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Original Article

Determinants of masticatory ability in Taiwanese patients with osteogenesis imperfecta

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Abstract *Background/purpose:* Despite the existing knowledge on osteogenesis imperfecta (OI), there is a notable lack of research focused on determining the optimal number and types of teeth that individuals with OI should keep to ensure effective chewing. This study aimed to identify variables influencing masticatory ability among patients with OI.
Materials and methods: A total of 37 patients with OI participated in the study. Data were collected through questionnaires and dental examinations. The questionnaire assessed sociodemographic information, oral habits, self-perceived health, and self-rated masticatory ability, utilizing 14 common Taiwanese food groups. Dental information was evaluated through clinical examinations. Statistical methods, including the Mann–Whitney U and Kruskal–Wallis tests, were employed to identify factors associated with self-rated masticatory ability. Subsequently, multiple logistic regression analysis was conducted to identify predictors of masticatory ability.
Results: The multiple logistic regression analysis identified the number of posterior functional tooth units (P-FTUs) as a significant predictor of masticatory difficulty in patients with OI.
Conclusion: Enhancing masticatory ability in patients with OI requires not only a sufficient number of natural teeth or fixed prosthetics but also a focus on the optimal arrangement and functionality of these dental supports.

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Introduction

Osteogenesis imperfecta (OI) is a rare genetic disorder caused by mutations in type I collagen, resulting in decreased bone strength and an increased risk of fractures. Often referred to as "brittle bone disease," OI manifests in varying degrees of severity. Although the precise prevalence of OI is difficult to determine, it is estimated to range from 1 in 15,000 to 1 in 20,000 individuals, with no significant disparities observed across sex or racial groups.[1,2] According to the Statistical Report of Rare Disease Confirmed Cases in Taiwan, as of December 31, 2022, the Health Promotion Administration, Ministry of Health and Welfare of Taiwan, had registered 396 cases of OI.[3]

OI exhibits considerable variability in clinical manifestations, ranging from mild osteoporosis to recurrent fractures, with severe cases potentially resulting in fractures even before birth. In the most severe instances, neonatal death shortly after birth or stillbirth may occur. Extraskeletal manifestations of OI include blue sclera, dentinogenesis imperfecta, hyperlaxity of ligaments and skin, hearing impairment, and the presence of wormian bones observable on X-rays.[4] Common dental anomalies in patients with OI include pulp obliteration and tooth agenesis.[5]

Studies have indicated that the risk of dental caries in patients with OI may be comparable to or even greater than that in the general population, suggesting that these individuals do not have a lower risk of dental caries compared to healthy individuals.[6,7] Additionally, the structural changes in teeth among patients with OI can lead to significant tooth erosion, often resulting in premature tooth loss.[8] These alterations can complicate specific dental interventions, including endodontic procedures, which can hinder tooth restoration and preservation, as well as affect the arrangement, number, and shape of the teeth.[9] As a result, these complexities may give rise to various issues, including pain, sensitivity, difficulties in speech and biting, aesthetic concerns, and impaired masticatory ability.[10] A multidisciplinary dental team is essential for effectively managing OI and should include the following professionals: pediatric dentist, restorative dentist, prosthodontics, orthodontics, psychiatrist, and maxillofacial surgeon.[11,12] An effective prevention management plan should include regular follow-up and monitoring. This should encompass providing advice on oral hygiene practices as well as dietary recommendations.[11,12]

Numerous studies have revealed a strong association between masticatory ability and both physiological and psychological well-being.[13—16] Impairments in masticatory function have been closely linked to various factors, including brain development and activity,[17] activities of daily living,[17] cognitive status,[13] and health-related quality of life (as measured by the SF-36).[14] Furthermore, Nguyen et al.[15] demonstrated a positive relationship between adults' masticatory ability and their oral health-related quality of life (assessed using the OHIP-3). Similarly, Schwahn et al.[16] highlighted that impaired masticatory ability resulting from tooth loss significantly increases the risk of mortality.

In 1989, Japan introduced the 8020 Campaign, which advocates for the retention of a minimum of 20 natural teeth to preserve optimal masticatory function.[18] Ueno et al.[19,20] further emphasized that maintaining favorable masticatory ability requires at least 20 natural teeth and 8 functional tooth units (FTUs). Additional studies investigating dental factors influencing masticatory ability have indicated that, in addition to retaining 20 natural teeth, the number of occluding pairs of teeth[21] and the presence of postcanine FTUs also play significant roles in determining masticatory function.[22,23] Despite the existing knowledge on OI, there is a notable lack of research focused on determining the optimal number and types of teeth that individuals with OI should keep to ensure effective chewing. Our study seeks to address this important issue.

Materials and methods

This study employed a cross-sectional design and utilized a convenient sample of Taiwanese patients with OI. The initial step involved collaboration with the Taiwan OI association, which facilitated outreach to potential participants through various association activities. The inclusion criteria were as follows: Taiwanese patients who (1) have been diagnosed with OI and (2) are able to comprehend and respond to the food questionnaire. Interested patients were provided with comprehensive explanations regarding the study's objectives and other relevant details. The exclusion criteria consisted of participants who (1) could not complete the questionnaire, (2) did not undergo a dental examination, (3) avoided consuming the foods listed in the questionnaire due to religious beliefs, or (4) adhered to a vegetarian diet. Recruitment of subjects occurred between May 2022 and November 2022. Prior to data collection, informed consent was obtained from all participants. The study received approval from the Institutional Review Board of Kaohsiung Medical University Chung-Ho Memorial Hospital (IRB number: KMUHIRB-SV(II)-20220011).

Data collection

Information was obtained through questionnaires that included sociodemographic characteristics (age, gender, education level, marital status, and occupation), self-perceived health (general health and oral health), oral habits (smoking, betel nut chewing, and alcohol consumption), and self-rated masticatory ability, as measured using a food intake questionnaire.

Self-rated masticatory ability was assessed using a food intake questionnaire developed for Taiwanese populations by Hsu et al.[24] The questionnaire comprised 14 common Taiwanese food groups: sliced guava, squid, soy sauce-braised pork ears, stir-fried peanuts, fried chicken leg or chicken fillet, grilled calamari or soy sauce-braised chicken gizzard, boiled sweet corn on the cob, sugar cane (not juice), sliced apple or pear, sliced cucumber or kidney bean, boiled bamboo shoots or broccoli, boiled white radish or carrot, sliced orange, and sliced star fruit or bell fruit.

Participants were instructed to rate the ease of eating these food groups over the past three months. They could select from three options: "easy to eat" (2 points), "somewhat difficult to eat" (1 point), and "unable to eat" (0 points). The scores from these 14 items were totaled to yield a self-rated masticatory ability score, with higher scores indicating better masticatory ability.

Dental examination

In accordance with the guidelines of the World Health Organization,[25] dental examinations were conducted by two dentists with a minimum of five years of clinical experience. The kappa coefficient for interrater reliability was found to be 0.850, indicating good agreement (Kappa $>$0.8) as per WHO standards.[25]

The clinical dental examinations collected information on the location, number, caries status, and mobility of natural teeth, as well as details regarding artificial teeth. Functional natural teeth (FNT) were defined as sound, decayed, filled, or filled but decayed natural teeth, excluding those with grade III mobility, retained roots, or extensive crown destruction (defined as at least three-quarters of the clinical crown destroyed). The number of functional natural teeth, excluding third molars, ranged from 0 to 28.

Functional teeth (FT) included both FNT and fixed artificial teeth, encompassing abutment teeth, pontics, and implant-supported prostheses. Fixed artificial teeth with grade III mobility and third molars were also excluded. The number of functional teeth ranged from 0 to 28. Functional tooth units (FTUs) were defined as pairs of occluding FT, with the number of FTUs ranging from 0 to 14. Posterior functional tooth units (P-FTUs) were specifically defined as pairs of occluding posterior FT, with the unit count being 1 for premolars and 2 for molars. Thus, the number of P-FTUs ranged from 0 to 12. Occlusal status was evaluated using the Eichner Index,[26] which classifies occlusal contacts in four zones formed by premolars and molars into three categories: Category A indicates occlusal contacts in all four zones; Category B indicates contacts in 1—3 zones or only in the anterior teeth; and Category C indicates no occlusal contacts in any of the four zones. In this study, the occlusal status of FT was assessed.

Statistical analysis

Following the methodology established by Hsu et al.,[24] the response options '1: somewhat difficult to eat' and '0: unable to eat' for each food group were categorized as "difficult to eat." Consequently, the three response options for each food group were dichotomized into 'easy to eat' and 'difficult to eat.' Participants were classified into the impaired masticatory ability group if they selected 4 or more food groups as "difficult to eat." Those who selected fewer than 4 food groups as "difficult to eat" were classified into the non-impaired masticatory ability group.

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to analyze the distributions of socio-demographic characteristics, self-perceived health, oral habits, dental status, self-rated masticatory ability scores, and responses indicating "difficulty to eat" for each food group. The Mann—Whitney U test and Kruskal—Wallis test were employed to assess the distribution of self-rated masticatory ability scores and the number of responses indicating "difficulty to eat" across different socio-demographic characteristics, self-perceived health, oral habits, and dental status.

Subsequently, age, gender, educational level, and other variables showing statistically significant differences in the distribution of self-rated masticatory ability scores and the number of responses indicating "difficulty to eat" were included in a multiple logistic regression analysis to identify predictors of the impaired masticatory ability group. A *P*-value of less than or equal to 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS v25.0 (IBM Corp., Chicago, IL, USA).

Results

A total of 37 subjects participated in the study. The ages of the participants ranged from 14 to 75 years, with a mean age of 38.6 $\pm$ 16.3 years. The majority of subjects were female (n = 21, 56.8 %). Most participants were younger than 35 years (n = 19, 51.4 %), and over half had a college education or higher (n = 20, 54.1 %). The majority were unmarried (n = 25, 67.6 %), and more than half were unemployed (n = 20, 54.1 %). Regarding self-perceived health, most participants rated their general health (n = 23, 62.2 %) and oral health (n = 23, 62.2 %) as good or fair. In terms of oral habits, the vast majority had never smoked (n = 35, 94.6 %), never chewed betel nut (n = 36, 97.3 %), and never consumed alcohol (n = 32, 86.5 %) (Table 1).

The mean number of functional natural teeth (FNT) among participants was 23.5 $\pm$ 8.3, while the mean number of functional teeth (FT) was 23.7 $\pm$ 8.3. The average number of posterior functional tooth units (P-FTUs) was 7.9 $\pm$ 3.9, and the number of functional tooth units (FTUs) was 9.3 $\pm$ 5.1. According to the Eichner index, 23 subjects (62.2 %) were classified as Eichner class A, 11 (29.7 %) as class B, and 3 (8.1 %) as class C (Table 2).

For self-rated masticatory ability, the most commonly identified easy-to-eat food groups from the 14 listed in the food intake questionnaire were "sliced star fruit or bell fruit" and "boiled white radish or carrot," with 36 subjects (97.3 %) reporting them as easy to eat. In contrast, "sugar cane (not juice)" was considered the most difficult to eat, with only 7 subjects (18.9 %) rating it as easy, 17 (45.9 %) as somewhat difficult, and 13 (35.1 %) as unable to eat. When combining the responses indicating "somewhat difficult to

Table 1 Distribution of socio-demographic data, oral habits and self-perceived health of participants (N = 37).

Variables	N	%	Mean ± SD
Socio-demographic characteristics			
Gender			
Male	16	43.2	
Female	21	56.8	
Age (years)			38.6 ± 16.3
< 35	19	51.4	
≥ 35	18	48.6	
Education level			
Less than college	17	45.9	
College or above	20	54.1	
Marital status			
Unmarried	25	67.6	
Married/Divorced/Widowed	12	32.4	
Occupation			
Full time/Part time	17	45.9	
Housekeeper/Student	20	54.1	
Retired/Unemployed			
Self-perceived health			
Self-perceived general health			
Good/Fair	23	62.2	
Poor	14	37.8	
Self-perceived oral health			
Good/Fair	23	62.2	
Poor	14	37.8	
Oral habits			
Smoking			
Never	35	94.6	
Current smokers/Ex-smokers	2	5.4	
Betel nut chewing			
Never	36	97.3	
Current chewers/Ex-chewers	1	2.7	
Alcohol			
Never	32	86.5	
Current drinkers/Ex-drinkers	5	13.5	

Table 2 Distribution of dentition status of participants (N = 37).

Variables	N	%	Mean ± SD
FNT			23.5 ± 8.3
FT			23.7 ± 8.3
P-FTUs			7.9 ± 3.9
FTUs			9.3 ± 5.1
Eichner index			
A	23	62.2	
B	11	29.7	
C	3	8.1	

FNT: Functional natural teeth; FT: Functional teeth; P-FTUs: Posterior-Functional tooth units; FTUs: Functional tooth units. Eichner Index. Class A: occlusal contacts in four zones; Class B: occlusal contacts in 1—3 zones or only in the anterior teeth; Class C: no occlusal contacts in any of the four zones.

eat" and "unable to eat," 23 subjects (62.2 %) identified 0—3 food groups as difficult to eat, while 14 (37.8 %) identified 4—14 food groups as difficult to eat. The self-rated masticatory ability scores were assigned as follows: 2 points for easy to eat, 1 point for somewhat difficult to eat, and 0 points for unable to eat. The mean score across all subjects was 23.8 ± 4.3 (Table 3).

In examining the correlation between self-rated masticatory ability and various factors, participants aged <35 years had a significantly lower number of responses indicating difficulty in eating food groups and a significantly higher self-rated masticatory ability score than those aged ≥35 years. Unmarried participants reported a significantly lower number of responses indicating difficulty to eat food groups and had a significantly higher self-rated masticatory ability score compared to those who were married, divorced, or widowed. Moreover, subjects who rated their self-perceived oral health as "good" or "fair" experienced a lower number of difficulties in eating food groups and had higher self-rated masticatory ability scores compared to those who rated their oral health as "poor." The analysis showed no significant differences in the correlation between masticatory ability and other factors such as socio-demographic variables, perceived health status, and oral habits (Table 4).

Table 5 illustrates the relationship between self-rated masticatory ability and dental status. The number of difficult-to-eat food groups varied significantly across dental factors such as FNT, FT, P-FTUs, and FTUs, with participants having a higher number of FNT, FT, P-FTUs, and FTUs reporting fewer difficulties in eating. Additionally, self-rated masticatory ability scores varied significantly across dental factors such as FNT, FT, P-FTUs, FTUs, and the Eichner Index, with more FNT or FT, P-FTUs, FTUs, and Eichner Index A correlating with higher scores.

Regarding predictors of impaired masticatory difficulty, multiple logistic regression was conducted to analyze factors associated with impaired masticatory ability, adjusting for age, gender, education level, marital status, and self-perceived oral health. The analysis revealed that only P-FTUs exhibited a significant difference (odds ratio = 11.27, 95 % confidence interval [CI] = 1.68—128.37). This finding indicates that subjects with fewer than 8 P-FTUs were 11.27 times more likely to experience impaired masticatory ability compared to those with 8 or more P-FTUs. Therefore, among dental factors such as FNT, FT, P-FTUs, and FTUs, only P-FTUs were identified as a predictive factor for impaired masticatory ability in patients with OI (Table 6).

Discussion

Specifically, tooth agenesis, often linked to alterations in dentin structure known as dentinogenesis imperfecta, is a frequent clinical characteristic in OI patients. Dentinogenesis imperfecta typically leads to tooth discoloration, presenting as amber or blue-gray hues, along with a translucent appearance. Radiographic examinations reveal short, contracted roots and enlarged dentin in affected teeth, resulting in pulp canal obliteration before or shortly

Table 3 Distribution of responses to food intake questionnaire and self-rated masticatory ability of participants (N = 37).

Food groups	N	%	Easy to eat		Somewhat difficult to eat		Unable to eat		mean ± SD
			N	%	N	%	N	%	
Boiled squid			25	67.6	11	29.7	1	2.7	
Stir-fried peanut			27	73	9	24.3	1	2.7	
Fried chicken leg or chicken fillet			32	86.5	5	13.5	0	0	
Soy sauce-braised pork ear			25	67.6	10	27	2	5.4	
Boiled sweet corn on the cob			29	78.4	6	16.2	2	5.4	
Sliced guava			26	70.3	10	27	1	2.7	
Sliced apple or pear			31	83.8	5	13.5	1	2.7	
Grilled calamari or soy sauce-braised chicken gizzard			16	43.2	15	40.5	6	16.2	
Sugar cane (not juice)			7	18.9	17	45.9	13	35.1	
Sliced cucumber or kidney bean			34	91.9	3	8.1	0	0	
Boiled bamboo shoots or broccoli			35	94.6	2	5.4	0	0	
Sliced orange			34	91.9	3	8.1	0	0	
Sliced star fruit or bell fruit			36	97.3	1	2.7	0	0	
Boiled white radish or carrot			36	97.3	1	2.7	0	0	
Number of response, 'difficulty to eat', to food groups									
0-3 group	23	62.2							
4-14 group	14	37.8							
Self-rated masticatory ability score									23.8 ± 4.3

after tooth eruption. Due to their unique composition, teeth impacted by dentinogenesis imperfecta are more susceptible to breakage compared to healthy teeth.[7] Ikebe et al.[26] noted that a primary objective of dental intervention is to restore dentition in order to regain masticatory function. However, patients with OI may face challenges in fully restoring their dentition due to factors such as limited accessibility to dental care and financial constraints resulting from difficulties in employment.

Numerous studies have highlighted the importance of preserving optimal masticatory ability to enhance oral health-related quality of life.[27,28] Our study aimed to identify the factors influencing masticatory ability in patients with osteogenesis imperfecta (OI). The findings revealed that among the various factors studied, only the number of P-FTUs was found to be a predictor of impaired masticatory ability. Patients with a greater number of P-FTUs were less likely to experience impaired masticatory ability, indicating the significance of maintaining sufficient posterior teeth for effective mastication.

The FTUs is an index that has been used to evaluate masticatory ability. Previous studies have reported that the number of FTUs is associated with chewing difficulty.[19,22,29] However, Ueno et al.[20] stated that if the total number of FTUs, defined as pairs of opposing posterior natural and prostheses, increased as a result of removable denture, it may not significantly improve masticatory ability. Hsu et al.[29] showed that when the number of FTUs increased due to the presence of removable dentures, significant improvements in masticatory ability are not observed. Thus, in the present study, P-FTUs were defined as pairs of occluding posterior functional natural teeth or fixed artificial teeth, excluding removable artificial teeth.

The regression analysis conducted in this study revealed that factors such as FNT, FT, and FTUs do not serve as predictors of self-rated impaired masticatory ability in patients with OI. However, P-FTUs were identified as the only significant predictor. Patients with at least 8 pairs of P-FTUs were less likely to experience self-rated impaired masticatory ability. These findings are consistent with several other studies, emphasizing the importance of maintaining posterior teeth for optimal mastication.[19,29] Ueno et al.[19] suggested that maintaining a minimum of 20 FNT and at least 8 pairs of FTUs, defined in the present study as P-FTUs, is essential to mitigate self-assessed chewing difficulty. Hsu et al.[29] indicated that preventing self-assessed chewing difficulty requires a minimum of 8.1 pairs of FNT or 9.6 pairs of FTUs, defined in the present study as P-FTUs. Our findings are consistent with those of Ueno et al.,[19] but differ slightly from those of Hsu et al.,[29] highlighting the importance of adequate P-FTUs in maintaining effective masticatory function.

Regarding factors influencing self-rated masticatory ability in patients with OI, the present study revealed significant differences in the distribution of difficult-to-eat food groups based on the number of FNT and FT. Patients with a greater number of FNT or FT tended to report better self-rated masticatory ability and chose fewer difficult-to-eat food groups. This finding is consistent with the results of several studies, which emphasize the role of sufficient FNT and FT in maintaining effective masticatory function.[19,30,31] Ueno et al.[19] reported a correlation between poor oral health status and reduced masticatory ability, with a greater number of missing teeth being associated with increased masticatory difficulty. Similarly, Unell et al.[31] observed a strong positive association between the number of remaining teeth and self-rated masticatory ability,

Table 4 Number of response 'difficulty to eat' to food groups and self-rated masticatory ability in terms of socio-demographic data, oral habits and self-perceived health (N = 37).

	Number of response 'difficulty to eat' to food groups	*P*-value	Self-rated masticatory ability score	*P*-value
	mean ± SD		mean ± SD	
Gender				
Male	2.6 ± 2.5	0.3860	24.8 ± 3.3	0.4299
Female	4.0 ± 3.9		23.2 ± 4.9	
Age (years)				
< 35	1.9 ± 2.3	0.0031	26.1 ± 2.3	0.0005
≥ 35	4.9 ± 3.7		21.6 ± 4.7	
Education level				
Less than college	3.7 ± 3.3	0.4416	23.2 ± 4.0	0.2549
College or above	3.1 ± 3.6		24.5 ± 4.6	
Marital status				
Unmarried	2.5 ± 2.5	0.0360	25.1 ± 3.1	0.0175
Married/Divorced/Widowed	5.3 ± 4.2		21.3 ± 5.4	
Occupation				
Full time/Part time	3.8 ± 4.0	0.7818	23.7 ± 5.1	0.9877
Housekeeper/Student Retired/Unemployed	3.1 ± 2.8		24.1 ± 3.6	
Self-perceived general health				
Good/Fair	3.2 ± 3.3	0.1440	24.2 ± 4.3	0.1033
Poor	6.0 ± 3.6		20.7 ± 3.8	
Self-perceived oral health				
Good/Fair	2.0 ± 1.8	0.0007	25.5 ± 3.0	0.0007
Poor	5.7 ± 3.5		21.2 ± 4.8	
Smoking				
Never	3.5 ± 3.4	0.2778	23.7 ± 4.4	0.4158
Current smokers/Ex-smokers	1.0 ± 0.0		26.5 ± 0.7	
Betel nut chewing				
Never	3.4 ± 3.4	0.4493	23.8 ± 4.3	0.4493
Current chewers/Ex-chewers	1.0 ± 0.0		27.0 ± 0.0	
Alcohol				
Never	3.6 ± 3.6	0.6059	23.7 ± 4.5	0.6537
Current drinkers/Ex-drinkers	2.2 ± 1.8		25.4 ± 2.1	

*The *P*-value is calculated using Mann–Whitney U tests.

indicating that having more remaining teeth corresponds to better self-rated masticatory ability. This relationship highlights the critical role of dental preservation in maintaining effective masticatory function and overall oral health.

The World Health Organization (WHO) emphasizes the importance of preserving a minimum of 20 natural teeth to maintain both functional and aesthetically pleasing dentition.[32] Agerberg et al.[33] reported that masticatory ability becomes significantly impaired when the number of missing teeth exceeds seven, underscoring the necessity of at least 20 natural teeth for adequate chewing functionality. Similarly, Sheiham et al.[34] suggested that maintaining sufficient masticatory ability requires preserving more than 20 natural teeth. These findings are consistent with the results of the present study, which indicated that patients with OI with more than 20 FNTs tend to select fewer difficult-to-eat food groups, reflecting better self-rated masticatory ability.

The distribution of difficult-to-eat food groups significantly differed between patients with OI who had P-FTUs and those with FTUs. Essentially, patients with OI who had a greater number of P-FTUs or FTUs tended to choose fewer difficult-to-eat food groups, indicating better self-rated masticatory ability. This finding is corroborated by numerous studies.[19,30] Zeng et al.[30] revealed that a reduction in the number of occluding units, including both anterior and posterior teeth, may lead to masticatory difficulties. Similarly, Sheiham et al.[34] demonstrated a positive association between the number of posterior occluding pairs and adequate masticatory ability, indicating that individuals with a greater number of posterior occluding pairs are more likely to possess sufficient masticatory ability.

In this study, we assessed the self-rated masticatory ability of patients with OI through a food intake questionnaire. This self-assessment approach offers several advantages compared to objective evaluations of chewing performance, which typically involve direct food chewing tests. The self-rated method is straightforward, easily understood by participants, and enables extensive data collection at a reduced cost, making it particularly well-suited for large-scale research.[24,35] While objective

Table 5 Number of response 'difficulty to eat' to food groups and self-rated masticatory ability in terms of dentition status (N = 37).

	Number of response 'difficulty to eat' to food groups	*P*-value	Self-rated masticatory ability score	*P*-value
	mean ± SD		mean ± SD	
FNT				
0-19	7.5 ± 3.9	0.0036	18.7 ± 5.5	0.0038
20-28	2.6 ± 2.7		24.9 ± 3.2	
FT				
0-19	6.2 ± 2.6	0.0197	20.6 ± 3.2	0.0209
20-28	2.9 ± 3.3		24.4 ± 4.2	
P-FTUs				
0-7	5.6 ± 3.8	0.0010	21.1 ± 4.9	0.0007
≥8	1.9 ± 2.0		25.8 ± 2.4	
FTUs				
0-11	4.6 ± 3.8	0.0257	22.4 ± 4.9	0.0164
≥12	2.0 ± 2.2		25.7 ± 2.5	
Eichner index				
A	2.4 ± 2.8	0.1730[a]	25.1 ± 3.3	0.0293[a]
B	4.7 ± 4.1		22.5 ± 5.5	
C	7.0 ± 2.6		19.7 ± 2.9	

FNT: Functional natural teeth; FT: Functional teeth; P-FTUs: Posterior-Functional tooth units; FTUs: Functional tooth units.
Eichner Index. Class A: occlusal contacts in four zones; Class B: occlusal contacts in 1–3 zones or only in the anterior teeth; Class C: no occlusal contacts in any of the four zones.
*The *P*-value is calculated using Mann–Whitney U test.
*The *P*[a]-value is calculated using Kruskal–Wallis test.

assessments might yield more precise evaluations of masticatory performance, they often require more time and specialized equipment, which can be a barrier in large-scale studies. Furthermore, numerous studies have demonstrated a strong correlation between self-rated masticatory ability and the outcomes of objective measurements.[35,36]

Although this study demonstrated that the numbers of FNT and FT do not predict self-rated masticatory ability, their contribution to masticatory function cannot be overlooked. In this study, the P-FTUs included both FNT and FT. Maintaining a sufficient number of FNT or FT is crucial to ensuring adequate P-FTUs, which fosters better self-rated masticatory ability. Specifically, both the quantity and distribution of teeth contribute to the number of P-FTUs, which are vital for enhancing masticatory efficiency. Naka et al.[23] reported a direct correlation between self-rated masticatory ability and the number and distribution of remaining teeth, regardless of the methods used to assess dental condition and masticatory capability. Similarly, Marcenes et al.[37] emphasized that having a minimum of 20 evenly distributed natural teeth is essential for ensuring satisfactory masticatory ability. Therefore, improving the masticatory ability of patients with OI requires an objective evaluation of dental status related to masticatory function, which can facilitate the development of tailored treatment plans that address individual patient needs.

This study has several limitations that should be acknowledged. The first limitation pertains to the representativeness of the study sample. Participants were primarily recruited through activities organized by the Taiwan OI Association, which may have excluded potential subjects, such as non-members, individuals with mobility constraints, or those unable to attend due to scheduling conflicts. This selective recruitment process could introduce bias into the study sample, compromising its overall representativeness. Second, the study is constrained by its small sample size, which limits the ability to categorize subjects based on the severity of their condition. As a result, the study may not adequately capture the diverse types of patients with OI and the varying factors influencing their masticatory ability. Third, the study utilized a cross-sectional design, which assessed the distribution of masticatory ability among patients with OI at only one time point. While there are certain limitations to this study, it is the first to examine factors affecting masticatory ability in patients with OI in Taiwan. It is recommended to develop a correction plan aimed at improving the accuracy of assessments related to masticatory ability and function. The longitudinal study design involved a substantial number of patients, including diverse potential subjects such as non-members and individuals with mobility limitation. This approach will help ensure a more thorough understanding of the various factors affecting the masticatory abilities of these patients.

In summary, this study highlights that the primary factor influencing masticatory ability in patients with OI is the count of P-FTUs. Among the various factors evaluated, only the number of P-FTUs was found to significantly predict challenges in mastication. Patients possessing a higher number of P-FTUs exhibit a lower likelihood of experiencing masticatory difficulties. Thus, improving masticatory function in individuals with OI requires not only a sufficient number of natural teeth or fixed prostheses but also a focus

Table 6 Logistic regression analysis for the predictors of impaired masticatory ability (N = 37).

Variables	Crude OR[a] (95%CI)	FNT	FT	P-FTUs	FTUs
		Adjusted OR[b] (95%CI)	Adjusted OR[b] (95%CI)	Adjusted OR[b] (95%CI)	Adjusted OR[b] (95%CI)
Age (years)					
< 35	1	1	1	1	1
≥ 35	8.38 (1.94–46.61)*	4.28 (0.55–39.00)	4.44 (0.58–40.53)	4.13 (0.44–47.9)	7.49 (0.88–86.89)
Gender					
Male	0.61 (0.15–2.33)	0.58 (0.08–3.81)	0.55 (0.07–3.57)	0.44 (0.05–3.19)	0.53 (0.07–3.45)
Female	1	1	1	1	1
Education level					
Less than college	2.07 (0.544–8.34)	1.58 (0.26–9.93)	1.45 (0.24–9.12)	0.90 (0.11–6.61)	0.77 (0.09–5.68)
College or above	1	1	1	1	1
Marital status					
Unmarried	1	1	1	1	1
Married/Divorced/Widowed	6.33 (1.48–31.78)*	1.77 (0.19–15.65)	1.96 (0.22–17.00)	2.02 (0.19–21.4)	1.32 (0.14–11.73)
Self-perceived oral health					
Good/Fair	1	1	1	1	1
Poor	3.78 (0.95–16.45)	2.24 (0.38–13.52)	2.48 (0.44–14.74)	4.44 (0.69–40.4)	3.17 (0.55–21.47)
FNT					
0-19	12.22 (1.67–252.25)*	6.48 (0.58–182.2)			
20-28	1	1			
FT					
0-19	8.80 (1.13–184.36)*		5.36 (0.44–157.12)		
20-28	1		1		
P-FTUs					
0-7	9.00 (2.11–46.5)*			11.27 (1.68–128.37)*	
≥8	1			1	
FTUs					
0-11	5.70 (1.35–30.77)*				7.32 (1.04–77.03)
≥12	1				1

FNT: Functional natural teeth; FT: Functional teeth; P-FTUs: Posterior-Functional tooth units; FTUs: Functional tooth units.
Impaired masticatory ability: Number of answer, 'difficulty to eat', to food groups ≥4.
OR: Odds ratios.
[a] Odds ratios were derived from univariate logistic regression model.
[b] Odds ratios were derived from a multiple logistic regression model.

on the proper arrangement and functionality of these dental units.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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