



Gender-specific Characteristics of Social Factors Related to Frequency of Daily Conversation Among Community-dwelling Older Adults: A Cross-sectional Observational Study

Mizue Suzuki¹ · Yuhei Otobe¹ · Takeo Ichikawa¹ · Shingo Koyama¹ · Shu Tanaka¹ · Yusuke Maetani¹ · Hiroaki Masuda¹ · Shuhei Shino¹ · Yosuke Kimura² · Minoru Yamada³

Accepted: 21 April 2022 / Published online: 29 April 2022

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract

Objectives This study examined the social factors affecting the frequency of going out, and social isolation related to the frequency of daily conversation, stratified by gender.

Method The participants comprised 1,016 community-dwelling older Japanese adults, who were categorized into four groups: those who are (1) not isolated socially and go out every day, (2) not isolated socially and do not go out every day, (3) socially isolated and go out every day, and (4) socially isolated and do not go out every day. We performed a logistic regression analysis to assess the relationship between the frequency of daily conversation and the four groups.

Results Our multivariable logistic regression analysis (reference, group 1) showed that the coexistence of poor social factors significantly affected men (group 2: odds ratio [OR] 2.13 [1.10 to 4.12]; group 3: OR 2.92 [1.70 to 5.00]; and group 4: OR 4.28 [2.43 to 7.54]). For women, the frequency of going out was related to daily conversation only with social isolation group (group 2: OR 1.51 [0.77 to 2.98]; group 3: OR 2.42 [1.25 to 4.68]; and group 4: OR 3.81 [2.08 to 7.00]).

Conclusion Our findings suggest that promoting daily conversations of community-dwelling older adults can help prevent related health adversities.

Keywords Community-dwelling older adults · Frequency of daily conversation · Frequency of going out · Social isolation

✉ Mizue Suzuki
blurosemusiker@gmail.com

Extended author information available on the last page of the article

Introduction

For adults, social engagement, that is, interaction with others, is a major indicator of “successful aging” (Reich et al., 2020). Daily conversation is a component of social engagement (Berkman et al., 2000). Several studies have reported the positive effects of social engagement. For example, by increasing the frequency of conversation and promoting conversational opportunities, social engagement can improve the cognitive functions and quality of life of older people (Cattan et al., 2011; Dodge et al., 2015). In this regard, the frequency of daily conversation is an important variable that can extend the healthy life expectancy of older adults.

The interpersonal interaction of older adults changes quantitatively and qualitatively as they age, with a decline in interaction more likely to increase the incidence of adverse health issues (Kelly et al., 2017; Holt-Lunstad et al., 2010). In particular, a decline in frequency of daily conversation has been found to be related to low oral function and sarcopenia in cross-sectional studies (Wang et al., 2012; Kurose et al., 2020) and dementia in a longitudinal study (Shimada et al., 2018). Thus, maintaining or increasing the frequency of conversation is an important factor for preventing adverse events in the life of older adults. The frequency of daily conversation is also intertwined with various social factors (Berkman et al., 2000). Therefore, we need to clarify the social factors affecting the daily conversation of older adults.

A decline in frequency of conversation has been related to a decrease in social factors, such as social isolation and poor social activity. Studies have found the co-existence of such factors associated with a decline in psychological and physical functions and mortality (Fujiwara et al., 2017; Sakurai et al., 2019). Thus, in this study, we focus on these variable social factors. We operationally define social isolation as a poor social network (small family and friend relationships) and poor social activity as a decrease in leaving home and going outside. In addition, age-related changes in social factors have been found to differ by gender, with retirement, changes in family structure, and other such factors affecting particularly men’s social engagement (Takashima et al., 2020; Wilson & Cordier, 2013; Nurmi et al., 2018). Notably, studies have found differences in the characteristics of social isolation and poor social activity by gender (Fujiwara et al., 2017), with possibly different effects on the frequency of daily conversation of community-dwelling older adults.

This study examined the factors related to frequency of community-dwelling older adults’ conversation based on social factors, with focus on the frequency of going out and social isolation, stratified by gender. We hypothesized that the daily conversation of older adults is related to both decrease in going out and social isolation, and that this relationship varies by gender. We believe that these findings can help promote social engagement and contribute to preventing related health adversities in older adults.

Methods

Participants

This observational study covered a cross section of community-dwelling older adults living in Maibara city, Shiga prefecture. Participants were recruited through public advertisements and an advertisement in the local newspaper. They were assessed for physical, cognitive, and oral functions in 2018. We recruited community-dwelling adults aged 65 years and older living independently. The exclusion criteria were older adults already eligible to receive benefits of long-term care insurance services, and missing data in the questionnaire and physical, cognitive, and oral assessments. All questionnaires were self-administered, with the physical, cognitive, and oral measurements performed by trained experts. The study was conducted according to the Declaration of Helsinki guidelines. Participants provided written informed consent, and the study protocol was reviewed and approved by the Ethics Committee of XXX (approval no. XX-XX).

Measurements of Daily Conversation

We examined the frequency of older adults' subjective daily conversation, number of days they conversed and number of people they conversed with per week through a questionnaire. Frequency of subjective daily conversation was the main outcome. This was assessed with the question, "What do you feel about yourself from the frequency of daily conversation?" The answers included (a) very talkative, (b) talkative, (c) normal, (d) silent, and (e) very silent. Options (d) and (e) represented operational definitions of "less daily conversation." Additionally, the questionnaire asked the participants to specify the number of days they conversed (daily or not) and number of people they conversed with (more than four or not) per week.

Measurements of Social Parameters

We operationally defined social isolation as poor social network and poor social activity because of a decrease in going outside home, and assessed these social parameters using questionnaires. Social isolation was evaluated using the Lubben Social Network Scale-6 (LSNS-6) (Lubben et al., 2006). This is a screening tool for social isolation among community-dwelling older adults. It includes six questions on social networks, with scores ranging from 0 to 5. The total score ranged from 0 to 30. We classified social isolation as less than 12 points following a previous study (Lubben et al., 2006). In addition, we assessed the frequency of going out through the question, "Do you go outside every day?" The answer "no" was considered a negative response. Participants were categorized into four groups based on the above two answers: group 1, not isolated socially and go out every day; group 2,

not isolated socially and do not go out every day; group 3, socially isolated and go out every day; and group 4, socially isolated and do not go out every day.

Measurements of Physical, Cognitive, and Psychological Functions

The physical functions of participants were measured using the Short Physical Performance Battery (SPPB), a widely used assessment tool for physical performance. The total score ranged from 0 to 12. We defined low physical function as ≤ 9 points (Chen et al., 2020). Cognitive function was assessed using the Mini-Mental State Examination (MMSE). We defined low cognitive function as scoring 26 or lower points (Kaufers et al., 2008). Psychological function was assessed through a question on depression risk from the Kihon Checklist (KCL), a comprehensive frailty index for community-dwelling older adults. The assessment of depression in KCL has been reported to indicate the risk of depression in a previous study (Sewo Sampaio et al., 2016). Depression was defined as two or more negative responses (Fukutomi et al., 2015).

Measurements of Oral Function

Oral function was assessed considering the maximum tongue pressure, oral diadochokinesis, peak cough flow, and maximum phonation time. Maximum tongue pressure was measured using a hand-held balloon probe and manometer (a JMS tongue pressure measurement instrument, GC, Tokyo, Japan). The pressure was recorded thrice, and the highest recording was used as a representative value. Oral diadochokinesis was calculated as the number of articulations per second separately for each syllable (“pa,” “ta,” and “ka”). The number of articulations was counted using a digital counter (T.K.K. 3350 digital counter; Takei Scientific Instruments Co., Ltd.). Peak cough flow was measured using a peak cough flow meter (Mini-Wright Standard ATS scale; Clement Clarke International, UK). It was measured twice for each participant, and the higher of the two measurements was used for analysis. Maximum phonation time was the longest period the participant could sustain phonation of the vowel sound /a/. This was also recorded twice, and the higher value was used for analysis.

Other Parameters

Demographic data were assessed for age, height, weight, body mass index (BMI), comorbidities, polypharmacy, living alone, and denture use obtained from self-reported questionnaires. The participants were asked to answer questions about their comorbidities relating to heart disease, hypertension, stroke, dyslipidemia, diabetes mellitus, musculoskeletal disorders, pulmonary disease, and malignant tumor. The answers were counted to obtain the cumulative number of comorbidities. Polypharmacy was defined as taking more than five medicines (Hsu et al., 2021).

Statistical Analyses

First, we compared the characteristics of the four groups using the Kruskal–Wallis test and chi-square test, stratified by gender. We also compared the differences in frequency of subjective daily conversation and social parameters by gender using the chi-square test. We then used a logistic regression analysis to find the relationship between the social parameters and subjective daily conversation. The logistic regression analysis used the categories of social isolation and frequency of going outside as independent variables (reference, group 1) and the frequency of subjective daily conversation (many, normal, or less) as the dependent variable. As the physical, cognitive, psychological, and oral functions of older adults could affect their daily conversation (Wang et al., 2012; Kurose et al., 2020; Shimada et al., 2018), we constructed the following models: Model 1 was a crude model. Model 2 was adjusted for age (65–74 years or ≥ 75 years), BMI (< 18.5 kg/m² or not), number of comorbidities (≥ 1 or not), polypharmacy (≥ 5 or not), and living alone. Model 3 was additionally adjusted for SPPB (≤ 9 or not), depression, and MMSE (≤ 26 points or not). Model 4 was further adjusted for denture use, maximum tongue pressure, oral diadochokinesis “pa,” “ta,” “ka,” peak cough flow, and maximum phonation time (\leq first quartile or not). All statistical analyses were performed using the IBM SPSS version 25.0 (IBM Japan, Tokyo, Japan). Statistical significance was set at $p < 0.05$.

Results

Of the 1,222 participants enrolled for this study, 206 were excluded owing to missing data, to finally result in 1,016 participants eligible for analysis. The participants' characteristics stratified by gender are presented in Tables 1 and 2. The median age [interquartile range; IQR] was 74.0 years [69.0–79.0] for men ($n = 475$) and 73.0 years [69.0–77.0] for women ($n = 541$). The proportion of those showing less frequency of daily conversation was 40.2% ($n = 191$) for men and 23.5% ($n = 127$) for women. Figure 1 shows the difference in subjective daily conversation and social parameters between genders. Men had a significantly higher proportion of those showing less frequency in daily conversation and social isolation than women ($p < 0.01$), while women had a higher proportion of those showing less frequency in going out than men ($p < 0.05$).

Overall, regarding men, 30.7% ($n = 146$) who were not socially isolated went out every day (group 1), 14.1% ($n = 67$) who were not socially isolated did not go out every day (group 2), 28.2% ($n = 134$) who were socially isolated went out every day (group 3), and 26.9% ($n = 128$) who were socially isolated did not go out every day (group 4). As for women, 29.6% ($n = 160$), 22.6% ($n = 122$), 19.8% ($n = 107$), and 28.1% ($n = 152$) of the participants fell under groups 1, 2, 3, and 4, respectively. Significant differences were observed for those showing less frequency in daily conversation in both genders ($p < 0.001$) (see Tables 1 and 2 and Fig. 2).

The results of logistic regression analysis are shown in Table 3. For men, the ORs (95% confidence interval [CI], p -value) of groups 2, 3, and 4 in the crude model were 2.50 (1.34–4.70, $p = 0.004$), 3.10 (1.84–5.23, $p < 0.001$), and 4.77 (2.81–8.09,

Table 1 Characteristics of men participants

	All	Group 1	Group 2	Group 3	Group 4	P	post-hoc
	n = 475	n = 146	n = 67	n = 134	n = 128		
	-100.00%	-30.70%	-14.10%	-28.20%	-26.90%		
Age (years), median [IQR]	74 [69.0 - 79.0]	71.5 [68.0 - 77.3]	75 [71.0 - 81.0]	73 [68.0 - 78.0]	74.5 [69.0 - 81.0]	0.003	1, 3
Height (cm), median [IQR]	165 [161.0 - 169.0]	166 [163.0 - 170.0]	165 [160.0 - 170.0]	165.4 [161.0 - 169.3]	164 [160.0 - 168.0]	0.005	3
Weight (kg), median [IQR]	62 [56.0 - 68.0]	62.8 [60.0 - 70.0]	63 [58.0 - 67.0]	62.8 [55.0 - 69.3]	60 [54.0 - 66.8]	0.003	3
BMI (kg/m ²), median [IQR]	22.9 [21.2 - 24.5]	22.9 [21.6 - 24.5]	23 [21.4 - 24.8]	23.1 [21.1 - 24.8]	22.4 [19.9 - 24.2]	0.136	
Number of comorbidities, median [IQR]	1 [1 - 2]	1 [1 - 2]	1 [1 - 2]	1 [1 - 2]	1 [0 - 2]	0.494	
Heart disease, n (%)	82 -17.3	22 -15.1	12 -17.9	27 -20.1	21 -16.4	0.882	
Hypertension, n (%)	216 -45.5	73 -50	33 -49.3	56 -41.8	54 -42.2	0.329	
Stroke, n (%)	18 -3.8	6 -4.1	4 -6	4 -3	4 -3.1	0.885	
Dyslipidemia, n (%)	32 -6.7	11 -7.5	3 -4.5	9 -6.7	9 -7	0.765	
Diabetes mellitus, n (%)	74 -15.6	22 -15.1	8 -11.9	25 -18.7	19 -14.8	0.701	
Musculoskeletal disorders, n (%)	96 -20.2	20 -13.7	17 -25.4	30 -22.4	29 -22.7	0.062	
Pulmonary disease, n (%)	23 -4.8	5 -3.4	4 -6	5 -3.7	9 -7	0.126	
Malignant tumor, n (%)	41 -8.6	6 -4.1	6 -9	14 -10.4	15 -11.7	0.041	n.s.
Polypharmacy, n (%)	109 -22.9	34 -23.3	16 -23.9	28 -20.9	31 -24.2	0.754	
Living alone, n (%)	35 -7.4	5 -3.4	4 -6	11 -8.2	15 -11.7	0.017	n.s.
LSNS-6 (points), median [IQR]	11 [6 - 15]	15 [13 - 15]	15 [13 - 15]	7 [5 - 9]	6 [3 - 9]	< 0.001	2, 3, 4, 5
SPPB (points), median [IQR]	12 [12 - 12]	12 [12 - 12]	12 [11 - 12]	12 [12 - 12]	12 [12 - 12]	0.139	
≤ 9 points, n (%)	25 -5.3	4 -2.7	5 -7.5	7 -5.2	9 -7	0.091	
MMSE (points), median [IQR]	29 [26 - 30]	29 [27 - 30]	28 [27 - 30]	29 [27 - 30]	28 [25 - 30]	0.001	3, 6
≤ 26 points, n (%)	126 -26.5	33 -22.6	15 -11.9	29 -21.6	49 -38.3	0.004	3, 6
Depression, n (%)	141 -29.7	24 -16.4	19 -28.4	38 -28.4	60 -46.9	< 0.001	3, 6
Use of dentures, n (%)	244 -51.4	74 -50.7	35 -52.2	69 -51.5	66 -51.6	0.871	
Maximum tongue pressure (kPa), median [IQR]	32.1 [26.4 - 37.7]	33.1 [27.0 - 39.4]	30.1 [23.4 - 34.6]	32.5 [27.6 - 37.7]	31.5 [25.1 - 37.2]	0.064	

Table 1 (continued)

	All	Group 1	Group 2	Group 3	Group 4	P	post-hoc
	n = 475	n = 146	n = 67	n = 134	n = 128		
	-100.00%	-30.70%	-14.10%	-28.20%	-26.90%		
Oral diadochokinesis 'pa' (times/s), median[IQR]	6.2 [5.4 - 6.8]	6.4 [5.8 - 6.8]	5.8 [5.4 - 6.4]	6.2 [5.6 - 6.8]	6 [5.2 - 6.6]	< 0.001	1, 3
Oral diadochokinesis 'ta' (times/s), median[IQR]	6 [5.4 - 6.6]	6.2 [5.6 - 6.8]	5.8 [4.8 - 6.6]	6 [5.4 - 6.6]	5.8 [5.2 - 6.4]	0.002	1, 3
Oral diadochokinesis 'ka' (times/s), median[IQR]	5.6 [4.8 - 6.2]	5.8 [5.2 - 6.2]	5.2 [4.2 - 6.0]	5.6 [4.8 - 6.2]	5.4 [4.6 - 6.2]	0.004	1, 3
Peak cough flow (L/min), median[IQR]	290 [200 - 380]	300 [200 - 380]	260 [160 - 340]	280 [200 - 380]	300 [190 - 390]	0.222	
Maximum phonation time (sec), median[IQR]	20.1 [14.4 - 25.9]	21.9 [16.2 - 28.0]	18.5 [12.9 - 23.8]	20.2 [14.4 - 26.1]	18.2 [13.0 - 24.7]	0.008	3
Subjective daily conversation (less), n (%)	191 -40.2	31 -21.2	27 -40.3	61 -45.5	72 -56.3	< 0.001	1, 2, 3
Number of day they converse (daily), n (%)	289 -60.8	127 -87	36 -53.7	86 -64.2	40 -31.3	< 0.001	1, 2, 3, 5, 6
Number of conversation people (4 or more), n (%)	278 -58.5	118 -80.8	42 -62.7	73 -54.5	45 -35.2	< 0.001	1, 2, 3, 5, 6

Group 1, not isolated socially and going out every day; Group 2, not isolated socially and not going out every day; Group 3, socially isolated and going out every day; Group 4, socially isolated and not going out every day. The number indicates a significant difference by the post hoc test: 1, Group1 vs Group2, 2, Group 1 vs Group 3, 3, Group 1 vs Group 4, 4, Group 2 vs Group 3, 5, Group 2 vs Group 4, 6, Group 3 vs Group 4

IQR Interquartile Range, *n.s* not significant, *BMI* Body Mass Index, *LSNS-6* Lubben Social Network Scale-6, *SPPB* Short Physical Performance Battery, *MMSE* Mini-Mental State Examination

Table 2 Characteristics of women participants

	All	Group 1	Group 2	Group 3	Group 4	P	post-hoc
	n = 541	n = 160	n = 122	n = 107	n = 152		
	-100.00%	-29.60%	-22.60%	-19.80%	-28.10%		
Age (years), median [IQR]	73 [69.0 - 77.0]	71.5 [69.0 - 77.0]	73 [70.0 - 78.0]	72 [67.0 - 76.0]	74 [70.0 - 78.0]	0.008	6
Height (cm), median [IQR]	151.8 [148.0 - 155.5]	152 [149.0 - 156.0]	152 [149.0 - 156.3]	153 [149.0 - 156.0]	150 [147.0 - 155.0]	0.035	n.s.
Weight (kg), median [IQR]	51 [46.5 - 56.0]	52 [46.6 - 56.8]	51 [46.4 - 56.0]	50 [47.0 - 55.0]	50 [46.0 - 56.0]	0.582	
BMI (kg/m ²), median [IQR]	22.1 [20.4 - 24.0]	22.2 [20.6 - 24.1]	21.9 [20.1 - 23.5]	21.7 [20.2 - 23.9]	22.4 [20.5 - 24.0]	0.368	
Number of comorbidities, median [IQR]	1 [1 - 2]	1 [1 - 2]	1 [0 - 2]	1 [1 - 2]	1 [1 - 2]	0.867	
Heart disease, n (%)	47 -8.7	11 -6.9	14 -11.5	5 -4.7	17 -11.2	0.074	
Hypertension, n (%)	226 -41.8	69 -43.1	44 -41.1	50 -41	63 -41.4	0.762	
Stroke, n (%)	10 -1.8	2 -1.3	3 -2.5	3 -2.8	2 -1.3	0.982	
Dyslipidemia, n (%)	105 -19.4	41 -25.6	19 -15.6	25 -23.4	20 -13.2	0.002	3
Diabetes mellitus, n (%)	34 -6.3	12 -7.5	10 -8.2	5 -4.7	7 -4.6	0.481	
Musculoskeletal disorders, n (%)	202 -37.3	50 -31.3	39 -32	42 -39.3	71 -46.7	0.018	3
Pulmonary disease, n (%)	19 -3.5	5 -3.1	3 -2.5	5 -4.7	6 -3.9	0.897	
Malignant tumor, n (%)	35 -6.5	13 -8.1	9 -7.4	5 -4.7	8 -5.3	0.443	
Polyparmacy, n (%)	93 -17.2	27 -16.9	20 -16.4	15 -14	31 -20.4	0.373	
Living alone, n (%)	86 -15.9	25 -15.6	27 -22.1	13 -12.1	21 -13.8	0.865	
LSNS-6 (points), median [IQR]	12 [8 - 15]	16 [14 - 19]	15 [13 - 16]	8 [5 - 10]	7 [5 - 9]	< 0.001	2, 3, 4, 5
SPPB (points), median [IQR]	12 [12 - 12]	12 [12 - 12]	12 [12 - 12]	12 [12 - 12]	12 [12 - 12]	0.045	n.s.
≤ 9 points, n (%)	17 -3.1	4 -2.5	3 -2.5	2 -1.9	8 -5.3	0.167	
MMSE (points), median [IQR]	29 [27 - 30]	30 [28 - 30]	29 [27 - 30]	29 [27 - 30]	29 [27 - 30]	0.018	3
≤ 26 points, n (%)	112 -20.7	23 -14.4	30 -24.6	21 -19.6	38 -25	0.012	n.s.
Depression, n(%)	206 -38.1	42 -26.3	43 -35.2	40 -37.4	81 -53.3	< 0.001	3, 5
Use of dentures, n (%)	299 -55.3	93 -58.1	70 -57.4	48 -44.9	88 -57.9	0.662	
Maximum tongue pressure (kPa), median [IQR]	30.5 [25.6 - 35.7]	32 [25.7 - 36.9]	29.9 [25.1 - 35.2]	31.7 [27.0 - 36.5]	29 [23.7 - 33.9]	0.008	3

Table 2 (continued)

	All	Group 1	Group 2	Group 3	Group 4	P	post-hoc
	n = 541	n = 160	n = 122	n = 107	n = 152		
	-100.00%	-29.60%	-22.60%	-19.80%	-28.10%		
Oral diadochokinesis 'pa' (times/s), median[IQR]	6.4 [5.8 - 6.8]	6.4 [6.0 - 7.0]	6.4 [5.8 - 6.8]	6.4 [6.0 - 7.0]	6.2 [5.6 - 6.6]	0.005	3, 6
Oral diadochokinesis 'ta' (times/s), median[IQR]	6.2 [5.6 - 6.8]	6.2 [5.8 - 6.8]	6.2 [5.4 - 6.7]	6.4 [5.8 - 7.0]	6 [5.4 - 6.6]	0.007	6
Oral diadochokinesis 'ka' (times/s), median[IQR]	6 [5.4 - 6.4]	6 [5.6 - 6.4]	5.8 [5.2 - 6.4]	6 [5.6 - 6.6]	5.8 [5.2 - 6.2]	0.001	3, 6
Peak cough flow (L/min), median[IQR]	200 [150 - 250]	190 [140 - 250]	190 [140 - 250]	220 [170 - 270]	200 [150 - 250]	0.061	
Maximum phonation time (sec), median[IQR]	17.6 [13.3 - 22.2]	18.7 [14.3 - 23.8]	17.2 [13.9 - 22.4]	16.6 [12.9 - 21.9]	17.4 [12.1 - 21.4]	0.062	
Subjective daily conversation (less), n (%)	127 -23.5	20 -12.5	22 -18	29 -27.1	56 -36.8	<0.001	2, 3, 5
Number of day they converse (daily), n (%)	304 -56.2	128 -80	71 -58.2	59 -55.1	46 -30.3	<0.001	1, 2, 3, 5, 6
Number of conversation people (4 or more), n (%)	359 -66.4	137 -85.6	87 -71.3	66 -61.7	69 -45.4	<0.001	1, 2, 3, 5, 6

Group 1, not isolated socially and going out every day; Group 2, not isolated socially and not going out every day; Group 3, socially isolated and going out every day; Group 4, socially isolated and not going out every day vs Group 4. The number indicates a significant difference by the post hoc test: 1, Group1 vs Group2, 2, Group 1 vs Group 3, 3, Group 1 vs Group 4, 4, Group 2 vs Group 3, 5, Group 2 vs Group 4, 6, Group 3 vs Group 4

IQR Interquartile Range, *n.s* not significant, *BMI* Body Mass Index, *LSNS-6* Lubben Social Network Scale-6, *SPPB* Short Physical Performance Battery, *MMSE* Mini-Mental State Examination

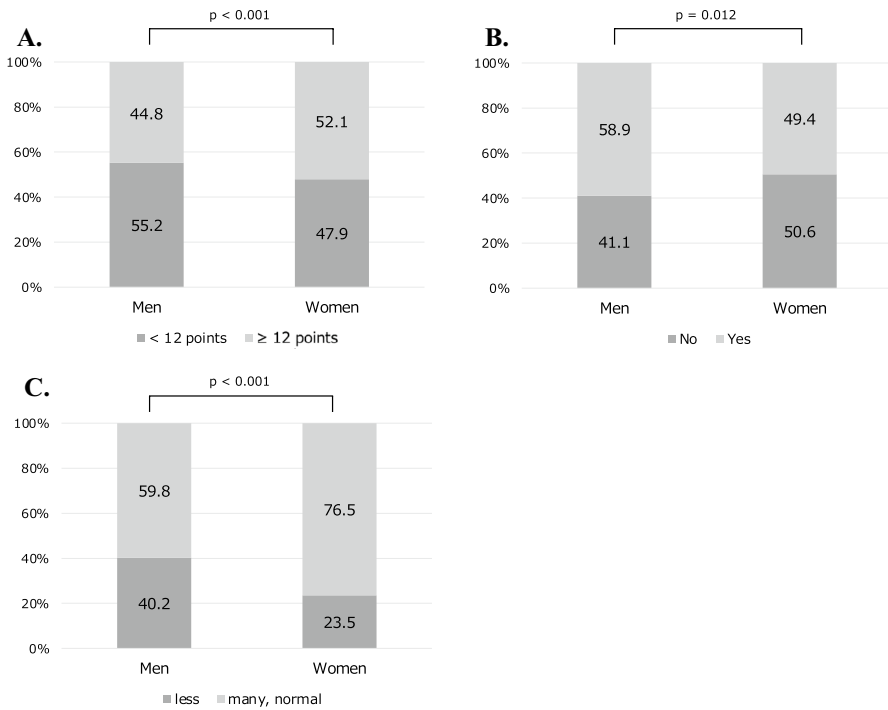


Fig. 1 Comparison of subjective daily conversation and social factors between genders. **A** Lubben Social Network Scale-6. **B** Going out every day. **C** Frequency of subjective daily conversation

$p < 0.001$), respectively. After adjusting for demographic, physical, cognitive, and oral functions, the ORs of the three groups were 2.13 (1.10–4.12, $p = 0.025$), 2.92 (1.70–5.00, $p < 0.001$), and 4.28 (2.43–7.54, $p < 0.001$), respectively. For women, no significant difference was found for group 2 (OR 1.54 [0.80–2.97, $p = 0.198$]), but the other two groups were significantly related to less frequency in daily conversation (group 3: OR 2.60 [1.38–4.90, $p = 0.003$]; group 4: OR 4.08 [2.30–7.24, $p < 0.001$]) in the crude model. A similar tendency was observed in multivariable analysis after adjusting for the confounding factors (group 2: OR 1.51 [0.77–2.98, $p = 0.235$]; group 3: OR 2.42 [1.25–4.68, $p = 0.008$]; and group 4: OR 3.81 [2.08–7.00, $p < 0.001$]).

Discussion

In this study, we examined the factors related to frequency in daily conversation of community-dwelling older adults stratified by gender based on the combination in frequency of going out and social isolation. The results for men showed that both less frequency in going out and social isolation were related to the frequency in daily conversation, with the coexistence of less frequency in going out and social isolation significantly related to less frequency in daily conversation. A similar relationship

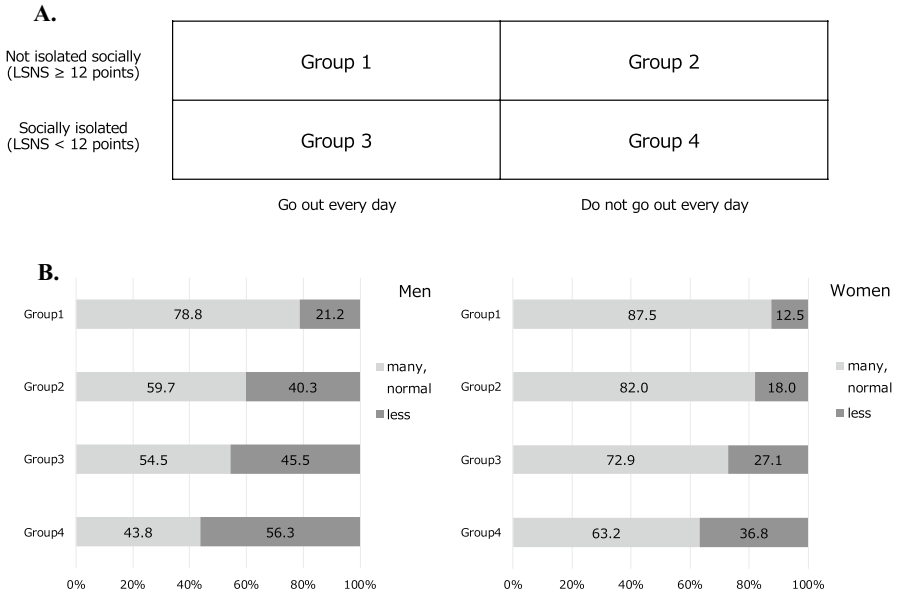


Fig. 2 **A** Classification of participants according to the combination of social isolation and frequency of going out. Group 1, not isolated socially and going out every day. Group 2, not isolated socially and not going out every day. Group 3, socially isolated and going out every day. Group 4, socially isolated and not going out every day. **B** Proportion of subjective daily conversation for each group

between the coexistence of poor social factors and daily conversation is observed for women. However, frequency in going out is related to the frequency of daily conversation only for women with social isolation. These results suggest the need for different types of social intervention strategies for promoting the daily conversation of men and women.

From this study’s findings, both the frequency in going out and social isolation are related to less frequency in daily conversation after adjusting for the confounding factors. Therefore, we need to examine the factors related to frequency in conversation of older adults from multiple perspectives, because age-related social factors change in diverse ways due to retirement, loss of family and friends, and changes in social roles (Courtin & Knapp, 2017; Shorey & Chan, 2021). In particular, the frequency in going out and social isolation are variable social factors, whose intervention effects have been examined (Fakoya et al., 2020). To promote daily conversation, the frequency in going out should be increased because this might lead to opportunities for conversation with friends and others. Additionally, a reduction in social isolation can strengthen the connections with others and increase the availability of quantitative and qualitative conversation partners. Thus, increasing the frequency in going out and expanding social networks may be useful for promoting the frequency in daily conversation.

Our results also showed that the relationship between frequency in daily conversation, frequency in going out, and social isolation differed by gender. The social engagement of older men changes drastically with retirement, making it necessary

Table 3 Multivariable analysis for subjective daily conversation

Men n=475	The proportion of less daily conversation			Model 1			Model 2			Model 3			Model 4		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Group 1 (n=146)	ref	-	-	ref	-	-	ref	-	-	ref	-	-	ref	-	-
Group 2 (n=67)	2.50	1.34–4.70	0.004	2.50	1.32–4.73	0.005	2.37	1.25–4.51	0.008	2.13	1.10–4.12	0.025	2.13	1.10–4.12	0.025
Group 3 (n=134)	3.10	1.84–5.23	<0.001	3.01	1.78–5.10	<0.001	2.87	1.69–4.88	<0.001	2.92	1.70–5.00	<0.001	2.92	1.70–5.00	<0.001
Group 4 (n=128)	4.77	2.81–8.09	<0.001	4.62	2.70–7.91	<0.001	4.10	2.36–7.13	<0.001	4.28	2.43–7.54	<0.001	4.28	2.43–7.54	<0.001
Women n=541	The proportion of less daily conversation			Model 1			Model 2			Model 3			Model 4		
Group 1 (n=160)	ref	-	-	ref	-	-	ref	-	-	ref	-	-	ref	-	-
Group 2 (n=122)	1.54	0.80–2.97	0.198	1.56	0.80–3.03	0.190	1.53	0.78–3.00	0.219	1.51	0.77–2.98	0.235	1.51	0.77–2.98	0.235
Group 3 (n=107)	2.60	1.38–4.90	0.003	2.69	1.42–5.10	0.002	2.57	1.35–4.91	0.004	2.42	1.25–4.68	0.008	2.42	1.25–4.68	0.008
Group 4 (n=152)	4.08	2.30–7.24	<0.001	4.32	2.41–7.73	<0.001	3.87	2.13–7.03	<0.001	3.81	2.08–7.00	<0.001	3.81	2.08–7.00	<0.001

Group 1, not isolated socially and going out every day; Group 2, not isolated socially and not going out every day; Group 3, socially isolated and going out every day; Group 4, socially isolated and not going out every day. Model 1: crude, Model 2: adjusted for age, BMI, number of comorbidities, polypharmacy, living alone, Model 3: Model 2 + adjusted for SPPB, depression, MMSE, Model 4: Model 3 + adjusted for use of dentures, maximum tongue pressure, oral diadochokinesis 'pa', 'ta', 'ka', peak cough flow, maximum phonation time

OR Odds Ratio, CI Confidence Interval

for them to establish new opportunities for social activities as well as social networks (Takashima et al., 2020). Older men have been shown to be more likely to become more socially inactive as they age compared to women (Wilson & Cordier, 2013; Nurmi et al., 2018), and so their high frequency in going out does not always lead to rich social networks (Fujiwara et al., 2017). Therefore, a comprehensive approach is needed for building social networks in addition to increasing the frequency of going out with social activity for promoting the daily conversation of older men. However, for women with good social networks, the frequency in going out is not related to less conversation. One possible reason is that women can talk with others without going out (e.g., by telephone and video calls) when social networks are well established. However, as a lower frequency in going out may further decrease the frequency of conversation for women with poor social networks, we need to work on both social factors to increase the frequency of conversation.

This study has clarified the gender-specific social factors related to low frequency in daily conversation. Our findings are clinically significant for promoting the daily conversation of older adults and preventing adverse health events. Previous studies have found that frequency in going out and social networks are closely related to both physical disability (Fujiwara et al., 2017) and oral functions (Nagayoshi et al., 2017; Morishita et al., 2021) of older adults. Our findings may help develop new concepts for maintaining or improving the oral function of older adults because an increase in frequency of conversation through social engagement may have a positive effect on their oral functions. Although our study has presented only basic information on the oral function of the groups considered, further research is needed to better understand the relationship between the daily conversation, social factors, and oral function of older adults.

This study has two limitations. First, the measurement of frequency in daily conversation was subjective. Currently, there is no instrument to quantitatively measure the older adults' frequency in conversation. The importance of objectively measuring frequency in conversation is well understood by many researchers and clinicians, but a measuring device has not yet been developed. In this study, subjective frequency in conversation is consistent with the number of days the older adults conversed and number of people they conversed with. Therefore, subjective daily conversation can reflect the frequency of actual conversation. Second, the target area was rural. Regional differences in social participation have been reported (Vogelsang, 2016), particularly for Japan, and social participation such as transportation (Abe et al., 2020), employment, and neighborhood committees (Ide et al., 2020) have been shown to differ between rural and urban areas. Therefore, the results for rural areas may differ from those for urban areas. Further verification is required to determine whether the results can be generalized to older adults.

In conclusion, we found that frequency in going out and social isolation are related to the frequency in daily conversation for older adults, and that gender-specific social characteristics affect them. Our findings can contribute to promoting daily conversation and prevent the related health adversities of community-dwelling older adults. A longitudinal study needs to clarify the positive effects of changes in social factors on the frequency of daily conversation.

Author Contributions Mizue Suzuki: Conceptualization, Methodology, Formal analysis, Data Curation, Writing—Original Draft. All the authors: Data Curation, Writing—Review & Editing. Minoru Yamada: Supervision.

Funding This work was supported by JSPS KAKENHI Grant Number 16H05921.

Declarations

Ethics Approval The study protocol was reviewed and approved by the Ethics Committee of Tsukuba University Graduate School of Comprehensive Human Sciences (approval no. 29–59).

Consent to Participate Participants were provided written informed consent and participant’ anonymity was preserved.

Consent for Publication All authors have contributed to this paper and take full responsibility for its content.

Conflict of Interest The authors declare that they have no conflict of interest.

References

- Abe, T., Kitamura, A., Seino, S., Yokoyama, Y., Amano, H., Taniguchi, Y., Nishi, M., Nofuji, Y., Ikeuchi, T., Sugiyama, T., & Shinkai, S. (2020). Frailty Status and Transport Disadvantage: Comparison of Older Adults’ Travel Behaviours between Metropolitan, Suburban, and Rural Areas of Japan. *International Journal of Environmental Research and Public Health*, *17*(17), 6367. <https://doi.org/10.3390/ijerph17176367>
- Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science and Medicine*, *51*(6), 843–857. [https://doi.org/10.1016/S0277-9536\(00\)00065-4](https://doi.org/10.1016/S0277-9536(00)00065-4)
- Cattan, M., Kime, N., & Bagnall, A. M. (2011). The use of telephone befriending in low level support for socially isolated older people—an evaluation. *Health and Social Care in the Community*, *19*(2), 198–206. <https://doi.org/10.1111/j.1365-2524.2010.00967.x>
- Chen, L. K., Woo, J., Assantachai, P., Auyeung, T. W., Chou, M. Y., Iijima, K., Jang, H. C., Kang, L., Kim, M., Kim, S., Kojima, T., Kuzuya, M., Lee, J. S. W., Lee, S. Y., Lee, W. J., Lee, Y., Liang, C. K., Lim, J. Y., Lim, W. S., & Arai, H. (2020). Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *Journal of the American Medical Directors Association*, *21*(3), 300–307 e302. <https://doi.org/10.1016/j.jamda.2019.12.012>
- Courtin, E., & Knapp, M. (2017). Social isolation, loneliness and health in old age: A scoping review. *Health and Social Care in the Community*, *25*(3), 799–812. <https://doi.org/10.1111/hsc.12311>
- Dodge, H. H., Zhu, J., Mattek, N., Bowman, M., Ybarra, O., Wild, K., Loewenstein, D. A., & Kaye, J. A. (2015). Web-enabled Conversational Interactions as a Means to Improve Cognitive Functions: Results of a 6-Week Randomized Controlled Trial. *Alzheimers Dement (n Y)*, *1*(1), 1–12. <https://doi.org/10.1016/j.trci.2015.01.001>
- Fakoya, O. A., McCorry, N. K., & Donnelly, M. (2020). Loneliness and social isolation interventions for older adults: A scoping review of reviews. *BMC Public Health*, *20*(1), 129. <https://doi.org/10.1186/s12889-020-8251-6>
- Fujiwara, Y., Nishi, M., Fukaya, T., Hasebe, M., Nonaka, K., Koike, T., Suzuki, H., Murayama, Y., Saito, M., & Kobayashi, E. (2017). Synergistic or independent impacts of low frequency of going outside the home and social isolation on functional decline: A 4-year prospective study of urban Japanese older adults. *Geriatrics & Gerontology International*, *17*(3), 500–508. <https://doi.org/10.1111/ggi.12731>
- Fukutomi, E., Okumiya, K., Wada, T., Sakamoto, R., Ishimoto, Y., Kimura, Y., Chen, W. L., Imai, H., Kasahara, Y., Fujisawa, M., Otsuka, K., & Matsubayashi, K. (2015). Relationships between each

- category of 25-item frailty risk assessment (Kihon Checklist) and newly certified older adults under Long-Term Care Insurance: A 24-month follow-up study in a rural community in Japan. *Geriatrics & Gerontology International*, 15(7), 864–871. <https://doi.org/10.1111/ggi.12360>
- Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, 7(7), e1000316. <https://doi.org/10.1371/journal.pmed.1000316>
- Hsu, H. F., Chen, K. M., Belcastro, F., & Chen, Y. F. (2021). Polypharmacy and pattern of medication use in community-dwelling older adults: A systematic review. *Journal of Clinical Nursing*, 30(7–8), 918–928. <https://doi.org/10.1111/jocn.15595>
- Ide, K., Tsuji, T., Kanamori, S., Jeong, S., Nagamine, Y., & Kondo, K. (2020). Social Participation and Functional Decline: A Comparative Study of Rural and Urban Older People, Using Japan Gerontological Evaluation Study Longitudinal Data. *International Journal of Environmental Research and Public Health*, 17(2), 617. <https://doi.org/10.3390/ijerph17020617>
- Kaufert, D. I., Williams, C. S., Braaten, A. J., Gill, K., Zimmerman, S., & Sloane, P. D. (2008). Cognitive screening for dementia and mild cognitive impairment in assisted living: Comparison of 3 tests. *Journal of the American Medical Directors Association*, 9(8), 586–593. <https://doi.org/10.1016/j.jamda.2008.05.006>
- Kelly, M. E., Duff, H., Kelly, S., McHugh Power, J. E., Brennan, S., Lawlor, B. A., & Loughrey, D. G. (2017). The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: A systematic review. *Systematic Reviews*, 6(1), 259. <https://doi.org/10.1186/s13643-017-0632-2>
- Kurose, S., Nishikawa, S., Nagaoka, T., Kusaka, M., Kawamura, J., Nishioka, Y., Sato, S., Tsutsumi, H., & Kimura, Y. (2020). Prevalence and risk factors of sarcopenia in community-dwelling older adults visiting regional medical institutions from the Kadoma Sarcopenia Study. *Scientific Reports*, 10(1), 19129. <https://doi.org/10.1038/s41598-020-76185-0>
- Lubben, J., Blozik, E., Gillmann, G., Iliffe, S., von Renteln Kruse, W., Beck, J. C., & Stuck, A. E. (2006). Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. *The Gerontologist*, 46(4), 503–513. <https://doi.org/10.1093/geront/46.4.503>
- Morishita, M., Ikeda, T., Saito, N., Sanou, M., Yasuda, M., & Takao, S. (2021). Relationship between oral function and life-space mobility or social networks in community-dwelling older people: A cross-sectional study. *Clin Exp Dent Res*, 7(4), 552–560. <https://doi.org/10.1002/cre2.381>
- Nagayoshi, M., Higashi, M., Takamura, N., Tamai, M., Koyamatsu, J., Yamanashi, H., Kadota, K., Sato, S., Kawashiri, S. Y., Koyama, Z., Saito, T., & Maeda, T. (2017). Social networks, leisure activities and maximum tongue pressure: Cross-sectional associations in the Nagasaki Islands Study. *British Medical Journal Open*, 7(12), e014878. <https://doi.org/10.1136/bmjopen-2016-014878>
- Nurmi, M. A., Mackenzie, C. S., Roger, K., Reynolds, K., & Urquhart, J. (2018). Older men's perceptions of the need for and access to male-focused community programmes such as Men's Sheds. *Ageing & Society*, 38(4), 794–816. <https://doi.org/10.1017/S0144686X16001331>
- Reich, A. J., Claunch, K. D., Verdeja, M. A., Dungan, M. T., Anderson, S., Clayton, C. K., Goates, M. C., & Thacker, E. L. (2020). What Does “Successful Aging” Mean to you? - Systematic Review and Cross-Cultural Comparison of Lay Perspectives of Older Adults in 13 Countries, 2010–2020. *Journal of Cross-Cultural Gerontology*, 35(4), 455–478. <https://doi.org/10.1007/s10823-020-09416-6>
- Sakurai, R., Yasunaga, M., Nishi, M., Fukaya, T., Hasebe, M., Murayama, Y., Koike, T., Matsunaga, H., Nonaka, K., Suzuki, H., Saito, M., Kobayashi, E., & Fujiwara, Y. (2019). Co-existence of social isolation and homebound status increase the risk of all-cause mortality. *International Psychogeriatrics*, 31(5), 703–711. <https://doi.org/10.1017/S1041610218001047>
- Sewo Sampaio, P. Y., Sampaio, R. A. C., Yamada, M., & Arai, H. (2016). Systematic review of the Kihon Checklist: Is it a reliable assessment of frailty? *Geriatrics & Gerontology International*, 16(8), 893–902. <https://doi.org/10.1111/ggi.12833>
- Shimada, H., Makizako, H., Lee, S., Doi, T., & Lee, S. (2018). Lifestyle activities and the risk of dementia in older Japanese adults. *Geriatrics & Gerontology International*, 18(10), 1491–1496. <https://doi.org/10.1111/ggi.13504>
- Shorey, S., & Chan, V. (2021). The experiences and needs of Asian older adults who are socially isolated and lonely: A qualitative systematic review. *Archives of Gerontology and Geriatrics*, 92, 104254. <https://doi.org/10.1016/j.archger.2020.104254>
- Takashima, R., Onishi, R., Saeki, K., & Hirano, M. (2020). The values and meanings of social activities for older urban men after retirement. *PLoS ONE*, 15(11), e0242859. <https://doi.org/10.1371/journal.pone.0242859>

- Vogelsang, E. M. (2016). Older adult social participation and its relationship with health: Rural-urban differences. *Health & Place*, 42, 111–119. <https://doi.org/10.1016/j.healthplace.2016.09.010>
- Wilson, N. J., & Cordier, R. (2013). A narrative review of Men's Sheds literature: Reducing social isolation and promoting men's health and well-being. *Health and Social Care in the Community*, 21(5), 451–463. <https://doi.org/10.1111/hsc.12019>
- Wang, T. F., Chen, I. J., & Li, I. C. (2012). Associations between chewing and swallowing problems and physical and psychosocial health status of long-term care residents in taiwan: a pilot study. *Geriatric Nursing (New York, N.Y.)*, 33(3), 184–193. <https://doi.org/10.1016/j.gerinurse.2011.12.002>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Mizue Suzuki MSc, Speech-language-hearing pathologist

Graduate School of Comprehensive Human Sciences, University of Tsukuba.

3-29-1 Otsuka, Bunkyo-ku, Tokyo 112-0012, Japan.

Tel: +81-3-3942-6863

Fax: +81-3-3942-6863

E-mail address: bluerosemusiker@gmail.com

Research

First author

1. Suzuki M, Maeda K, Shamoto S, Wakabayashi H. "Effects of aging and sarcopenia on strength of swallowing muscles in older adults" *Geriatr Gerontol Int*. 2017 Feb;17(2):360-361.
2. Suzuki M, Koyama S, Kimura Y, Ishiyama D, Otobe Y, Nishio N, Ichikawa T, Kunieda Y, Ohji S, Ito D, Yamada M. "Relationship between characteristics of skeletal muscle and oral function in community-dwelling older women" *Archives of Gerontology and Geriatrics*. 2018 Nov - Dec;79:171-175.
3. Suzuki M, Koyama S, Kimura Y, Ishiyama D, Ohji S, Otobe Y, Nishio N, Kunieda Y, Ichikawa T, Ito D, Ogawa H, Yamada M. "Relationship between tongue muscle quality and swallowing speed in community-dwelling older women" *Aging Clin Exp Res*. 2020 Oct;32(10):2073-2079.
4. Suzuki M, Kimura Y, Otobe Y, Kikuchi T, Masuda H, Taguchi R, Tanaka S, Narita Y, Shino S, Kusumi H, Yamada M. "Relationship between Sarcopenia and Swallowing Capacity in Community-Dwelling Older Women." *Gerontology*. 2020;66(6):549-552.

Co-author

1. Yamada M, Kimura Y, Ishiyama D, Nishio N, Tanaka T, Ohji S, Otobe Y, Koyama S, Sato A, Suzuki M, Ogawa H, Ichikawa T, Ito D, Arai H. "Plasma amino acid concentrations are associated with muscle function in older Japanese women" *J Nutr Health Aging*. 2018;22(7):819-823.
2. Koyama S, Katata H, Ishiyama D, Komatsu T, Fujimoto J, Suzuki M, Yamada M, Yamatoku M. "Preadmission frailty status as a powerful predictor of dependency after discharge in hospitalized older patients: a clinical-based prospective study" *Geriatr Gerontol Int*, 2018 Dec;18(12):1609-1613.
3. Kimura Y, Yamada M, Ishiyama D, Nishio N, Kunieda Y, Koyama S, Sato A, Otobe Y, Ohji S, Suzuki M, Ogawa H, Ito D, Ichikawa T, Hamanaka K, Tanaka N, Muroh Y. "Impact of unilateral spatial neglect with or without other cognitive impairments on independent gait recovery in stroke survivors" *J Rehabil Med*. 2018 Dec 25;51(1):26-31.
4. Yamada M, Kimura Y, Ishiyama D, Nishio N, Otobe Y, Tanaka T, Ohji S, Koyama S, Sato A, Suzuki M, Ogawa H, Ichikawa T, Ito D, Arai H. "Phase Angle is a Useful Indicator for Muscle Function in Older Adults" *J Nutr Health Aging*. 2019;23(3):251-255.
5. Kimura Y, Yamada M, Ohji S, Ishiyama D, Nishio N, Otobe Y, Koyama S, Suzuki M, Ichikawa T, Ito D, Maehori N, Nagae H. "Presence of sarcopenic obesity and evaluation of the associated muscle quality in Japanese older men with prostate cancer undergoing androgen deprivation therapy" *J Geriatr Oncol*. 2019 Sep;10(5):835-838.
6. Kimura Y, Ohji S, Ishiyama D, Nishio N, Otobe Y, Suzuki M, Ogawa H, Ichikawa T, Taguchi R, Shino S, Tanaka S, Yamada M. "Factors associated with functional recovery in Japanese patients with convalescent stroke stratified by age: a multicenter observational study" *Int J Rehabil Res*. 2019 Sep;42(3):249-255.

7. Yamada M, Kimura Y, Ishiyama D, Nishio N, Otobe Y, Tanaka T, Ohji S, Koyama S, Sato A, Suzuki M, Ogawa H, Ichikawa T, Ito D, Arai H. “Synergistic effect of bodyweight resistance exercise and protein supplementation on skeletal muscle in sarcopenic or dynapenic older adults” *Geriatr Gerontol Int*. 2019 May;19(5):429-437.

8. Ito D, Tanaka T, Kunieda Y, Kimura Y, Ishiyama D, Nishio N, Otobe Y, Koyama S, Ohji S, Suzuki M, Ichikawa T, Ogawa H, Narita Y, Yoshida T, Yamada M, Kondo K. “Factors associated with post-stroke apathy in subacute stroke patients” *Psychogeriatrics*. 2020 Sep;20(5):780-781.

9. Koyama S, Komatsu T, Ishiyama D, Fujimoto J, Suzuki M, Kimura Y, Otobe Y, Yamada M, Yamatoku M. “The influence of the combination of visiting frequency of family caregivers and pre-admission frailty status on dependency after discharge among hospitalized older patients: A clinically-based prospective study” *Eur Geriatr Med*. 2020 Jun;11(3):483-490.

10. Yamada M, Kimura Y, Ishiyama D, Otobe Y, Suzuki M, Koyama S, Kikuchi T, Kusumi H, Arai H. “Effect of the COVID-19 Epidemic on Physical Activity in Community-Dwelling Older Adults in Japan: A Cross-Sectional Online Survey” *J Nutr Health Aging*. 2020 Jun 23:1–3.

11. Yamada M, Kimura Y, Ishiyama D, Otobe Y, Suzuki M, Koyama S, Kikuchi T, Kusumi H, Arai H. “Recovery of Physical Activity Among Older Japanese Adults Since the First Wave of the COVID-19 Pandemic” *J Nutr Health Aging*. 2020 Sep 8:1–2.

12. Kimura Y, Nishio N, Abe Y, Ogawa H, Taguchi R, Otobe Y, Koyama S, Suzuki M, Kikuchi T, Masuda H, Kusumi H, Yamada M. “Relationship between physical activity levels during rehabilitation hospitalization and life-space mobility following discharge in stroke survivors: A multicenter prospective study” *Top Stroke Rehabil*. 2020 Oct 20:1-7.

13. Koyama S, Komatsu T, Ishiyama D, Suzuki M, Kimura Y, Otobe Y, Taguchi R, Shino S, Yamada M, Yamatoku M. “Impact of physical, cognitive, and psychological functions on incident homebound status after discharge among hospitalized older patients: A clinical-based prospective study” *Arch Gerontol Geriatr*. 2021 Jan-Feb;92:104258.


14. Masuda H, Ishiyama D, Yamada M, Iwashima F, Kimura Y, Otobe Y, Tani N, Suzuki M, Nakajima H. “Relationship Between Long-Term Objectively Measured Physical Activity and Glycemic Control in Type 2 Diabetes Mellitus Patients: A Prospective Cohort Study” *Diabetes Metab Syndr Obes*. 2021;14:2057-2063.

15. Yamada M, Kimura Y, Ishiyama D, Otobe Y, Suzuki M, Koyama S, Kikuchi T, Kusumi H, Arai H. “The Influence of the COVID-19 Pandemic on Physical Activity and New Incidence of Frailty among Initially Non-Frail Older Adults in Japan: A Follow-Up Online Survey” *J Nutr Health Aging*. 2021. <https://doi.org/10.1007/s12603-021-1634-2>.

16. Kunieda Y, Arakawa C, Yamada T, Suzuki M, Koyama S, Kimura Y, Ichikawa T, Shino S, Yamada M, Hirokawa R, Matsuda T, Takakura T, Adachi T, Hoshino H. “Characteristics of Regional Cerebral Blood Flow in Alzheimer Disease and Amnesic Mild Cognitive Impairment by Single-Photon Emission Computerized Tomography: A Cross-Sectional Study” *Dement Geriatr Cogn Disord Extra* 2021;11:91-98.

17. Tanaka S, Ito D, Kimura Y, Ishiyama D, Suzuki M, Koyama S, Narita Y, Masuda H, Suzukawa K, Yamada M. “Relationship between longitudinal changes in skeletal muscle characteristics over time and functional recovery during intensive rehabilitation of patients with subacute stroke” *Top Stroke Rehabil*. 2021 Jun 28:1-10. <https://doi.org/10.1080/10749357.2021.1940724>. Epub ahead of print. PMID: 34180362.

Authors and Affiliations

Mizue Suzuki¹  · Yuhei Otobe¹ · Takeo Ichikawa¹ · Shingo Koyama¹ ·
Shu Tanaka¹ · Yusuke Maetani¹ · Hiroaki Masuda¹ · Shuhei Shino¹ ·
Yosuke Kimura² · Minoru Yamada³

¹ Graduate School of Comprehensive Human Sciences, University of Tsukuba, 3-29-1 Otsuka, Bunkyo-ku, Tokyo 112-0012, Japan

² College of Science and Engineering, Health and Sports Technology Course, Kanto Gakuin University, 1-50-1 Mitsuura-higashi, Kanazawa-ku, Yokohama 236-8501, Japan

³ Faculty of Human Sciences, University of Tsukuba, 3-29-1 Otsuka, Bunkyo-ku, Tokyo 112-0012, Japan