

Determining the Onset Age for Early Intervention of Oral Frailty

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Background: Oral frailty is defined as the functional decline of the oral function due to aging, and it is associated with frailty and chronic disease. Most of the frailty intervention is for adults aged 65 years and older. However, early intervention for preventive disorder is most important. The objective of this study was to identify the age at which oral frailty surpass the “normal” range.

Methods: This cross-sectional study included 719 adults (aged 30~89 years) residing in Gangwon province in May 2023. Risk of oral frailty was assessed using criteria from The Korean Academy of Geriatric Dentistry including oral function such as swallowing and mastication, and frailty. Frailty was assessed using the Kihon Checklist. To determine when oral frailty surpass the “normal” status, statistical analysis including chi-squared tests and multiple logistic regression analysis were performed using R (ver. 4.3.1).

Results: There were 388 (54.0%) individuals who had a “normal” status risk of oral frailty. The risk of oral frailty was higher in the 50~54 age group compared to the 30~34 age group (odds ratio [OR] 0.50, 95% confidence interval [CI] 0.28~0.91), after adjusting for gender, education, income, occupation, and frailty (OR 0.46, 95% CI 0.22~0.94). This means that from 50~54 years old, regardless of gender, education, income, occupation, or frailty condition, there is a distinction from the “normal” status.

Conclusion: We found that intervention for oral frailty is needed starting from age 50 years. This is the stage where early indications of oral frailty become apparent. Early intervention for oral frailty can lead to a decrease in the prevalence of diseases and medical expenditure. Therefore, early intervention in middle-aged adults of oral frailty is necessary to improve the quality of life related to oral health.

Key Words: Aging, Early diagnosis, Frailty, Oral health, Prevention

Introduction

1. Background

The elderly population in Korea is steadily increasing, expected to transition into a super-aged society by 2025¹⁾. In 2020, the frailty prevalence among the elderly was 23%, reaching 56% when considering pre-frailty, indicating that over half of the aged 65 and older population is at risk of frailty²⁾. Recognizing the importance of preventing frailty for healthy aging and overall well-being in older adults, it becomes imperative to discuss appropriate interventions and timely strategies.

Frailty is state of increased functional dependence, vulnerability, or a heightened likelihood of hospitalization due to age-related physical functional decline³⁾. A primary preventive approach to efficiently address frailty is either inhibiting its occurrence⁴⁾ or delaying its onset. Achieving this goal requires the identification of risk factors contributing to frailty. Previous studies have highlighted factors such as low muscle mass⁵⁾, malnutrition⁶⁾, and poor oral health⁷⁾ as significant contributors to frailty, underscoring the necessity for intervention in these areas. Oral frailty, specifically, is defined as age-related functional decline in the orofacial structure⁸⁾. Individuals with oral

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frailty⁹⁾ are at a two-fold higher risk of general frailty compared to those without, and oral frailty can influence the development of general frailty¹⁰⁾. Because oral function affects life expectancy¹¹⁾ and contributes to improving the quality of life in the elderly¹²⁾, thus, early identification and intervention are important.

Studies conducted in the UK have expanded the understanding of frailty, revealing its prevalence in adults aged 37 years and above, indicating that frailty is not limited to the elderly¹³⁾. Similarly, research involving French middle-aged adults (50~65 years) showed that 70% of this population is at risk for frailty¹⁴⁾. Early detection and prevention of frailty in middle age can significantly influence the quality of life in older age, in addition, may reducing medical, hospitalization, and welfare-related public expenditures¹⁵⁾. Despite the high prevalence of frailty among the middle-aged people in Korea, limited research has been conducted in this regard. Furthermore, existing studies have primarily focused on rehabilitation and recover of oral function, rather than emphasizing the critical importance of early prevention and intervention¹⁶⁾.

2. Objectives

This study aimed to identify the onset age for early intervention by investigating age ranges deviating from the 'normal' oral frailty status and assessing the association between age and oral frailty.

Materials and Methods

1. Research Ethics

This cross-sectional study utilized stratified sampling with age and gender. A survey was conducted through face-to-face interviews with adults aged 30 to 90 years residing in Gangwon province in May 2023. A total of 719 participants were informed of the study and provided consent to participate. The participants were assured that the collected data would not be used for other purposes. The study received approval from the Institutional Review Board of Yonsei University Mirae Campus (IRB No. 1041849-202211-SB-216-02).

2. Study variables

1) Socio-economic and demographic variables

Socio-economic and demographic variables included gender, age, education, income, and occupation. Gender was categorized into men and women, while age was grouped into 5-year intervals, resulting in 12 groups. Education was classified into 4 categories: \leq middle school, high school, 2/3-year College, and \geq 4-year university. Income was measured in Korean Won (1,000 KRW) and was categorized into 6 grades: <2,000, 2,000~2,999, 3,000~3,999, 4,000~4,999, 5,000~5,999, and 6,000 or more. Occupation was grouped into eight categories based on the Korean Standard Classification of Occupations: managers/professions employees; office workers; service workers; sales workers; farmers and fishers; machine operators, daily labors, and simple labors; the others (soldiers, freelancers, non-response); and inoccupation (housewives, students).

2) Number of present teeth

The investigator assessed the number of present teeth face-to-face using a questionnaire. Participants with complete dentures were considered to have 0 present teeth. Those with prosthetic teeth (crowns and implants) were excluded, and the total number of teeth, including wisdom teeth, ranged from 0 to 32.

3) Screening instrument of oral frailty

The condition of oral frailty was determined using a screening instrument for oral frailty reported by the Korean Academy of Geriatric Dentistry¹⁷⁾. The questionnaire included 11 questions related to frailty symptoms and oral frailty symptoms, such as difficulties with chewing, swallowing, and speaking. The condition level of oral frailty was categorized based on the summed scores of 11 questions, ranging from 0 to 18.5. The three risk categories were 'Normal (0~0.5 points),' 'Risk (1~3 points),' and 'High-risk (\geq 3.5 points).' Those at 'risk' and 'high-risk' of oral frailty may require clinical examinations and diagnosis. The reliability of the screening instrument for oral frailty demonstrated a Cronbach's alpha of 0.88.

4) Frailty assessment instrument

Frailty was assessed using the Kihon Checklist (KCL) developed by the Ministry of Health, Labour and Welfare¹⁸⁾. The Korean version of KCL, translated by Sunwoo et al.¹⁹⁾, was revised for this study. It comprises seven dimensions, including frail condition, physical strength, nutritional status, oral function, cognitive function, and depression (24 items in total)²⁰⁾. The total score ranges from 0 (minimum) to 24 (maximum), with higher scores indicating more frailty. Participants were categorized into ‘Robust (0~3 points),’ ‘Pre-frailty (4~7 points),’ and ‘Frailty (≥8 points)’ based on frailty criteria. The reliability of the frailty instrument demonstrated a Cronbach’s alpha of 0.77.

3. Statistical methods

Participants’ socio-economic and demographic characteristics, number of present teeth, and frailty status were analyzed using descriptive statistics. Cross-sectional analysis was performed for the socio-economic and demographic characteristics and oral frailty status as per frailty condition. To perform multiple logistic regression analysis, a score of “1” was given to ‘Normal’ among the oral frailty risk level, while a score of “0” was given to ‘Risk’ and ‘High-risk.’ The multiple logistic regression models were used to identify influencing factors in groups with oral frailty by age. Model I is a crude model. Model II adjusted for socio-economic and demographic characteristics (gender, education, income, and occupation), Model III adjusted for socio-economic and demographic characteristics and number of present teeth, and Model IV adjusted for socio-economic and demographic characteristics, number of present teeth, and frailty status. Data were analyzed using R (version: 4.3.1; R Core Team, 2023). The p-value of <0.05 was considered statistically significant.

Results

1. Characteristic of the study subjects

Table 1 shows participants’ socio-economic and demographic characteristics. The mean age of the study population was 51.6±13.5 years, and 53.5% (385 of 719) were women. Most participants were in their 50s (50~54, 55~

59 years of age), accounting for 24.9%. Most participants were 4-year university graduates, accounting for 35.6%, followed by high school (31.7%) and 2/3-year College (19.2%). At 21.3%, income of ‘5,000,000 KRW’ was the

Table 1. Variable Distributions of the Study Subjects

Variable	Value
Total	719 (100)
Gender	
Men	334 (46.5)
Women	385 (53.5)
Average age (y)	51.6±13.5
Age (y)	
30~34	101 (14.0)
35~39	65 (9.0)
40~44	73 (10.2)
45~49	77 (10.7)
50~54	100 (13.9)
55~59	79 (11.0)
60~64	91 (12.7)
65~69	86 (12.0)
70~74	13 (1.8)
75~79	16 (2.2)
80~84	8 (1.1)
85~89	10 (1.4)
Education	
≤ Middle school	97 (13.5)
High school	228 (31.7)
2/3-year College	138 (19.2)
≥ 4-year University	256 (35.6)
Income (1,000 KRW)	
< 2,000	117 (16.3)
2,000~2,999	90 (12.5)
3,000~3,999	151 (21.0)
4,000~4,999	108 (15.0)
5,000~5,999	153 (21.3)
≥ 6,000	100 (13.9)
Occupation	
Managers and Professionals	81 (11.3)
Office workers	130 (18.1)
Service workers	87 (12.1)
Sales workers	147 (20.4)
Farmers and Fishers	68 (9.5)
Machine operators and Daily labors	61 (8.5)
The others	35 (4.9)
Inoccupation	110 (15.3)
Frailty	
Robust	332 (46.2)
Pre-frailty	203 (28.2)
Frailty	184 (25.6)
Average number of present teeth	24.5±7.2

Values are presented as n (%) or mean±standard deviation.

highest income, and most participants were sales workers (20.4%), followed by office workers (18.1%) and inoccupation (15.3%). The mean number of present teeth was

24.5±7.2 teeth. In frailty, 332 participants (46.2%) were robust, 203 (28.2%) were pre-frailty, and 184 (25.6%) were frailty.

Table 2. Oral Frailty According to Independent Variables

Variable	Total (n)	Oral Frailty			p	
		Normal	Risk	High-risk		
Total	719	388 (54.0)	170 (23.6)	161 (22.4)		
Gender						
Men	334	167 (50.0)	82 (24.6)	85 (25.4)	0.098	
Women	385	221 (57.4)	88 (22.9)	76 (19.7)		
Average age (y)	51.6±13.5	47.6±11.9	52.0±12.8	61.0±13.1	<0.001	
Age (y)						
30 ~ 34	101	74 (73.3)	21 (20.8)	6 (5.9)	<0.001	
35 ~ 39	65	42 (64.6)	18 (27.7)	5 (7.7)		
40 ~ 44	73	53 (72.6)	15 (20.5)	5 (6.8)		
45 ~ 49	77	48 (62.3)	13 (16.9)	16 (20.8)		
50 ~ 54	100	58 (58.0)	27 (27.0)	15 (15.0)		
55 ~ 59	79	42 (53.2)	19 (24.1)	18 (22.8)		
60 ~ 64	91	36 (39.6)	23 (25.3)	32 (35.1)		
65 ~ 69	86	25 (29.1)	28 (32.6)	33 (38.4)		
70 ~ 74	13	5 (38.5)	2 (15.4)	6 (46.2)		
75 ~ 79	16	4 (25.0)	2 (12.5)	10 (62.5)		
80 ~ 84	8	-	1 (12.5)	7 (87.5)		
85 ~ 89	10	1 (10.0)	1(10.0)	8 (80.0)		
Education						
≤Middle school	97	24 (24.7)	27 (27.8)	46 (47.4)	<0.001	
High school	228	106 (46.5)	48 (21.1)	74 (32.5)		
2/3-year College	138	82 (59.4)	37 (26.8)	19 (13.8)		
≥4-year University	256	176 (68.8)	58 (22.6)	22 (8.6)		
Income (1,000 KRW)						
< 2,000	117	49 (41.9)	22 (18.8)	46 (39.3)	<0.001	
2,000 ~ 2,999	90	48 (53.3)	26 (28.9)	16 (17.8)		
3,000 ~ 3,999	151	90 (59.6)	40 (26.5)	21 (13.9)		
4,000 ~ 4,999	108	48 (44.4)	24 (22.2)	36 (33.3)		
5,000 ~ 5,999	153	87 (56.9)	34 (22.2)	32 (20.9)		
≥6,000	100	66 (66.0)	24 (24.0)	10 (10.0)		
Occupation						
Managers and Professionals	81	57 (70.4)	19 (23.5)	5 (6.2)	<0.001	
Office workers	130	82 (63.1)	26 (20.0)	22 (16.9)		
Service workers	87	50 (57.5)	25 (28.7)	12 (13.8)		
Sales workers	147	74 (50.3)	34 (23.1)	39 (26.6)		
Farmers and Fishers	68	30 (44.1)	20 (29.4)	18 (26.5)		
Machine operators and Daily labors	61	24 (39.3)	17 (27.9)	20 (32.8)		
The others	35	19 (54.3)	7 (20.0)	9 (25.7)		
Inoccupation	110	52 (47.3)	22 (20.0)	36 (32.7)		
Number of present teeth	24.5±7.2	26.1±5.7	25.4±6.7	21.8±9.6		<0.001
Frailty						
Robust	332	242 (72.9)	76 (22.9)	14 (4.2)	<0.001	
Pre-frailty	203	111 (54.7)	56 (27.6)	36 (17.7)		
Frailty	184	35 (19.0)	38 (20.7)	111 (60.3)		

Values are presented as n (%) or mean±standard deviation.

2. Oral frailty according to characteristics of the study subjects

Table 2 classified the participants into normal, risk, and high-risk groups by oral frailty conditions, and socio-economic and demographic characteristics. Most participants (54.0%) were in the normal group, followed by 170 (23.6%) and 161 (22.4%) were in risk and high-risk groups, respectively. In the normal group, the mean age was 47.6±11.9 years old, and the mean age of the risk (52.0±12.8 years old) and high-risk (61.0±13.1 years old) groups was 5 and 14 years older than that of the normal group, respectively. In the normal group, participants aged 30~34 years and who have income of 6,000,000 KRW were highest ($p < 0.001$). The occupation shows the highest concentration in managers, professionals, and relevant employees ($p < 0.001$). The mean number of present teeth was 26.1, 25.4, and 21.8 teeth for normal, risk, and high-risk groups, respectively, showing that as the number of present teeth decreases, the oral frailty score increases ($p < 0.001$).

Fig. 1 shows the distribution of oral frailty conditions by age. For participants aged 30 to 34 years, the proportion of participants who were in normal, risk, and high-risk groups was 73.3%, 20.8%, and 5.9%, respectively. The highest distribution was observed in the normal group. Among those aged 60~64 years, the proportion of participants in the normal group was 39.6%, and the proportion of those in the risk and high-risk groups was 60.4%. Among those aged 65~69 years, the proportion of participants in the normal, risk, and high-risk groups was 29.1%, 32.6%, and 38.4%, respectively.

The distribution of high-risk group was higher than the normal group in those aged 65 years and older. As age increases, the distribution of the normal group decreased, whereas the distribution of the high-risk group of oral frailty increased.

3. Multivariable logistic regression

Table 3 shows the results of logistic regression analysis performed to investigate influencing factors on oral frailty by age group. Compared to those aged 30~34 years, odds ratio (OR) for oral frailty to be in normal condition was significant for those aged 50~54 years and older (OR 0.50, 95% confidence interval [CI] 0.28~0.91). As age increased, the OR decreased. Similar results were observed in the Model II (OR 0.52, 95% CI 0.28~0.97) and Model III (OR 0.53, 95% CI 0.28~0.99). In the Model IV, OR was significant for those aged 55~59 years and older (OR 0.46, 95% CI 0.22~0.94). Moreover, OR for oral frailty to be in normal status was 0.45 (95% CI 0.31~0.65) and 0.09 (95% CI 0.06~0.13) times higher for pre-frailty and frailty, respectively, compared to robust. Similar results were observed even if gender, education, occupation, and income were adjusted. According to the results, oral frailty condition changes according to the frailty condition. Consequently, age is likely to be the remarkable influencing factor for oral frailty regardless of socio-economic and demographic status, and frailty status is also associated with the oral frailty status via age.

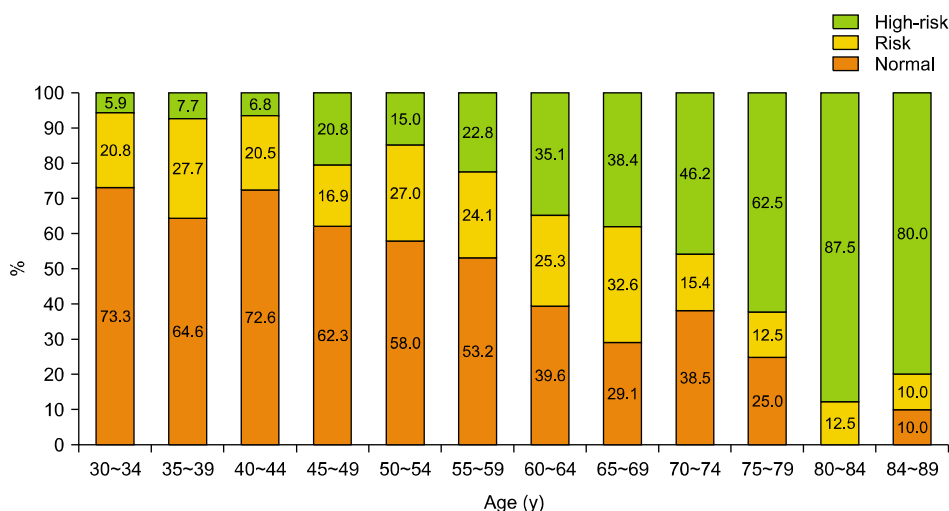


Fig. 1. Distribution of oral frailty group by age. As age increases, the distribution of the high-risk group for oral frailty increases and the distribution of the normal group decreases.

Table 3. Multivariable Logistic Regression

	Model I			Model II			Model III			Model IV		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Age (y)												
30 ~ 34	Intercept			Intercept			Intercept			Intercept		
35 ~ 39	0.67	0.34 ~ 1.31	0.237	0.54	0.27 ~ 1.08	0.082	0.54	0.27 ~ 1.08	0.082	0.60	0.28 ~ 1.26	0.178
40 ~ 44	0.97	0.49 ~ 1.92	0.922	0.87	0.43 ~ 1.77	0.701	0.90	0.44 ~ 1.83	0.764	0.96	0.46 ~ 2.03	0.957
45 ~ 49	0.60	0.32 ~ 1.14	0.121	0.60	0.31 ~ 1.18	0.140	0.61	0.31 ~ 1.20	0.155	0.71	0.35 ~ 1.46	0.374
50 ~ 54	0.50	0.28 ~ 0.91	0.024	0.52	0.28 ~ 0.97	0.041	0.53	0.28 ~ 0.99	0.046	0.54	0.28 ~ 1.04	0.074
55 ~ 59	0.41	0.22 ~ 0.77	0.006	0.43	0.22 ~ 0.85	0.015	0.44	0.22 ~ 0.86	0.017	0.45	0.22 ~ 0.93	0.035
60 ~ 64	0.24	0.13 ~ 0.43	<0.001	0.26	0.13 ~ 0.49	<0.001	0.26	0.13 ~ 0.50	<0.001	0.33	0.16 ~ 0.66	0.002
65 ~ 69	0.15	0.08 ~ 0.28	<0.001	0.16	0.08 ~ 0.33	<0.001	0.17	0.08 ~ 0.35	<0.001	0.24	0.11 ~ 0.51	<0.001
70 ~ 74	0.23	0.06 ~ 0.74	0.016	0.22	0.06 ~ 0.81	0.025	0.26	0.06 ~ 1.01	0.054	0.27	0.06 ~ 1.09	0.113
75 ~ 79	0.12	0.03 ~ 0.38	0.001	0.13	0.03 ~ 0.47	0.003	0.15	0.03 ~ 0.57	0.007	0.22	0.05 ~ 0.88	0.068
80 ~ 84	0.00	-	0.974	0.00	-	0.973	0.00	-	0.973	0.00	-	0.973
85 ~ 89	0.04	0.00 ~ 0.23	0.003	0.05	0.00 ~ 0.37	0.011	0.07	0.00 ~ 0.51	0.023	0.11	0.00 ~ 0.86	0.105
AIC	926.4			921.53			922.74			839.16		
Frailty												
Robust	Intercept			Intercept			Intercept			Intercept		
Pre-frailty	0.45	0.31 ~ 0.65	<0.001	0.45	0.30 ~ 0.66	<0.001	0.46	0.31 ~ 0.68	<0.001	0.49	0.32 ~ 0.73	0.001
Frailty	0.09	0.06 ~ 0.13	<0.001	0.10	0.06 ~ 0.16	<0.001	0.10	0.06 ~ 0.17	<0.001	0.12	0.07 ~ 0.19	<0.001
AIC	852.68			843.72			843.2			839.16		

OR:odds ratio, CI: confidence intervals, AIC: Akaike information criterion.

Model I Unadjusted model. Model II adjusted for Gender, Education, Income and Occupation. Model III adjusted for Gender, Education, Income, Occupation and Number of present teeth. Model IV adjusted for Gender, Education, Income, Occupation, Number of present teeth and Frailty group.

Discussion

1. Interpretation

This study was to explore the onset age for early intervention in oral frailty, conducted cross-sectional a face-to-face survey, including 719 participants (51.6±13.5 years). Findings showed that oral frailty is associated with age and frailty. Notably, a significant deviation from the ‘normal’ status of oral frailty occurred among individuals aged ‘50 ~ 54 years.’

Early intervention in frailty is crucial for identifying and mitigating risk factors, potentially reducing the prevalence of dysfunction, and yielding economic benefits, including a decrease in hospitalization and medical expenses^{21,22}. Early intervention can enhance overall health and quality of life during old age, contributing to a larger population of healthy older adults and ensuring a more active aging population²³.

2. Key results and comparison

Frailty is recognized as an age-related symptom, and

previous research has illustrated that aging does not progress uniformly throughout life but speeds up at specific ages, such as 34, 60, and 78 years old²⁴. We observed the aging process to start approximately 34 years old, with an increased risk of frailty from that point onwards.

In Korea, the definition and concept of older adults varies on the purposes (i.e. starting point of welfare benefits and retirement, etc.) The Welfare of senior citizen Act²⁵ and the Long-Term Care Insurance Act²⁶ both define older adults as those aged ≥65 years, or those aged <65 years with senile diseases like dementia/cerebrovascular diseases. Although the conventional definition considers individuals aged 65 years or older as so-called “elderly and/or older adults”. This study revealed that 71% of those aged 65 years and older were already at risk or high-risk for oral frailty, emphasizing the need for early intervention in middle-aged adults before they reach older adulthood.

3. Suggestion

Early intervention in oral frailty can be achieved through

national screening programs for the transitional ages, from middle-aged to old-aged. Health risk factors and chronic diseases can be detected and managed early by this program for those aged 65 and older receiving insurance benefits. People will be screened for eyesight, hearing, osteoporosis (for women), depression (70 years old), and teeth²⁷). To monitor oral frailty, oral health questionnaires should include items related to it. Early intervention in oral frailty can delay the onset of oral dysfunction, improving quality of life in relation to oral health.

4. Limitations

This study has some limitations. First, this study population was limited to Gangwon province of Korea. It could not be generalized to the entire population. Second, there is a possibility that this study could be biased by unmeasured factors such as multimorbidity, polypharmacy, etc. Third, this study could not be confirmed causality between age and oral frailty due to its cross-sectional design.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study was approved by the institutional review board of Yonsei University (IRB No.1041849-202211-SB-216-02).

Author contributions

Conceptualization: Hye-Lim Hong and Nam-Hee Kim. Data acquisition: Hye-Lim Hong and Nam-Hee Kim. Formal analysis: Hye-Lim Hong. Funding: Nam-Hee Kim. Supervision: Nam-Hee Kim. Writing-original draft: Hye-Lim Hong and Nam-Hee Kim. Writing-review & editing: Hye-Lim Hong and Nam-Hee Kim.

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Data availability

Data files are available upon request.

References

1. Statistics Korea: 2022 Elderly statistics. Retrieved September 4, 2023, from https://kostat.go.kr/board.es?mid=a10301010000&bid=10820&tag=&act=view&list_no=420896&ref_bid (2022, September 29).
2. Kang MG, Kim OS, Hoogendijk EO, Jung HW: Trends in frailty prevalence among older adults in Korea: a nationwide study from 2008 to 2020. *J Korean Med Sci* 38: e157, 2023. <https://doi.org/10.3346/jkms.2023.38.e157>
3. Kim KI: Frailty: a core geriatric concept. *J Korean Geriatr Soc* 14: 1-7, 2010. <https://doi.org/10.4235/jkgs.2010.14.1.1>
4. Lee YH: Evidence-based prevention of frailty in older adults. *J Korean Geriatr Soc* 19: 121-129, 2015. <https://doi.org/10.4235/jkgs.2015.19.3.121>
5. Dodds R, Sayer AA: Sarcopenia and frailty: new challenges for clinical practice. *Clin Med (Lond)* 16: 455-458, 2016. <https://doi.org/10.7861/clinmedicine.16-5-455>
6. Ni Lochlainn M, Cox NJ, Wilson T, et al.: Nutrition and frailty: opportunities for prevention and treatment. *Nutrients* 13: 2349, 2021. <https://doi.org/10.3390/nu13072349>
7. Jung EJ, Song AH: Relationship between frailty and oral health among the elderly. *J Korean Soc Dent Hyg* 20: 347-357, 2020. <https://doi.org/10.13065/jksdh.20200032>
8. Parisius KGH, Wartewig E, Schoonmade LJ, Aarab G, Gobbens R, Lobbezoo F: Oral frailty dissected and conceptualized: a scoping review. *Arch Gerontol Geriatr* 100: 104653, 2022.

- <https://doi.org/10.1016/j.archger.2022.104653>
9. Tanaka T, Takahashi K, Hirano H, et al.: Oral frailty as a risk factor for physical frailty and mortality in community-dwelling elderly. *J Gerontol A Biol Sci Med Sci* 73: 1661-1667, 2018.
<https://doi.org/10.1093/gerona/glx225>
 10. Kuo YW, Lee JD: Association between oral frailty and physical frailty among rural middle-old community-dwelling people with cognitive decline in Taiwan: a cross-sectional study. *Int J Environ Res Public Health* 19: 2884, 2022.
<https://doi.org/10.3390/ijerph19052884>
 11. Minakuchi S, Tsuga K, Ikebe K, et al.: Oral hypofunction in the older population: position paper of the Japanese Society of Gerodontology in 2016. *Gerodontology* 35: 317-324, 2018.
<https://doi.org/10.1111/ger.12347>
 12. Azami-Aghdash S, Pournaghi-Azar F, Moosavi A, Mohseni M, Derakhshani N, Kalajahi RA: Oral health and related quality of life in older people: a systematic review and meta-analysis. *Iran J Public Health* 50: 689-700, 2021.
<https://doi.org/10.18502/ijph.v50i4.5993>
 13. Hanlon P, Nicholl BI, Jani BD, Lee D, McQueenie R, Mair FS: Frailty and pre-frailty in middle-aged and older adults and its association with multimorbidity and mortality: a prospective analysis of 493 737 UK Biobank participants. *Lancet Public Health* 3: e323-e332, 2018.
[https://doi.org/10.1016/S2468-2667\(18\)30091-4](https://doi.org/10.1016/S2468-2667(18)30091-4)
 14. Segaux L, Broussier A, Oubaya N, et al.: Several frailty parameters highly prevalent in middle age (50-65) are independent predictors of adverse events. *Sci Rep* 11: 8774, 2021.
<https://doi.org/10.1038/s41598-021-88410-5>
 15. Buist Y, Rijken M, Lemmens L, Baan C, de Bruin S: Collaborating on early detection of frailty; a multifaceted challenge. *Int J Integr Care* 19: 6, 2019.
<https://doi.org/10.5334/ijic.4176>
 16. Jung H, Kim M, Lee Y, Won CW: Prevalence of physical frailty and its multidimensional risk factors in Korean community-dwelling older adults: findings from Korean frailty and aging cohort study. *Int J Environ Res Public Health* 17: 7883, 2020.
<https://doi.org/10.3390/ijerph17217883>
 17. Kang JH, Ko SM, Kim NH, et al.: Clinical practice guidelines for oral frailty. Korea Health Policy Institute, Seoul, pp.15, 2023.
 18. Satake S, Senda K, Hong YJ, et al.: Validity of the Kihon Checklist for assessing frailty status. *Geriatr Gerontol Int* 16: 709-715, 2016.
<https://doi.org/10.1111/ggi.12543>
 19. Sunwoo D, Lee SH, Park JS, et al.: Analysis of the effects of muscle strength exercise on physical function and quality of life in the frail elderly. *Korean J Health Educ Promot* 25: 39-53, 2008.
 20. Ishikawa N, Katsura T, Hara M: Changes in Kihon Checklist items and new Certification of long-term care needs among Japanese community-dwelling elders. *J Rural Med* 16: 270-279, 2021.
<https://doi.org/10.2185/jrm.2021-032>
 21. Apóstolo J, Cooke R, Bobrowicz-Campos E, et al.: Effectiveness of interventions to prevent pre-frailty and frailty progression in older adults: a systematic review. *JBIG Database System Rev Implement Rep* 16: 140-232, 2018. Erratum in: *JBIG Database System Rev Implement Rep* 16: 1282-1283, 2018.
<https://doi.org/10.11124/JBISRIR-2017-003382>
 22. Dury S, Dierckx E, van der Vorst A, et al.: Detecting frail, older adults and identifying their strengths: results of a mixed-methods study. *BMC Public Health* 18: 191, 2018.
<https://doi.org/10.1186/s12889-018-5088-3>
 23. Cylus J, Al Tayara L: Health, an ageing labour force, and the economy: does health moderate the relationship between population age-structure and economic growth? *Soc Sci Med* 287: 114353, 2021.
<https://doi.org/10.1016/j.socscimed.2021.114353>
 24. Lehallier B, Gate D, Schaum N, et al.: Undulating changes in human plasma proteome profiles across the lifespan. *Nat Med* 25: 1843-1850, 2019.
<https://doi.org/10.1038/s41591-019-0673-2>
 25. Korea Law: Welfare of senior citizens act. Retrieved September 18, 2023, from <https://www.law.go.kr/%EB%B2%95%EB%A0%B9%EB%85%B8%EC%9D%B8%EB%B3%B5%EC%A7%80%EB%B2%95> (2016, December 2).
 26. Korea Law: Long-term care insurance act. Retrieved September 18, 2023, from <https://www.law.go.kr/%EB%B2%95%EB%A0%B9%EB%85%B8%EC%9D%B8%EC%9E%A5%EA%B8%B0%EC%9A%94%EC%96%91%EB%B3%B4%ED%97%98%EB%B2%95> (2018, December 11).
 27. National Health Insurance Service: Life transition period health check-up. Retrieved November 5, 2023, from <https://www.nhis.or.kr/nhis/healthin/wbhaca04700m01.do>