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Leisure activities and instrumental activities of daily living: a 3-year cohort study from the JAGES

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Ethical approval and informed consent: The study protocol for the JAGES project was approved by the Ethics Committee of the National Center for Geriatrics and Gerontology, Japan (no. 992–3), and the Hokkaido University Graduate School of Medicine Institutional Ethical Board, Japan (no. 14–024).

Abstract

Aim: We prospectively examined the association between leisure activities and changes in instrumental activities of daily living (IADL) among Japan Gerontological Evaluation Study participants.

Methods: We analyzed data collected from 49,732 participants (23,359 men and 26,373 women) of the Japan Gerontological Evaluation Study, aged ≥65 years, from 24 municipalities in Japan. Measurements: Baseline data were obtained for 25 types of leisure activities in which the cohort members participated. Baseline (2010) and follow-up (2013) data on IADL were collected—the outcome indicated changes in IADL scores from 2010 to 2013. We regressed changes in IADL scores from the 2010–2013 to the number of leisure activities.

Results: Older adults who engaged in more leisure activities had higher changes in IADL scores than those who engaged in fewer leisure activities: the β values (95% confidence interval [CI]) of the IADL scores were 0.001 [-0.04–0.04], 0.04 [0.01–0.08], 0.09 [0.05–0.13], 0.09 [0.05–0.14], 0.08 [0.02–0.13], and 0.13 [0.07–0.18] for having one, two, three, four, five, and more than six types of leisure activities (p for trend < .001), respectively. Similar associations were found for different types of leisure activities, including predominantly physical and cultural activities. Statistically significant linear trends were obtained among the group, solitary, and other leisure activity subgroups (p for trend < .05).

Conclusions: Encouraging engagement in leisure activities may promote maintenance of IADL among older populations. Different types of leisure activities appear to have similar positive impacts on IADL.

Keywords: instrumental activities of daily living, leisure activity, social participation, gerontology, epidemiology

Introduction

As the global population ages, helping older populations maintain daily activities is becoming increasingly important. When older individuals are unable to complete normal daily activities, they require increased care[1]. Moreover, as older populations face reduced abilities to complete normal daily activities, demands from the healthcare system will increase. The demand for long-term care has already been projected to grow substantially during this century[2].

One of the most frequently used methods to assess the extent to which individuals, including members of older populations, maintain their daily activities is a measure known as instrumental activities of daily living (IADL)[3]. IADL refers to activities in which individuals who live independently can complete on their own[4]. IADL is associated with several health issues, including frailty[5], health comorbidities (including hypertension)[6], fatigue[7], and mortality[8]. Various methods have been reported to be potentially effective for improving IADL. For example, occupational and activity-based interventions are effective for improving IADL[9]. Multicomponent interventions, including both physical exercise and cognitive training, may be most effective in improving IADL[10].

One potential method that can be used to improve IADL is through the promotion of leisure activities[11]. Leisure activities are defined as activities that individuals engage in for their personal satisfaction and pleasure for purposes other than money making. Examples of leisure activities are hobbies like gardening or sewing. There are good reasons to expect that participating in leisure activities may be protective of performing IADL[12-14]. Studies have found that engagement in hobbies may promote maintenance of IADL[15]. Specific activities such as Tai Chi[16] and hobbies[17] have also been effective in improving IADL. Social engagement associated with leisure-time physical activities may also be protective against declines in IADL[18-21]. However, previous studies have focused on the effects of a single or only a small number of leisure activities on IADL. Some were cross-sectional studies[15,19,20], where it was not possible to rule out reverse causality.

To address these gaps between what is known about the relationship between leisure activities and IADL, we prospectively examined whether an association exists between leisure activities and IADL among participants of the Japan Gerontological Evaluation Study. Moreover, since we hypothesized that the number of leisure activities might be associated with improved IADL, we also examined whether IADL was higher among those who reported more leisure activities. We expected such an association because previous research suggested such a dose-response relationship, meaning more benefit with more leisure activities, may exist[22].

Methods

Study population

Data from the 2010 and 2013 waves of the Japan Gerontological Evaluation Study were used for this analysis. This study has been described in detail elsewhere[22]. Briefly, 92,272 of 141,452 people contacted who were aged ≥65 years without disabilities from 24 municipalities in Japan were enrolled in the first wave of the study in 2010 (response rate, 65.2%). This response rate indicates that the findings of this study may be generalizable to the Japanese population. Data were obtained through a self-administered questionnaire distributed and collected by mail. A follow-up survey was conducted among individuals who participated in the 2010 wave. In total, 62,438 participants responded to the 2013 wave.

Of the original cohort members, those with missing data on leisure activities (n = 2,202) and IADL scores (n = 6,770) in the 2010 and 2013 waves (n = 3,734) were excluded. Therefore, 49,732 participants (23,359 men and 26,373 women) who had complete data were analyzed in this study.

The study protocol for the JAGES project was approved by the Ethics Committee of the National Center for Geriatrics and Gerontology, Japan (no. 992–3), and the Hokkaido University Graduate School of Medicine Institutional Ethical Board, Japan (no. 14–024).

Data collection

Assessment of IADL

IADL was assessed using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC), which uses scales with confirmed reliability and validity[23]. The TMIG-IC was developed to evaluate the competence required for older people to live autonomously. The TMIG-IC consists of 13 items. For each item, respondents selected either "practicable" (1 point) or "unfeasible" (0 points). Scores range from 0 to 13, with higher scores indicating a higher level of IADL performance.

The TMIG-IC has three subscales, including five items for Instrumental Self-Maintenance (using public transport, shopping, preparing a meal, paying bills, and banking), four items for Intellectual Activity (filling out forms, reading a newspaper, reading books or magazines, interest in news or stories dealing with health), and four items for Social Role (visiting friends, being called on advice, visiting sick friends, and conversation with young people). The change in IADL score from 2010 to 2013 was the dependent variable in this study, with a negative score change indicating deterioration of functional status from 2010 to 2013.

Assessment of leisure activity

Information about leisure activities was obtained from the 2010 Wave Questionnaire. The participants were asked about their leisure activities as follows: "Do you have any hobbies or take lessons?" If they answered yes, they were asked to report the specific leisure activities that they were involved in from among the following 25 items (respondents could selected any that applied): playing golf, playing mini-golf, playing gate ball, exercise/playing Tai Chi Chuan, walking/jogging, playing Go/Shogi/Mahjong, reading books, using a personal computer, playing a musical instrument, joining a chorus/singing folk song, singing karaoke, dancing, making traditional Japanese poems (Haiku/Tanka/Senryu), writing calligraphy, playing the Japanese art of tea ceremony/flower arrangement, making handicrafts, drawing pictures, taking photos, gardening,

growing crops, traveling, hiking, fishing, playing pachinko, and others. We categorized the number of leisure activities into seven categories, namely “0,” “1,” “2,” “3,” “4,” “5,” and “6 or more.” These seven categories were used to ensure an adequate number of participants in each category of leisure activities. If the number of leisure activities higher than six was divided into individual categories, there would have been very few participants in these categories thus leading to low power in detecting differences.

We divided leisure activities into three categories:

1. Physical leisure activities, which refer to activities with a substantial physical component: playing golf, playing mini-golf, playing gate ball, exercising/playing Tai Chi Chuan, walking/jogging, playing dancing, gardening, growing crops, and hiking.
2. Cultural leisure activities, referring to activities without a substantial physical component (playing Go/Shogi/Mahjong, reading books, using a personal computer, playing a musical instrument, joining a chorus/singing folk song, making traditional Japanese poems, writing calligraphy, playing the Japanese art of tea ceremony/flower arrangement, making handicrafts, drawing pictures, and taking photos).
3. Other activities (singing karaoke, traveling, fishing, playing pachinko, and others)

Further, leisure activities were divided into group, solitary, and other leisure activities:

1. Group leisure activities included playing golf, playing mini-golf, playing Go/Shogi/mahjong, playing gate ball, joining a chorus/singing folk song, singing karaoke, and dancing.
2. Solitary leisure activities included reading books, using a personal computer, playing musical instrument, making Japanese traditional poems, writing calligraphy, making handcrafts, drawing pictures, fishing, and playing pachinko).
3. Other leisure activities (exercising/playing Tai Chi Chuan, walking/jogging, playing the Japanese art of tea ceremony/flower art, taking photos, gardening, growing crops, traveling,

hiking, and others).

In certain cases, this categorization may not accurately reflect the nature of the activity that was performed. However, in most instances, the group activities will be performed with others and the solitary activities will be done alone.

Covariates

Demographic information such as age (65–69, 70–74, 75–79 or ≥80 years), sex (man or woman), marital status (married, widowed/divorced, or single), employment status (working or not working), educational attainment (<6, 6–9, 10–12, or ≥13 years), annual equivalized incomes (<2.00, 2.00–3.99, ≥4.00 million yen), and medical histories of cancer (presence or absence/missing), heart disease (presence or absence/missing), stroke (presence or absence/missing), respiratory disease (presence or absence/missing), arthritic disorder (presence or absence/missing), trauma or bone fracture (presence or absence/missing), and cognitive complaints (presence or absence/missing) were also collected through the 2010 wave questionnaire. Cognitive complaints were measured using three self-reported items from the Kihon Checklist–Cognitive Function scale: asking the same questions frequently, having trouble making a phone call, and losing track of today's date. The predictive validity of these items for dementia incidence has been confirmed previously[24]. Participants with at least one item were considered to have a cognitive complaint[24].

Statistical analyses

The characteristics of the study participants according to the number of leisure activities were compared using the χ^2 test and analysis of covariance. Group differences in IADL score changes from 2010 to 2013 were evaluated using a multiple linear regression model to calculate the non-standardized regression coefficient (β) with the 95% confidence interval (CI) adjusted for all covariates and IADL scores in the 2010 wave. Model 1 was adjusted for age and sex. Model 2 was

adjusted for the other potential confounding variables: marital status, employment status, educational attainment, annual equivalized household income, and medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, trauma or bone fracture, and cognitive complaints. Trend p-values were calculated to assess the associations between the original continuous variables of leisure activities and changes in the IADL score. The analyses were repeated for each IADL subscale. We further performed subgroup analyses using the three groupings of leisure activities: physical, cultural, and other activities. We hypothesized that different activities may have different impacts. For example, physical leisure activities may result in improvements in physical health. Conversely, leisure cultural activities are more likely to affect the benefits of social interactions or cognitive activities. Engagement in such cultural leisure activities may increase social engagement and improve health through the benefits of social networks[22].

Missing covariate values were inputted using multiple imputations with the fully conditional specification (FCS) method[25] to create five complete datasets. The FCS statement of the PROC MI procedure in SAS was used to obtain estimates combining five estimates consisting of five analyses using the PROC MIANALYZE procedure. Differences were considered statistically significant at an alpha level of 0.05. All analyses were performed using SAS 9.4 TS Level 1M6 (SAS Institute Inc., Cary, NC, USA).

Results

The characteristics of the participants according to the number of leisure activities in the 2010 wave are summarized in Table 1. Most participants reported engaging in two or fewer leisure activities. Compared to participants in the lowest category, those in the highest category were more likely to be male, young, married, not working, college-educated, have a higher income, fewer comorbidities, fewer cognitive complaints, and higher IADL scores ($p < 0.001$).

Table 2 presents the multiple linear regression of the changes in IADL scores according to

the number of leisure activities. After adjusting for potential confounders (Model 2), the β values (95% confidence interval [CI]) of the IADL scores were 0.001 [-0.04–0.04], 0.04 [0.01–0.08], 0.09 [0.05–0.13], 0.09 [0.05–0.14], 0.08 [0.02–0.13], and 0.13 [0.07–0.18] for having one, two, three, four, five, and more than six types of leisure activities (p for trend < .001). Similar associations were identified among the instrumental, intellectual, and social IADL subscales (p for trend < .05).

Tables 3 and 4 summarize the multiple linear regression of the changes in IADL scores according to the subgroup of leisure activities. Higher numbers of physical, cultural, and other leisure activities were associated with higher β values (95% CI) of IADL scores. Statistically significant linear trends were obtained among the group, solitary, and other leisure activity subgroups (p for trend < .05).

Discussion

Our study findings indicate that older adults who engaged in more leisure activities maintained higher changes in IADL scores than those who engaged in fewer leisure activities. Similar associations were identified among the different IADL subscales and different subtypes of leisure activities (i.e., physical vs. cultural).

These findings are consistent with previous research demonstrating that leisure activities are associated with IADL[12-14], indicating that social activities have a protective effect on IADL[15] and that social engagement has a similar protective impact[19-23]. Some previous studies suggested that specific types of physical activity, such as Tai chi[16] and hobbies[17], specifically had these effects. However, a protective relationship concerning IADL was found for different types of leisure activities suggests that the effect is not limited to specific types of activities and may apply to leisure activities. The potential mechanisms that might underlie any protective effect on the relationship between leisure activities and IADL are unclear. However, engaging in physical activities helps maintain a certain amount of physical fitness[26]. They may be effective in preventing

declines in IADL by promoting mobility[27]. Similarly, staying active through leisure physical activities may also help maintain the cognitive functioning necessary to maintain IADL[28]. Furthermore, engaging in activities with other people may be associated with beneficial health effects that are known to be associated with social interactions[29]. This effect may be significant for non-physical leisure activities. Engagement in solitary activities may help to preserve IADL even if they do not involve physical activity or social interaction. The reason is that even activities such as playing a musical instrument involve stimulating neural activity in the brain[30], which could translate to the performance of other daily tasks such as reading the newspaper or managing finances.

The findings from this study add to the findings of previous research studies. This study examined the multiple subscales of leisure activities, making it possible to assess whether the relationship with leisure activities was only due to specific aspects of leisure activities. Our findings suggest that the association is not necessarily due to specific leisure activities because of positive findings on the individual subscales. An additional strength of this study is its longitudinal design. Some of the previous research studies on this topic were cross-sectional[15,19,20] so the results may have been affected by reverse causality. For example, the studies might have observed a relationship between IADL and leisure activities because subjects with more IADL were engaged more in leisure activities. In this study, we found that engaging in leisure activities preceded improvements in IADL, which suggests that these activities may have a causal effect on IADL. Another strength of this research was the availability of multiple covariates to examine the role of confounding factors. Finally, the cohort from which the data for this study were collected was from all parts of Japan. This diversity of the study population means that the findings generated from the study may be generalizable to older adults living in the entire country.

The findings of this study have several limitations. The most important limitation is that we cannot completely exclude the possibility of reverse causality, even with a prospective design. That is, baseline differences in engagement in leisure activities might be due to unobserved

differences in individuals' "fitness" or vitality. A fixed-effects design (i.e., regressing changes in IADL scores on changes in leisure activity engagement) could partially correct this bias. Unfortunately, questions about leisure activity were not asked consistently during the study; thus, we could not construct a change score. Misclassification of leisure activities was possible. The respondents self-reported their leisure activities, suggesting that they may have forgotten or overreported some of their activities. Respondents may also have different perceptions of what constitutes these types of leisure activities. Our classification of solo and group leisure activities may not have always accurately represented the activities. In some cases, solo activities may have been performed with others, and those classified as group activities may have been performed alone. However, this misclassification was likely non-differential concerning subsequent IADL decline from baseline. Accordingly, the direction of the bias is likely toward the null. The generalizability of these findings may be questionable. This study was conducted in a cohort of older adults throughout Japan. However, whether similar relationships are observed in other countries or populations is uncertain. In the present study, the frequency and duration of these activities may also be essential to consider and are not reviewed. Further research should determine whether improvements in IADL associated with more leisure activities are clinically significant. While these findings suggest that there are fundamental differences in IADL among those with more leisure activities, further research should examine the clinical significance of these differences.

This study suggests that engaging in leisure activities may be a new method for promoting IADL. Encouraging older adults to engage in leisure activities may have a beneficial effect on IADL. Future experimental studies may consider utilizing IADL as an intervention and investigating whether it improves IADL among older adults.

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Table 1 Characteristics of participants according to the number of leisure activities in the 2010 wave (n = 49,732)

Variable	Number of leisure activities							p-value
	0 (n = 13,545)	1 (n = 7,896)	2 (n = 8,604)	3 (n = 7,456)	4 (n = 5,193)	5 (n = 3,375)	6 to 16 (n = 3,663)	
Sex								
Men	42.3	45.9	46.4	49.0	50.0	52.0	54.6	< .001
Women	57.7	54.1	53.6	51.0	50.0	48.0	45.4	
Age (years)								
65–69	35.4	32.2	35.3	36.0	37.4	38.0	39.3	< .001
70–74	30.4	30.1	30.9	31.6	32.4	32.9	34.0	
75–79	20.0	22.8	21.1	21.5	20.4	20.0	18.3	
≥ 80	14.1	14.9	12.6	10.9	9.8	9.1	8.4	
Marital status								
Married	69.4	71.1	73.6	74.6	76.6	77.9	78.6	< .001
Widowed/divorced	25.2	23.3	21.8	21.0	19.9	19.1	18.0	
Single	2.2	2.0	1.8	2.1	1.6	1.5	1.6	
Employment status								
Working	25.8	22.9	22.4	21.4	19.6	18.1	18.7	< .001
No working	61.4	64.3	67.0	69.9	73.5	75.1	75.6	
Educational attainment (years)								
< 6	2.5	1.8	1.3	1.0	0.6	0.5	0.2	< .001
6–9	51.1	47.8	42.9	37.5	31.7	28.5	21.5	
10–12	30.7	32.6	35.6	37.4	41.5	40.5	42.8	
≥ 13	12.5	14.1	17.4	21.4	24.3	28.5	33.5	
Annual equivalized incomes (million yen)								
< 2.00	45.8	44.1	40.7	36.7	34.7	33.4	29.5	< .001
2.00–3.99	29.0	30.2	34.6	39.6	42.8	44.7	48.2	
≥ 4.00	6.0	6.3	6.8	7.9	8.7	10.0	11.4	

Medical history of								
Cancer								
Presence	4.0	3.8	3.7	3.6	3.9	3.8	3.6	< .001
Absence	94.0	94.3	94.7	94.9	94.8	95.0	95.1	
Heart disease								
Presence	11.3	11.3	10.9	11.0	11.1	10.1	10.3	< .001
Absence	86.6	86.8	87.5	87.6	87.6	88.7	88.4	
Stroke								
Presence	1.2	1.4	1.1	0.9	0.8	1.0	1.1	< .001
Absence	96.7	96.7	97.3	97.7	97.9	97.8	97.7	
Respiratory disease								
Presence	3.3	3.2	3.1	2.7	3.1	2.7	2.3	< .001
Absence	94.6	94.9	95.2	95.9	95.6	96.1	96.4	
Arthritic disorder								
Presence	10.7	10.9	11.5	9.4	9.0	9.2	7.8	< .001
Absence	87.3	87.2	86.9	89.2	89.8	89.6	91.0	
Trauma and/or bone fracture								
Presence	1.4	1.2	1.1	1.0	0.8	0.7	0.6	< .001
Absence	96.6	96.9	97.3	97.6	97.9	98.1	98.1	
Cognitive complaints								
Presence	36.6	35.0	30.9	28.8	26.3	23.8	22.3	< .001
Absence	63.4	65.0	69.1	71.2	73.7	76.2	77.7	
IADL								
Total	11.1(2.1)	11.5(1.8)	11.8(1.5)	12.1(1.3)	12.3(1.2)	12.4(1.0)	12.6(0.8)	< .001
Instrumental Self-Maintenance	4.6(0.9)	4.7(0.7)	4.8(0.6)	4.8(0.5)	4.9(0.4)	4.9(0.4)	4.9(0.3)	< .001
Intellectual Activity	3.4(0.9)	3.5(0.8)	3.7(0.6)	3.8(0.5)	3.8(0.5)	3.8(0.4)	3.9(0.3)	< .001
Social Role	3.1(1.1)	3.3(1.0)	3.4(0.9)	3.5(0.8)	3.6(0.8)	3.6(0.7)	3.7(0.6)	< .001

Values are expressed as percentages or mean (standard deviation). The proportion of each variable does not always add up to 100 owing to missing data. IADL, instrumental activities of daily living (ranging from 0 to 13) consists of 3 sub-categories including Instrumental Self-Maintenance (ranging from 0 to 5), Intellectual Activity (ranging from 0 to 4), and Social Role (ranging from 0 to 4), higher score indicates more independency in daily livings. p-values were calculated with chi-square tests or analysis of varian.

Table 2 Multiple linear regression of changes in IADL score according to the number of leisure activities (n = 49,732)

	Number of leisure activities							
	0 (n = 13,545)	1 (n = 7,896)	2 (n = 8,604)	3 (n = 7,456)	4 (n = 5,193)	5 (n = 3,375)	6 to 16 (n = 3,663)	P for trend[3]
IADL								
β coefficient (95% CI)[1]	Ref	0.003 (-0.02, 0.02)	0.05 (0.03, 0.07)	0.10 (0.08, 0.12)	0.10 (0.08, 0.12)	0.09 (0.06, 0.12)	0.14 (0.11, 0.17)	< .001
β coefficient (95% CI)[2]	Ref	0.001 (-0.04, 0.04)	0.04 (0.01, 0.08)	0.09 (0.05, 0.13)	0.09 (0.05, 0.14)	0.08 (0.02, 0.13)	0.13 (0.07, 0.18)	< .001
Instrumental Self-Maintenance								
β coefficient (95% CI)[1]	Ref	0.03 (0.02, 0.04)	0.05 (0.04, 0.06)	0.08 (0.06, 0.09)	0.06 (0.05, 0.07)	0.08 (0.06, 0.09)	0.08 (0.06, 0.09)	< .001
β coefficient (95% CI)[2]	Ref	0.03 (0.02, 0.05)	0.05 (0.03, 0.07)	0.08 (0.06, 0.09)	0.06 (0.04, 0.08)	0.07 (0.05, 0.10)	0.07 (0.05, 0.10)	< .001
Intellectual Activity								
β coefficient (95% CI)[1]	Ref	-0.01 (-0.02, -0.01)	0.004 (-0.004, 0.01)	0.004 (-0.004, 0.01)	0.02 (0.01, 0.03)	0.02 (0.01, 0.03)	0.02 (-0.01,0.03)	0.001
β coefficient (95% CI)[2]	Ref	-0.02 (-0.03, 0.002)	0.002 (-0.01, 0.02)	0.003 (-0.02, 0.02)	0.02 (-0.003, 0.04)	0.01 (-0.01, 0.04)	0.01 (-0.01, 0.04)	0.02
Social Role								
β coefficient (95% CI)[1]	Ref	-0.02 (-0.03, -0.004)	-0.01 (-0.02, 0.002)	0.01(0.002, -0.03)	0.02 (0.001, 0.03)	-0.005 (-0.02, -0.005)	0.04 (0.02, 0.05)	0.005
β coefficient (95% CI)[2]	Ref	-0.02 (-0.04, 0.01)	-0.01 (-0.03, 0.01)	0.02 (-0.01, 0.04)	0.02 (-0.01, 0.04)	-0.003 (-0.04, 0.03)	0.04 (0.01, 0.07)	0.004

IADL, instrumental activities of daily living (ranging from 0 to 13) consists of 3 sub-categories including Instrumental Self-Maintenance (ranging from 0 to 5), Intellectual Activity (ranging from 0 to 4), and Social Role (ranging from 0 to 4), higher score indicates more independency in daily livings, CI confidence interval.

1adjusted for age, sex.

2adjusted for age, sex, marital status, employment status, educational attainment, annual equivalized household income, and medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, trauma and/or bone fracture, and cognitive complaints.

3tests for linear trends were conducted to assess associations between the original continuous variables of number of leisure activity and changes in IADL score.

Table 3 Multiple linear regression of changes in IADL score according to physical, cultural, and other types of leisure activities (n = 49,732)

	Number of physical leisure activities				Number of cultural leisure activities				Number of other leisure activities			
	0 (n = 20,894)	1 (n = 13,980)	2 to 8 (n = 14,858)	P for trend[3]	0 (n = 29,755)	1 (n = 12,533)	2 to 8 (n = 7,444)	P for trend[3]	0 (n = 25,273)	1 (n = 15,379)	2 to 6 (n = 9,080)	P for trend[3]
IADL												
β coefficient (95% CI)[1]	Ref	0.04 (0.01, 0.07)	0.08 (0.05, 0.11)	< .001	Ref	0.06 (0.03, 0.09)	0.08 (0.04, 0.12)	< .001	Ref	0.04 (0.02, 0.07)	0.06 (0.03, 0.10)	< .001
β coefficient (95% CI)[2]	Ref	0.02 (-0.01, 0.05)	0.05 (0.02, 0.08)	0.002	Ref	0.05 (0.02, 0.08)	0.06 (0.02, 0.10)	< .001	Ref	0.02 (-0.01, 0.05)	0.03 (-0.002, 0.07)	0.05
Instrumental Self-Maintenance												
β coefficient (95% CI)[1]	Ref	0.03 (0.02, 0.05)	0.04 (0.03, 0.06)	< .001	Ref	0.04 (0.03, 0.05)	0.05 (0.03, 0.06)	< .001	Ref	0.04 (0.03, 0.05)	0.05 (0.03, 0.06)	< .001
β coefficient (95% CI)[2]	Ref	0.02 (0.01, 0.04)	0.03 (0.01, 0.04)	0.001	Ref	0.03 (0.02, 0.04)	0.03 (0.01, 0.05)	< .001	Ref	0.03 (0.02, 0.04)	0.03 (0.01, 0.05)	< .001
Intellectual Activity												
β coefficient (95% CI)[1]	Ref	0.004 (-0.009, 0.02)	0.01 (-0.002, 0.02)	0.03	Ref	0.01 (-0.001, 0.02)	0.03 (0.01, 0.04)	< .001	Ref	0.001 (-0.01, 0.01)	-0.001 (-0.01, 0.01)	0.96
β coefficient (95% CI)[2]	Ref	0.002 (-0.01, 0.02)	0.007 (-0.006, 0.02)	0.27	Ref	0.01 (-0.002, 0.02)	0.03 (0.009, 0.04)	0.001	Ref	-0.003 (-0.01, 0.009)	-0.009 (-0.02, 0.007)	0.30
Social Role												
β coefficient (95% CI)[1]	Ref	-0.001 (-0.02, 0.02)	0.02 (0.003, 0.04)	0.01	Ref	0.01 (-0.008, 0.03)	0.01 (-0.01, 0.03)	0.10	Ref	0.004 (-0.01, 0.02)	0.02 (-0.001, 0.04)	0.06
β coefficient (95% CI)[2]	Ref	-0.004(-0.02, 0.02)	0.02 (-0.003, 0.04)	0.06	Ref	0.005 (-0.01, 0.02)	0.001 (-0.02, 0.03)	0.40	Ref	-0.001 (-0.0, 0.01)	0.02 (-0.01, 0.03)	0.31

IADL, instrumental activities of daily living (ranging from 0 to 13) consists of 3 sub-categories including Instrumental Self-Maintenance (ranging from 0 to 5), Intellectual Activity (ranging from 0 to 4), and Social Role (ranging from 0 to 4), higher score indicates more independency in daily livings, CI confidence interval.

[1]adjusted for age, sex, marital status, employment status, educational attainment, annual equivalized household income, medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, and trauma and/or bone fracture, and cognitive complaints.

[2]adjusted for age, sex, marital status, employment status, educational attainment, annual equivalized household income, medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, and trauma and/or bone fracture, cognitive complaints, and other types of leisure activities (physical and/or cultural and/or other).

[3]tests for linear trends were conducted to assess associations between the original continuous variables of number of leisure activity and changes in IADL score.

Table 4 Multiple linear regression of changes in IADL score according to group, solitary, and other types of leisure activities (n = 49,732)

	Number of group leisure activities				Number of solitary leisure activities				Number of other leisure activities			
	0 (n = 33,964)	1 (n = 11,625)	2 to 6 (n = 4,143)	P for trend[3]	0 (n = 28,545)	1 (n = 13,635)	2 to 6 (n = 7,552)	P for trend[3]	0 (n = 18,190)	1 (n = 12,344)	2 to 8 (n = 19,198)	P for trend[3]
IADL												
β coefficient (95% CI)[1]	Ref	0.04(0.01, 0.07)	0.10(0.05, 0.14)	< .001	Ref	0.04(0.01, 0.07)	0.07(0.04, 0.11)	< .001	Ref	0.03(-0.004, 0.06)	0.08(0.05, 011)	<.001
β coefficient (95% CI)[2]	Ref	0.03 (0.0004, 0.06)	0.08(0.03, 0.13)	0.001	Ref	0.02(-0.01, 0.05)	0.05(0.01, 0.08)	0.01	Ref	0.01(-0.01, 0.05)	0.06(0.03, 0.09)	<.001
Instrumental Self-Maintenance												
β coefficient (95% CI)[1]	Ref	0.03 (0.02, 0.05)	0.04 (0.02, 0.06)	< .001	Ref	0.03(0.02, 0.04)	0.04(0.02, 0.06)	< .001	Ref	0.03(0.02, 0.05)	0.05(0.04, 0.07)	<.001
β coefficient (95% CI)[2]	Ref	0.03 (0.01, 0.04)	0.03 (0.01, 0.05)	< .001	Ref	0.02(0.01, 0.03)	0.03(0.01, 0.04)	0.001	Ref	0.02(0.01, 0.04)	0.04(0.03, 0.06)	<.001
Intellectual Activity												
β coefficient (95% CI)[1]	Ref	0.004(-0.01, 0.02)	0.009(-0.01, 0.03)	0.38	Ref	0.01(-0.01, 0.02)	0.02(0.004, 0.04)	0.01	Ref	-0.001(-0.01, 0.01)	0.01(-0.002, 0.02)	0.10
β coefficient (95% CI)[2]	Ref	0.002(-0.01, 0.02)	0.01 (-0.01, 0.03)	0.66	Ref	0.004(-0.01, 0.02)	0.02(0.001, 0.03)	0.03	Ref	-0.005(-0.02, 0.15)	0.01(-0.01, 0.02)	0.43
Social Role												
β coefficient (95% CI)[1]	Ref	0.005(-0.01, 0.02)	0.05(0.02, 0.08)	0.005	Ref	0.001(-0.02, 0.02)	0.01(-0.01, 0.03)	0.26	Ref	-0.004(-0.02, 0.02)	0.02(0.001, 0.04)	0.03
β coefficient (95% CI)[2]	Ref	0.003(-0.02, 0.02)	0.05(0.02, 0.07)	0.01	Ref	-0.01(-0.02, 0.01)	0.002(-0.02, 0.03)	0.76	Ref	-0.001(-0.03, 0.01)	0.01(-0.01, 0.03)	0.13

IADL, instrumental activities of daily living (ranging from 0 to 13) consist of 3 sub-categories including Instrumental Self-Maintenance (ranging from 0 to 5), Intellectual Activity (ranging from 0 to 4), and Social Role (ranging from 0 to 4), higher score indicates more independency in daily livings, CI confidence interval.

[1]adjusted for age, sex, marital status, employment status, educational attainment, annual equivalized household income, medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, and trauma and/or bone fracture, cognitive complaints, and IADL score in the 2010 wave.

[2]adjusted for age, sex, marital status, employment status, educational attainment, annual equivalized household income, medical history of cancer, heart disease, stroke, respiratory disease, arthritic disorder, and trauma and/or bone fracture, cognitive complaints, IADL score in the 2010 wave, and other types of leisure activities (physical and/or cultural and/or other).

[3]tests for linear trends were conducted to assess associations between the original continuous variables of number of leisure activity and changes in IADL score.