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Author(s)	Kugimiya, Yoshihiro; Watanabe, Yutaka; Ueda, Takayuki; Motokawa, Keiko; Shirobe, Maki; Igarashi, Kentaro; Hoshino, Daichi; Takano, Tomofumi; Sakurai, Kaoru; Taniguchi, Yu; Kitamura, Akihiko; Shinkai, Shoji; Hirano, Hirohiko
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1 **Rate of Oral Frailty and Oral Hypofunction in Rural Community-Dwelling Older Japanese**

2 **Individuals**

3 RUNNING TITLE: Oral frailty and hypofunction in Japan

4 Yoshihiro Kugimiya¹, Yutaka Watanabe^{2,3}, Takayuki Ueda¹, Keiko Motokawa², Maki Shirobe⁴,

5 Kentaro Igarashi⁵, Daichi Hoshino⁶, Tomofumi Takano¹, Kaoru Sakurai¹, Yu Taniguchi⁷, Akihiko

6 Kitamura⁷, Shoji Shinkai⁸, Hirohiko Hirano²

7 ¹ Removable Prosthodontics and Gerodontology, Tokyo Dental College, Tokyo, Japan

8 ² Research Team for Promoting Independence and Mental Health, Tokyo Metropolitan Institute of

9 Gerontology, Tokyo, Japan

10 ³ Gerodontology, Department of Oral Health Science, Faculty of Dental Medicine, Hokkaido

11 University, Sapporo, Japan

12 ⁴ Action Research Center for Community Prevention of Frailty, Tokyo Metropolitan Institute of

13 Gerontology, Tokyo, Japan

14 ⁵ Removable Prosthodontics, Nihon University School of Dentistry at Matsudo, Chiba, Japan

15 ⁶ Special Needs Dentistry, Division of Community Based Comprehensive Dentistry, School of

16 Dentistry, Showa University, Tokyo, Japan

17 ⁷ Research Team for Social Participation and Health Promotion, Tokyo Metropolitan Institute of

18 Gerontology, Tokyo, Japan

1 ⁸ Vice director, Social Sciences and Human Care, Tokyo Metropolitan Institute of Gerontology, Tokyo,

2 Japan

3

4 Corresponding author:

5 Yutaka Watanabe

6 Gerodontology, Department of Oral Health Science, Faculty of Dental Medicine, Hokkaido University,

7 Nishi-7, Kita-13, Kita-ku, Sapporo 060-8586, Japan

8 E-mail: ywata@den.hokudai.ac.jp

9

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1 **ABSTRACT**

2 **Objective:** To clarify the rate of oral frailty and oral hypofunction in rural community-dwelling older
3 adults.

4 **Background:** Recently, in Japan, the oral function of older adults has been evaluated multilaterally
5 based on two concepts: oral frailty and oral hypofunction. Oral frailty is defined as a decrease in the
6 oral function accompanied by a decrease in mental and physical functions. Oral hypofunction is a
7 disease where the oral function is comprehensively decreased. However, their rates have not yet been
8 elucidated.

9 **Materials and methods:** Oral frailty and Oral hypofunction were evaluated in 679 older adults from
10 rural areas. To investigate the difference in occurrence rates due to the evaluation method, one of the
11 subordinate symptoms of oral hypofunction, the reduced occlusal force, was evaluated either using the
12 occlusal force method (main method) or the number of teeth (alternative method).

13 **Results:** The rate of oral frailty was 22.3% in males and 22.7% in females. The rate of oral
14 hypofunction was 39.0% in males and 46.9% in females. The overall rate of oral hypofunction was
15 43.6% when the reduced occlusal force of oral hypofunction was evaluated by the main method, and
16 46.4% when evaluated by the alternative method. The proportion of subjects with decreased occlusal
17 force, the number of present teeth, oral diadochokinesis, tongue pressure, and masticatory
18 performance increased with age in both males and females.

1 **Conclusion:** Among rural community-dwelling older adults, the rate of oral frailty was 22.5% and
2 oral hypofunction was 43.6%.

3

4 **Keywords:** Oral frailty, oral hypofunction, oral motor function, rural community dwellers

5

1 INTRODUCTION

2 It has been recently reported that a decrease in oral motor function is a risk factor for physical frailty,
3 sarcopenia, cognitive decline, and lower quality of life.¹⁻⁶ Since a decrease in oral function also
4 influences the general health of older adults, it is important to identify and treat older adults with
5 decreased oral function.

6 Recently, in Japan, the oral function of older adults has been evaluated multilaterally based on two
7 concepts that indicate oral function deterioration; the state of oral frailty and the disease of oral
8 hypofunction.^{1,7} As of 2019, oral frailty is defined in Japan as follows: a series of phenomena and
9 processes that lead to changes in various oral conditions (number of teeth, oral hygiene, oral functions,
10 etc.) associated with aging, and accompanied by decreased interest in oral health, reduced physical,
11 and mental reserve capacity, and an increase in oral frailty leading to eating dysfunction. This affects
12 frailty and leads to the deterioration of physical and mental function. As of 2019, oral hypofunction is
13 defined in Japan as follows: a disease in which the oral function is complexly reduced, not only by
14 aging but also by a variety of factors such as diseases and disorders.

15 Currently, oral frailty is diagnosed by the number of present teeth, chewing ability, articulatory oral
16 motor skill, tongue pressure, and subjective difficulties concerning eating and swallowing.¹ On the
17 other hand, oral hypofunction is diagnosed by oral hygiene, oral moisture, occlusal force, tongue-lip
18 motor function, tongue pressure, masticatory function, and the swallowing function.⁷ In addition,

1 among the evaluation components of oral hypofunction, oral moisture, occlusal force, masticatory
2 function, and swallowing function can be evaluated using two methods: main method or alternative
3 method.⁷ Oral frailty and oral hypofunction, both refer to a decrease in oral function but the evaluation
4 components and the origin of the two phenomena, are completely different.⁸

5 It was assumed that oral frailty was an early stage of oral hypofunction, which illustrated the
6 concept of oral hypofunction as of 2016.⁷ However, in a longitudinal study¹ published in 2018, the
7 lowest quintile among of the subjects was chosen as the cutoff value for oral frailty, resulting in a
8 discrepancy, with the cutoff values for oral hypofunction based on cross-sectional studies up to 2016.
9 Therefore, as of 2019, oral frailty is considered a separate concept⁸ rather than an early stage of oral
10 hypofunction.

11 A longitudinal study reported that oral frailty is a risk factor for physical frailty and mortality in
12 community-dwelling older adults.¹ On the other hand, the concept of oral hypofunction developed on
13 the basis of a cross-sectional study,⁷ has not yet been investigated in any longitudinal study and the
14 effects of oral hypofunction on the health of community-dwelling older adults remain largely unclear.

15 In addition, there is little evidence about the diagnostic criteria for oral hypofunction and the cut-off
16 values that define healthy individuals vs. individuals with oral hypofunction. In addition, it is unclear
17 what the rate of oral hypofunction in community-dwelling older adults is as well as a difference in the
18 rate when evaluated by the main and the alternative method. Therefore, we planned a two-stage study

1 design. The first stage, this study aimed to clarify the rate of oral hypofunction in community-dwelling
2 older adults. The second stage, we plan to conduct a longitudinal study using this study as a baseline.
3 In the longitudinal study, we will examine the cut-off value of each component of oral hypofunction
4 including when the nutritional status is an outcome, when the influence of the decrease in oral
5 function on the general health condition, and the background factors leading to the decrease in oral
6 function. We investigated the rate of oral frailty using the cut-off values from the Kashiwa study¹ as a
7 reference, in addition to the rate and the actual condition of oral function based on sex and age in this
8 study. The evaluations and the cut-off values used for defining oral hypofunction should be examined
9 in a longitudinal study. Hence, we investigated the actual state of oral function in rural
10 community-dwelling older adults who have lived in the same community for a while, without any
11 change in their environment.

12 The objectives of this study, which was the first stage, were (1) to clarify the rate of oral frailty and
13 oral hypofunction in rural community-dwelling older adults and their relationship, and (2) to clarify
14 the rate of oral hypofunction when examined by different methods of assessment.

15

1 **2 METHODS**

2 **2.1 Participants**

3 This study involved 2,478 adults living in the town of Kusatsu, Gunma Prefecture, aged 65 years or
4 older at the end of March 2019. A comprehensive health examination invitation was sent by mail to all
5 subjects. The health examination was conducted for five days in early July 2018 at the public health
6 center located in the town center. All participants were informed verbally and in writing about the
7 purpose and content of the health examination, and their consent to participate in the study was
8 obtained in writing. Among the participants who visited the health examination, those who did not
9 have their oral function examined at their own request were excluded. For participants who normally
10 wore removable dentures, oral examinations were performed while they wore their dentures. This
11 study was approved by the Ethics Committee of the Tokyo Metropolitan Institute of Gerontology
12 (Approval No. 3 in 2008, No. zin 15 in 2018). The STROBE (Strengthening the Reporting of
13 Observational Studies in Epidemiology) statement was reviewed and checked. Experiments were
14 carried out according to the tenets of the 1964 Helsinki declaration.

15 **2.2 Diagnostic items for oral frailty and oral hypofunction**

16 Oral frailty was diagnosed using six items: the number of present teeth, masticatory performance as
17 evaluated using color-changeable chewing gum, oral diadochokinesis (ODK) /ta/, tongue pressure,
18 and subjective difficulties concerning eating, and swallowing.¹ Oral hypofunction was diagnosed

1 using seven items: tongue coating index (TCI), oral moisture, occlusal force, the number of present
2 teeth, ODK /ta/, tongue pressure, masticatory performance as evaluated using a test gummy jelly, and
3 EAT-10.⁷

4 **2.3 Oral examinations**

5 Oral frailty and oral hypofunction were diagnosed from a multi-faceted based on dental status, oral
6 functions, and subjective difficulties. Oral examinations were performed by 10 dentists who were
7 trained in advance and adopted standardized evaluation criteria.

8 **2.3.1 Dental status**

9 For dental status, the number of present teeth, the number of artificial teeth, oral moisture, and the
10 degree of tongue coating were evaluated. Oral moisture was evaluated using the oral moisture checker
11 (Mucus, Life Co., Ltd., Saitama, Japan) for mucosal wetness in the central area of the tongue dorsum.⁹
12 The degree of tongue coating was evaluated using the TCI by visual inspection.¹⁰

13 **2.3.2 Oral functions**

14 For oral function, the occlusal force, tongue dexterity, tongue pressure, masticatory performance,
15 and swallowing function were evaluated objectively. The occlusal force was evaluated using a
16 pressure-sensitive sheet (Dental Prescale 50 H R type, Fuji Film Co., Tokyo, Japan).¹¹ The oral
17 diadochokinesis /ta/ was used to evaluate the tongue dexterity using an automatic counter
18 (KENKOU-KUN handy, Takei Scientific Instruments Co., Ltd., Niigata, Japan).¹² The pronunciation

1 of / ta / was repeated as fast as possible in one evaluation for 5 seconds, and the number of syllables
2 generated per second was calculated. Tongue pressure was evaluated using a tongue pressure
3 measurement device (JMS tongue pressure device, JMS Co., Ltd., Hiroshima, Japan).¹³ Masticatory
4 performance was evaluated using a color-changeable chewing gum (Masticatory Performance
5 Evaluating Gum XYLITOL, Lotte Co., Ltd., Tokyo, Japan)^{14,15} and a test gummy jelly (the test
6 gummy jelly, UHA Mikakuto Co., Ltd., Osaka, Japan.).^{15,16} The swallowing function was evaluated
7 using a self-administered questionnaire for swallowing screening (the 10-item Eating Assessment
8 Tool [EAT-10])¹⁷ and the repetitive saliva swallowing test (RSST).¹⁸

9 **2.3.3 Subjective difficulties**

10 Subjectively assessed difficulties concerning eating and swallowing were evaluated by two
11 questionnaires in the Kihon checklist questionnaire^{1,19} with the following questions: “Do you have any
12 difficulties eating tough foods compared to 6 months ago: Yes or No?”; and “Have you choked on your
13 tea or soup recently: Yes or No?”.

14 **2.4 Diagnosis of oral frailty**

15 As reported by Tanaka *et al.*, the cut-off values for the subordinate symptoms of oral frailty were the
16 number of present teeth (less than 20), masticatory performance evaluated on the a* axis using a
17 color-changeable chewing gum (males: < 14.2, females: < 10.8), ODK /ta/ (males: < 5.2 times/s,
18 females: < 5.4 times/s), tongue pressure (males: < 27.4 kPa, females: < 26.5 kPa), difficulties eating

1 tough foods (yes), and difficulties swallowing tea or soup (yes).¹ In this study, each item below the
2 cut-off value was regarded as one point. The total score of the following six items was taken as the oral
3 frailty score: the number of present teeth, chewing gum score (chewing ability), ODK (articulatory
4 oral motor skill), tongue pressure, difficulties eating tough foods, and difficulties in swallowing on tea
5 or soup.¹ An oral frailty score of 0 was defined as robust, a score of 1-2 points was defined as an oral
6 prefrailty, and a score of 3 or more points was defined as oral frailty.

7 2.5 Diagnosis of oral hypofunction

8 As reported by Minakuchi *et al.*, the cut-off values for the subordinate symptoms of oral
9 hypofunction were: TCI ($\geq 50\%$), oral moisture (< 27), occlusal force (< 200 N), the number of
10 present teeth (less than 20), ODK /ta/ (< 6 times/s), tongue pressure (< 30 kPa), masticatory
11 performance as evaluated using a test gummy jelly (score < 2), and EAT-10 (score ≥ 3).⁷ In this study,
12 each item below the cut-off value was regarded as one point. The total score of the following seven
13 items was calculated: TCI (poor oral hygiene), oral moisture (oral dryness), occlusal force (reduced
14 occlusal force), ODK (decreased tongue motor function), tongue pressure (decreased tongue pressure),
15 gummy jelly score (decreased masticatory function), and EAT-10 (deterioration of swallowing
16 function).⁷ A total score > 3 points was defined as an oral hypofunction. In addition, as a proposed
17 method for assessing the deterioration of the swallowing function, we examined the rate of RSST,
18 which is an evaluation of function by actual measurement (with ≤ 2 times/30 s as the cutoff value).¹⁸

1 **2.6 Other recorded variables**

2 To understand the characteristics of the subjects, the following parameters were also evaluated: grip
3 strength and gait speed,²⁰ skeletal muscle mass index (SMI),²¹ muscle mass using the body mass index
4 (BMI), Japan Science and Technology Agency index of competence (JST-IC),²² to assess competence,
5 geriatric depression scale (GDS)-short version²³ to assess depression, and mini-mental state
6 examination (MMSE)²⁴ to assess the cognitive state. These survey items were evaluated by 12 nurses
7 and clinical psychologists who were trained in advance and who adopted the standardized evaluation
8 criteria.

9 **2.7 Statistical analyses**

10 Nonparametric tests were used since the evaluated variables were not normally distributed. The
11 sex differences of continuous variables were analyzed using the Mann-Whitney U test and categorical
12 variables using the chi-squared test. The age-specific trends of oral functions were analyzed using the
13 Jonckheere-Terpstra and chi-squared tests. The Bonferroni correction was performed for the
14 Jonckheere-Terpstra test. All analyses were performed using IBM SPSS, version 25 (IBM Corp.,
15 Armonk, NY, USA). The significance level was set at 0.05.

16

1 **3 RESULTS**

2 Of the 2,478 adults, aged 65 or above and living in the town of Kusatsu, Gunma Prefecture, 769
3 (31.0%) visited the public health center and participated in a comprehensive health examination.
4 Among the participants, 90 adults (3.6%) who did not want oral function examinations were excluded.
5 Therefore, a total of 679 subjects (27.4%, 252 males and 397 females, mean age 76.3 ± 6.5 years) were
6 included in the analysis.

7 The subject characteristics are shown in Table 1. Significant differences were evaluated between the
8 males and females in TCI, occlusal force, tongue pressure, chewing gum score, gummy jelly score,
9 EAT-10 score, and RSST. The removable denture users constituted 61.2% of the study population. In
10 the other variables assessed, there were significant differences in handgrip strength, SMI, and BMI
11 between males and females. All the evaluation components that showed significant differences
12 between males and females yielded higher values or scores for males compared to females.

13 The oral frailty score and the number of subordinate symptoms of oral hypofunction are shown in
14 Figure 1. Of the 679 subjects, 61.9% (420 subjects) were classified as possessing oral prefrailty and
15 22.5% (153 subjects) were classified with oral frailty. The rate of oral prefrailty in males and females
16 was 58.5% (165 subjects) and 64.2% (255 subjects), respectively. The rate of oral frailty was 22.3%
17 (63 subjects) and 22.7% (90 subjects) in males and females, respectively. Two hundred and ninety-six
18 subjects (43.6% of the total study subjects), and specifically 110 males (39.0%) and 186 females

1 (46.9%), had an oral hypofunction. The rate of oral frailty and oral hypofunction exhibited a tendency
2 to increase with age in both sexes.

3 The rates of oral frailty and oral hypofunction are shown in Figure 2. One hundred and nineteen
4 subjects (17.5%) were classified with both, oral frailty and oral hypofunction, 34 subjects (5.0%) with
5 only oral frailty, and 117 subjects (26.1%) with oral hypofunction. Appendix A shows the rates of oral
6 frailty and oral hypofunction in males and females. The proportions of males and females with oral
7 frailty and both oral frailty and oral hypofunction were almost identical (5% of males vs. 5% of
8 females and 17.4% of males vs. 17.6% of females, respectively).

9 The values of the evaluation components and the corresponding rates of subordinate symptoms for
10 oral frailty and oral hypofunction in each age group are shown in Tables 2 and 3. Occlusal force, the
11 number of present teeth, ODK / ta /, tongue pressure, chewing gum score, gummy jelly score, EAT-10
12 score, and RSST tended to decrease with age. The least common subordinate symptom of oral frailty
13 was the chewing ability (12.5%; 85 subjects), and the most common was the number of present teeth
14 (55.1%; 374 subjects). The least common subordinate symptom of oral hypofunction was poor oral
15 hygiene (22.2%; 151 subjects), and the most common was the number of present teeth (55.1%; 374
16 subjects). Among the subordinate symptoms of oral frailty, the rate of the number of present teeth,
17 articulatory oral motor skill, and tongue pressure increased with age. On the other hand, the rate of
18 chewing ability and difficulty in eating tough foods did not show a clear increase with age. Among the

1 subordinate symptoms of oral hypofunction, the rate of reduced occlusal force, decreased tongue
2 motor function, decreased tongue pressure and decreased masticatory function, increased with age.
3 The rate of poor oral hygiene and oral dryness did not show a clear increase with age. As a result of
4 examining the sex separately, among the subordinate symptoms of oral frailty, the rates of the number
5 of present teeth, articulatory oral motor skill, and tongue pressure increased with age in both males and
6 females (see Appendices B-E). Among the subordinate symptoms of oral hypofunction, the rates of
7 reduced occlusal force decreased tongue motor function, decreased tongue pressure, and decreased
8 masticatory function increased with age in both males and females (see Appendices B-E).

9 Table 4 shows the rates of reduced occlusal force and deterioration of swallowing function, which
10 are subordinate symptoms of oral hypofunction. The reduced occlusal force was evaluated by the
11 recommended methods, namely the occlusal force and the number of present teeth. The deterioration
12 of the swallowing function was evaluated by RSST, in addition, to EAT-10, which is the recommended
13 method. The combination of the number of present teeth and EAT-10 was the most common, at 46.4%
14 (315 subjects). The combination of occlusal force and RSST was the least common, at 40.2% (273
15 subjects). In addition, the combination of the occlusal force and RSST was present in 33.7% of the
16 male subjects (95 subjects) and 44.8% of the female subjects (178 subjects).

1 **4 DISCUSSION**

2 Decreased oral function leads to the deterioration of the general health of individuals.¹⁻⁵ To maintain
3 the overall health condition of older adults, it is important to detect decreased oral function at an early
4 stage and take appropriate measures. The rate of decreased oral function in community-dwelling older
5 adults in Japan is not clear. We examined the rate of two phenomena, oral frailty, and hypofunction,
6 which are used to assess the oral function status in a multifaceted manner.

7 Older adults with less than 20 present teeth, constituted more than half of the males and females in
8 this study, and older adults who used removable dentures were very common. The measured handgrip
9 strength and gait speed, which represent the physical function, and the SMI of participants in our study
10 showed similar values when compared to those in another study²⁵ investigating Japanese adults with
11 similar age and sex ratios. In addition, the minimum value of the MMSE score was 14 and the
12 maximum value of the GDS-short score was 15. There were 21 subjects with MMSE score less than 24,
13 and 45 subjects with a GDS-short score of 10 or more. As shown by MMSE and GDS-short test results,
14 very few subjects had a serious cognitive function disorder or severe depression.

15 The occlusal force, the number of present teeth, ODK /ta/, tongue pressure, and the gummy jelly
16 score are known to decrease with age.^{5,26,27} The results of this study were similar to those of previous
17 reports, confirming that these evaluation items are factors that increase the rate of oral hypofunction
18 with age. In addition, it is reported that the number of present teeth affects the occlusal force and the

1 gummy jelly score.^{27,28} This suggests that the number of present teeth has a significant effect on the
2 rate of oral hypofunction. Therefore, it is necessary to consider the influence of age and the number of
3 present teeth in these evaluation items when conducting research on oral hypofunction. In this study,
4 TCI and oral moisture did not decrease with age. Our results are similar to other previous studies
5 which showed that the degree of tongue coating and xerostomia were not associated with age.^{29,30} As a
6 result, in the evaluation of swallowing function using subjective difficulty, EAT-10 and RSST, we did
7 not find any deterioration with age, in either males or females (see Appendices B-E). Dysphagia is
8 caused not only by aging but also by multiple other factors.³¹ Therefore, the influence of age on this
9 swallowing function was minimal.

10 Two evaluation methods, the main and the alternative methods, can be used in the evaluation of oral
11 hypofunction.⁷ In order to examine the differences in the rate of oral hypofunction due to differences
12 in evaluation methods, reduced occlusal force and swallowing difficulties were evaluated using
13 different evaluation methods.

14 The reduced occlusal force was evaluated using the occlusal force method, the main method, and by
15 counting the number of present teeth, the alternative method. When oral hypofunction was evaluated
16 using the main method, the rate was lower than when the alternative method was used. In addition, the
17 rate of oral hypofunction was different in males and females. A difference between the sexes in
18 occlusal force has been reported.^{1,25,32} Oral hypofunction is partially different from oral frailty based

1 on the factors evaluated and, as shown in Figure 2, does not necessarily detect the same individuals
2 with decreased oral function. In addition, unlike in oral frailty evaluation, the same oral cutoff values
3 in males and females have been used in diagnosing oral hypofunction. Therefore, while the rate of oral
4 frailty is almost the same in males and females, the results suggest that there is a difference in the rate
5 of oral hypofunction between them. It is necessary to examine the validity of using the same cutoff
6 values in regard to the factors evaluated and validate the differences in the rate of oral hypofunction in
7 the two sexes. The occlusal force is improved by performing appropriate prosthodontic treatments³³;
8 in other words, even if the number of present teeth is reduced, the occlusal force may not be
9 significantly decreased due to the prosthetic treatment. Therefore, in order to evaluate the current
10 actual occlusal force, it is more appropriate to evaluate the occlusal force rather than the number of
11 present teeth, that cannot be increased.

12 Functional evaluation may be different from the subjective and objective evaluation.^{30,34,35} Even in
13 the evaluation of swallowing function, divergence may occur between these evaluations. We, therefore,
14 evaluated the deterioration of swallowing using the EAT-10 by questionnaire and the RSST by actual
15 measurements. The EAT-10 results in this study are comparable to the results obtained in other studies
16 of community-dwelling older adults.³⁶ There is a weak correlation between EAT-10 and RSST.³⁷
17 EAT-10 is associated with oral hygiene and subjective symptoms, whereas RSST is known to be
18 associated with masticatory function and nutritional status.³⁷ EAT-10 and RSST are similarly

1 established swallowing screening tools, but the background factors, influencing their assessment, are
2 different. In this study, the RSST revealed a lower rate of oral hypofunction than that obtained using
3 EAT-10. In the future, it will be necessary to clarify what should be evaluated when screening for the
4 deterioration in the swallowing function including the background factors and consider combining the
5 EAT-10 with the RSST, or determining the appropriate test selection.

6 Oral frailty and oral hypofunction are usually not comparable; however, when the rates of the two
7 were compared, the rate of oral hypofunction (43.6%) was higher than that of oral frailty 22.5%. There
8 are several possible reasons for this. First, the cut-off values for the subordinate symptoms of oral
9 hypofunction were set at higher values for the same evaluation item than those used for oral frailty in
10 the Kashiwa Study¹ used as a reference. The higher the cut-off value, the higher the number of
11 applicable older adults, so the rate of oral hypofunction is considered to be higher than the oral frailty.
12 Second, it is thought that the difference in evaluation items has an influence on the difference between
13 the two rates. In oral hypofunction, in addition to the evaluation items similar to oral frailty, the oral
14 environment of poor oral hygiene and oral dryness was evaluated. Poor oral hygiene was 22.2% and
15 oral dryness was 27.1%, which is thought to have led to a rise in the rate of oral hypofunction. In
16 addition, an evaluation item that greatly differs in the rate between oral frailty and oral hypofunction is
17 a masticatory performance. Older adults with decreased masticatory performance accounted for
18 12.5% of oral frailty and 31.8% for oral hypofunction. The masticatory performance, that can be

1 objectively evaluated, is classified into crushing ability, mixing ability, and shearing ability.¹⁵ The
2 color-changeable chewing gum used in oral frailty represents the ability to mix food and saliva, and
3 the test gummy jelly used in oral hypofunction represents the ability to shear food. Both, the mixing
4 ability and the shearing ability, are a part of the masticatory performance and the number of present
5 teeth, occlusal force, tongue pressure, etc. affect both abilities; however, the influence of these factors ,
6 particularly the number of present teeth, on both the abilities is quite different.²⁸ There were older
7 adults whose shearing ability was decreased but mixing ability was not. Therefore, the ratio of those
8 who have a decreased masticatory performance due to oral frailty and oral hypofunction is quite
9 different. In order to prevent undernutrition in older adults, it is necessary to consider the stage and
10 evaluation method in order to identify older adults who are at risk of deteriorating nutritional status.

11 Currently, oral hypofunction has been diagnosed based on at least three out of the seven points. The
12 rate of oral hypofunction was 23.7% (161 subjects) for four points or more and 9.9% (67 subjects) for
13 five points or more when the number of subclinical symptoms diagnosed as hypofunction was
14 changed. Based on the rates presented here, it is necessary to examine the validity of the cut-off values
15 for the subordinate symptoms of oral hypofunction and the appropriate number of subordinate
16 symptoms for the diagnosis using longitudinal data, such as, for example, the occurrence of
17 undernutrition as an outcome.

18 Currently, in Japan, there are approximately 28 million adults aged 65 years or older who do not

1 require certification for long-term care³⁸ and are similar to the subjects in this study. Based on the
2 results of this study, the rate of oral frailty would 20% and the rate of oral hypofunction be 40%, which
3 accounts for approximately 5.6 million and 11.2 million older adults, who do not require any form of
4 medical care in Japan, that have oral frailty and oral hypofunction, respectively. There are
5 approximately 68,000 dental clinics in Japan.³⁹ Assuming that all independent older adults who are not
6 in need of nursing care, have chosen a dental clinic, each dental clinic will be responsible for 160
7 adults with an oral hypofunction. Currently, dental clinics mainly treat dental caries, periodontal
8 disease, and tooth defects. Evaluation of oral function has largely been overlooked. Conventional
9 dental treatment may have missed older adults with a decreased oral function.

10 Recently, through interventional studies on oral function, it is clear that oral functions such as tongue
11 coating, resting salivation, ODK, tongue pressure, RSST, and masticatory performance have
12 improved.⁴⁰⁻⁴⁵ Since a decrease in oral motor function leads to deterioration of general health, as future
13 prospects, oral function examinations should be carried out on all older adults in order to find and
14 promptly treat those with a decreased oral function.

15 The following limitations to our study need to be considered: First, the study was conducted on
16 those who visited the public health center for a health examination. Therefore, those with severely
17 reduced physical function were not included, limiting the generalizability of the results. However,
18 multifaceted assessments of oral function and treatment for decreased oral function are usually

1 performed at dental clinics and it is assumed that older adults presenting at dental clinics maintain their
2 physical function similar to subjects in our study. In this study, the proportion of old adults who can
3 independently visit the dental clinic for regular check-ups was also calculated and this result can be
4 considered when evaluating possible countermeasures for future cases of decreased oral function.
5 Second, as this study was conducted in only one area, the national rate could not be calculated. In the
6 future, the calculation of the rates in other areas will be required in order to clarify the characteristics
7 of oral function decrease and to accumulate evidence on issues such as the relationship between oral
8 function and general health.

9 This study clarified the rates of oral frailty and oral hypofunction in rural community-dwelling older
10 adults. We believe that the main results, i.e., 40% of the older adults were affected by oral
11 hypofunction, which will lead to a change in the awareness of not only the older adults themselves but
12 also the dentists. The decrease of oral function is complex; therefore, the oral function must be
13 evaluated from multiple perspectives. However, preferential evaluation of items with a high hit rate
14 shown in this study, that is items with a high risk of decrease, may lead to more efficient oral function
15 examination and a reduction in the burden on the subjects.

16 **5 CONCLUSIONS**

17 (1) Among rural community-dwelling older adults, the rate of oral frailty was 22.5% and that of oral
18 hypofunction was 43.6%: Hence the rate of oral hypofunction is higher than the oral frailty. The rates

1 of both oral frailty and hypofunction increased with age.

2 (2) The rate was 43.6% when the reduced occlusal force of oral hypofunction was evaluated by
3 using the occlusal force method (main method) and 46.4% when evaluated by the number of present
4 teeth (alternative method). The rate was 43.6% when swallowing deterioration is evaluated using the
5 main method, i.e. the EAT-10 method, and 40.2% when evaluated using the RSST, the probationary
6 alternative method.

7 This study presents baseline data that can be helpful when measures to treat decreased oral function
8 are considered.

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TABLES

Table 1. Characteristics of community-dwelling older adults in Japan who participated in the study

	Overall (n=679)	Males (n=282)	Females (n=397)	p-value
	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	
Age (years)	75, (70, 80)	75, (70, 79)	76, (71, 80)	0.055 ^a
TCI	16.7, (0, 38.9)	16.7, (0, 50)	11.1, (0, 33.3)	<0.001 ^{a*}
Oral moisture / H	28.5, (26.8, 29.8)	28.5, (27.0, 29.9)	28.4, (26.7, 29.8)	0.765 ^a
Occlusal force (N) / H	221.2, (104.3, 375.1)	268.1, (124.3, 444)	195.9, (92.6, 346.3)	<0.001 ^{a*}
Number of present teeth / F&H	18, (6, 25)	19, (6, 25)	17, (5, 24)	0.194 ^a
Number of artificial teeth	6, (0, 22)	6, (0, 21)	7, (0, 22)	0.381 ^a
ODK /ta/ (times/s) / F&H	6.2, (5.8, 6.6)	6.2, (5.6, 6.6)	6.2, (5.8, 6.8)	0.068 ^a
Tongue pressure (kPa) / F&H	29.0, (23.9, 33.6)	30.2, (25.1, 34.5)	28.4, (23.4, 33.1)	0.006 ^{a*}
Chewing gum score / F	18.1, (14.4, 22.3)	19.6, (15.7, 23.1)	17.5, (13.6, 21.5)	<0.001 ^{a*}
Gummy jelly score / H	4, (2, 6)	5, (2, 6)	4, (1, 6)	<0.001 ^{a*}
EAT - 10 score / H	0, (0, 3)	0, (0, 2)	0, (0, 3)	0.034 ^{a*}
RSST (times/30 s) / H	4, (3, 6)	5, (4, 6)	4, (3, 5)	<0.001 ^{a*}
Handgrip strength (kg)	24.0, (19.0, 31.0)	33.0, (28.8, 38.0)	20.0, (17.0, 23.2)	<0.001 ^{a*}
Gait speed (m/s)	78.9, (69.8, 88.2)	81.1, (71.4, 88.2)	78.9, (69.8, 85.7)	0.165 ^a
Skeletal muscle mass index (kg/m ²)	8.5, (7.9, 9.5)	9.6, (9.0, 10.1)	8.1, (7.6, 8.5)	<0.001 ^{a*}

Body mass index (kg/m ²)		22.8, (20.8, 25.0)	23.4, (21.3, 25.3)	22.4, (20.4, 24.5)	<0.001 ^{a*}
JST-IC score		13, (12, 13)	13, (11, 13)	13, (12, 13)	0.432 ^a
GDS-short score		3, (1, 5)	3, (1, 5)	3, (1, 5)	0.844 ^a
MMSE score		29, (28, 30)	29, (28, 30)	29, (28, 30)	0.548 ^a
		N, (%)	N, (%)	N, (%)	p-value
Difficulties eating tough foods	Yes	138, (20.3)	56, (19.9)	82, (20.7)	0.799 ^b
Difficulties swallowing tea or soup	Yes	172, (25.3)	68, (24.1)	104, (26.1)	0.539 ^b
Eichner index	A	180, (27.1)	81, (29.6)	99, (25.3)	0.480 ^b
	B	246, (37.0)	98, (35.8)	148, (37.9)	
	C	239, (35.9)	95, (34.7)	144, (36.8)	
Removable denture use	Yes	413, (61.2)	167, (59.9)	246, (62.1)	0.552 ^b

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test; JST-IC, Japan Science and Technology Agency Index of Competence; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; F, Evaluation items of oral frailty; H, Evaluation items of oral hypofunction; F&H, Evaluation items of oral frailty and oral hypofunction; Q1, First quartile; Q3, Third quartile

^aMann–Whitney U test

^bChi-squared test

* $p < 0.05$

Table 2. Values of the evaluation items for oral frailty and oral hypofunction in each age group

	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	85- (years)	p-value
Overall	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	
TCI / H	13.9, (0, 50.0)	16.7, (0, 33.3)	16.7, (0, 37.5)	16.7, (0, 50.0)	16.7, (11.1, 48.6)	0.150 ^a
Oral moisture / H	28.6, (13.9, 29.8)	28.6, (27.0, 29.9)	28.4, (26.7, 29.8)	28.5, (27.5, 29.6)	27.9, (26.0, 29.7)	0.340 ^a
Occlusal force (N) / H	275.7, (136.4, 397.6)	242.6, (134.7, 381.4)	244.3, (120.0, 384.7)	176.5, (75.2, 370.4)	108.1, (44.7, 212.6)	<0.001 ^{a*}
Number of present teeth / F&H	22, (16, 27)	21, (12, 25)	15, (4, 23)	8, (0, 24)	4, (0, 14)	<0.001 ^{a*}
ODK /ta/ (times/s) / F&H	6.4, (6.0, 7.0)	6.2, (5.8, 6.7)	6.2, (5.8, 6.6)	6.0, (5.4, 6.6)	5.8, (5.3, 6.4)	<0.001 ^{a*}
Tongue pressure (kPa) / F&H	31.8, (27.0, 36.9)	29.7, (25.0, 33.0)	29.2, (24.0, 34.2)	26.2, (20.6, 31.0)	24.5, (18.5, 29.0)	<0.001 ^{a*}
Chewing gum score / F	19.6, (14.7, 23.0)	19.9, (15.5, 23.3)	17.3, (13.6, 21.0)	18.0, (15.2, 21.6)	16.5, (13.2, 19.9)	<0.001 ^{a*}
Gummy jelly score / H	5, (4, 6)	5, (2, 6)	4, (2, 6)	4, (1, 6)	1, (0, 4)	<0.001 ^{a*}
EAT-10 score / H	0, (0, 2)	0, (0, 2)	0, (0, 3)	0, (0, 4)	1, (0, 3)	0.003 ^{a*}
RSST (time/30 s) / H	5, (3, 6)	5, (3, 6)	5, (3, 6)	4, (3, 5)	4, (3, 5)	<0.001 ^{a*}
	n, (%)	n, (%)	n, (%)	n, (%)	n, (%)	p-value
Difficulties eating tough foods (Yes) / F	24, (17.1)	29, (18.0)	43, (21.2)	29, (24.6)	13, (22.8)	0.552 ^b
Difficulties swallowing tea or soup (Yes) / F	27, (19.3)	39, (24.2)	56, (27.6)	32, (27.1)	18, (31.6)	0.316 ^b

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test; F, Evaluation items for oral frailty; H, Evaluation items for oral hypofunction; F&H, Evaluation items of oral frailty and oral hypofunction; Q1, First quartile; Q3, Third quartile

^a Jonckheere-Terpstra test, * $p < 0.005$

^b Chi-squared test, * $p < 0.05$

Table 3. Subordinate symptoms of oral frailty and oral hypofunction by age group

	Overall	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	≥85 (years)
	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)
Oral frailty						
Number of present teeth	374, (55.1)	50, (35.7)	73, (45.3)	124, (61.1)	78, (66.1)	49, (86.0)
Chewing ability / Chewing gum score	85, (12.5)	16, (11.4)	18, (11.2)	32, (15.8)	9, (7.6)	10, (17.5)
Articulatory oral motor skill / ODK /ta/	100, (14.7)	11, (7.9)	21, (13.0)	25, (12.3)	26, (22.0)	17, (29.8)
Tongue pressure	261, (38.4)	36, (25.7)	53, (32.9)	75, (36.9)	62, (52.5)	35, (61.4)
Difficulties eating tough foods	138, (20.3)	24, (17.1)	29, (18.0)	43, (21.2)	29, (24.6)	13, (22.8)
Difficulties swallowing tea or soup	172, (25.3)	27, (19.3)	39, (24.2)	56, (27.6)	32, (27.1)	18, (31.6)
Oral hypofunction						
Poor oral hygiene / TCI	151, (22.2)	35, (25.0)	24, (14.9)	45, (22.2)	33, (28.0)	14, (24.6)
Oral dryness / Oral moisture	184, (27.1)	37, (26.4)	42, (26.1)	58, (28.6)	23, (19.5)	24, (42.1)
Reduced occlusal force / Occlusal force	306, (45.1)	55, (39.3)	66, (41.0)	82, (40.4)	62, (52.5)	41, (71.9)
Reduced occlusal force / Number of present teeth	374, (55.1)	50, (35.7)	73, (45.3)	124, (61.1)	78, (66.1)	49, (86.0)
Decreased tongue motor function / ODK	214, (31.5)	23, (16.4)	42, (26.1)	63, (31.0)	52, (44.1)	34, (59.6)
Decreased tongue pressure / Tongue pressure	373, (54.9)	53, (37.9)	83, (51.6)	108, (53.2)	83, (70.3)	46, (80.7)
Decreased masticatory function / Gummy jelly score	216, (31.8)	25, (17.9)	40, (24.8)	64, (31.5)	47, (39.8)	40, (70.2)
Deterioration of swallowing function / EAT-10	177, (26.1)	31, (22.1)	31, (19.3)	59, (29.1)	40, (33.9)	16, (28.1)
Deterioration of swallowing function / RSST	73, (10.8)	14, (10.0)	16, (9.9)	18, (8.9)	18, (15.3)	7, (12.3)

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test.

Table 4. The rate of oral hypofunction calculated using different methods of assessment of reduced occlusal force and deterioration of swallowing function

Overall		Deterioration of swallowing function	
		EAT-10	RSST
Reduced occlusal force	Occlusal force	43.6%, (296)	40.2%, (273)
	Number of present teeth	46.4%, (315)	42.4%, (288)
Males			
Reduced occlusal force	Occlusal force	39.0%, (110)	33.7%, (95)
	Number of present teeth	44.3%, (125)	38.3%, (108)
Females			
Reduced occlusal force	Occlusal force	46.9%, (186)	44.8%, (178)
	Number of present teeth	47.9%, (190)	45.3%, (180)

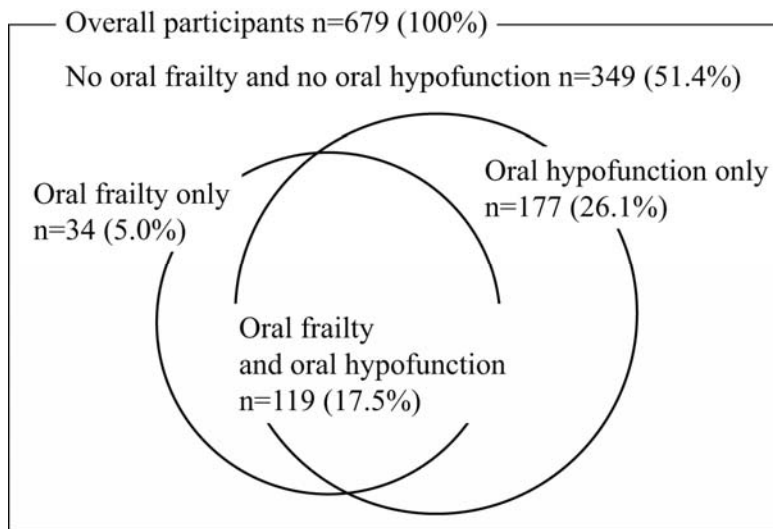
EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test

FIGURE LEGENDS

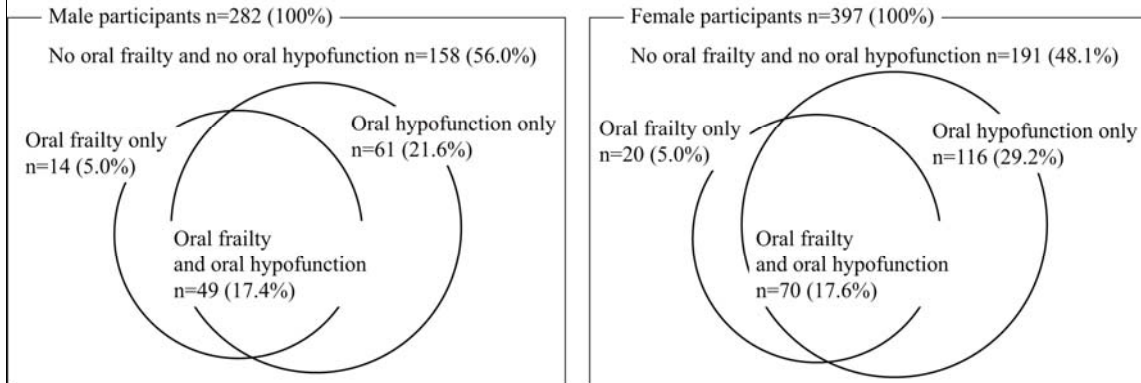
Figure 1: Subordinate symptoms of oral frailty and oral hypofunction.

Figure 2: Rates of oral frailty and oral hypofunction.

Figure 2



APPENDIX A: The incidence of oral frailty and oral hypofunction by sex.



APPENDIX B: Values of the evaluation components for oral frailty and oral hypofunction in males by age group.

	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	≥85 (years)	p-value
Males	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	
TCI / H	19.4, (0, 50.0)	16.7, (0, 33.3)	27.8, (0, 50.0)	22.2, (5.6, 50.0)	22.2, (11.1, 38.9)	0.179 ^a
Oral moisture / H	28.6, (19.4, 29.7)	28.8, (27.0, 30.0)	28.5, (27.2, 29.9)	28.6, (27.9, 29.9)	26.4, (23.9, 29.5)	0.483 ^a
Occlusal force (N) / H	312.7, (173.7, 501.6)	288.5, (176.7, 458.3)	264.5, (116.6, 448.8)	219.4, (93.1, 505)	126.4, (42.3, 256.3)	0.003 ^{a*}
Number of present teeth / F&H	23, (12, 27)	21, (11, 25)	15, (2, 25)	13, (1, 25)	6, (0, 15)	<0.001 ^{a*}
ODK (times/s) /ta/ / F&H	6.4, (6.0, 6.8)	6.2, (5.8, 6.6)	6.2, (5.6, 6.6)	5.8, (5.4, 6.4)	5.6, (5.1, 6.4)	<0.001 ^{a*}
Tongue pressure (kPa) / F&H	33.1, (28.2, 38.3)	30.4, (26.7, 34.1)	31.2, (26.9, 35.4)	25.8, (19.3, 30.8)	22.9, (17.7, 27.9)	<0.001 ^{a*}
Chewing gum score / F	20.3, (17.0, 23.6)	21.0, (15.9, 23.4)	18.5, (14.3, 22.1)	19.5, (16.4, 23.5)	16.1, (11.7, 22.6)	0.061 ^a
Gummy jelly score / H	6, (4, 7)	5, (3, 6)	5, (3, 6.5)	4, (2, 7)	1, (0, 4)	<0.001 ^{a*}
EAT-10 score / H	0, (0, 2)	0, (0, 1)	0, (0, 3)	0, (0, 5)	0, (0, 3)	0.115 ^a
RSST (times/30 s) / H	5, (4, 7)	5, (4, 7)	5, (4, 6)	5, (3, 6)	4, (3, 6)	0.062 ^a
	n, (%)	n, (%)	n, (%)	n, (%)	n, (%)	p-value
Difficulties eating tough foods (Yes) / F	11, (16.7)	11, (15.5)	15, (19.7)	15, (30.6)	4, (20.0)	0.305 ^b
Difficulties swallowing tea or soup (Yes) / F	10, (15.2)	17, (23.9)	24, (31.6)	11, (22.4)	6, (30.0)	0.226 ^b

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test; F, Evaluation items for oral frailty; H, Evaluation items for oral hypofunction; F&H, Evaluation items of oral frailty and oral hypofunction; Q1, First quartile; Q3, Third quartile

^a Jonckheere-Terpstra test, * $p < 0.005$

^b Chi-squared test, * $p < 0.05$

APPENDIX C: The age-related subordinate symptoms of oral frailty and oral hypofunction in males.

	Males	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	≥85 (years)
Oral frailty	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)
Number of present teeth	149, (52.8)	25, (37.9)	33, (46.5)	44, (57.9)	30, (61.2)	17, (85.0)
Chewing ability / Chewing gum score	48, (17.0)	9, (13.6)	11, (15.5)	17, (22.4)	5, (10.2)	6, (30.0)
Articulatory oral motor skill / ODK	34, (12.1)	5, (7.6)	8, (11.3)	6, (7.9)	10, (20.4)	5, (25.0)
Tongue pressure	96, (34.0)	14, (21.2)	20, (28.2)	20, (26.3)	28, (57.1)	14, (70.0)
Difficulties eating tough foods	56, (19.9)	11, (16.7)	11, (15.5)	15, (19.7)	15, (30.6)	4, (20.0)
Difficulties swallowing tea or soup	68, (24.1)	10, (15.2)	17, (23.9)	24, (31.6)	11, (22.4)	6, (30.0)
Oral hypofunction	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)
Poor oral hygiene / TCI	73, (25.9)	20, (30.3)	10, (14.1)	24, (31.6)	16, (32.7)	3, (15.0)
Oral dryness / Oral moisture	70, (24.8)	17, (25.8)	18, (25.4)	18, (23.7)	6, (12.2)	11, (55.0)
Reduced occlusal force / Occlusal force	104, (36.9)	20, (30.3)	23, (32.4)	28, (36.8)	20, (40.8)	13, (65.0)
Reduced occlusal force / Number of present teeth	149, (52.8)	25, (37.9)	33, (46.5)	44, (57.9)	30, (61.2)	17, (85.0)
Decreased tongue motor function / ODK	99, (35.1)	11, (16.7)	19, (26.8)	31, (40.8)	25, (51.0)	13, (65.0)
Decreased tongue pressure / Tongue pressure	137, (48.6)	23, (34.8)	32, (45.1)	30, (39.5)	34, (69.4)	18, (90.0)
Decreased masticatory function / Gummy jelly score	70, (24.8)	11, (16.7)	15, (21.1)	17, (22.4)	13, (26.5)	14, (70.0)
Deterioration of swallowing function / EAT-10	67, (23.8)	15, (22.7)	9, (12.7)	20, (26.3)	18, (36.7)	5, (25.0)
Deterioration of swallowing function / RSST	12, (4.3)	4, (6.1)	3, (4.2)	2, (2.6)	2, (4.1)	1, (5.0)

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test

APPENDIX D: Values of the evaluation items for oral frailty and oral hypofunction in females by age group.

	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	≥85 (years)	p-value
Females	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	Median, (Q1, Q3)	
TCI / H	11.1, (0, 33.3)	11.1, (0, 33.3)	16.7, (0, 33.3)	5.6, (0, 50.0)	16.7, (11.1, 50.0)	0.333 ^a
Oral moisture / H	28.6, (11.1, 29.8)	28.5, (26.9, 29.9)	28.3, (26.5, 29.8)	28.5, (27.1, 29.6)	28.1, (26.5, 29.8)	0.572 ^a
Occlusal force (N) / H	224.2, (117.0, 365.3)	203.0, (123.6, 364.8)	230.1, (123.2, 356.0)	155.4, (64.2, 314.2)	102.2, (49.0, 185.6)	<0.001 ^{a*}
Number of present teeth / F&H	21, (19, 26)	21, (12, 26)	15, (4, 23)	6, (0, 22)	3, (0, 11)	<0.001 ^{a*}
ODK (times/s) /ta/ / F&H	6.6, (6.1, 7.1)	6.3, (5.8, 6.8)	6.2, (5.8, 6.6)	6, (5.6, 6.6)	5.8, (5.3, 6.5)	<0.001 ^{a*}
Tongue pressure (kPa) / F&H	31.3, (25.6, 36.0)	29.3, (23.5, 32.6)	27.8, (22.4, 33.9)	26.6, (22.3, 31.1)	25.4, (18.8, 29.8)	<0.001 ^{a*}
Chewing gum score / F	17.6, (13.5, 22.2)	19.0, (14.6, 23.2)	16.8, (13.4, 20.2)	17.0, (14.5, 20.5)	16.6, (13.4, 18.3)	0.026 ^a
Gummy jelly score / H	5, (3, 6)	4, (2, 6)	4, (1, 6)	3, (1, 5)	2, (0, 4)	<0.001 ^{a*}
EAT-10 score / H	0, (0, 1.3)	0, (0, 2.3)	1, (0, 3)	1, (0, 3.5)	2, (0, 3)	0.021 ^a
RSST (times/30 s) / H	4, (3, 6)	4, (3, 5)	4, (3, 6)	3, (3, 5)	4, (3, 5)	0.011 ^a
	n, (%)	n, (%)	n, (%)	n, (%)	n, (%)	p-value
Difficulties eating tough foods (Yes) / F	13, (17.6)	18, (20.0)	28, (22.0)	14, (20.3)	9, (24.3)	0.923 ^b
Difficulties swallowing tea or soup (Yes) / F	17, (23)	22, (24.4)	32, (25.2)	21, (30.4)	12, (32.4)	0.737 ^b

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test; F, Evaluation items for oral frailty; H, Evaluation items for oral hypofunction; F&H, Evaluation items for oral frailty and oral hypofunction; Q1, First quartile; Q3, Third quartile

^a Jonckheere-Terpstra test, * $p < 0.005$

^b Chi-squared test, * $p < 0.05$

APPENDIX E: The age-related subordinate symptoms of oral frailty and oral hypofunction in females.

	Females	65-69 (years)	70-74 (years)	75-79 (years)	80-84 (years)	≥85 (years)
	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)	(n, %)
Oral frailty						
Number of present teeth	225, (56.7)	25, (33.8)	40, (44.4)	80, (63)	48, (69.6)	32, (86.5)
Chewing ability / Chewing gum score	37, (9.3)	7, (9.5)	7, (7.8)	15, (11.8)	4, (5.8)	4, (10.8)
Articulatory oral motor skill / ODK /ta/	66, (16.6)	6, (8.1)	13, (14.4)	19, (15)	16, (23.2)	12, (32.4)
Tongue pressure	165, (41.6)	22, (29.7)	33, (36.7)	55, (43.3)	34, (49.3)	21, (56.8)
Difficulties eating tough foods	82, (20.7)	13, (17.6)	18, (20.0)	28, (22.0)	14, (20.3)	9, (24.3)
Difficulties swallowing tea or soup	104, (26.2)	17, (23)	22, (24.4)	32, (25.2)	21, (30.4)	12, (32.4)
Oral hypofunction						
Poor oral hygiene / TCI	78, (19.6)	15, (20.3)	14, (15.6)	21, (16.5)	17, (24.6)	11, (29.7)
Oral dryness / Oral moisture	114, (28.7)	20, (27.0)	24, (26.7)	40, (31.5)	17, (24.6)	13, (35.1)
Reduced occlusal force / Occlusal force	202, (50.9)	35, (47.3)	43, (47.8)	54, (42.5)	42, (60.9)	28, (75.7)
Reduced occlusal force / Number of present teeth	225, (56.7)	25, (33.8)	40, (44.4)	80, (63.0)	48, (69.6)	32, (86.5)
Decreased tongue motor function / ODK /ta/	115, (29.0)	12, (16.2)	23, (25.6)	32, (25.2)	27, (39.1)	21, (56.8)
Decreased tongue pressure / Tongue pressure	236, (59.4)	30, (40.5)	51, (56.7)	78, (61.4)	49, (71.0)	28, (75.7)
Decreased masticatory function / Gummy jelly score	146, (36.8)	14, (18.9)	25, (27.8)	47, (37.0)	34, (49.3)	26, (70.3)
Deterioration of swallowing function / EAT-10	110, (27.7)	16, (21.6)	22, (24.4)	39, (30.7)	22, (31.9)	11, (29.7)
Deterioration of swallowing function / RSST	61, (15.4)	10, (13.5)	13, (14.4)	16, (12.6)	16, (23.2)	6, (16.2)

TCI, Tongue Coating Index; ODK, Oral Diadochokinesis; EAT-10, 10-Item Eating Assessment Tool; RSST, Repetitive Saliva Swallowing Test