	(70.3)	(82.0)	(69.2)	(75.7)	(87.5)	(95.5)
	Not-independent; less than 5points	2,594	1,412	2,415	497	2,479	956	966	70
		(39.9)	(36.7)	(25.6)	(15.0)	(27.3)	(20.8)	(9.2)	(2.3)
Walking hours, min/day*	<30	2,704	1,534	2,666	524	3,726	1,771	3,126	565
		(41.6)	(39.9)	(28.3)	(15.8)	(41.1)	(38.6)	(29.8)	(18.7)
	30−59	1,884	1,124	3,368	1,303	2,616	1,437	3,743	1,176
		(29.0)	(29.2)	(35.7)	(39.2)	(28.8)	(31.3)	(35.7)	(38.8)
	60−89	802	509	1,668	745	1,017	527	1,647	610
		(12.3)	(13.2)	(17.7)	(22.4)	(11.2)	(11.5)	(15.7)	(20.1)
	≥90	920	585	1,626	730	1,104	563	1,602	617
		(14.2)	(15.2)	(17.2)	(22.0)	(12.2)	(12.3)	(15.3)	(20.4)
History of diabetes mellitus	Yes	980	582	1,415	491	1,048	466	968	264
		(15.1)	(15.1)	(15.0)	(14.8)	(11.6)	(10.2)	(9.2)	(8.7)
History of hypertension	Yes	2,429	1,446	3,594	1,245	3,775	1,931	4,255	1,086
		(37.4)	(37.6)	(38.1)	(37.5)	(41.6)	(42.1)	(40.6)	(35.8)
History of stroke	Yes	160	90	162	59	85	31	59	19
		(2.5)	(2.3)	(1.7)	(1.8)	(0.9)	(0.7)	(0.6)	(0.6)
History of heart disease	Yes	981	570	1,353	460	994	464	907	244
		(15.1)	(14.8)	(14.4)	(13.8)	(11.0)	(10.1)	(8.7)	(8.1)
History of mental disorder**	Yes	81	33	53	23	138	60	90	13
		(1.3)	(0.9)	(0.6)	(0.7)	(1.5)	(1.3)	(0.9)	(0.4)
History of hearing loss**	Yes	564	325	701	209	731	387	691	149
		(8.7)	(8.5)	(7.4)	(6.3)	(8.1)	(8.4)	(6.6)	(4.9)
Political groups/organizations**	Yes	130	153	398	178	103	214	482	136
		(2.0)	(4.0)	(4.2)	(5.4)	(1.1)	(4.7)	(4.6)	(4.5)
Volunteer groups**	Yes	239	188	971	657	204	205	1,003	644
		(3.7)	(4.9)	(10.3)	(19.8)	(2.3)	(4.5)	(9.6)	(21.3)
Sports groups/clubs**	Yes	131	465	2,249	1,370	115	513	2,859	1,486
		(2.0)	(12.1)	(23.9)	(41.2)	(1.3)	(11.2)	(27.3)	(49.0)
Neighborhood associations**	Yes	497	350	1,307	704	306	256	935	447
		(7.6)	(9.1)	(13.9)	(21.2)	(3.4)	(5.6)	(8.9)	(14.8)
Senior clubs**	Yes	322	313	1,206	579	509	531	1,758	672
		(5.0)	(8.1)	(12.8)	(17.4)	(5.6)	(11.6)	(16.8)	(22.2)
Frequency of meeting friends*	≥4 times/week	667	486	1,212	492	1,233	665	1,629	584
		(10.3)	(12.6)	(12.9)	(14.8)	(13.5)	(14.5)	(15.5)	(19.3)
	2–3 times/week	791	615	1,937	833	1,676	1,082	3,221	1,197
		(12.2)	(16.0)	(20.5)	(25.1)	(18.5)	(23.6)	(30.7)	(39.5)
	1 time/week	772	590	1,589	634	1,310	842	2,099	582
		(11.9)	(20.5)	(16.9)	(19.1)	(14.4)	(18.3)	(20.0)	(19.2)
	1–2 times/month	1,195	700	2,023	744	1,705	909	1,964	419
		(18.4)	(18.8)	(21.5)	(22.4)	(18.8)	(19.8)	(18.7)	(13.8)
	less than 1 times/year	2,734	1,286	2,441	123	2,447	797	1,161	169
		(42.1)	(33.5)	(25.9)	(17.4)	(27.0)	(17.4)	(11.1)	(5.6)

All data are presented by means (standard deviations) or numbers (percentages).
*P for differences in proportions across the number of leisure-time activities: $P < 0.001$.
** P for trends in means and proportions across the number of leisure-time activities: $P < 0.001$.

Table 2
Sex-specific the number (proportion) of higher-loading, lower-loading and other non-specified leisure-time activities

	Men	Women
	Number (%)	Number (%)
Higher-loading leisure-time activities		
Walking/Running	6,119 (55.4)	4,936 (44.6)
Gardening	5,675 (42.6)	7,653 (57.4)
Traveling	5,354 (48.3)	5,742 (51.7)
Cultivation of agricultural crops	3,118 (46.6)	3,572 (53.4)
Karaoke	2,660 (48.5)	2,826 (48.5)
Fishing	2,488 (96.2)	99 (3.8)
Golf	2,381 (90.0)	264 (10.0)
Photography	2,170 (77.5)	629 (22.5)
Grand golf	2,162 (53.5)	1,875 (46.5)
Exercise/Tai Chi	827 (22.6)	2,829 (77.4)
Mountain climbing	654 (65.1)	351 (34.9)
Instrument performance	465 (30.9)	1,040 (69.1)
Gate ball	370 (50.7)	359 (49.3)
Dance	312 (15.4)	1,710 (84.6)
Chorus/ Folk song	217 (15.2)	1,207 (84.8)
Lower-loading leisure-time activities		
Reading	3,865 (50.4)	3,805 (49.6)
Computer	3,148 (75.9)	1,002 (24.1)
Igo/Shogi/Mahjong	2,513 (91.8)	225 (8.2)
Pachinko	1,511 (74.3)	523 (25.7)
Painting/Picture letter	647 (33.1)	1,309 (66.9)
Calligraphy	573 (31.1)	1,270 (68.9)
Haiku/Tanka/Senryu	416 (37.6)	766 (62.4)
Handicrafts	306 (7.5)	3,782 (92.5)
Tea ceremony/Flower arrangement	84 (6.4)	1,223 (93.6)
Other non-specified activities	2,512 (43.5)	3,262 (56.5)

two to three times/week, one time/week, one to two times/month, less than one times/year).

2.5. Statistical analyses

Sex-specific differences in baseline characteristics according to the number of leisure-time activities were examined using the chi-square test for categorical variables, one-way analysis of variance (ANOVA) for continuous variables, and Cochran-Armitage test for variables expressed as percentage. Cox proportional hazards regression was used to calculate the HR and 95% CI of functional disability after controlling for confounding variables. We also calculated the HR of functional disability associated with higher- and lower- loading leisure-time activities, separately. The confounding variables for the multivariable adjustment in model 1 were age, educational level, occupational status, equivalized income, marital status, smoking status, IADL status, walking hours, histories of diabetes mellitus, hypertension, stroke, heart disease, mental disorder, and hearing loss. Model 2 was adjusted further for engagement in social activities of political groups/organizations, volunteer groups, sports groups/clubs, neighborhood associations, senior clubs, and frequency of meeting friends. For participants with missing data, we imputed "missing-variable" as covariate. All missing data were considered as missing completely at random, and the number of participants with missing data were generally small. Meanwhile, functional disability that occurred from year 1 to year 3 were included in the sensitive analysis to reduce the possibility of reverse causation. P-values ≤ 0.05 (two-sided tails) were considered as significant. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

The participant's mean ages at baseline were 73.9 years for men and 74.2 years for women. The number of newly certified LTCI according to the number of leisure-time activities and sex were as follows: 1,643 for no activity, 933 for one activity, 1,522 for two to four activities, and 399 for five or more activities in men, and 2,712, 1,189, 1,865, 368, respectively in women.

Table 1 shows the sex-specific baseline characteristics according to the number of leisure-time activities. In brief, younger individuals, higher educational level, unemployed status, high IADL status, higher current equivalized income, ≥30 walking hours, the participation in political groups/organizations, volunteer groups, sports groups/clubs, neighborhood associations, senior clubs, and frequency of meeting friends were more prevalent in individuals with higher number of leisure-time activities for both men and women. Meanwhile, never and former smokers and histories of diabetes mellitus, stroke, heart diseases, mental disorder, and hearing loss were inversely associated with the number of leisure-time activities for both men and women.

The proportion of each leisure-time activity according to the number of leisure-time activities is summarized in Table 2. Many of the participants performed walking/running (6,119 men, 4,936 women), gardening (5,675 men, 7,653 women), traveling (5,354 men, 5,742 women), reading (3,865 men, 3,805 women), computer (3,148 men, 1,002 women), and handicrafts (306 men, 3,782 women) as leisure-time activities.

During a median follow-up of 5.8 years, 10,631 participants (4,497 men, 6,134 women) developed functional disability. The sex-specific HRs and 95% CIs for functional disability, according to the number of leisure-time activities, are summarized in Table 3. The number of leisure-time activities was inversely associated with the risk of functional disability for both men and women even after adjustment for potential confounding variables. In the final model (model 2), the multivariable HRs (95% CIs) for functional disability were as follows: 0.89 (0.82–0.97) for one activity, 0.72 (0.67–0.78) for two to four activities, and 0.66 (0.58–0.74) for five or more activities (P for trend, <0.001) in men, 0.84 (0.78–0.90), 0.77 (0.72–0.82), 0.70 (0.62–0.79) (P for trend, <0.001), respectively in women. The dose–response associations were not attenuated, after exclusion of early onsets of functional disability from 1 to 3 years for both men and women (P for trend, <0.001).

The HRs and 95% CIs for functional disability, according to higher- and lower- loading leisure-time activities are summarized in Table 4. The higher loading leisure-time activities were inversely associated with the risk of functional disability even after adjustment for potential confounding variables. The lower loading leisure-time activities also tended to be inversely associated with the risk of functional disability.

The sex-specific associations between each leisure-time activities and the risk of functional disability are shown in Supplementary Table 1. For both men and women, traveling, cultivation of agricultural crops were inversely associated with the risk of functional disability. An inverse association was also observed between walking/running, computer, fishing, golf, mountain climbing and the risk of functional disability for men, and between gardening, instrument performance, dance, handicrafts and the risk of functional disability for women, but no significant association was observed between other leisure-time activities and the risk for both men and women.

4. Discussion

In this large prospective cohort study of older men and women, we found inverse associations between the number of leisure-time activities

Table 3
Sex-specific hazard ratio (HR) and 95% confidence interval (CI) for functional disability according to the number of leisure-time activities

	Men				Women			
	Number of leisure-time activities				Number of leisure-time activities			
	0	1	2–4	≥5	0	1	2–4	≥5
Number at risk, n	6,503	3,848	9,429	3,323	9,071	4,591	10,491	3,030
Person-years	30,604	18,469	48,279	17,464	42,907	22,624	54,346	16,240
Number of cases, n	1,643	933	1,522	399	2,712	1,189	1,865	368
Age-adjusted HRs (95%CIs)	Ref	0.86 (0.79–0.93)	0.61 (0.57–0.65)	0.47 (0.42–0.52)	Ref	0.78 (0.73–0.84)	0.65 (0.61–0.69)	0.52 (0.47–0.58)
Multivariable HRs[1]* (95%CIs)	Ref	0.87 (0.80–0.94)	0.69 (0.64–0.74)	0.60 (0.54–0.67)	Ref	0.82 (0.77–0.88)	0.74 (0.70–0.79)	0.65 (0.58–0.72)
Multivariable HRs[2]** (95%CIs)	Ref	0.89 (0.82–0.97)	0.72 (0.67–0.78)	0.66 (0.58–0.74)	Ref	0.84 (0.78–0.90)	0.77 (0.72–0.82)	0.70 (0.62–0.79)
Onset within 1 year excluded								
Number at risk, n	5,159	3,056	8,075	2,971	6,882	3,570	8,870	2,707
Person-years	26,194	15,818	43,532	16,197	35,730	19,124	48,741	15,081
Number of cases, n	1,344	792	1,354	352	2,189	1,021	1,621	323
Age-adjusted HRs (95%CIs)	Ref	0.89 (0.81–0.97)	0.65 (0.60–0.70)	0.49 (0.44–0.55)	Ref	0.82 (0.76–0.88)	0.68 (0.63–0.72)	0.54 (0.48–0.61)
Multivariable HRs[1]* (95%CIs)	Ref	0.89 (0.82–0.98)	0.72 (0.67–0.78)	0.61 (0.54–0.69)	Ref	0.86 (0.80–0.92)	0.77 (0.72–0.82)	0.66 (0.58–0.75)
Multivariable HRs[2]** (95%CIs)	Ref	0.91 (0.84–0.99)	0.75 (0.69–0.81)	0.66 (0.58–0.75)	Ref	0.87 (0.81–0.94)	0.79 (0.73–0.85)	0.70 (0.62–0.80)
Onset within 2 year excluded								
Number at risk, n	5,486	3,234	8,326	3,026	7,387	3,780	9,186	2,762
Person-years	26,693	16,082	43,913	16,277	36,480	19,436	49,217	15,164
Number of cases, n	1,017	614	1,103	297	1,684	811	1,305	268
Age-adjusted HRs (95%CIs)	Ref	0.90 (0.82–0.99)	0.68 (0.63–0.74)	0.53 (0.46–0.60)	Ref	0.83 (0.76–0.90)	0.69 (0.64–0.74)	0.56 (0.49–0.64)
Multivariable HRs[1]* (95%CIs)	Ref	0.91 (0.82–1.00)	0.76 (0.69–0.83)	0.65 (0.57–0.75)	Ref	0.87 (0.80–0.94)	0.76 (0.71–0.82)	0.66 (0.58–0.75)
Multivariable HRs[2]** (95%CIs)	Ref	0.93 (0.84–1.02)	0.79 (0.72–0.87)	0.70 (0.61–0.81)	Ref	0.88 (0.81–0.96)	0.79 (0.73–0.85)	0.71 (0.61–0.81)
Onset within 3 year excluded								
Number at risk, n	5,767	3,385	8,597	3,099	7,880	3,985	9,537	2,820
Person-years	27,394	16,460	44,584	16,460	37,699	19,944	50,094	15,312
Number of cases, n	736	463	832	224	1,191	606	954	210
Age-adjusted HRs (95%CIs)	Ref	0.94 (0.84–1.06)	0.70 (0.63–0.77)	0.54 (0.46–0.62)	Ref	0.87 (0.79–0.96)	0.69 (0.63–0.75)	0.59 (0.51–0.69)
Multivariable HRs[1]* (95%CIs)	Ref	0.95 (0.85–1.07)	0.78 (0.70–0.86)	0.67 (0.57–0.78)	Ref	0.90 (0.82–0.99)	0.77 (0.70–0.83)	0.69 (0.59–0.80)
Multivariable HRs[2]** (95%CIs)	Ref	0.97 (0.87–1.09)	0.81 (0.73–0.90)	0.71 (0.60–0.83)	Ref	0.91 (0.82–1.00)	0.77 (0.71–0.85)	0.72 (0.61–0.85)

* Multivariable HRs[1] were adjusted for age, educational level, occupational status, equivalized income, marital status, smoking status, instrumental activities of daily living (IADL) status, walking hours, histories of diabetes mellitus, hypertension, stroke, heart disease, mental disorder, and hearing loss.
** Multivariable HRs[2] were adjusted further for sports groups/clubs, senior clubs, neighborhood associations, volunteer groups, political groups/organizations, and frequency of meeting friends.
All of the *P* for trend were < 0.001.

and the risk of functional disability for both men and women. Compared with persons without leisure-time activities, those with one or more leisure-time activities had reduced risk of functional disability in a dose–response manner. These associations did not substantially change after exclusion of early onsets of functional disability.

In a previous JAGES study conducted in 13,310 Japanese aged ≥ 65 years, social participation in three or more in hobby clubs, sports groups, and local community activities were associated with a 43% lower risk of functional disability compared with no social participation in the 4-year follow-up (Kanamori et al., 2014). In another JAGES study conducted in 44,978 Japanese aged ≥ 65 years, the high frequency of social participation in both sports and the hobby and high frequency of social participation in both political and industry/trade activities were associated with reduced risks of functional disability by 34% and 29%, respectively compared with the low frequency of social participation in the 3-year follow-up (Ukawa et al., 2020). In a previous 3-year follow-up study of 6,360 Japanese older adults, the participation in hobby clubs was associated with a 32% reduced risk of functional disability for men and a 47% reduced risk of functional disability for women compared with no social participation (Tomioka et al., 2017). These previous studies, however, did not examine the association between the number of leisure-time activities and risk of functional disability.

We found an association between functional disability and various leisure-time activities such as traveling, cultivation of agricultural crops, walking/running (men only), computer (men only), fishing (men only), golf (men only), mountain climbing (men only), and gardening (women only), instrument performance (women only), dance (women only), handicrafts (women only). The guidelines by the Ministry of Health and Labour and Welfare, Japan recommend that older adults (aged ≥ 65 years) should perform at least 10 MET-hours/week of physical activity. A prospective cohort study of 1,445 Japanese men aged ≥ 65 years showed that persons who performed ≥ 18MET-hours/weeks of leisure-time activities had a 52% lower risk of developing functional disability, compared with those who did not engage in leisure-time activities during 11.6 years median follow-up (Matsunaga et al., 2017). By contrast, our study showed that even lower-loading leisure-time activities tended to be associated with a reduced the risk of functional disability. We assume that lower-loading activities likely make older people to be less physically fatigued, and to be continued as habits. Most of lower-loading activities needs manual dexterity which was associated with a lower risk of mild cognitive impairment in 7-year follow-up of 1,160 older Americans (Beeri et al., 2021).

Table 4
Hazard ratio (HR) and 95% confidence interval (CI) for functional disability according to the number of higher- and lower- loading leisure-time activities

	Number of higher-loading leisure-time activities				Number of lower-loading leisure-time activities			
	0	1	2–4	≥5	0	1	2–4	≥5
Number at risk, n	19,759	10,561	17,680	2,196	31,987	11,833	6,381	85
Person-years	93,310	52,983	92,813	11,828	157,643	60,180	32,661	450
Number of cases, n	5,460	2,332	2,597	242	7,489	2,111	1,017	14
Age-adjusted HRs (95%CIs)	Ref	0.76	0.57	0.46	Ref	0.81	0.74	0.74
		(0.73–0.80)	(0.54–0.59)	(0.41–0.53)		(0.77–0.85)	(0.70–0.80)	(0.44–1.24)
Multivariable HRs (95%CIs)	Ref	0.83	0.70	0.66	Ref	0.89	0.88	1.02
		(0.79–0.87)	(0.66–0.73)	(0.58–0.76)		(0.85–0.94)	(0.82–0.94)	(0.60–1.72)
Onset within 1 year excluded								
Number at risk, n	15,291	8,654	15,360	1,985	25,714	9,998	5,506	72
Person-years	78,648	46,107	84,604	11,058	136,444	53,916	29,661	397
Number of cases, n	4,468	1,997	2,320	211	6,273	1,835	875	13
Age-adjusted HRs (95%CIs)	Ref	0.78	0.60	0.47	Ref	0.83	0.75	0.80
		(0.74–0.83)	(0.57–0.63)	(0.41–0.54)		(0.79–0.87)	(0.70–0.81)	(0.47–1.38)
Multivariable HRs (95%CIs)	Ref	0.84	0.71	0.65	Ref	0.91	0.88	1.07
		(0.80–0.89)	(0.68–0.75)	(0.56–0.75)		(0.86–0.96)	(0.82–0.95)	(0.62–1.85)
Onset within 2 year excluded								
Number at risk, n	16,345	9,057	15,767	2,018	27,060	10,381	5,674	72
Person-years	80,219	46,717	85,219	11,108	138,476	54,481	29,910	397
Number of cases, n	3,414	1,594	1,913	178	4,927	1,452	707	13
Age-adjusted HRs (95%CIs)	Ref	0.81	0.62	0.50	Ref	0.83	0.76	1.01
		(0.76–0.86)	(0.59–0.66)	(0.43–0.58)		(0.78–0.88)	(0.71–0.83)	(0.59–1.74)
Multivariable HRs (95%CIs)	Ref	0.86	0.74	0.67	Ref	0.91	0.89	1.31
		(0.81–0.91)	(0.69–0.79)	(0.57–0.78)		(0.85–0.96)	(0.82–0.96)	(0.76–2.26)
Onset within 3 year excluded								
Number at risk, n	17,296	9,466	16,248	2,060	28,385	10,762	5,848	75
Person-years	82,582	47,732	86,422	11,212	141,760	55,440	30,344	404
Number of cases, n	2,463	1,185	1,432	136	3,602	1,071	533	10
Age-adjusted HRs (95%CIs)	Ref	0.82	0.63	0.50	Ref	0.83	0.78	1.08
		(0.77–0.88)	(0.59–0.67)	(0.42–0.60)		(0.78–0.89)	(0.72–0.86)	(0.58–2.00)
Multivariable HRs (95%CIs)	Ref	0.87	0.73	0.65	Ref	0.91	0.91	1.38
		(0.81–0.93)	(0.68–0.78)	(0.54–0.78)		(0.85–0.97)	(0.83–1.00)	(0.74–2.57)

Multivariable HRs were adjusted for sex, age, educational level, occupational status, equivalized income, marital status, smoking status, instrumental activities of daily living (IADL), walking hours, histories of diabetes mellitus, hypertension, stroke, heart disease, mental disorder, and hearing loss, sports groups/clubs, senior clubs, neighborhood associations, volunteer groups, political groups/organizations, frequency of meeting friends.
All of the *P* for trend were < 0.001.

Our study has two strengths. First, we followed up over 50,000 older adults for a median of 5.8 years. Second, the 24 types of leisure-time activities were tested to examine the impact of the number of leisure-time activities on functional disability.

This study has several limitations. First, objective assessment for clinical diagnosis of functional disability was not conducted systematically at enrollment so that in some participants functional disability might have existed in our study. Second, the reverse causation for the association between leisure-time activities and the risk of functional disability remained. However, the absence of substantial changes in the association after the exclusion of early onsets of functional disability from the baseline up to 3 years suggested that the reverse causation may be unlikely.

5. Conclusion

We found inverse dose–response associations between the number of leisure-time activities including lower-loading activities and the risk of functional disability among Japanese older men and women. Our finding suggests that engaging in various types of leisure-time activities may contribute to the prevention of functional disability.

CRediT authorship contribution statement

Yoshihiro Fuji: Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Formal analysis, Software. **Ryoto Sakaniwa:** Conceptualization, Supervision, Validation, Formal analysis, Software, Writing – review & editing. **Kokoro Shirai:** Conceptualization, Supervision, Validation, Formal analysis, Software, Writing – review & editing. **Tami Saito:** Conceptualization, Validation, Formal analysis, Writing – review & editing. **Shigekazu Ukawa:** Conceptualization, Validation, Formal analysis, Writing – review & editing. **Hiroyasu Iso:** Conceptualization, Supervision, Validation, Formal analysis, Software, Writing – review & editing. **Katsunori Kondo:** Conceptualization, Investigation, Validation, Formal analysis, Funding acquisition, Project administration, Resources, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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