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The Relationship between chewing ability and sarcopenia in Japanese community-dwelling elderly

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Abstract

**Aim:** Sarcopenia, defined as the degenerative loss of skeletal muscle mass, has recently been considered to involve a decline in muscle strength. It has been reported that the age-related loss of skeletal muscle mass leads to a decline in daily living activities of elderly subjects, which leads to difficulties in maintaining their quality of life. It has also been reported that if nutrient intake is unbalanced, muscle mass, muscle strength and physical performance declines, and therefore it is important to maintain chewing ability to keep a balanced nutrient intake. The relationship between chewing ability and sarcopenia has not been previously reported. Therefore, this study investigated the relationship between chewing ability and sarcopenia in addition to known sarcopenia related factors.

**Methods:** We examined 752 subjects aged from 65 to 85 years old (average 73.0 ± 5.1), who lived in the Itabashi ward of Tokyo, and attended a comprehensive geriatric health examination for early detection and early care of geriatric syndrome. Our research was designed to examine the prevalence of elderly subjects with sarcopenia, as well as the relationship between chewing ability and sarcopenia. We performed regression analysis
to analyze the relationship with sarcopenia related factors with consideration to their age.

**Results:** Among the 752 subjects examined, 5.6% (42 subjects) had severe sarcopenia, 12.8% (96 subjects) had sarcopenia, 22.5% (169 subjects) had pre-sarcopenia and the remainder had no sarcopenia. We divided the subjects into two groups in terms of the stage of sarcopenia according to whether there was deterioration of muscle strength or physical performance, and performed logistic regression analyses on the value as a dependent variable, including known sarcopenia related factors. There were significant correlations of sarcopenia with age (odds ratio (OR) = 2.46, 95% confidence interval (CI) = 1.65-3.67), serum albumin level (OR = 0.36, CI = 0.17-0.76) and chewing ability (OR = 2.32, CI = 1.36-3.96).

**Conclusions:** This study shows that chewing ability is related to sarcopenia, which is equal to the relationship with the known factor of age by OR.

**Keywords:** sarcopenia, community-dwelling elderly, chewing ability, color-changeable gum
**Introduction**

Sarcopenia, defined as the degenerative loss of skeletal muscle mass, has recently been considered to result from a decline in muscular strength.\(^1,2\) It has been reported that the age-related loss of skeletal muscle mass leads to a decline in activities of daily living (ADL) in elderly subjects, leading to difficulties in maintaining their quality of life (QOL). Studies have shown that if nutrient intake is unbalanced, muscle mass, muscle strength and physical performance declines\(^3\) and it is important to maintain chewing ability to keep a balanced nutrient intake.\(^4,5\) Enjoying meals is one of the most important factors to support the QOL in senile subjects and it is also important to maintain and promote their health.\(^6,7\)

Several studies have reported on the relationship between chewing ability and grip strength / physical performance,\(^8,9\) and on the relationship between tongue muscle thickness and sarcopenia,\(^10\) but there have been no reports addressing the possible relationship between chewing ability and sarcopenia. Therefore, we conducted this research targeted on Japanese community-dwelling elderly subjects and investigated the relationship between chewing ability and sarcopenia in addition to known Sarcopenia
related factor.

**Methods**

**Participants**

Tokyo Metropolitan Institute of Gerontology (TMIG) sent invitations for a comprehensive geriatric health examination for early detection and early care of geriatric syndrome to 7,015 male and female subjects aged from 65 to 85 years who lived within 9 towns in the Itabashi city (Tokyo, Japan), excluded nursing home residents and those who have participated in our previous interventional research studies. Among them, 1,325 people offered to attend and 835 people actually attended. Excluding withdrawals due to the terms of our research and also exclusions of missing values due to people with heart pacemakers, walking difficulties, etc, the data of 752 subjects were analyzed in our study.

This research was conducted at the Tokyo Metropolitan Institute of Gerontology from 25 September 2012 to 5 October 2012. These subjects attended by walking, driving or being driven by family members and by using public transportation and moreover who can understand and follow our instructions. We received written informed consent from each subject individually. This research was conducted with permission of the Tokyo Metropolitan Institute of Gerontology Ethics Committee (Issue #.23-1253 in
2011).

**Stages of Sarcopenia**

The guidelines of the European Working Group on Sarcopenia in Older People (EWGSOP)\(^1\) were used to classify the severity of sarcopenia (Stage of Sarcopenia: SSp) according to muscle mass (skeletal muscle mass measured by bioelectrical impedance analysis: BIA), muscle strength (grip strength) and physical performance (usual walking speed) (Table 1). In addition, subjects were classified by SSp into a healthy and pre-sarcopenia group in which declines in muscle strength or physical performance were not observed (Maintenance Group: MG), or into a sarcopenia and severe sarcopenia group in which declines in muscle strength or physical performance were significant (Decline Group: DG).

**General evaluation**

Height: Each subject was advised to keep their heels, buttocks, back and head touching the stadiometer. Making sure that their neck, waist and knees were straight, their height was measured per 0.1 cm.

Weight: Each subject was advised to stand on a weight scale quietly and the stable value of their weight was measured per 0.1 kg.
SMI (Skeletal Muscle mass Index): Body composition was measured with BIA, using an InBody720 (Bio Space, Seoul, Korea) and extremity muscle mass (kg) was determined from the sum of the upper and lower extremities. We divided the measured extremity muscle mass by the squared height (m conversion) and the adjusted extremity muscle mass was used as the SMI. We used the standard value by Tanimoto et al.\textsuperscript{12} for the SMI cut-off value of sarcopenia.

Nutrition evaluation: Serum albumin levels were measured as an indicator of the nutritional status of the subjects. The bromocresol green method (BCG) was used for the measurement.

**Physical function evaluation**

Physical function was measured following the Functional improvement manual issued by the Ministry of Health, Labor and Welfare.\textsuperscript{13}

Grip strength: Grip strength was used as an indicator of muscle strength, and was measured using a Smedley dynamometer (As one Co., Ltd., Osaka, Japan). Measurements were performed twice and the higher value was used.\textsuperscript{14,15} The cut-off value of grip strength was set as the lowest of quartile value, according to the method by Tanimoto et al.\textsuperscript{16}
Usual walking speed (walking ability): Subjects walked along a walking path with 3 m acceleration zone, 5 m measurement zone and 3 m deceleration zone and the time each subject’s feet were in the swing phase (the foot apart from the ground) was measured from the start point of the measurement zone to the end point of the measurement zone. Measurements were taken twice and the faster time was used in the analysis. The cut-off value of walking speed was set as the lowest of quartile value, according to the method by Tanimoto et al.16

**Oral examination**

Oral examinations were carried out by two dentists and five dental hygienists who evaluated standardization before the study.

Chewing ability: A color-changeable chewing gum (Masticatory performance evaluating gum Xylitol®; Lotte Co., Ltd., Saitama, Japan) was used to examine chewing ability. After chewing the gum for 1 minute, the subject spit the gum on a piece of white paper and the gum was analyzed with a color chart into 5 levels by testers.17 Levels 1 and 2, which were approximately the lowest of quartile value, were classified as "Poor" and levels 3, 4 and 5 were classified as "Good".
Number of existing teeth: The number of existing intraoral erupted teeth was counted, excluding the residual roots.

Number of functional teeth: The number of prosthetic treatment bridges, plate dentures (removal dentures) and implants (artificial roots) of defect sites and the number of existing teeth were counted.

Occlusal force: An occlusal force measurement system film was used, Dental Prescale 50H Type R (Fuji Photo Film Co., Ltd., Tokyo, Japan) and Occuluser (Fuji Photo Film Co., Ltd., Tokyo, Japan). Following the method of Matsui et al., the subject sat on a chair, making sure that the Frankfurt horizontal plane and the floor were as parallel as possible and then was asked to bite down on the prescale at the intercuspal position as hard as possible. Occlusal force was measured in newtons (N).

Statistical analysis

For sex classification, the Mann–Whitney U test was performed to assess differences between continuous variables in the two groups. For the categorical variable, the Chi-square ($\chi^2$) test was used. For SSp and other factor comparisons, the Kruskal-Wallis test and Bonferroni post-hoc test was used. Logistic regression analysis was used for the purpose of researching
factors related to DG. All statistical analyses were done using SPSS20.0J for Windows and a risk ratio of less than 5% is considered a significant difference.

Results

Basic attributes of the subjects

The basic attributes of the subjects in this study are shown in Table 2. There were 752 subjects (average age, 73.0 years old ± 5.1), 311 males (73.6 years old ± 5.4) and 441 females (72.6 years old ± 4.9). Females had higher values for serum albumin levels (P=0.001), number of existing teeth (P=0.048) and number of functional teeth (P=0.048). Males had higher values for age (P=0.013), SMI (P<0.001), grip strength (P<0.001) and occlusal force (P=0.007).

The SSp for males was; 16.4% pre-sarcopenia, 10.3% sarcopenia and 7.1% severe sarcopenia. The SSp for females was; 26.8% pre-sarcopenia, 14.5% sarcopenia and 4.5% severe sarcopenia. However, the percentage of DG was not significantly different between males and females.

SSp Comparisons

Comparisons of each variable between SSps is shown in Table 3. The ages of the subjects were higher with DG (P<0.001). As DG, serum albumin level
(P<0.001), SMI (P<0.001), grip strength (P<0.001), normal walking speed (P<0.001), number of existing teeth (P<0.001), occlusal force (P<0.001) and chewing ability (P<0.001) declined. Among patients aged less than 75 years old, 22.9% had pre-sarcopenia, 9.8% had sarcopenia, and 1.7% had severe sarcopenia. Among subjects aged more than 75 years old, 21.8% had pre-sarcopenia, 17.3% had sarcopenia, 11.6% had severe sarcopenia and a higher percentage of DG was found in subjects aged more than 75 years old (P<0.001).

Logistic regression analysis

The results of the logistic regression analysis are shown in Table 4. The dependent variable was 0 for MG and 1 for DG. As a result, sex, age, serum albumin level, number of existing teeth, occlusal force and chewing ability were selected as independent variables. Age (OR = 2.46, 95%CI: 1.65-3.67), serum albumin level (OR = 0.36, 95%CI: 0.17-0.76) and chewing ability (OR = 2.32, 95%CI: 1.36-3.96) were significant factors of sarcopenia.

Discussion

There have been many reports about sarcopenia, regarding the concept of
the Frail model proposed by Fried et al.\textsuperscript{19} It has been reported that sarcopenia decreases the ADL of elderly subjects, makes it difficult to maintain their QOL\textsuperscript{1,2} and it is important to intake a good balance of nutrition to prevent a decline in muscle mass, muscle strength and physical performance.\textsuperscript{3} It has been reported that it is essential to maintain the ability to chew to keep a good balance of nutrient intake.\textsuperscript{4,5} From these understandings, a strong relationship between chewing ability and sarcopenia has been inferred, but this hypothesis has not been tested. Thus, we examined the relationship with chewing ability and sarcopenia in addition to known sarcopenia related factor.

**Validity of subjects**

The prevalence of severe sarcopenia in this study was 5.6\% (42 subjects), 12.8\% (96 subjects) had sarcopenia and 22.5\% (169 subjects) had pre-sarcopenia. Three factors of EWGSOP, muscle mass, muscle strength and physical performance were used as a concept of sarcopenia in this study. This EWGSOP consensus guide is used worldwide for diagnostic criteria of sarcopenia intended to unify views of the definition of sarcopenia.\textsuperscript{11} However, the basic value of EWGSOP is targeted for white and black subjects in US
and Europe. Therefore, it is difficult to apply to physically different Japanese people.\(^{20}\) We classified sarcopenia according to cut-off values and basic values of SMI, grip strength and usual walking speed targeted for Japanese people by Tanimoto et al.\(^{12,16}\) Since this classification of sarcopenia is different from the ones used by Tanimoto et al., we cannot compare the results indiscriminately. However, the percentages of the group with an observed decline of muscle strength and physical performance are almost the same. Our research subjects are considered to be appropriate Japanese community-dwelling elderly subjects. In addition, serum albumin levels significantly decreased as the DG. Several studies have reported that serum albumin levels significantly decrease in subjects with sarcopenia,\(^{21,22}\) and since we were obtained similar results in this study, we believe that our research results are valid. However, in this study, serum albumin was significantly higher in women. According to previous studies of community dwelling elders, serum albumin was lower in women.\(^{22}\) This difference was noted between the previous studies and this study. We considered that one of the factors for this difference was the low average age and high number of existing teeth and functional teeth of the women.
Validity of chewing ability evaluation using a color-changeable chewing gum

A color-changeable chewing gum was used to evaluate chewing ability. With this evaluation method, the chewing ability of each subject can be evaluated easily and in a short amount of time, and it has been correlated with other chewing ability evaluation methods. One previous study reported that results from color charts, like the one used in our study, correlated well with results using a color difference meter. We used the same cut-off value for chewing ability as the lowest quartile used for the cut-off value for grip strength and walking speed in EWGSOP. As a result, out of 5 stages of chewing ability, it was matched with the lowest of quartile, by setting 1 and 2 as “Poor” and the percentages as 14.1%. In a previous study with a color-changeable chewing gum, the percentages of “Poor” were similar to our results and this supports the validity of our results.

Results on logistic regression analysis

To make the SSp dependent variable, we set the cut-off value between pre-sarcopenia and sarcopenia. This is because it is considered that not only a decline in muscle mass, but also a decline in muscle strength and physical performance exist in the stage between pre-sarcopenia and sarcopenia. It is
considered to be a turning point of the decline in the QOL of elderly subjects, since it has been reported that a decline in muscle strength of the knees and ankles are related to the balance ability of the extremities in daily life and a decline in walking speed.\textsuperscript{25} And it reported that a decline in general function can be a predictive factor for worsening of the health status.\textsuperscript{26}

We performed a logistic regression analysis on sarcopenia-related factors, which confirmed that sarcopenia is related to age and serum albumin levels, similar to previous reports.\textsuperscript{27,28} We did not investigate daily intake of protein in this subjects. Similar to previous reports\textsuperscript{27,28} depressed metabolism and depressed appetite could be caused due to decline in general function. It was considered that if daily nutritional intake lacks, negative cycle of decline in serum albumin, muscle mass and general function occurs.

This study showed the relationship with chewing ability and sarcopenia. Three factors of EWGSOP; muscle mass, muscle strength and physical performance, were used for the concept of sarcopenia in this study. There has been a lot of reports of the relationship between these three factors and age and nutrition.\textsuperscript{2,3} It has also been reported both muscle strength and physical performance has a relationship with chewing ability. Moriya, et al reported
the relationship between chewing ability and grip strength regardless of
the number of existing teeth. Takata, et al also reported the relationship
between chewing ability and general function regardless of the number of
existing teeth. There has been no report about the relationship between
general muscle mass and chewing ability, while there have been reports
about the relationship between chewing ability related tongue thickness and
brachial muscle mass. Many muscles related to sarcopenia components;
muscle strength and physical performance are antigravity muscles and it
was reported that decline in strength of antigravity muscle occurs all over
the body. Since many muscles related to chewing ability are classified as
antigravity muscles, it is considered that decline in muscle strength occurs
simultaneously. It has been also reported that decline in muscle mass causes
decline in muscle strength and the decline in muscle strength causes atrophy
of muscle and decline in function. From the above, it was considered that
the reason for a notable relationship between chewing ability and sarcopenia
in consideration of age and nutrition, could be related to changes in general
muscle mass and muscle mass related to chewing ability. Present research
revealed the relationship between chewing ability and sarcopenia, which will
be meaningful to consider solutions to suppress sarcopenia in elderly subjects in terms of dentistry in the future.

**Acknowledgements**

We thank everyone who participated in this research, particularly Drs. Yuki Ohara, Ayako Edahiro, Hisashi Kawai, Shuichi Obuchi, Hunkyung Kim and Hideyo Yoshida (Tokyo Metropolitan Institute of Gerontology) who guided us in our research.

**Disclosure statement**

None of the authors has a conflict of interest to declare.
Reference


18 Matsui Y, Ohno K, Michi K, Suzuki Y, Yamagata K. A computerized method for


**Table 1. EWGSOP Stage of Sarcopenia (SSp)**

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<thead>
<tr>
<th>Stage</th>
<th>Muscle mass</th>
<th>Muscle strength</th>
<th>Physical performance</th>
</tr>
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<tbody>
<tr>
<td>Presarcopenia</td>
<td>low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarcopenia</td>
<td>low</td>
<td>low</td>
<td>Or</td>
</tr>
<tr>
<td>Severe sarcopenia</td>
<td>low</td>
<td>low</td>
<td>And</td>
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We used SMI for muscle mass, grip strength for muscle strength and normal walking speed for physical performance.
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<tr>
<th></th>
<th>Total (n: 752)</th>
<th>Male (n: 311)</th>
<th>Female (n: 441)</th>
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<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>73.0 ± 5.1</td>
<td>73.6 ± 5.4</td>
<td>72.6 ± 4.9</td>
<td>0.013 (u)</td>
</tr>
<tr>
<td>Serum albumin level (g/dL)</td>
<td>4.3 ± 0.3</td>
<td>4.3 ± 0.3</td>
<td>4.4 ± 0.2</td>
<td>0.001 (u)</td>
</tr>
<tr>
<td>SMI (kg/m²)</td>
<td>8.6 ± 1.1</td>
<td>9.5 ± 0.9</td>
<td>8.0 ± 0.6</td>
<td>&lt;0.001 (u)</td>
</tr>
<tr>
<td>Grip strength (kg)</td>
<td>24.3 ± 8.3</td>
<td>31.3 ± 7.1</td>
<td>19.4 ± 4.7</td>
<td>&lt;0.001 (u)</td>
</tr>
<tr>
<td>Usual walking speed (m/s)</td>
<td>1.4 ± 0.2</td>
<td>1.4 ± 0.2</td>
<td>1.4 ± 0.3</td>
<td>0.824 (u)</td>
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<tr>
<td>No. existing teeth</td>
<td>19.9 ± 8.9</td>
<td>19.0 ± 9.4</td>
<td>20.5 ± 8.6</td>
<td>0.048 (u)</td>
</tr>
<tr>
<td>No. functional teeth</td>
<td>27.0 ± 3.0</td>
<td>26.8 ± 3.6</td>
<td>27.1 ± 2.6</td>
<td>0.048 (u)</td>
</tr>
<tr>
<td>Occlusal force (N)</td>
<td>531 ± 342</td>
<td>580 ± 382</td>
<td>497 ± 306</td>
<td>0.007 (u)</td>
</tr>
<tr>
<td>Chewing ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good (3, 4, 5)</td>
<td>646 (85.9)</td>
<td>273 (87.8)</td>
<td>373 (84.6)</td>
<td>0.214 (χ²)</td>
</tr>
<tr>
<td>Poor (1, 2)</td>
<td>106 (14.1)</td>
<td>38 (12.2)</td>
<td>68 (15.4)</td>
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<tr>
<td>Stages of sarcopenia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG {</td>
<td>Normal</td>
<td>445 (59.2)</td>
<td>206 (66.2)</td>
<td>0.557 (χ²)</td>
</tr>
<tr>
<td>Presarcopenia</td>
<td>169 (22.5)</td>
<td>51 (16.4)</td>
<td>118 (26.8)</td>
<td></td>
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<tr>
<td>DG {</td>
<td>Sarcopenia</td>
<td>96 (12.8)</td>
<td>32 (10.3)</td>
<td></td>
</tr>
<tr>
<td>Severe sarcopenia</td>
<td>42 (5.6)</td>
<td>22 (7.1)</td>
<td>20 (4.5)</td>
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Values are mean ± SD, standard deviation. MG, Maintenance Group; DG, Decline Group; SMI, Skeletal Muscle mass Index; u, Mann-Whitney U-test; χ², χ²-test.
<table>
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<tr>
<th></th>
<th>Normal</th>
<th>Presarcopenia</th>
<th>Sarcopenia</th>
<th>Severe sarcopenia</th>
<th>Kruskal Wallis test</th>
<th>Bonferroni test</th>
<th>P-value</th>
</tr>
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<tr>
<td>Age (years)</td>
<td>72.2 ± 5.0</td>
<td>72.9 ± 4.8</td>
<td>74.9 ± 4.9</td>
<td>78.5 ± 4.5</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
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<tr>
<td>Early elderly</td>
<td>300 (65.5)</td>
<td>105 (22.9)</td>
<td>45 (9.8)</td>
<td>8 (1.7)</td>
<td>&lt;0.001 (χ²)</td>
<td></td>
<td></td>
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<tr>
<td>Late elderly</td>
<td>145 (49.3)</td>
<td>64 (21.8)</td>
<td>51 (17.3)</td>
<td>34 (11.6)</td>
<td>&lt;0.001 (χ²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum albumin level (g/dL)</td>
<td>4.4 ± 0.3</td>
<td>4.4 ± 0.2</td>
<td>4.3 ± 0.2</td>
<td>4.2 ± 0.3</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMI (kg/m²)</td>
<td>9.1 ± 1.0</td>
<td>7.9 ± 0.7</td>
<td>7.8 ± 0.7</td>
<td>8.1 ± 0.7</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grip strength (kg)</td>
<td>26.5 ± 8.7</td>
<td>23.4 ± 6.2</td>
<td>19.4 ± 5.5</td>
<td>16.4 ± 5.2</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual walking speed (m/s)</td>
<td>1.4 ± 0.2</td>
<td>1.5 ± 0.2</td>
<td>1.2 ± 0.2</td>
<td>1.0 ± 0.2</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. existing teeth</td>
<td>20.8 ± 8.4</td>
<td>20.4 ± 8.8</td>
<td>17.3 ± 9.7</td>
<td>14.6 ± 10.5</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. functional teeth</td>
<td>27.0 ± 2.7</td>
<td>27.1 ± 2.9</td>
<td>27.0 ± 3.1</td>
<td>25.9 ± 5.5</td>
<td>0.505</td>
<td></td>
<td></td>
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<tr>
<td>Occusal force (N)</td>
<td>564 ± 347</td>
<td>543 ± 328</td>
<td>443 ± 316</td>
<td>337 ± 307</td>
<td>&lt;0.001</td>
<td></td>
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</tr>
<tr>
<td>Chewing ability</td>
<td>Good (3, 4, 5)</td>
<td>403 (62.4)</td>
<td>147 (22.8)</td>
<td>72 (11.3)</td>
<td>24 (3.7)</td>
<td>&lt;0.001 (χ²)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor (1, 2)</td>
<td>42 (39.6)</td>
<td>22 (20.8)</td>
<td>24 (22.6)</td>
<td>18 (17.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are mean ± SD, standard deviation; MG, Maintenance Group; DG, Decline Group; Early elderly, under 75 years old; Late elderly, upper 75 years old; SMI, Skeletal Muscle mass Index; N, Normal; P, Presarcopenia; S, Sarcopenia; SS, Severe Sarcopenia; χ² , χ²-test.
**Table 4.** Logistic regression analysis

Dependent variable; Cut off SSp at MG and DG

Independent variable; age (early elderly and late elderly), serum albumin level, number of existing teeth, occlusal force (evaluated by newton with dental prescale) and chewing ability (Divided the color changes of color-changeable gum into 5 stages, 1 and 2 with less color changes into Poor and 3, 4 and 5 with more color changes into Good)

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ( Early elderly = 0, Late elderly = 1)</td>
<td>2.46</td>
<td>(1.65-3.67)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Serum albmin level (/g/dL)</td>
<td>0.36</td>
<td>(0.17-0.76)</td>
<td>0.007</td>
</tr>
<tr>
<td>No. existing teeth (/tooth)</td>
<td>0.99</td>
<td>(0.97-1.02)</td>
<td>0.517</td>
</tr>
<tr>
<td>Occlusal force (/N)</td>
<td>1.00</td>
<td>(1.00–1.00)</td>
<td>0.046</td>
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<tr>
<td>Chewing ability (Good =0, Poor = 1)</td>
<td>2.32</td>
<td>(1.36-3.96)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Early elderly, under 75 years; Late elderly, upper 75 years old