



# Self-rated Masticatory Ability and Independent Life in Community Dwelling Elderly Populations

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### Abstract

**Objective:** Poor chewing ability is associated with deterioration in the quality of life in older adults. Little is known about how self-rated chewing ability is related with an independent life in community-dwelling older adults. This study examined whether self-rated chewing ability was associated with independent life in community-dwelling older people.

**Methods:** This cross-sectional study assessed 1,377 subjects over the age of 65 who lived in Kumamoto City, Japan (mean age 79.8 years). Participants divided three groups based on their self-rated chewing ability; good, fair and poor. We assessed needs for support to the community-dwelling older adults with various questionnaires such as, basic information, residential environment, and activity of daily living, cognitive function, community activity and neighbor environment. These questionnaire items were weighted in accordance with independence in daily living.

**Result:** A logistic regression analysis adjusted for various confounding factors including sex, age, BMI and certification of long-term care insurance revealed a significant correlation between self-rated chewing ability and scores of basic information, activity of daily living, cognitive function, community activity and the total sum. Multiple analyses of variance demonstrated that scores of these 4 items and the total sum were significantly higher in the good chewing group than in the others.

**Conclusion:** Self-rated chewing ability was associated with the various factors for living supports in community-dwelling older adults, suggesting that the self-rated chewing ability might be a predictor for independence in later life.

### Keywords

Chewing; Older adult; Self-reliant life; Epidemiology

## Introduction

Japan is one of the most rapidly aging societies and the population aging rate reached 26.0% in 2015. Ratio of public long-term care insurance recipients was 17.9% in Japan. Over the last four decades the cost of social security benefits, including public pension, medical

insurance and welfare, as a percentage of national income, increased from 5.8% to 30.7%, costing 118 trillion yen (1 trillion dollars) per year. Municipality-established community general support centers implemented a preventive long-term care plan that includes improvement of oral functions in 2006, to avoid a decline in people under long-term care. In order to implement efficient care prevention for community-dwelling older adults, it is important to consolidate the support for the community-dwelling older adults to include local residents, the staffs of community general support center, welfare commission volunteers and neighbors.

Many older adults tend to become sedentary from sarcopenia resulting from malnutrition [1,2]. Multiple lines of evidence demonstrate that physical dysfunction such as ambulation marks a serious decline in functional health, increasing the risk of institutionalization and death [3-6]. Walking ability is one of core factors of independent life in older adults. Slow gait speed is closely associated with mortality in even well-functioning older adults [7]. A logistic regression analysis adjusted for age, history of stroke, fracture, joint or muscle disease and ophthalmologic disease revealed that the prevalence of long-term care-required certification after 4 years in slow self-rated gait speed group of men and women was 3.09 and 3.52 times higher, respectively, than in the fast groups [8]. A previous study showed the prevalence of long-term care-required certification in the group that could not continue walking for 15 min was 3.2 times higher than that in the group that could walk for over 15 min [9]. Recent studies in animals and humans demonstrate that the sensation of oral cavity during active mastication has a salutary influence on hippocampus function via a neuronal and/or humoral pathway and mastication modulates learning and memory [10]. Recent findings from epidemiological studies indicate that cognitive function is closely correlated with chewing ability in the older adults [11-15]. The relationship between cognitive function and chewing ability is evaluated using bite force, occlusal contact area, and the number of chewable foods, self-rated chewing ability and objective chewing efficiency assessed by color-changeable chewing gum. Chewing ability also declines with age [7-9,11]. Poor chewing ability is closely associated with a less varied diet and lower food intake, leading to worsening health status, lower quality of life (QoL) and mortality in older adults [11,16]. A recent study suggests that self-perceived chewing ability is significantly associated with early-onset impairment, often followed by younger older persons requiring long-term care [17]. Although the evidences indicated above suggested relationship between lower chewing ability and frailness in older adults, chewing ability have not been examine the relationship with prospective independence in community-dwelling older adults. Based on these points, we hypothesized that the self-perceived chewing ability could explain the independence of community-dwelling older adults. The aim of the present study was to elucidate the relationship between self-rated chewing ability and the need for support for the community-dwelling older adults based on questionnaire assessment. The results suggest that self-rated chewing ability could be an effective marker for accessing the community-dwelling older adults.

## Methods

This cross-sectional study recruited 1,706 individuals that were 65-years-of-age and above, living in Kumamoto City and obtained

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informed consent from 1,554 of those subjects in 2013. These subjects lived in catchment areas of the regional welfare commission volunteers who participated in this study. We surveyed all older people living in this area. The study excluded subjects that died, moved, or were hospitalized during the study and thus 1,377 individuals participated (459 males and 910 females, mean age 79.8 ± 6.6 years). This interview-based study was conducted in conjunction with regional welfare commission volunteers and community comprehensive care center staff with full understanding of this survey.

The questionnaire contains six items; basic information, residential environment, activity of daily living, cognitive function, community activity and neighbor environment (Appendix Table 1). Each item was weighted to bring the total to 100 points. A higher point indicated a higher level of independence. The basic information included age, sex, family structure, experience of severe illness, walking for 15 min with or without a stick and self-perceived health. The residential environment was evaluated in order to understand the need for support for safety at home including; ventilation in the house, well-organized home, steps in the house, someone smoking in bed and detached house. Activity of daily living was made up of 5 sub-items; anxiety about falling, going out at least once a day, the number of meals per day, daily shopping by oneself and taking trash out by oneself. Cognitive function was assessed with 4 sub-items; forgetfulness, making phone calls, using home electronic appliances and making payments by oneself. Community activity was assessed with three items; having a hobby or culture lesson, exchange visits at a friend's house and relationships among neighbors. The neighbor environment was assessed by the accessibility of places where subjects wanted to go; a sloping road around home, public facilities around home, public transportation around home and neighboring house around home.

Self-rated chewing ability was assessed on a three points scale; being able to eat whatever subjects want to eat (good), able to eat most foods expect some hard ones (fair) and limited foods because of inadequate chewing or a fluid diet (poor). Body mass index (BMI) was defined as the weight in kilograms divided by height in meters squared. BMI was divided into three groups; <18.5, 18.5-25 and >25. Age groups were designated; 65-74 years, 75-84 years and >85 years.

This study was approved by the Ethical Committee of Kumamoto Health Science University, Kumamoto, Japan (No. 23-12 for epidemiology) and informed content was obtained from all participants.

### Statistical Analysis

Categorical variables were compared using the chi-squared test. A multivariate logistic regression analysis was used to calculate the

odds ratios (ORs) and 95% confidence intervals (CIs) after controlling simultaneously for potential confounders. Comparison between multiple groups was performed by using a multivariate analysis of variance (ANOVA) adjusted with covariates. All statistical analyses were performed using IBM SPSS Statics for Japan version 19.0 for Windows (IBM, Japan). A value of  $p < 0.05$  was considered to be statistically significant.

The ORs and 95% CIs associated with chewing ability with respect to each item and the total sum, were determined by a logistic regression analysis (Table 1). The present study defined independent living in older persons as having good self-perceived health without receiving long-term care insurance. The mean difference between the thresholds of basic information, residential environment, activity of daily living, cognitive function, community activities, neighbor environment and total sum of each item in the group having good self-perceived health without receiving long-term care and the other group, were 15, 9, 14, 13, 7, 8 and 70, respectively.

In this study, independence variable was each score of parameter in questionnaire (i.e. each score of basic information, residential environment, activity of daily living, cognitive function, community activities, neighbor environment and total sum of scores) and dependent variable was self-rated chewing ability (i.e. good, fair and poor).

### Results

The older adult's age, sex, BMI, long-term care certification and scores of questionnaire were compared in association with their self-rated chewing ability (Table 2). The chi-squared test demonstrated that the self-rated chewing ability was significantly associated with age, BMI, long-term care certification and the score of questionnaire, but not sex. Table 3 shows that the logistic regression analysis adjusted for sex, age, BMI and long-term care certification revealed that having poorer chewing ability was significantly associated with lower scores in basic information, activity of daily living, cognitive function, community activities and the total sum. The prevalence of lower scores of basic information, activity of daily living, cognitive function and total sum was increased by 1.9 to 3.1-fold and 3.1 to 7.3-fold in fair and poor self-rated chewing ability group, respectively. Residential environment or neighbor environment were not associated with the self-rated chewing ability. The prevalence of a lower score of all items and the total sum were 1.4 to 7.9-fold higher in certification of long term-care insurance group than the other, suggested that the score of each item and the total sum closely reflected the needs for support to the community dwelling older adults. In addition, a logistic regression analysis adjusted for age, sex, BMI and long-term

Table 1: Score threshold of each item of questionnaire for logistic regression analysis.

Items (max)	Self-Perceived Good Health Without Receiving Long-Term Care		p-Value†	Score Threshold For Logistic Regression Analysis
	Yes (n=678)	No (n=642)		
Basic information (27)	19.9 ± 3.4	14.1 ± 5.2	<0.001	15
Residential environment (12)	10.0 ± 1.8	8.9 ± 2.1	<0.001	9
Activity of daily living (19)	17.0 ± 2.8	13.3 ± 3.6	<0.001	14
Cognitive function (16)	13.8 ± 2.9	12.1 ± 3.9	<0.001	13
Community activities (14)	9.6 ± 4.2	6.2 ± 4.6	<0.001	7
Neighbor environment (12)	8.3 ± 2.6	7.8 ± 2.6	<0.001	8
Total sum (100)	78.6 ± 9.7	62.4 ± 13.5	<0.001	70

Note: †Differences between groups were tested by t-test.

**Table 2:** Relationship between self-rated chewing ability and each score of items of questionnaire.

Items		Self-Rated Chewing Ability						Total	p-Value†
		Good		Fair		Poor			
Age	65-74	158	(53.1)	126	(42.4)	13	(4.4)	297	<0.001
	75-84	300	(42.9)	361	(51.7)	37	(5.3)	698	
	>85	114	(32.6)	193	(55.3)	42	(12.0)	349	
Sex	man	203	(44.8)	221	(48.8)	29	(6.4)	453	0.547
	woman	374	(41.7)	461	(51.4)	62	(6.9)	897	
Body mass index	<18.5	39	(30.0)	77	(59.2)	14	(10.7)	130	<0.001
	18.5-25	395	(49.0)	371	(46.0)	40	(5.0)	806	
	>25	105	(54.1)	78	(40.2)	11	(5.6)	194	
Long-term care certification	Yes	104	(22.5)	302	(65.4)	56	(12.1)	462	<0.001
	No	464	(53.0)	376	(42.9)	36	(4.1)	876	
<b>Scores of questionnaire</b>									
Basic information	≤15	84	(24.2)	219	(63.1)	44	(12.6)	347	<0.001
	≥16	488	(48.8)	464	(46.4)	48	(4.8)	1000	
Residential environment	≤9	170	(31.1)	323	(59.1)	53	(9.7)	546	<0.001
	≥10	402	(50.1)	360	(44.9)	39	(4.9)	801	
Activity of daily living	≤14	108	(23.6)	296	(64.7)	53	(11.5)	457	<0.001
	≥15	464	(52.1)	387	(43.4)	39	(4.3)	890	
Cognitive function	≤13	216	(31.6)	387	(56.7)	79	(11.5)	682	<0.001
	≥14	356	(53.5)	296	(44.5)	13	(2.0)	665	
Community activities	≤7	184	(32.0)	341	(59.4)	49	(8.5)	574	<0.001
	≥8	388	(50.1)	342	(44.2)	43	(5.6)	773	
Neighbor environment	≤8	263	(35.6)	412	(55.9)	62	(8.4)	737	<0.001
	≥9	309	(50.6)	271	(44.4)	30	(4.9)	610	
Total sum	≤70	161	(26.7)	380	(63.2)	60	(10.0)	601	<0.001
	≥71	411	(55.0)	303	(40.6)	32	(4.3)	746	

Note: †Differences between two groups were tested using chi-squared test. The number in a parenthesis indicated %.

**Table 3:** Logistic regression analysis for each item of questionnaire.

Parameters	Basic Information	Residential Environment	Activity Of Daily Living	Cognitive Function	Community Activities	Neighbor Environment	Total Sum
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>BMI</b>							
<18.5	1	1	1	1	1	1	1
18.5-25	1.1 (0.6-2.0)	0.9 (0.6-1.5)	0.6 (0.4-1.1)	0.6* (0.4-1.0)	0.4** (0.3-0.7)	1.2 (0.7-1.8)	0.5* (0.3-0.9)
>25	1.6** (1.1-2.3)	1.0 (0.7-1.4)	1.1 (0.8-1.7)	0.8 (0.6-1.1)	0.9 (0.6-1.3)	1.1 (0.8-1.5)	1.3 (0.9-1.9)
<b>Long-Term Care Certification</b>							
No	1	1	1	1	1	1	1
Yes	6.5** (4.8-8.9)	2.0** (1.5-2.7)	6.7** (4.9-9.0)	1.6* (1.2-2.1)	2.8** (2.1-3.8)	1.4* (1.1-1.9)	7.9* (5.8-11.0)
<b>Chewing Ability</b>							
Good	1	1	1	1	1	1	1
Fair	2.9** (1.6-5.2)	1.1 (0.7-1.9)	3.4** (1.8-6.2)	3.0** (1.6-5.6)	1.9* (1.1-3.3)	0.8 (0.5-1.4)	3.1** (1.6-6.1)
Poor	5.4** (3.0-10.0)	1.7 (0.9-2.9)	7.3** (3.9-13.6)	5.7** (3.0-10.8)	3.1** (1.8-5.6)	1.3 (0.8-2.2)	7.3** (3.7-14.4)

Note: Odds ratio with 95% confidence intervals was calculated using the logistic regression analysis. \*p<0.05, \*\*p<0.01.

care certification determined the ORs and 95% CI for maintaining the ability to continue walking for 15 min and having poor self-perceived health both sub-items in basic information; (Appendix Table 2). The prevalence of continued walking less than 15 min and having poor self-perceived health was 2.6, 4.6 and 5.8, 9.7 times higher in fair and poor chewing ability group, respectively, than good chewing ability group.

The multivariate ANOVA adjusted for sex, age, BMI and certification of long-term care insurance was calculated to compare the mean scores of all items and total sum of questionnaire in three groups by self-rated chewing ability (Table 4). The scores of basic

information, activity of daily living, cognitive function, community activities scores and the total sum of questionnaire were significantly decreased with fair or poor self-rated chewing ability (p<0.001).

## Discussion

This study investigated whether the self-rated chewing ability was associated with independent living in community-dwelling older adults. The score of each item other than residential environment, neighbor environment, and the total sum of questionnaire were strongly associated with self-rated chewing ability. The residential environment item was evaluated by questionnaires on accident

**Table 4:** Comparison of each item of questionnaire (adjusted mean with 95% confidence interval) for the three group by self-rated chewing ability.

Parameters	Self-rated chewing ability			p-value
	Good	Fair	Poor	
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	
Basic information	16.4 <sup>#</sup> (15.8-17.1)	15.4 <sup>†</sup> (14.8-16)	12.1 <sup>†</sup> (10.7-13.6)	<0.001
Residential environment	9.4 <sup>#</sup> (9.1-9.8)	8.9 <sup>†</sup> (8.5-9.2)	8.7 <sup>†</sup> (7.9-9.4)	<0.001
Activity of daily living	15.4 <sup>#</sup> (14.9-16)	14.2 <sup>†</sup> (13.6-14.7)	13.0 <sup>‡</sup> (11.8-14.2)	<0.001
Cognitive function	13.2 <sup>#</sup> (12.7-13.8)	12.1 <sup>†</sup> (11.6-12.7)	9.1 <sup>†</sup> (7.9-10.4)	<0.001
Community activities	8.1 <sup>#</sup> (7.4-8.9)	6.8 <sup>†</sup> (6.0-7.5)	4.0 <sup>†</sup> (2.3-5.7)	<0.001
Neighbor environment	8.4 <sup>#</sup> (7.9-8.8)	7.8 <sup>†</sup> (7.4-8.3)	7.4 <sup>†</sup> (6.4-8.4)	<0.001
Total sum	71.3 <sup>#</sup> (69.4-73.2)	65.4 <sup>†</sup> (63.5-67.2)	54.7 <sup>†</sup> (50.5-58.9)	<0.001

**Note:** †Multivariate ANOVA for comparison between groups adjusted for BMI and certification of long-term care insurance. Data with different symbols are statistically significantly different (p<0.001).

prevention at home, such as the ventilation in the house, or steps in the house. Similarly, the neighbor environment item was assessed by questionnaires on accessibility, such as a sloping road around the home, or the location of public facilities near the home. Therefore, it was not surprising that these two items were not directly associated with the self-rated chewing ability.

As pilot study, we extracted items which distinguished by certification of long-term care-required and identified questions for survey of living conditions of older adults. The questionnaire used in this study is useful to assess living independent life in community-dwelling older adults. While on the other hand, unlike psychological scale, this questionnaire was not for a certain concept configuration, such as anxiety, QoL, or social attitude. The questions within each item and these scores conveniently put together to assess the need for support, but was not get by factor analysis. Then, it should be noted that the questionnaire did not verify relevance between items, as using this questionnaire.

Basic information included the self-perceived walking ability for 15 min with or without stick. The present study found that the decline of the ability to continue walking was closely related to poorer self-rated chewing ability in older adults. This is the first report on the relationship between the ability to continue walking and chewing ability. This study also investigated relationship between self-perceived health and chewing ability. The prevalence of poor self-perceived health in the fair and poor self-rated chewing ability group was 4.6 and 9.7 times higher than that in the good group (Appendix Table 2). This result is consistent with previous studies on QoL [11,18-22]. The number of chewable foods, but not the number of teeth, is closely associated with the QoL evaluated by the face scale in 80-year-old Japanese subjects [21]. A linear regression of analysis of oral health-related QoL determined by geriatric oral health assessment index (GOHAI) adjusted for demographic and socioeconomic variables revealed that the number of easily chewable foods, but not the number of teeth or wearing dentures is associated with scores of the GOHAI in an older Taiwanese population [23]. These findings suggested that QoL in elderly subjects has a closer relationship with chewing ability than the number of teeth. The assessment of self-rated chewing ability would be useful tool for the community monitoring by regional non-dental professionals, like volunteers, social welfare workers, or the neighbors of older adults, because it is easier for people, other than dental professionals, to determine the self-rated chewing ability than to determine the number of remaining teeth.

There are various methods to assess cognitive function in the older adults, including that Hasegawa dementia rating scale, Mini-mental state examination and Frontal Assessment Battery. The

questionnaire used in this study assessed cognitive function with just 4 items (Appendix Table 1). Although the items for assessing cognitive function in this questionnaire are less accurate than surveys specific to cognitive functional assessment, the questionnaire used in this study is easier and less stressful for both elderly subjects and volunteer investigators in the community. The present study found a significant relationship between self-rated chewing ability and the cognitive function score. Prevention of wandering triggered by cognitive impairment is another purpose for the regional monitoring system for the older adults. The results suggest that regularly hearing and information-sharing on the self-rated chewing ability of older adults would be useful to assess the cognitive function of older adults. On the other hands, negative evidences on relationship between chewing ability and cognitive function in older adults also should be considered. Most recent study indicated that neither accumulation of amyloid-beta nor associated learning and memory were aggravated by tooth loss in mice [24]. In addition, many older people have a tendency to under-estimate their eating problems, because deterioration of oral function slowly progress. Previous study demonstrated that there were significant differences in number of subjects expressing difficulty to chewing various foods when responding to open and closed questions in UK older adults, suggesting availability of semi-structured interview with open and closed questions for older adults [25].

In conclusion, the present study showed that the matter of living supports in older adults were closely correlated with the self-rated chewing ability, suggesting that the self-rated chewing ability would be useful predictor for self-reliant life in community-dwelling older adults. These results reaffirm the significance of oral health-related professionals based in clinics and/or the community has a critical role in ensuring the well-being and independence of the older adults via maintenance of chewing ability.

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**Conflict of interest**

There is no conflict of interest.

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