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RESEARCH

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Association between masticatory function and cognitive ability in mild cognitive impairment

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Abstract

Background Mastication is linked to cognitive function and influences brain activity, blood flow, and neurotrophic factors. A decrease in masticatory function may exacerbate mild cognitive impairment (MCI), a reversible condition affecting older adult. Identifying the masticatory factors associated with MCI could help guide interventions. To investigate the relationship between masticatory function and associated with MCI and identify oral functional factors that influence cognitive ability in older adult.

Methods A cross-sectional study was conducted on 137 participants (100 normal, 37 MCI), aged ≥ 65 years, recruited from Yonsei University Dental and Severance Hospitals (2020–2024). Participants with ≥ 20 teeth without systemic diseases or chewing problems were included. Objective assessments (e.g., tongue pressure [TP], oral diadochokinesis [ODK], and masseter muscle thickness [MMT]) and subjective evaluations (e.g., the Korean Mini-Mental State Examination, 2nd edition [KMMSE-2], Food Intake Ability [FIA]) were performed. Statistical analyses were conducted to identify associations between masticatory factors and MCI.

Results Significant differences in the number of remaining teeth, the number of posterior teeth, the Eichner index, TP, ODK (/pa/, /ta/, /ka/), and MMT (all $p < 0.05$) were detected between the normal and MCI groups. Multiple Logistic regression with Firth' method revealed that posterior occlusal support (Eichner index), TP, ODK (/pa/, /ka/), and MMT were significantly associated with MCI.

Conclusion Posterior occlusal support and oral muscle-related factors (e.g., TP, ODK, MMT) are associated with MCI in older adult. These findings suggest that tailored interventions, including muscle training and posterior occlusal rehabilitation, could mitigate declines in cognitive functions associated with MCI in older adult.

Keywords Mastication, Posterior occlusal support, Mild cognitive impairment, Oral diadochokinesis, Tongue pressure

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Background

Mastication is not only a functional process involving multiple oral structures, such as the teeth, tongue, lips, and masticatory (e.g., masseter) muscles, for nutritional intake [1, 2] but is also associated with cognitive ability [2–5]. Mastication increases cerebral blood flow (CBF) in major cortical areas of the cerebrum, including the somatosensory and supplementary motor cortices. A previous study reported that chewing increased regional CBF by 25–28% in the primary sensorimotor area and by 9–17% in the supplementary motor area and insula using positron emission tomography (PET) data superimposed on magnetic resonance images (MRI) [6, 7]. In addition, mastication stimulates the production of several cell growth factors in the salivary glands, particularly influencing brain-derived neurotrophic factor (BDNF) secretion and expression. BDNF is predominantly found in the hippocampus and is associated with episodic memory [8, 9]. The functions of the brain are highly complex and not yet fully understood, but the activation of the hippocampus by chewing has been consistently reported in previous studies [10]. In contrast, reduced masticatory stimulation could lead to cognitive decline through reduced cortical area activation, decreased CBF, and particularly lower blood oxygen levels in the frontal cortex [11].

Cognition is a mental process function that deteriorates with age, leading to declines in attention, judgment, language skills, and memory. Mild cognitive impairment (MCI), a continuum between normal cognitive function and dementia, is characterized by impairments in cognitive functions that do not significantly impact daily activities [12]. Notably, MCI is reversible, with a prevalence of approximately 3% to 22% in in older adults [13]. Over a 2–5-year follow-up period, the reversion rate to normal cognition was 30–50%, which is higher than the progression rate to dementia, which ranges from 4–40% [14]. These findings suggest that MCI does not necessarily lead to dementia; therefore, to prevent or delay the progression of MCI to dementia, an oral rehabilitation guide that may contribute to improving masticatory function in older adult is needed.

Mastication has multiple functional aspects and has been investigated using various methods, including subjective methods, which are based on the patient's own evaluation, and objective methods, which use quantifiable indicators for assessment [3, 15]. In objective evaluations, factors such as the number of remaining teeth, bite force (BF), posterior occlusal support, and chewing ability have been identified as being related to masticatory function [3, 4, 11, 16, 17] and muscle-related orofacial variables such as tongue pressure (TP), handgrip (HG) strength, and oral diadochokinesis (ODK) tend to decrease with age [18]. Because subjective assessments, such as the Korean Mini-Mental State Examination, 2nd edition (KMMSE-2), Patient Health Questionnaire (PHQ)-9, Food Intake Ability (FIA), and Oral Health Impact Profile (OHIP)-14, are influenced by an individual's mental and psychological state, the data from both assessments have not coincided [3, 19, 20]. For example, participants with depressive symptoms tend to underestimate their self-evaluated masticatory performance (MP), whereas participants with cognitive impairment tend to overestimate it [21]. Therefore, it must be comprehensively evaluated by considering both objective indicators and subjective evaluation.

Studies investigating the association between MCI and masticatory function have reported varying conclusions. Tooth loss can reduce masticatory function, which is crucial in transmitting sensory information to the brain, leading to diminished hippocampal functions related to learning and memory [2, 3, 5, 6, 22, 23]. For a few studies, a lack of posterior occlusal support has been reported to have a greater impact on cognitive decline than the number of remaining teeth [11, 24]. Furthermore, a decline in oral motor skills, such as TP and ODK, can weaken swallowing function and result in unclear speech, making communication more challenging and leading to reduced social participation, which is considered one of the factors associated with cognitive impairment [25–28]. However, most previous studies have employed cohort or cross sectional designs characterized by heterogeneity in participant selection, inconsistency in the use of neurological cognitive assessment, and substantial variation in both cognitive and oral function measurement. For example, although several studies reported comparable conclusions that tooth loss and reduced masticatory function were significantly associated with cognitive impairment, the methods used to assess cognitive status varied substantially, ranging from a four-item survey in an American public database [23], to the KMMSE in Korean patients [3], an MCI blood biomarker in a Japanese cohort [4], and a comprehensive 12-test cognitive battery in a Swedish population [11]. These methodological discrepancies — including differences in participant selection, the presence or absence of standardized neurological evaluation, and heterogeneity of cognitive and oral function measures — may contribute to the inconsistent findings and underscore the need for studies adopting uniform, clinically validated cognitive assessments when investigating the association between masticatory function and cognitive impairment. The aim of the present study was to clarify the relationship between cognitive ability and masticatory functional factors by focusing on a population with oral conditions as close to normal as possible and identify the masticatory factors influencing MCI to inform tailored dental interventions that may help delay the onset of MCI in older adult.

Methods

Study participants

This cross-sectional study included 137 patients who visited the Department of Advanced General Dentistry at Yonsei University Dental Hospital and the Department of Neurology at Yonsei University Severance Hospital from August 2020 to February 2024, 100 of whom were cognitively intact healthy older adults and 37 of whom were diagnosed with MCI. Patients with a KMMSE-2 score than 27 were classified into the normal group, while those in the MCI group were diagnosed by neurologists using neuropsychological assessment tools such as the KMMSE-2 z-score of ≤ -1.5 SD adjusted for sex, age, and education level [29], as well as a Clinical Dementia Rating (CDR) of 0.5, a Korean Instrumental Activities of Daily Living (K-IADL) score of < 0.4, or a Seoul-Instrumental Activities of Daily Living (S-IADL) score of < 8. The patients who met the following common criteria were included: [1] aged 65 years and above and voluntarily agreed to participate; and [2] had at least 20 remaining teeth, including fixed dental prostheses, and were capable of independent living. The common exclusion criteria were as follows: [1] patients with systemic or oral mucosal diseases related to decreased saliva secretion; [2] patients with systemic diseases or taking medications related to muscular or neurological disorders; and [3] patients with untreated temporomandibular joint disorders. A total of 137 (62 men, 75 women) participants were included. Based on previous study using G-power software (Kiel University, Kiel, Germany), the required sample size was calculated and verified to be 26 per group, based on an effect size of 0.8, a significance level of $\alpha = 0.05$, and a power of 0.8 [3].

Study design

This study was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of Yonsei University College of Dentistry (No. 2-2020-0047). The evaluation of masticatory function was conducted through both subjective and objective assessments, utilizing the same methodology used in our previous studies [3, 18, 20]. Two researchers were responsible for the objective and subjective assessments, respectively, throughout the entire process to avoid inter-observer measurement errors.

Objective assessment

Objective assessments can be divided into static and dynamic categories. Static assessments.

included the number of remaining teeth, the Eichner index of posterior support, oral dryness, and masseter muscle thickness (MMT), whereas dynamic assessments included MP, BF, TP, HG, and ODK.

Tooth number, Eichner index The Eichner index representing the number of occlusal support zones in the posterior contact area was recorded by counting the number of functional tooth pairs formed by remaining natural or restored teeth, excluding the third molars and roots. This index is classified into three main groups (A, B, C) and subgroups (A1-A3, B1-B4, C1-C3) [24].

MP, BF, TP, HG MP was measured using the Glucosensor GS-2 (GC, Tokyo, Japan), a special device that measures the glucose concentration extracted from chewed jelly (Gurucolum, GC, Tokyo, Japan). BF was evaluated by instructing participants to sit comfortably with their heads upright, ensuring that the Frankfort horizontal plane was parallel to the ground. A properly sized pressure-sensitive film (Dental Prescale 50 H, GC, Japan) was placed intraorally, and participants were instructed to bite with maximum force for 3 s in the maximum intercuspal position. The BF was analyzed using an occlusal force analyzer (Occluser 709, GC, Japan) [20]. To measure TP, a balloon-based device (TPM-01, JMS, Hiroshima, Japan) was used. The participants were asked to position a balloon between the anterior part of the hard palate and the tongue, close their mouths, and exert maximum pressure for approximately 7 s. TP was recorded as the average of three attempts for each participant. HG, which reflects overall physical strength, was tested using a portable dynamometer (TKK 5401, Takei Scientific Instruments Co., Ltd., Tokyo, Japan). The participants were asked to stand and squeeze the hand dynamometer with maximum force. Each hand was tested two times, and the average value was recorded [18].

Oral dryness Oral moisture was assessed by touching an oral moisture-checking instrument (Mucus®, Life Co., Ltd., Saitama, Japan) at the center of the lingual mucosa, approximately 10 mm from the tongue tip. The average of three measurements was then recorded.

ODK ODK was assessed to evaluate the motor skills of the lips, anterior tongue, and posterior tongue. Using an automatic measuring device (Kenkou-kun Handy, Takei Scientific Instruments Co., Ltd., Japan), participants were instructed to repeat the monosyllables /pa/, /ta/, and /ka/ as quickly as possible for 5 s. Auditory analysis calculated the repetition rate per second for each syllable individually [18].

MMT The MMT is a useful indicator for evaluating the strength of the masseter muscle and can be measured using an ultrasound device. In this study, values were obtained from the left and right masseter muscles during relaxation and contraction. Relaxation was achieved by instructing participants to maintain slight interocclusal contacts, and contraction was achieved by instructing them to clench maximally in an upright position with the Frankfort Horizontal plane parallel to the floor. Measurements were taken at three specific sites on the masseter muscle, spaced 1 cm apart along the posterior border of the mandibular ramus and positioned 2 cm above the inferior border of the mandible: anterior, middle, and posterior. Muscle thickness was measured as the distance between the outer muscle fascia and the lateral bony surface of the ramus (Fig. 1), a method noted for its high reproducibility [30, 31]. The average thickness from these three cross-sectional points was recorded using an ultrasound device (Minisono, Alpinion, Korea).

Subjective assessments

Four questionnaires were used to evaluate cognitive ability, psychological state, and subjective masticatory function: the KMMSE-2, the PHQ-9, the FIA questionnaire, and the OHIP-14.

The KMMSE-2 consists of 30 questions, with a score range of 0 to 30, with lower scores indicating greater cognitive impairment [32].

The severity of self-reported depression was assessed using the PHQ-9, with scores of 5, 10, 15, and 20 indicating mild, moderate, moderately severe, and severe depression, respectively [33].

The FIA questionnaire asked participants to evaluate their masticatory ability by listing 14 foods ranging from easy to difficult to chew. Masticatory ability was assessed using a 5-point Likert scale as follows: 1 point (cannot chew at all), 2 points (difficult to chew), 3 points (neither), 4 points (slightly able to chew), and 5 points (able to chew well) [20].

The OHIP-14 was used to assess oral health-related quality of life (OHRQoL). It consists of 14 items rated on a 5-point Likert scale, with responses ranging from 0 (never) to 4 (very often) [34].

Statistical analysis

All the statistical analyses were conducted using SAS 9.4 software (SAS Institute, Inc., Cary, NC, USA). The differences between groups for continuous dependent variables were assessed using the Wilcoxon rank-sum test, whereas the chi-square test and Fisher's exact test were used for the analysis of categorical variables. Multiple logistic regression with Firth's penalized likelihood method was performed to identify the masticatory factors associated with MCI. Firth's method incorporates a Jeffreys-prior-based penalty into the likelihood function, reducing small-sample bias and stabilizing coefficient estimation when the information in one of the diagnostic groups is relatively limited [35, 36]. Age, sex, and BMI were included as covariates in the logistic regression [3]. The significance level of all the statistical analyses was 0.05. All methodologies were reviewed by an independent statistical expert.

Results

Demographic characteristics of participants in the Normal and MCI groups

The participants consisted of 137 participants (75 women and 62 men), and the mean age was 74.20 years. Although

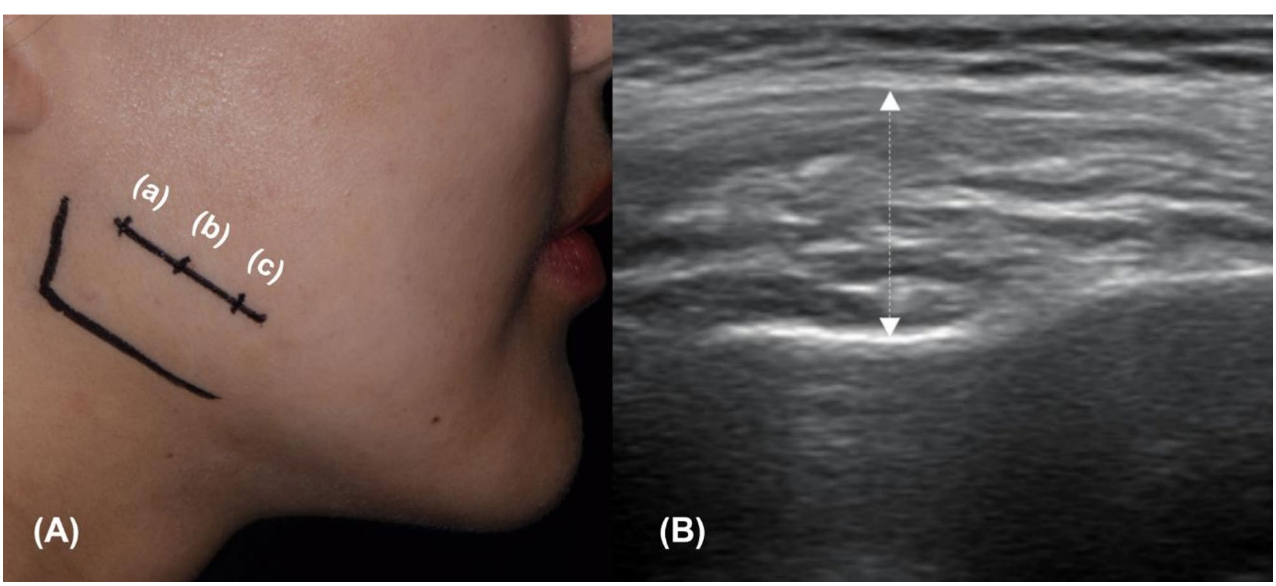

Fig. 1 Assessment of masseter muscle thickness using ultrasound. **A** Ultrasound scanning sites for the superficial portion of the masseter muscle. Muscle thickness was measured at three sites along the posterior border of the mandibular ramus, spaced 1 cm apart and positioned 2 cm above the inferior border of the mandible: (**a**) posterior masseter area (PMA), (**b**) middle masseter area (MMA), and (**c**) anterior masseter area (AMA).**B** White arrow line indicates muscle thickness

Table 1 Demographic characteristics of participants in the Normal and MCI groups

		Total	Normal	MCI	p value*
Subjects, N (%)		137 (100)	100 (72.99)	37 (27.01)	
Age (years)		74.20 ± 6.25	73.19 ± 5.70	76.95 ± 6.92	0.0046
Sex (%)	Male	62 (45.26)	45 (45)	17 (45.95)	0.9213†
	Female	75 (54.74)	55 (55)	20 (54.05)	
BMI (Kg/m²)		23.50 ± 2.92	23.79 ± 2.87	22.71 ± 2.94	0.0629

Mean±SD

*Wilcoxon rank sum test

†Chi-square test

*p<.05

the proportion of females was greater in both groups, the difference in the sex distribution between the two groups was not statistically significant. The mean age in the MCI group was significantly greater than that in the normal group (Table 1).

Comparison of objective masticatory function between Normal and MCI groups

The values of the objective masticatory function assessments were compared in Table 2. Compared with those in the normal group, the number of remaining teeth and posterior teeth in the MCI group were significantly lower. The normal group had a greater proportion of Eichner A, whereas the MCI group had a significantly greater proportion of Eichner B. Dynamic methods for objective assessment, such as BF and BF max, did not significantly differ, whereas the biting area significantly differed. In the MCI group, TP, ODK /pa/, /ta/, /ka/, and MMT were significantly lower than those in the normal group.

Table 3 Comparison of subjective masticatory function between Normal and MCI groups

Variable	Total (n = 137)	Normal (n = 100)	MCI (n = 37)	P value*
KMMSE-2	27.50 ± 2.52 28(2); 15–30	28.48 ± 0.98 29(1); 27–30	24.86 ± 3.41 25(4); 15–30	< 0.0001*
PHQ-9	2.67 ± 3.40	2.55 ± 3.39	3.00 ± 3.43	0.4646
FIA	66.13 ± 7.86	66.14 ± 8.40	66.11 ± 6.29	0.4808
OHIP-14	4.06 ± 5.80	3.69 ± 5.62	5.05 ± 6.24	0.2569

KMMSE-2 Korean Mini-Mental State Examination. 2nd edition, *PHQ-9* Patient Health Questionnaire-9, *FIA* food intake ability, *OHIP-14* Oral Health Impact Profile-14

Mean ± SD; median(IQR); min-max

*Wilcoxon rank sum test

*p<.05

Comparison of subjective masticatory function between Normal and MCI groups

Table 3 shows the results of the subjective assessments of masticatory and cognitive functions. There were no significant differences between the two groups in the PHQ-9, FIA, and OHIP-14 scores. Only the KMMSE-2 scores were significantly lower in the MCI group than in the normal group.

Table 2 Comparison of objective masticatory function between Normal and MCI groups

Variable		Total (n = 137)	Normal (n = 100)	MCI (n = 37)	P value*
Remaining teeth		26.96 ± 1.63	27.17 ± 1.56	26.41 ± 1.72	0.0172*
Posterior teeth		15.12 ± 1.38	15.32 ± 1.21	14.59 ± 1.66	0.0247*
Anterior teeth		11.84 ± 0.64	11.85 ± 0.67	11.81 ± 0.57	0.6963
Eichner index (A: B)		128:9	98:2	30:7	0.0015†
MP		225.63 ± 71.08	221.71 ± 55.54	236.22 ± 102.20	0.2185
BF		665.32 ± 357.39	691.11 ± 365.60	595.62 ± 328.77	0.1903
BF max		99.08 ± 22.90	98.63 ± 22.24	100.31 ± 24.87	0.4771
Biting area		20.53 ± 9.91	21.60 ± 10.32	17.62 ± 8.11	0.0497*
TP		28.07 ± 7.62	29.64 ± 7.07	23.84 ± 7.52	0.0008*
HG		22.79 ± 8.47	23.41 ± 8.55	21.11 ± 8.14	0.1903
Oral dryness		27.75 ± 2.12	27.81 ± 2.08	27.58 ± 2.26	0.8163
ODK	/Pa/	5.10 ± 1.00	5.29 ± 0.77	4.61 ± 1.34	0.0082*
	/ta/	5.08 ± 1.02	5.23 ± 0.88	4.68 ± 1.25	0.0397*
	/ka/	4.85 ± 1.06	5.06 ± 0.86	4.30 ± 1.32	0.0028*
MMT	Relax	10.47 ± 2.35	10.85 ± 2.43	9.44 ± 1.76	0.0037*
	Contract	12.65 ± 2.60	13.18 ± 2.63	11.22 ± 1.89	< 0.0001*

MP masticatory performance, *BF* bite force, *TP* tongue pressure, *HG* handgrip strength, *ODK* oral diadochokinesis, *MMT* masseter muscle thickness

Mean ± SD

*Wilcoxon rank sum test

†Fisher's exact test

*p<.05

Table 4 Association between MCI and masticatory function factor

Variable		Model 1			Model 2		
		OR	95% CI	*P* value*	OR	95% CI	*P* value*
Remaining teeth		0.77	0.61–0.97	0.0260*	0.84	0.66–1.06	0.1441
Posterior teeth		0.70	0.54–0.92	0.0096*	0.77	0.58–1.02	0.0719
Eichner index (A: B)	A	1.00	-	-	1.00	-	-
	B	9.69	2.03–46.25	0.0044*	6.21	1.21–31.92	0.0288*
Biting area		0.96	0.92-1.00	0.0453*	0.96	0.92–1.01	0.0978
TP		0.90	0.85–0.95	0.0003*	0.92	0.86–0.98	0.0063*
ODK	/Pa/	0.51	0.34–0.77	0.0014*	0.54	0.34–0.87	0.0120*
	/ta/	0.60	0.41–0.88	0.0092*	0.67	0.43–1.03	0.0683
	/ka/	0.51	0.35–0.76	0.0007*	0.55	0.36–0.85	0.0071*
MMT	relax	0.75	0.61–0.91	0.0032*	0.74	0.59–0.92	0.0071*
	contract	0.71	0.59–0.86	0.0003*	0.69	0.56–0.85	0.0005*
KMMSE-2		0.35	0.24–0.52	< 0.0001*	0.37	0.25–0.55	< 0.0001*

OR Odds ratio, *CI* Confidence interval, *TP* tongue pressure, *ODK* oral diadochokinesis, *MMT* masseter muscle thickness, *KMMSE-2* Korean Mini-Mental State Examination, 2nd edition

Reference: Normal group

Model 1 is a simple logistic regression with Firth's method

Model 2 is a multiple logistic regression with Firth's method adjusted sex, age, BMI

**p<.05*

Association between MCI and masticatory function

The results of simple and multiple logistic regression analyses of the associations between MCI and subjective and objective assessment factors are presented in Table 4. Model 2, a multiple logistic regression model adjusted for sex, age, and body mass index (BMI), revealed that the Eichner index, TP, ODK /pa/, /ka/, MMT, and KMMSE-2 were significantly associated with MCI.

Discussion

The study was conducted on patients diagnosed with MCI by neurologists to ensure comparative accuracy, with the primary aim of investigating the influence of masticatory factors associated with MCI in older adults.

This study revealed a significant association between the Eichner index and associated with MCI, but no significant associations were found between tooth number or MP and associated with MCI, regardless of sex, age, or BMI. The Eichner index indicates posterior occlusal support on the basis of the number of occluding contact sites [24]. A recent study revealed that cognitive decline was significantly associated with posterior occlusal support factors, which is consistent with our findings [11, 24, 37]. However, although previous studies reported that tooth number and MP were significantly associated with MCI [2–6, 22, 23], the present study revealed no significant associations between MCI and either MP or tooth number. What caused this difference between the present study and the results of the previous studies? In this study, the average number of teeth was similar between the normal (27.17 ± 1.56) and MCI (26.41 ± 1.72) groups because participants with 20 or more teeth were selected for both groups to limit the effect of the number of teeth. According to the concept of a shortened dental arch, masticatory function is considered within the normal range if there are more than 20 remaining teeth [38]. Therefore, it can be presumed that MP was not significantly impaired and that the number of remaining teeth was unimportant. Notably, despite the absence of significant differences in the MP and tooth number between the two groups, posterior occlusal support was significantly associated with MCI. This result suggests that securing posterior occlusal support in older adults may be more important for preserving cognitive function than merely increasing the number of teeth or altering prosthetic strategies [11, 24, 39, 40].

The ODK is a measure to evaluate the speed and dexterity of tongue–lip motor function and is influenced by the linguistic background [18, 41]. While this study did not enable the identification of bilateral causal mechanisms underlying the relationship between cognitive ability and TP or ODK, it confirmed a significant association between muscle-related functional indicators—such as TP, ODK (/pa/and/ka/), and MMT—and associated with MCI, independent of sex, age, and BMI. Notably, previous research has demonstrated that older adult' social engagement contributes to maintaining cognitive abilities. For example, a study of community-dwelling individuals revealed that those with higher TP were more socially active than those with lower TP [26–28]. Furthermore, large-scale studies have established an association between lip movement disorders and the prevalence of MCI, emphasizing that reduced lip mobility can hinder effective communication [25, 26]. These findings suggest that the role of muscle-related oral function in cognitive decline may extend beyond the well-documented relationship between aging and sarcopenia [18, 42, 43]. Therefore, regular oral function assessments using objective measures such as TP and ODK, alongside targeted interventions, including orofacial muscle training (e.g., tongue-lip strength) or prosthetic treatments, may serve as proactive strategies for mitigating the progression of oral frailty. Such approaches not only contribute to the maintenance of oral function but also hold the potential for reducing factors associated with MCI. Based on these findings, it could be inferred that "masticatory function", "chewing ability" or "oral function" described in the previous, which are significantly associated with cognitive impairment, potentially through mechanism such as increased cerebral blood flow, stimulation of BDNF, and activation of the hippocampus researches, may refer to oral motor efficiency within the stomatognathic system, rather than simply the act of chewing itself. This highlights the importance of considering broader oral motor function when assessing the relationship between oral function and cognitive health.

MCI requires a complex and multifaceted diagnostic process. While previous studies have relied predominantly on tools such as the MMSE to diagnose MCI [3, 4, 21, 25, 26], the present study focused on patients diagnosed by neurologists using standardized diagnostic criteria to ensure a more accurate diagnosis. This approach enables a more precise assessment, enhancing data accuracy compared with prior methods.

Despite these strengths, several limitations should be addressed. Notably, this study did not distinguish between different subtypes of dementia, such as Alzheimer's disease, Parkinson's disease, and vascular dementia, nor did it adequately consider potential covariates such as nutrition, other cardiovascular, lifestyle, and psychosocial factors, which may affect the generalizability of the findings. Furthermore, as a cross-sectional study, it is limited in drawing conclusions regarding the risk of MCI or causal relationships. Future research should address these limitations by more comprehensively categorizing dementia subtypes, expanding the sample size, and including a broader range of oral health conditions. These improvements would help establish more robust diagnostic markers and increase the overall reliability of the findings, ultimately enhancing our understanding of both MCI and dementia, and informing the development of more effective, personalized dental treatment strategies.

Conclusion

This study confirmed that among various masticatory variables, posterior occlusal support and muscle-related factors such as TP, ODK, and MMT were significantly associated with MCI. These findings suggest the potential utility of these oral function measures in identifying factors associated with MCI and underscore the importance of oral rehabilitation strategies that secure posterior occlusal support, and orofacial muscle training for older adults.

Abbreviations

CBF	Cerebral Blood Flow
PET	Positron Emission Tomography
MRI	Magnetic Resonance Imaging
BDNF	Brain-derived Neurotrophic Factor
MCI	Clinical Dementia Rating
K-IADL	Korean Instrumental Activities of Daily Living
S-IADL	Seoul-Instrumental Activities of Daily Living
BMI	Body Mass Index
MP	Masticatory Performance
BF	Bite Force
TP	Tongue Pressure
HG	Handgrip Strength
ODK	Oral Diadochokinesis
MMT	Masseter Muscle Thickness
KMMSE-2	Korean Mini-Mental State Examination, 2nd edition
PHQ	Patient Health Questionnaire
FIA	Food Intake Ability
OHIP	Oral Health Impact Profile

Authors' contributions

B.S.Y. and B.-Y.J. contributed to conceptualization and validation.B.-Y.J. was responsible for funding acquisition and writing—review & editing.S.Y.K. and J.-H.O. contributed to data curation, investigation, and resources.S.J. conducted the methodology.S.Y.K. wrote the original draft.All authors reviewed and approved the final manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author, Dr. Bock-Young Jung, upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the institutional review board committee of the Yonsei School of Dentistry (No. 2-2020-0047), and informed consent was obtained from all the participants involved in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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