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

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A R T I C L E   I N F O

Keywords:
- Leisure-time activities
- Functional disability
- Older population
- Lower-loading
- Prospective study

A B S T R A C T

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
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: 0.95, 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%) (Vergehen 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 (Oxley 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 were received public and social welfare services for adult daily 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, igohshogi/mahjong, pachinko, painting/picture letter, calligraphy, haiku/tanka/serenyu, 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 Number of leisure-time activities (%) | Women 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 |
| Age, years**             | (28.2) | (16.6) | (40.8) | (14.4) | (33.4) | (16.9) | (38.6) | (11.2) |
| Educational level, years**| 74.2 | 74.7 | 73.6 | 73.0 | 75.1 | 75.2 | 75.5 | 72.3 |
| ≥10                      | (6.4) | (6.3) | (5.7) | (5.3) | (6.7) | (6.3) | (5.7) | (5.0) |
| Occupational status**    | 1,797 | 1,000 | 3,270 | 1,201 | 2,409 | 1,318 | 3,961 | 1,363 |
| Not employed             | (27.6) | (26.0) | (34.7) | (36.1) | (26.6) | (28.7) | (37.8) | (45.0) |
| Equivalized income, 10,000 JPY* | 3,866 | 2,367 | 6,313 | 2,422 | 5,586 | 2,857 | 7,281 | 2,343 |
| ≥200                     | (59.4) | (62.0) | (67.0) | (72.9) | (61.6) | (62.2) | (71.4) | (77.7) |
| Educational level, years**| 1,395 | 832 | 1,388 | 309 | 2,012 | 990 | 1,662 | 329 |
| Not employed             | (21.5) | (21.6) | (14.7) | (9.3) | (22.2) | (21.6) | (15.8) | (10.9) |
| Marital status*          | 5,416 | 3,187 | 8,170 | 2,991 | 4,892 | 2,501 | 6,299 | 1,904 |
| Widowed                   | (83.3) | (82.8) | (86.7) | (90.1) | (53.9) | (54.5) | (60.0) | (62.8) |
| Smoking status*          | 1,082 | 759 | 2,237 | 826 | 6,868 | 3,529 | 8,661 | 2,521 |
| Instrumental activities of daily living (IADL) status** | 3,597 | 2,254 | 6,626 | 2,724 | 6,274 | 3,474 | 7,198 | 2,892 |
| Not-independent; less than Spont | 2,594 | 1,412 | 2,415 | 497 | 2,479 | 956 | 966 | 70 |
| Walking hours, min/day*  | 2,704 | 1,534 | 2,666 | 524 | 3,726 | 1,771 | 3,126 | 565 |
| ≥30                      | (41.6) | (39.9) | (28.3) | (15.8) | (41.1) | (38.6) | (29.8) | (18.7) |
| History of diabetes mellitus | 1,884 | 1,124 | 3,368 | 1,303 | 2,616 | 1,437 | 3,743 | 1,176 |
| History of hypertension | 2,429 | 1,446 | 3,594 | 1,245 | 3,775 | 1,931 | 4,255 | 1,086 |
| History of stroke        | 160 | 90 | 162 | 59 | 85 | 31 | 59 | 19 |
| History of heart disease | 981 | 570 | 935 | 460 | 994 | 353 | 907 | 244 |
| History of mental disorder** | 81 | 33 | 53 | 23 | 138 | 60 | 90 | 13 |
| History of hearing loss** | 564 | 325 | 701 | 209 | 731 | 387 | 691 | 264 |
| Political groups/organizations** | 130 | 153 | 398 | 178 | 103 | 214 | 482 | 136 |
| Volunteer groups**       | 239 | 188 | 971 | 657 | 204 | 205 | 1,003 | 644 |
| Sports groups/club**     | 131 | 465 | 2,249 | 1,570 | 115 | 520 | 2,859 | 1,486 |
| Neighborhood associations** | 497 | 350 | 1,307 | 704 | 306 | 256 | 935 | 447 |
| Frequency of meeting friends* | 667 | 486 | 1,212 | 492 | 1,233 | 665 | 1,629 | 584 |
| ≥4 times/week            | (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 |
| 1 time/week              | (12.2) | (16.0) | (20.5) | (25.1) | (18.5) | (23.6) | (30.7) | (39.5) |
| 1–2 times/month          | 1,195 | 700 | 2,023 | 744 | 1,705 | 909 | 1,964 | 419 |
| less than 1 times/year   | (18.4) | (18.8) | (21.5) | (22.4) | (18.8) | (19.8) | (18.7) | (13.8) |
| Frequency of meeting friends* | 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) |
Table 2
Sex-specific the number (proportion) of higher-loading, lower-loading and other non-specified leisure-time activities

| Men            | Number (%) | Women            | 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/Sharig/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, equivalentized 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, higher 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, 3,148 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

| Number of leisure-time activities | Men | Women |
|----------------------------------|-----|-------|
|                                  |     |       |
| 0                                |     |       |
| 1                                | 6,503 | 9,071 |
| 2–4                              | 5,215 | 4,429 |
| ≥5                               | 1,191 | 1,855 |
| Person-years                     | 30,604 | 24,907 |
| Number of cases, n               | 1,643 | 2,712 |
| Age-adjusted HRs (95%CIs)        | 0.86 | 0.78 |
| Multivariable HRs (95%CIs)       | (0.77–0.93) | (0.73–0.84) |
| Multivariable HRs** (95%CIs)     | 0.87 | 0.82 |
| Multivariable HRs*** (95%CIs)    | 0.89 | 0.84 |

Onset within 1 year excluded

| Number of leisure-time activities | Men | Women |
|----------------------------------|-----|-------|
|                                  |     |       |
| 0                                |     |       |
| 1                                | 5,159 | 6,882 |
| 2–4                              | 4,792 | 5,720 |
| ≥5                               | 1,344 | 2,189 |
| Person-years                     | 26,194 | 35,730 |
| Number of cases, n               | 1,344 | 2,189 |
| Age-adjusted HRs (95%CIs)        | 0.89 | 0.82 |
| Multivariable HRs (95%CIs)       | (0.80–0.97) | (0.77–0.88) |
| Multivariable HRs** (95%CIs)     | 0.91 | 0.87 |
| Multivariable HRs*** (95%CIs)    | 0.91 | 0.87 |

Onset within 2 year excluded

| Number of leisure-time activities | Men | Women |
|----------------------------------|-----|-------|
|                                  |     |       |
| 0                                |     |       |
| 1                                | 5,486 | 7,387 |
| 2–4                              | 5,114 | 6,480 |
| ≥5                               | 1,017 | 1,684 |
| Person-years                     | 26,693 | 36,480 |
| Number of cases, n               | 1,017 | 1,684 |
| Age-adjusted HRs (95%CIs)        | 0.90 | 0.83 |
| Multivariable HRs (95%CIs)       | (0.81–0.97) | (0.76–0.90) |
| Multivariable HRs** (95%CIs)     | 0.91 | 0.87 |
| Multivariable HRs*** (95%CIs)    | 0.91 | 0.88 |

Onset within 3 year excluded

| Number of leisure-time activities | Men | Women |
|----------------------------------|-----|-------|
|                                  |     |       |
| 0                                |     |       |
| 1                                | 5,767 | 7,880 |
| 2–4                              | 5,294 | 6,599 |
| ≥5                               | 1,317 | 1,994 |
| Person-years                     | 27,394 | 37,699 |
| Number of cases, n               | 1,317 | 1,994 |
| Age-adjusted HRs (95%CIs)        | 0.94 | 0.87 |
| Multivariable HRs (95%CIs)       | (0.84–1.06) | (0.79–0.96) |
| Multivariable HRs** (95%CIs)     | 0.95 | 0.90 |
| Multivariable HRs*** (95%CIs)    | 0.97 | 0.91 |

* Multivariable HRs were adjusted for age, educational level, occupational status, equalized 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 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 (Tomokawa 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), instrumental 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 during 11.6 years median follow-up (Matsunaga et al., 2017).
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 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 Sakanawa: 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. Hirouyau 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.

Acknowledgement

We do not have the contribution of others who merit authorship and sponsor.

Funding

This study used data from JAGES (The Japan Gerontological Evaluation Study). This study was supported by Grants-in-Aid for Scientific Research (15H01972, 15H04781, 15H05059, 15 K03417, 15 K03982, 15 K1611, 16 K17232, 15 K18174, 15 K19241, 15 K21266, 15 K20007, 15K20097, 15K0556, 16 K0122, 16 K0913, 16 K02025, 16 K12964, 16 K13443, 16 K14265, 16 K16569, 16 K16633, 16 K17256, 16 K17281, 16 K19247, 16 K19267, 16 K21461, 16 K21465, 16K00014, 16K00059, 17 K04305, 17 K34567, 17 K43060, 25253052, 25713027, 26285138, 26460828, 26780328, 18H03018, 18H04071, 18H03047, 18H00953, 18H00955, 18K0057, 19H03901, 19H03915, 19H03860, 19 K04785, 19 K16441, 19

Table 4

| Number of higher-loading leisure-time activities | Number of lower-loading leisure-time activities |
|-----------------------------------------------|-----------------------------------------------|
| Number at risk, n | Person-years | Person-years | Number at risk, n | Person-years | Person-years | Number at risk, n | Person-years | Person-years |
| 0 | 1 | 2–4 | ≥5 | 0 | 1 | 2–4 | ≥5 |
| 19,759 | 10,561 | 17,680 | 2,196 | 31,967 | 11,833 | 6,381 | 85 |
| 93,310 | 52,983 | 92,613 | 11,828 | 157,643 | 60,180 | 32,661 | 450 |
| 5,460 | 2,332 | 2,597 | 242 | 7,489 | 2,111 | 1,017 | 14 |
| Age-adjusted HRs (95%CI) | 0.76 | 0.57 | 0.46 | Ref | 0.81 | 0.74 | 0.74 |
| Multivariable HRs (95%CI) | 0.79–0.87 | 0.56–0.73 | 0.58–0.76 | Ref | 0.89 | 0.88 | 0.88 |
| Onset within 1 year excluded | 0.74–0.83 | 0.57–0.63 | 0.41–0.54 | Ref | 0.79–0.87 | 0.70–0.81 | 0.47–1.38 |
| 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 |
| Multivariable HRs (95%CI) | 0.84 | 0.71 | 0.65 | Ref | 0.91 | 0.88 | 1.07 |
| Onset within 2 year excluded | 0.80–0.89 | 0.68–0.75 | 0.56–0.75 | Ref | 0.86–0.96 | 0.82–0.95 | 0.62–1.85 |
| 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 |
| Multivariable HRs (95%CI) | 0.86 | 0.74 | 0.67 | Ref | 0.91 | 0.89 | 1.31 |
| Onset within 3 year excluded | 0.81–0.91 | 0.69–0.79 | 0.57–0.78 | Ref | 0.85–0.96 | 0.82–0.96 | 0.76–2.26 |
| Number at risk, n | 17,296 | 9,466 | 16,248 | 2,060 | 28,385 | 10,762 | 5,848 | 75 |
| Person-years | 82,582 | 46,622 | 86,322 | 11,212 | 141,760 | 55,440 | 30,344 | 404 |
| Multivariable HRs (95%CI) | 0.87 | 0.73 | 0.65 | Ref | 0.91 | 0.91 | 1.38 |

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.
Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101741.

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K1I1657, 19K19818, 19K19455, 19K24060, 19K20909, 20H00557 (from JSPS (Japan Society for the Promotion of Science); Health Labour Sciences Research Grants (h26-Chou-Ippan-006, h27-Ninchisyou-Ippan-001, h28-Chou-Ippan-002, h28-Ninchisyou-Ippan-002, h29-Chikyukubo-Ippan-001, h30-Jyunkankindo-Ippan-004, 18H04071, 19FA1012, 19FA2001) from the Ministry of Health, Labour and Welfare, Japan; the Research and Development for Longevity Science from Japan Agency for Medical Research and Development (AMED) (JP17zd010027, JP18zd010027, JP18zd0110002, JP18zd0110009, JP20zd0110034, JP20zd0110037, 21zk010017th30002), the Research Funding for Longevity Sciences from National Center for Geriatrics and Gerontology (20-19, 21-20, 24-17, 24-23, 29-42, 30-30-30-22); Open Innovation Platform with Enterprises, Research Institute and Academy (OPERA, JPMOP1831) from the Japan Science and Technology (JST); a grant from the Japan Foundation For Aging And Health (J09FK08004), a grant from Innovative Research Program on Suicide Countermeasures (1–4), a grant from Sasakiwa Sports Foundation, a grant from Japan Health Promotion & Fitness Foundation, a grant from Chiba Foundation for Health Promotion & Disease Prevention, the 8020 Research Grant, Todor-Kokudo fiscal 2019 from the 8020 Promotion Foundation (adopted number: 19-2-06), a grant from Niimi University (19150101), grants from Meiji Yasuda Life Foundation of Health and Welfare, Osaka University Center of Medical Data Science Advanced Clinical Epidemiology Investigator’s Research, and the OU-UCL Joint-Lab Research Center in Osaka University. The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the respective funding organizations.

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