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Prevalence of oral frailty and its association with dietary variety, social engagement, and physical frailty: Results from the Oral Frailty 5-item Checklist

RUNNING TITLE: The Oral Frailty 5-item Checklist

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ABSTRACT

Aim: This cross-sectional study had two aims: to assess the prevalence of oral frailty (OF), according to the Oral Frailty 5-item Checklist (OF-5), among community-dwelling older adults and to examine the associations among oral frailty, dietary variety, social engagement, and physical frailty.

Methods: We pooled data from two population-based studies (the Otassha Study and the Itabashi Longitudinal Study on Aging). With the OF-5, OF is characterized by the presence of two or more of the following: (i) fewer teeth, (ii) difficulty in chewing, (iii) difficulty in swallowing, (iv) dry mouth, and (v) low articulatory oral motor skills. We calculated the OF prevalence for each sex. We assessed dietary variety, social engagement, and physical frailty. Generalized structural equation modeling was employed to investigate the associations among oral frailty, low dietary variety (dietary variety score $\leq$ 3), social isolation (Lubben Social Network Scale score $<$ 12), and physical frailty (Japanese version of the Cardiovascular Health Study score $\geq$ 3).

Results: A total of 1,206 individuals (626 women and 580 men) with a mean age of 74.7 years were included. The prevalence of OF was 36.7%, and it increased with age; however, there was no significant sex difference. OF was significantly indirectly associated with physical frailty via low dietary variety (odds ratio [OR]=1.43, 95% confidence interval [CI]=1.04–1.97) and social isolation (OR=1.42, 95% CI=1.04–1.94).

51 **Conclusions:** Two out of five community-dwelling older adults exhibited OF. Low dietary
52 variety and social isolation are potential underlying mechanisms through which OF is indirectly
53 associated with physical frailty.

54

55 **KEYWORDS:** dietary intake; frailty; oral function; public health; social isolation

56

INTRODUCTION

Maintaining good oral health later in life is important for general health and social well-being.¹⁻⁶ Oral health refers not only to the number of teeth present and the level of oral hygiene but also to functions such as chewing, swallowing, saliva secretion, and articulatory oral motor skills.⁷ Accumulated impairments in multiple oral health aspects and functions have been termed “oral frailty”.⁸ One of the aims of defining this concept is to increase the number of older adults who are aware of their oral conditions.^{8,9} While promoting public awareness of oral frailty and multidisciplinary cooperation in this line of research is key, a simple assessment of oral function is lacking. Such an assessment is crucial for implementing community-wide assessments and interventions for oral frailty.^{8,10} In 2023, we developed the Oral Frailty 5-item Checklist (OF-5) as a simple tool for this purpose.¹¹ The OF-5 consists of 5 criteria for oral frailty: (i) fewer teeth, (ii) difficulty in chewing, (iii) difficulty in swallowing, (iv) dry mouth, and (v) low articulatory oral motor skills. In the Kashiwa Study, where the OF-5 was first operationally defined, low articulatory oral motor skills (a component of the OF-5) were determined based on objective indicators, i.e., measuring the repetitive articulatory rate or oral diadochokinesis (oral DDK).¹¹ Although oral DDK is a reliable measure of articulatory oral motor skills,^{7,8,12} oral DDK measurement requires specific devices; therefore, it can be performed only in limited places/situations, such as dental institutions and community-based epidemiological studies.

75 There was a need to develop a self-report measure for articulatory oral motor skills. The main
76 advantage of self-report measures is that they are relatively simple ways to assess oral function
77 in a time- and cost-effective manner. In response to such a request, we recently developed a
78 single-item self-report measure of articulatory oral motor skills and demonstrated its validity.¹³
79 With these approaches, all of the components of the OF-5 can be assessed via self-reports;
80 therefore, the OF-5 enables oral frailty assessment outside dental healthcare settings in
81 community activities and self-evaluations by older adults.

82 A recent study demonstrated that oral frailty (assessed with the OF-5) was associated
83 with an increased risk of physical frailty in Japanese older adults.¹¹ The possible mechanisms
84 underlying this association are an unhealthy diet (such as low dietary variety) and social isolation
85 due to poor oral health and function.¹⁴⁻¹⁸ However, to date, the associations of oral frailty
86 (assessed with the OF-5) with dietary variety, social engagement, and physical frailty have not
87 been fully investigated.

88 The present cross-sectional study had two aims: first, to determine the prevalence of oral
89 frailty (assessed with the OF-5) among Japanese community-dwelling older adults; and second,
90 to examine the associations among oral frailty, dietary variety, social engagement, and physical
91 frailty. Our hypothesis was that oral frailty is indirectly associated with physical frailty via low
92 dietary variety and social isolation.

93

94 **METHODS**

95

96 **Design, setting, and participants**

97 This study analyzed data from two cohort studies: the Otassha Study and the Itabashi

98 Longitudinal Study on Aging (I-LSA). Both studies included community-dwelling adults aged

99 ≥ 65 years who were listed in the basic resident register of areas surrounding the Tokyo

100 Metropolitan Institute for Geriatrics and Gerontology in the Itabashi ward of northwest Tokyo,

101 Japan. The designs and protocols of the studies have been described elsewhere.^{19,20} Both studies

102 mailed surveys to the participants and performed on-site comprehensive geriatric assessments.

103 The variables included in the OF-5 were assessed in 2022; therefore, the data collected in 2022

104 were extracted and analyzed in the present study.

105 Participants without missing data were eligible for inclusion in this study. The Otassha

106 Study and the I-LSA were conducted in full accordance with the ethical principles of the

107 Declaration of Helsinki and were approved by the Ethics Committee of the Tokyo Metropolitan

108 Institute for Geriatrics and Gerontology. All participants provided written informed consent prior

109 to participating.

Given that the current study was a secondary study of data from the 2022 waves of the Otassha Study and the I-LSA, no sample size calculations were conducted. All available participants who met the eligibility criteria were included in the study.

Assessment of oral frailty using the OF-5

The OF-5 (Tables S1 and 2)¹¹ consists of the following five components. (i) “Fewer teeth” is indicated by a response of “0–19 teeth” to the question “How many of your natural teeth are left?”. (ii) “Difficulty in chewing” is indicated by a response of “yes” to the question “Do you have any difficulties eating tough foods compared to 6 months ago?”. (iii) “Difficulty in swallowing” is indicated by a response of “yes” to the question “Have you choked on your tea or soup recently?”. (iv) “Dry mouth” is indicated by a response of “yes” to the question “Do you often experience having a dry mouth?”. (v) “Low articulatory oral motor skills” is indicated by a response of “yes” to the question “Have you had a difficulty in clear pronunciation recently?”.¹³ Each component is allocated one point if present. The overall OF-5 score ranges from 0 to 5 (0 = best to 5 = worst) and indicates the presence (2 to 5 points) or absence (0 or 1 point) of oral frailty.¹¹

Assessments of dietary variety, social engagement, and physical frailty

128 The dietary variety of participants was assessed using the dietary variety score (DVS).²¹ Low
129 dietary variety was defined as a DVS score ≤ 3 .^{22,23}

130 Participants' social engagement was assessed using the Japanese version of the Lubben
131 Social Network Scale (LSNS-6).^{24,25} We defined social isolation as an LSNS-6 score < 12 .²⁵

132 Physical frailty was assessed using the Japanese version of the Cardiovascular Health
133 Study (J-CHS) criteria.²⁶ Participants with a J-CHS score ≥ 3 were defined as exhibiting physical
134 frailty.²⁶

135 A more detailed explanation of the assessments of dietary variety, social engagement, and
136 physical frailty is provided in the supporting information.

137

138 **Covariate data collection**

139 Data on age, sex, years of education, smoking status (never, former, or current), drinking habits
140 (never, former, or current), and living arrangements (living alone or with others) were obtained
141 via a questionnaire.

142 Cognitive status was assessed using the Japanese version of the Mini Mental State
143 Examination (MMSE-J),²⁷ which was administered by qualified examiners. Cognitive
144 impairment was defined as an MMSE-J score ≤ 23 .

145 Trained nurses collected comorbidity data (hypertension, heart disease, stroke, diabetes

mellitus, dyslipidemia, osteoporosis, chronic obstructive pulmonary disease, and cancer) during medical interviews. According to a previous study,²⁸ the number of comorbidities was included in the analyses.

Statistical analyses

First, we calculated descriptive statistics (medians [25th–75th percentiles] for continuous variables without a normal distribution, means [standard deviations] for continuous variables with a normal distribution, and numbers and percentages for categorical variables) of the study population characteristics. Comparisons of study population characteristics between groups with and without oral frailty were made using Student's t test, the Mann–Whitney U test, and the chi-squared test, as appropriate. Second, we tabulated the prevalence of oral frailty in each 5-year age group (65–69, 70–74, 75–79, and ≥80 years) for each sex. Because only 49 (4.1%) participants were aged ≥85 years, they were combined into the ≥80 years category. We performed the Cochran–Armitage test to evaluate linear trends in the prevalence of oral frailty across age groups within each sex. We also examined sex differences in oral frailty within each 5-year age group using the χ^2 test.

Finally, associations among oral frailty, low dietary variety, social isolation, and physical frailty were examined. We constructed the hypothesized model based on plausible associations

among oral frailty, low dietary variety, social isolation, and physical frailty (Figure 1).^{2,7,8,18,29-32}

This mediation model consisted of 4 variables: oral frailty as an independent variable, low dietary variety and social isolation as mediator variables, and physical frailty as an outcome variable. Before the mediation analyses, individual associations among the exposure, mediators, and outcome were assessed using multivariable logistic regression analysis. Multivariable models were adjusted for the following variables (determined based on prior knowledge of the associations among oral frailty, low dietary variety, social isolation, and physical frailty^{2,7,8,18,29-32}): age, sex, educational level, smoking status, drinking habits, living arrangements, cognitive function, and number of comorbidities. Because the current investigation analyzed pooled data from two cohort studies, the random effects of cohort were tested by applying a multilevel model. Furthermore, effect modification by sex was evaluated by adding interaction terms to the regression models.

To investigate the direct (Path A in Figure 1) and indirect (Paths BC and DE in Figure 1) effects of oral frailty on physical frailty, mediation analysis was performed using generalized structural equation modeling (GSEM) with a binomial family and a logit link. Odds ratios (ORs) were calculated to represent the directions and strengths of the estimated effects. Bias-corrected standard errors of the effects were calculated using a bootstrapping approach with 1,000 resamples. No model fit statistics were calculated for our model because the observed exogenous

variables were conditioned. As a sensitivity analysis, we estimated the direct and indirect effects of oral frailty on physical frailty among those without severe cognitive impairment (defined as an MMSE-J score $<18^{33}$).

Analyses were performed with the statistical software package STATA, version 18.0 (StataCorp, College Station, USA). The significance threshold was set to 0.05. Given the multiple comparisons (tests for sex differences in oral frailty prevalence according to 5-year age groups), the significance threshold was adjusted by the Bonferroni method to prevent type I errors.

RESULTS

Study population

In total, 1,277 individuals (623 from the Otassha Study and 654 from the I-LSA) completed the survey. We excluded 71 of these individuals (43 from the Otassha Study and 28 from the I-LSA) because of missing data. The remaining 1,206 individuals (626 women and 580 men, with a mean [standard deviation] age of 74.7 [5.5] years) were included in the present analysis.

Table 1 presents the study participants' characteristics. Overall, the prevalence of oral frailty, low dietary variety, social isolation, and physical frailty were 36.7%, 46.4%, 34.6%, and 6.4%, respectively. Oral frailty was associated with low dietary variety, social isolation, physical

frailty, advanced age, lower education level, drinking habits, cognitive impairment, and a greater number of comorbidities.

Prevalence of oral frailty according to age and sex

Table 2 presents the prevalence of oral frailty according to age and sex. The oral frailty prevalences for individuals aged 65–69, 70–74, 75–79, and ≥ 80 years in the overall population were 33.2%, 31.9%, 40.0%, and 44.3%, respectively. For male participants, the corresponding values were 28.4%, 30.0%, 42.7%, and 43.8%, respectively. For female participants, the corresponding values were 35.9%, 33.9%, 36.8%, and 44.7%, respectively. In the overall population and among male participants, there were significant upward trends in oral frailty prevalence with increasing age ($p < 0.01$). Upward trends in oral frailty prevalence with increasing age among female participants approached our significance threshold ($p = 0.09$). Sex differences in oral frailty prevalence were not observed in any of the age groups.

Associations among oral frailty, dietary diversity, social engagement, and physical frailty

Table 3 shows the results of the multivariable logistic regression analyses. No significant random effects due to cohort were observed (p values of the likelihood ratio tests > 0.05); therefore, a single-level model was used. Furthermore, there was no significant effect of the

interactions of oral frailty, low dietary variety, or social isolation with sex (p values of the interaction terms > 0.05); therefore, sex stratification was not performed. After adjusting for age, sex, educational level, smoking status, drinking habits, living arrangements, cognitive function, and the number of comorbidities, oral frailty was significantly associated with low dietary variety (OR = 1.61, 95% confidence interval [CI] = 1.25 to 2.07) and social isolation (OR = 1.55, 95% CI = 1.20 to 2.01). Low dietary variety (OR = 2.26, 95% CI = 1.34 to 3.81) and social isolation (OR = 2.35, 95% CI = 1.44 to 3.86) significantly increased the odds of physical frailty.

The indirect, direct, and total effects of oral frailty on physical frailty are shown in Table 4. The indirect effect (Path BC in Figure 1) of oral frailty on physical frailty, mediated by low dietary variety, was significant (OR = 1.43, 95% CI = 1.04 to 1.97). The indirect effect (Path DE in Figure 1) of oral frailty on physical frailty, mediated by social isolation, was also significant (OR = 1.42, 95% CI = 1.04 to 1.94). These associations were independent of age, sex, and other covariates. There was no significant direct effect of oral frailty on physical frailty (Path A in Figure 1). As shown in Table S3, exclusion of study participants whose MMSE-J scores were <19 did not significantly attenuate the associations among oral frailty, dietary variety, social engagement, and physical frailty.

DISCUSSION

In this study, we first investigated the prevalence of oral frailty (assessed with the OF-5) in a large-scale, pooled sample of community-dwelling Japanese older adults. The oral frailty prevalence in the overall population was 36.7%, and it increased with advancing age. There was no significant sex difference in oral frailty prevalence (in men, 36.0%; in women, 37.4%).

Second, we examined the associations among oral frailty, dietary variety, social engagement, and physical frailty. The GSEM results indicated that oral frailty was indirectly associated with physical frailty and that low dietary variety and social isolation mediated this association.

There is another tool for oral frailty assessment: the Oral Frailty Index (OFI-8).⁹ The OFI-8 is an eight-item screening questionnaire that assesses oral health-related behaviors and frailty concepts. The OFI-8 contains questions not directly related to the oral cavity (i.e., “Do you go out less frequently than you did last year?”). In addition, each of the 8 components is not equally weighted; therefore, attention should be given to OFI-8 scoring. Compared to the OFI-8, the OF-5 is simpler (i.e., each of the 5 components has an equally weighted score) and is therefore easier to implement. Moreover, the OF-5 covers broader aspects of oral function including social function of oral cavity (oral motor skills that are important for communicating with others). Overall, the OF-5 is recommended for use in future interprofessional work to prevent oral frailty. The application of the OF-5 can lead to older adults’ early recognition of minor declines in their oral function and proactive consultation with health professionals.

Moreover, the application of the OF-5 enables health professionals to make early contact with individuals at greater risk for oral function decline, recommend them for health checkups, and refer them to community gathering places such as "Kayoinoba."

Previous studies have demonstrated that older adults with poor oral health and function tend to avoid hard-to-chew foods such as vegetables, fruits, and meat, which generally contain rich nutrients.³⁴⁻³⁶ Avoidance of these foods can lead to low dietary variety. A previous study demonstrated that older adults with oral frailty were more likely to have low dietary variety.² Moreover, the mouth is used for social communication functions such as speaking with others and expressing emotions.³⁷ We assume that adults with difficulties communicating due to low articulatory oral motor skills have difficulties in social engagement. Furthermore, tooth loss can have negative effects on both social interaction skills and orofacial appearance.^{18,29,38,39} Studies have demonstrated that older adults with severe tooth loss tend to feel embarrassed and avoid face-to-face social interaction, including smiling, speaking, and eating,⁴⁰⁻⁴² which can lead to a reduction in social activities.^{18,29,30} Previous studies have demonstrated that poor oral health and oral health problems are associated with low social engagement.^{16-18,43} Overall, oral frailty, a state of accumulated impairments in multiple oral health aspects and functions, may pose a barrier to a healthy diet (including a variety of foods) and social engagement.

A diverse diet ensures an adequate and balanced supply of nutrients,²³ which plays a key

role in the prevention and management of physical frailty.⁴⁴ Moreover, socially isolated older adults are prone to reduced physical activity and greater sedentary time^{45,46}; such inactivity can increase the risk of physical frailty.⁴⁷ In fact, studies have demonstrated that both low dietary variety³¹ and social isolation³² are associated with physical frailty. Considering the above evidence of associations among oral frailty, dietary variety, social engagement, and physical frailty, it is reasonable that our mediation analysis indicated that low dietary variety and social isolation are potential underlying mechanisms by which oral frailty is indirectly associated with physical frailty among community-dwelling older adults.

This study has several limitations. First, although a hypothetical causal path was confirmed in our GSEM, this study had a cross-sectional design, which prevented us from assessing the temporality of associations. Collecting prospective data on associations among oral frailty, dietary variety, social engagement, and physical frailty is an important next step. Second, we did not determine whether other potential confounders, such as income, influenced the observed associations.

The current study analyzed data collected from individuals who lived in one specific area of Japan (i.e., Tokyo) and who voluntarily participated in the survey. Although the observed prevalences of oral frailty, social isolation, and physical frailty were similar to those reported in previous studies,^{20,48,49} the prevalence of low dietary variety (46.4%) was greater than that

reported in a previous study (28.6%).^{22,50} One potential explanation for this discrepancy is that the previous study^{22,50} had a longitudinal design and excluded participants with frailty at baseline from the investigation. However, further studies are needed to verify whether the present findings can be applied to a broader population.

In conclusion, we demonstrated that 2 out of 5 Japanese community-dwelling older adults exhibited oral frailty according to the OF-5 and that oral frailty is significantly indirectly associated with physical frailty via low dietary variety and social isolation.

AUTHOR CONTRIBUTIONS

Research conception and study design, data analysis and interpretation: M.I., T.T., T.U., K. Ikebe, K. Iijima and H.H. Statistical analysis: M.I. Data acquisition: M.I., M.S., and K.M. Supervision: S.M., M.A., H.A., K. Iijima, H.S., S.O., and H.H. Each author made important intellectual contributions during manuscript drafting or revision and is accountable for the overall work, ensuring that questions pertaining to the accuracy and integrity of any portion of the work are appropriately investigated and resolved. M.I. is responsible for the honest, accurate, and transparent reporting of this study, ensuring that no important aspects of the study have been omitted and ensuring that any discrepancies from the study as planned have been explained.

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312

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318

319 **CONFLICT OF INTEREST DISCLOSURE**

320 M.A. received research grants from Bayer HealthCare, Chugai Pharmaceutical, Daiichi Sankyo,
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323 The other authors declare that they have no conflicts of interest to disclose.

324

325 **DATA AVAILABILITY STATEMENT**

326 The data are not publicly available due to ethical and legal restrictions imposed by the ethics
327 committee of the Tokyo Metropolitan Institute for Geriatrics and Gerontology (the data include
328 potentially identifying or sensitive patient information). The data may be made available from
329 the corresponding author upon request.

330

331 **ETHICS APPROVAL STATEMENT**

332 The present study was conducted in full accordance with the ethics principles of the Declaration
333 of Helsinki and was approved by the ethics committee of the Tokyo Metropolitan Institute for
334 Geriatrics and Gerontology (approval number, R21-06; approval date, August 27, 2021 for the
335 Otassha Study; approval number, R21-056; approval date, January 21, 2022 for the I-LSA).

336

337 **INFORMED CONSENT STATEMENT**

338 All the study participants provided written informed consent prior to being included in the study.

339

340 **CLINICAL TRIAL REGISTRATION**

341 n/a

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491 **TABLES**

492 **Table 1.** Participant characteristics according to the presence of oral frailty

	Total	Oral frailty		
	N=1,206	Absence	Presence	p value [§]
	N=763	N=443		
OF-5 score [‡]	1 (0-2)	0 (0-1)	2 (2-3)	<0.01
OF-5 components [†]				
Fewer teeth	334 (27.7%)	116 (15.2%)	218 (49.2%)	<0.01
Difficulty in chewing	279 (23.1%)	35 (4.6%)	244 (55.1%)	<0.01
Difficulty in swallowing	355 (29.4%)	78 (10.2%)	277 (62.5%)	<0.01
Dry mouth	321 (26.6%)	88 (11.5%)	233 (52.6%)	<0.01
Low articulatory oral motor skills	207 (17.2%)	38 (5.0%)	169 (38.1%)	<0.01
Low dietary variety [†]	560 (46.4%)	318 (41.7%)	242 (54.6%)	<0.01
Social isolation [†]	417 (34.6%)	232 (30.4%)	185 (41.8%)	<0.01
Physical frailty [†]	77 (6.4%)	39 (5.1%)	38 (8.6%)	0.02
Age [*]	74.7 (5.5)	74.3 (5.4)	75.3 (5.6)	<0.01
Sex [†]				0.63
Female	626 (51.9%)	392 (51.4%)	234 (52.8%)	
Male	580 (48.1%)	371 (48.6%)	209 (47.2%)	
Years of education [‡]	14 (12-16)	14 (12-16)	12 (12-16)	<0.01
Smoking status [†]				0.19
Never	722 (59.9%)	468 (61.3%)	254 (57.3%)	
Former	392 (32.5%)	244 (32.0%)	148 (33.4%)	
Current	92 (7.6%)	51 (6.7%)	41 (9.3%)	
Drinking habits [†]				0.01
Never	467 (38.7%)	287 (37.6%)	180 (40.6%)	
Former	119 (9.9%)	62 (8.1%)	57 (12.9%)	
Current	620 (51.4%)	414 (54.3%)	206 (46.5%)	
Living alone [†]	317 (26.3%)	189 (24.8%)	128 (28.9%)	0.12
Cognitive impairment [†]	63 (5.2%)	28 (3.7%)	35 (7.9%)	<0.01
Number of comorbidities [‡]	1 (1-2)	1 (1-2)	2 (1-3)	<0.01

493 [†]Presented as n (%).

494 ‡Presented as the median (25th–75th percentile).

495 *Presented as the mean (standard deviation).

496 §P values for comparisons of study population characteristics between groups with and without
497 oral frailty were calculated using Student's t test, the Mann–Whitney U test, and the chi squared
498 test, as appropriate.

499 OF-5 = Oral Frailty 5-item Checklist

Table 2. Prevalence of oral frailty according to age group and sex

	Age group (years)					<i>p</i> for trend [†]
	Total	65–69	70–74	75–79	≥80	
Total						
N	1,206	184	461	315	246	
Oral frailty [‡]	443 (36.7%)	61 (33.2%)	147 (31.9%)	126 (40.0%)	109 (44.3%)	<0.01
Men						
N	580	67	237	171	105	
Oral frailty [‡]	209 (36.0%)	19 (28.4%)	71 (30.0%)	73 (42.7%)	209 (43.8%)	<0.01
Women						
N	626	117	224	144	141	
Oral frailty [‡]	234 (37.4%)	42 (35.9%)	76 (33.9%)	53 (36.8%)	234 (44.7%)	0.09
<i>p</i> for sex comparison [§]	0.63	0.30	0.36	0.29	0.89	

[†]The linear trends in the prevalence of oral frailty across age groups within each sex were evaluated using the Cochran–Armitage test.

[‡]Presented as n (%).

§Sex differences in oral frailty within each 5-year age group were assessed using the χ^2 test. The level of significance (two-tailed test) was set to 0.01.

Table 3. Associations among oral frailty, low dietary variety, social isolation, and physical frailty according to logistic regression analysis[†]

Independent variable	Outcome variable	Odds ratio	95% CI		p value
Oral frailty	Low dietary variety	1.61	(1.25 to	2.07)	<0.01
Oral frailty	Social isolation	1.55	(1.20 to	2.01)	<0.01
Oral frailty	Physical frailty	1.29	(0.79 to	2.11)	0.30
Low dietary variety	Physical frailty	2.26	(1.34 to	3.81)	<0.01
Social isolation	Physical frailty	2.35	(1.44 to	3.86)	<0.01

CI = confidence interval.

[†]Models are adjusted for age (continuous), sex (dichotomous: male or female), educational level (continuous: years of education), smoking status (categorical: never, former, or current), drinking habits (categorical: never, former, or current), living arrangements (dichotomous: living alone or with others), cognitive function (dichotomous: presence or absence of cognitive impairment), and the number of comorbidities (continuous).

Table 4. Direct and indirect effects of oral frailty on physical frailty according to generalized structural equation modeling[†]

Outcome variable Physical frailty								
Independent variable	Indirect effect Mediator variable				Direct effect		Total effect	
	Low dietary variety (Path BC in Figure 1)		Social isolation (Path DE in Figure 1)		(Path A in Figure 1)			
	Odds ratio (95% CI)	<i>p</i> value	Odds ratio (95% CI)	<i>p</i> value	Odds ratio (95% CI)	<i>p</i> value	Odds ratio (95% CI)	<i>p</i> value
Oral frailty	1.43 (1.04 to 1.97)	0.03	1.42 (1.04 to 1.94)	0.03	1.14 (0.65 to 1.98)	0.65	2.31 (1.23 to 4.34)	0.01

CI = confidence interval.

[†]Models are adjusted for age (continuous), sex (dichotomous: male or female), educational level (continuous: years of education), smoking status (categorical: never, former, or current), drinking habits(categorical: never, former, or current), living arrangements (dichotomous: living alone or with others), cognitive function (dichotomous: presence or absence of cognitive impairment), and the number of comorbidities (continuous).

FIGURE LEGENDS

Figure 1. Associations among oral frailty, low dietary variety, social isolation, and physical frailty