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Original Article

Posterior occlusal support and self-reported chewing discomfort beyond the number of remaining teeth in Korean adults: KNHANES 2007 – 2018

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Purpose: Although the number of remaining teeth is widely used to summarize oral function, the same tooth count may correspond to different functional states depending on which teeth are lost. We examined whether the location of tooth loss, particularly posterior occlusal support, is associated with chewing discomfort independently of the number of remaining teeth. **Materials and Methods:** We analyzed pooled data from 60,306 dentate adults aged 19 years or older in the Korea National Health and Nutrition Examination Survey (2007 - 2018). Posterior occlusal support was quantified as the number of antagonist premolar or molar pairs in occlusion (posterior occluding pairs). Complex-survey logistic regression estimated adjusted odds ratios (aOR) for self-reported chewing discomfort, conditioning on the total number of remaining teeth and covariates. **Results:** At an identical tooth count, chewing discomfort differed markedly by posterior occlusal support (e.g., 30.9% vs. 45.9% among adults with 20 - 24 teeth). Each additional posterior occluding pair was independently associated with lower odds of chewing discomfort (aOR, 0.749; 95% CI, 0.732 - 0.767), whereas the total tooth count no longer showed its expected protective association once support was accounted for. Posterior tooth loss raised the odds (aOR, 1.126), but anterior loss did not. Prostheses partially attenuated the association. **Conclusion:** The location of tooth loss, especially posterior occlusal support, appears to be a major determinant of chewing discomfort beyond the number of teeth. Preserving or re-establishing posterior occlusal contacts, rather than maximizing tooth count alone, may be central to maintaining masticatory function. **(J Dent Rehabil Appl Sci 2026;42(3):238-50)**

Key words: cross-sectional studies; dental occlusion; dental prosthesis; mastication; quality of life; tooth loss

Introduction

Tooth loss remains common in adult populations and is consistently associated with impaired masticatory function and reduced oral-health-related quality of life. A large body of evidence, including systematic reviews and meta-analyses, has established that having fewer teeth is associated with poorer chewing ability and worse quality of life across diverse populations.[1-3] On this basis, the World Health Organization has long promoted the retention of a "functional dentition" of at least 20 natural teeth as a public health goal, and the number of remaining teeth has become the dominant metric in both clinical practice and population research.[4]

However, tooth count alone captures only part of oral function. The same number of remaining teeth can correspond to very different functional states

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depending on which teeth are lost and whether the remaining teeth still meet their antagonists. Several studies have noted that the quantity of teeth lost does not fully reflect the impact of tooth loss, and that the position and distribution of the remaining dentition matter.[5,6] In particular, anterior and posterior teeth serve different functions, and their loss has been reported to affect distinct dimensions of oral health.[7] The number of occluding pairs, rather than the simple tooth count, has likewise been linked to masticatory ability and quality of life.[2,8]

Despite these observations, most population-based studies continue to summarize dentition by the total number of teeth, and relatively few have isolated the contribution of the location of tooth loss, specifically the loss of posterior occlusal support, from the number of teeth itself. To our knowledge, no previous population-based study has explicitly conditioned on the total number of remaining teeth while simultaneously evaluating posterior occlusal support, which is the central methodological feature of the present analysis. This distinction is clinically important: if posterior occlusal support, rather than tooth count, is the main driver of masticatory impairment, then preventive and prosthodontic strategies should prioritize preserving or re-establishing posterior antagonist contacts rather than maximizing the number of teeth alone. Examining this question requires a large, representative sample in which the number and location of tooth loss can be disentangled analytically.

Using nationally representative data from the Korea National Health and Nutrition Examination Survey (2007 - 2018), we therefore examined whether the location of tooth loss, and posterior occlusal support in particular, is associated with self-reported chewing discomfort independently of the number of remaining teeth. Specifically, we aimed (i) to determine whether chewing discomfort differs by posterior occlusal support among adults with the same number of remaining teeth, (ii) to estimate the independent contributions of posterior versus anterior tooth loss and of individual tooth positions, and (iii) to assess whether prosthetic rehabilitation modifies these associations.

Materials and Methods

Study design and data source

This study was a cross-sectional analysis of pooled data from the fourth through seventh cycles of the Korea National Health and Nutrition Examination Survey (KNHANES IV - VII, 2007 - 2018), a nationally representative, rolling survey of the non-institutionalized Korean civilian population conducted by the Korea Disease Control and Prevention Agency. KNHANES employs a multistage, stratified, clustered probability sampling design and includes a standardized oral examination performed by trained and calibrated dentists. The study was conducted in accordance with the Declaration of Helsinki. As a secondary analysis of non-identifiable public data, it was approved with a waiver of informed consent by the Institutional Review Board of Dankook University (DKU-2026-02-004).

Study population

Of 85,652 participants who underwent the oral examination across the four cycles (2007 - 2018), we first restricted the sample to adults aged 19 years or older, excluding 19,662 participants younger than 19 years. Among the remaining adults, we sequentially excluded participants with missing self-reported chewing discomfort (n = 2,080), those whose tooth status could not be determined because no permanent tooth surface was recorded (n = 1,604), and those with missing covariate data (n = 2,000). The final analytic sample comprised 60,306 adults (cycle IV, 16,430; cycle V, 17,245; cycle VI, 14,120; cycle VII, 12,511).

Outcome: chewing discomfort

The outcome was self-reported chewing discomfort, assessed by the standardized KNHANES item asking adults whether they experienced discomfort when chewing food because of problems with their teeth, dentures, or mouth. Responses were recorded on a five-point scale (1 = very uncomfortable, 2 =

uncomfortable, 3 = neither, 4 = not very uncomfortable, 5 = not uncomfortable at all). Consistent with the official KNHANES derived indicator, responses of very uncomfortable or uncomfortable were classified as the presence of chewing discomfort, and the remaining responses as its absence. The original five-point ordinal response was retained for sensitivity analysis.

Exposures: number and location of tooth loss

Tooth status was determined from surface-level examination codes recorded for the five surfaces of each tooth. Third molars were excluded from all analyses; the functional dentition was therefore defined over the 28 non-third-molar permanent teeth. A tooth was classified as present (functional) if any surface was coded as sound, carious, filled, sealed, or restored, and as missing if its surfaces were coded as lost. The total number of remaining teeth was the count of teeth classified as present (range 0 - 28).

To characterize the location of tooth loss, each tooth was assigned to one of eight groups defined by arch (maxilla, mandible) and tooth type (incisor, canine, premolar, molar). For each group we counted the number of missing teeth. We additionally summarized loss by region (anterior [incisors and canines] vs. posterior [premolars and molars]) and by arch (maxillary vs. mandibular).

Posterior occlusal support was quantified as the number of antagonist premolar or molar pairs in which both the maxillary tooth and its mandibular counterpart were present, that is, the number of posterior occluding pairs (range 0 - 8). Here, one occluding pair denotes a single maxillary tooth in occlusion with its mandibular antagonist at the same tooth position, counted per tooth rather than per support region. Because each side of the arch contributes four posterior positions (the first and second premolars and the first and second molars, with third molars excluded), the two sides together yield a maximum of eight occluding pairs. This individual tooth-pair count (0 - 8) is therefore distinct from the four Eichner support zones (right and left premolar and molar regions), which are used only in the sensitivity analysis below. Because the survey did not record occlusal contacts directly, antagonist pairs were defined operationally by matching tooth positions. For sensitivity analysis, posterior occlusal support was additionally categorized using an Eichner-type scheme.

Prosthetic status and covariates

Prosthetic status was based on the presence of any fixed or removable dental prosthesis recorded at examination. Covariates were age, sex, household income, educational attainment, current smoking, and survey cycle, all of which are associated with both tooth loss and self-reported oral function.

Statistical analysis

All analyses accounted for the complex survey design. An integrated weight was constructed by multiplying each survey year's oral-examination weight by that year's share of the pooled survey period. Following the KNHANES analytic guidelines for combining data across phases, each survey year was assigned a value proportional to its field-survey period; because the 2007 survey covered only the second half of the year, it was assigned 0.5 rather than 1.0. Consequently, the combined denominator across phases IV - VII (0.5 for 2007 plus 1.0 for each of the eleven years from 2008 to 2018) is 11.5 rather than 12. Accordingly, the 2007 oral-examination weights were multiplied by 0.5/11.5 and the weights for each year from 2008 to 2018 by 1/11.5. Variance was estimated by Taylor-series linearization, with strata defined by the cross-classification of survey cycle and the KNHANES stratification variable, and primary sampling units nested within strata. The weighted prevalence of chewing discomfort was estimated overall and within strata of the number of remaining teeth, cross-classified by preserved versus lost posterior occlusal support. For these descriptive analyses, posterior occlusal support was dichotomized at five occluding pairs because this threshold provided a clinically interpretable separation while preserving adequate numbers within each subgroup; the regression analyses modeled posterior occluding

pairs as a continuous variable and did not depend on this cut-point. Survey-weighted logistic regression estimated adjusted odds ratios (aOR) and 95% confidence intervals (CI). To separate the location of tooth loss from its amount, we fitted three models, each parameterizing tooth loss differently and fitted separately (defined in Table 3). Model 1 entered posterior occluding pairs together with the total number of remaining teeth; Model 2 entered anterior and posterior teeth lost; and Model 3 entered maxillary and mandibular teeth lost. Effects of individual tooth positions were additionally estimated and displayed as a tooth-location map. Stratified analyses by tooth-count category and tests of interaction with prosthetic status were performed. Sensitivity analyses were performed to evaluate the robustness of the findings to alternative outcome definitions and alternative parameterizations of posterior occlusal support, using cumulative-cut ordinal models of the five-point chewing scale and the Eichner-type categorization. Analyses were conducted in Python 3.12 (NumPy, pandas, and statsmodels), using a custom complex-survey estimator implementing Taylor-series linearization for the stratified, clustered design. Two-sided $P < 0.05$ was considered significant.

Results

The final sample comprised 60,306 dentate adults aged 19 years or older (weighted mean age, 45.8 years; 51.4% women). On average, participants retained 24.7 of 28 teeth and had 6.3 of a possible 8 posterior occluding pairs (Table 1). Posterior teeth were lost more often than anterior teeth (mean, 2.4 vs. 0.9 teeth lost), and 36.0% wore a prosthesis. The weighted prevalence of chewing discomfort was 24.3%.

The prevalence of chewing discomfort rose steeply as the number of remaining teeth fell, from 11.4% among adults with a complete dentition (28 teeth) to 57.9% among those with 10 - 19 teeth (Table 2), confirming the expected count-dependent gradient. However, at the same number of remaining teeth the prevalence diverged sharply according to posterior occlusal support. Among adults with 20 - 24 teeth, chewing discomfort was reported by 30.9% of those who had preserved posterior support (≥ 5 occluding pairs) but by 45.9% of those who had lost it (< 5 pairs), an absolute difference of 15.0 percentage points at an identical tooth count (Table 2). In contrast, among adults with only 10 - 19 teeth, chewing discomfort was uniformly high regardless of posterior occlusal support (55.9% vs. 58.0%), suggesting that once the dentition is severely compromised, preserving posterior support alone may be insufficient to maintain chewing function. This dispersion at a fixed count indicates that the number of teeth alone does not fully capture masticatory impairment, and that two individuals with the same number of teeth may differ markedly in function depending on where those teeth are located.

After adjustment for the total number of remaining teeth and covariates, each additional posterior occluding pair was associated with substantially lower odds of chewing discomfort (adjusted odds ratio [aOR], 0.749; 95% confidence interval [CI], 0.732 - 0.767; Table 3, Model 1). In the same model, the total number of remaining teeth did not retain its expected protective association once posterior support was accounted for (aOR, 1.039 per tooth), indicating that the apparent benefit associated with a greater

Table 1. Baseline characteristics of the study population

Characteristic	Total (N = 60,306)
Age, year, mean (SD)	45.8 (16.2)
Female, %	51.4
Remaining teeth, n, mean (SD)	24.7 (6.2)
Posterior occlusal pairs, n, mean (SD)	6.3 (2.5)
Anterior teeth lost, n, mean (SD)	0.9 (2.5)
Posterior teeth lost, n, mean (SD)	2.4 (4.0)
Any prosthesis, %	36.0
Current smoker, %	24.0
Chewing discomfort, %	24.3

SD, standard deviation. Estimates account for the complex survey design. Third molars were excluded; remaining teeth range 0 - 28 and posterior occlusal pairs 0 - 8. Any prosthesis denotes a fixed dental prosthesis, removable partial denture, or complete denture recorded at examination; dental implants, which are recorded separately in KNHANES, are not included in this variable.

Table 2. Prevalence of chewing discomfort by number of remaining teeth and posterior occlusal support

Remaining teeth (n)	Overall %	Preserved support (≥ 5 pairs) %	Lost support (< 5 pairs) %	Difference (%p)
10 - 19	57.9	55.9	58.0	+2.1
20 - 24	39.2	30.9	45.9	+15.0
25 - 27	24.5	24.5	–	–
28	11.4	11.4	–	–

%p, percentage points. Among adults with ≥ 25 teeth, posterior occlusal support was almost always preserved, so a "lost support" group was not estimable (–). The within-stratum gap was concentrated in the 20 - 24 tooth range.

Table 3. Independent associations of tooth-loss location with chewing discomfort

Model	Variable	aOR (95% CI)	*P*
Model 1	Posterior occlusal pairs (per pair)	0.749 (0.732 - 0.767)	< 0.001
Model 1	Remaining teeth (per tooth)	1.039 (1.031 - 1.046)	< 0.001
Model 2	Anterior teeth lost (per tooth)	0.948 (0.935 - 0.962)	< 0.001
Model 2	Posterior teeth lost (per tooth)	1.126 (1.114 - 1.138)	< 0.001
Model 3	Maxillary teeth lost (per tooth)	1.054 (1.043 - 1.065)	< 0.001
Model 3	Mandibular teeth lost (per tooth)	1.045 (1.033 - 1.057)	< 0.001

aOR, adjusted odds ratio; CI, confidence interval. The three models differ in how tooth loss is parameterized and were fitted separately. Model 1 enters the number of posterior occluding pairs together with the total number of remaining teeth, to separate occlusal support from sheer tooth count. Model 2 replaces these with the numbers of anterior and posterior teeth lost, entered simultaneously, to contrast loss by region. Model 3 enters the numbers of maxillary and mandibular teeth lost, to contrast loss by arch. All models were adjusted for age, sex, household income, education, current smoking, and survey cycle.

number of teeth operates through the occlusal support those teeth provide rather than through their number per se.

The distinction between posterior and anterior loss was equally clear. When the numbers of anterior and posterior teeth lost were entered simultaneously, each posterior tooth lost raised the odds of chewing discomfort (aOR, 1.126; 95% CI, 1.114 - 1.138), whereas anterior tooth loss did not (aOR, 0.948; Model 2). Loss in the two arches contributed similarly (maxillary aOR, 1.054; mandibular aOR, 1.045; Model 3). At the level of individual tooth positions, the location map (Fig. 1) showed the same gradient: loss of molars carried the largest per-tooth odds (aOR ≈ 1.24 - 1.25) and loss of incisors a modest effect (aOR ≈ 1.04 - 1.06). Contrary to the expected pattern, loss of canines showed a paradoxical inverse association (aOR ≈ 0.77 - 0.80); this counterintuitive finding is examined in the Discussion. Both the above-unity coefficient for remaining teeth in Model 1 and the inverse association for canine loss are statistical artifacts of mutual adjustment rather than causal effects, and should not be read as a benefit of having more teeth or of losing a canine; their interpretation is detailed in the Discussion.

The protective association of posterior occlusal support persisted within strata of remaining tooth count (Table 4, by number of remaining teeth). It was not significant among adults with 10 - 19 teeth (aOR, 0.959; $P = 0.13$) but was strong among those with 20 - 24 teeth (aOR, 0.859) and 25 - 27 teeth (aOR, 0.769).

Prosthetic rehabilitation modified this association (Table 4, by prosthetic status). The protective effect of posterior occlusal support was markedly stronger among adults without a prosthesis (aOR, 0.591) than among those with any prosthesis (aOR, 0.846), and the posterior support × prosthesis interaction was significant (aOR, 1.311; 95% CI, 1.269 - 1.355), indicating that the protective effect of each additional posterior occluding pair was attenuated among prosthesis wearers.

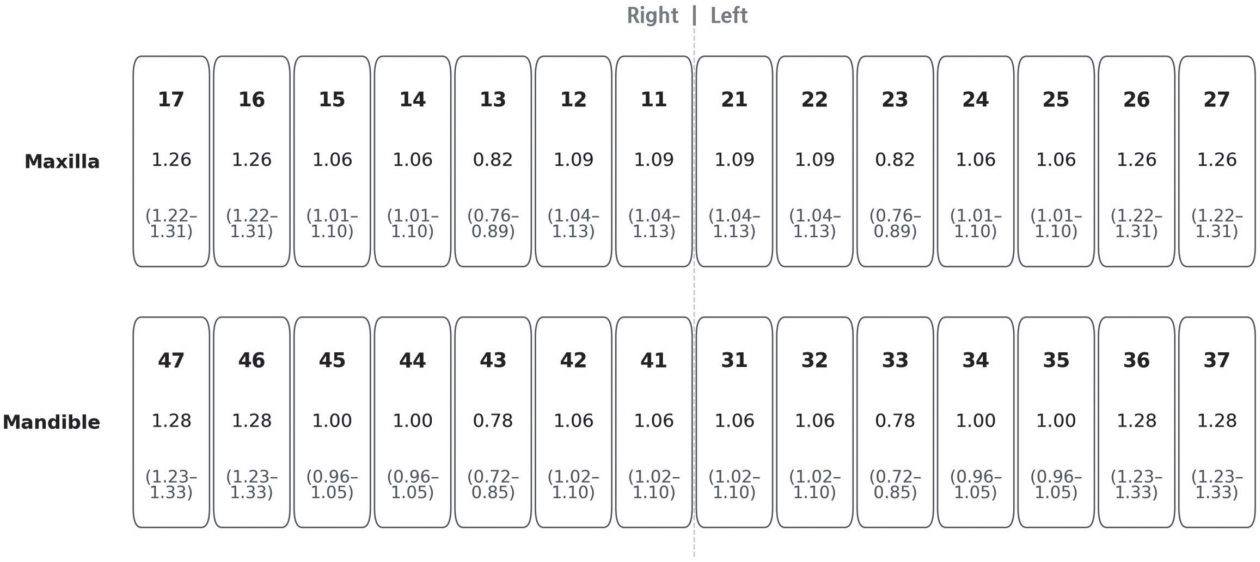

Fig. 1. Adjusted odds ratio for chewing discomfort associated with loss at each FDI tooth position, from a survey-weighted logistic model including all tooth positions and the total number of remaining teeth.

Table 4. Posterior occlusal support and chewing discomfort, stratified by number of remaining teeth and by prosthetic status (extending Model 1 of Table 3)

Subgroup	N	aOR (95% CI)	*P*
By number of remaining teeth			
10 - 19 teeth	5,329	0.959 (0.909 - 1.012)	0.127
20 - 24 teeth	8,973	0.859 (0.826 - 0.893)	< 0.001
25 - 27 teeth	16,771	0.769 (0.726 - 0.814)	< 0.001
By prosthetic status			
No prosthesis	34,454	0.591 (0.558 - 0.626)	< 0.001
Any prosthesis	25,852	0.846 (0.825 - 0.868)	< 0.001
Prosthesis × support interaction	60,306	1.311 (1.269 - 1.355)	< 0.001

aOR, adjusted odds ratio per additional posterior occluding pair, from the Model 1 specification of Table 3 fitted within each subgroup and adjusted for the same covariates. The 28-tooth stratum was omitted because posterior support was saturated. The interaction term is the product of posterior occlusal support and prosthetic status, estimated in the full sample.

The protective association of posterior occlusal support was present in every age group and was somewhat stronger in younger adults (aOR, 0.723 at 19 - 39 years) than in the oldest group (aOR, 0.819 at ≥ 70 years; Fig. 2), with overlapping confidence intervals across the age range.

Findings were robust in both sensitivity analyses (Table 5). Modeling the original five-point chewing-discomfort scale with cumulative-cut logistic models produced nearly identical estimates at every threshold (aOR, 0.71 - 0.75), confirming that the result did not depend on the binary cut-point. Categorizing posterior support using an Eichner-type scheme showed a graded dose-response: relative to near-complete posterior support, the odds of chewing discomfort were progressively higher with partial support (aOR, 2.54) and with no posterior support (aOR, 3.15), reinforcing the continuous-pair findings.

Discussion

In this nationally representative sample of 60,306 Korean adults, the location of tooth loss, not merely the number of teeth lost, was a key determinant of

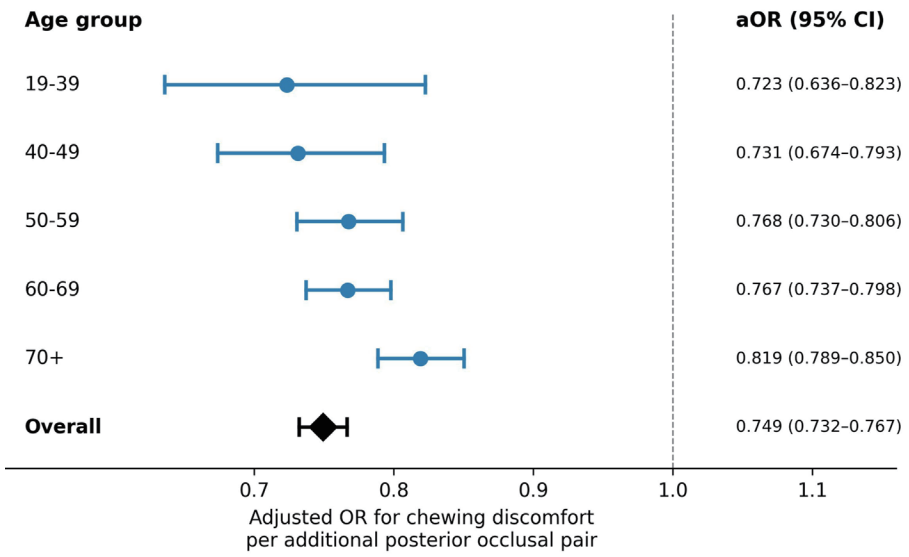

Fig. 2. Adjusted odds ratio for chewing discomfort per additional posterior occluding pair, by age group. Points and horizontal lines indicate adjusted odds ratios and 95% confidence intervals from survey-weighted logistic regression.
aOR, adjusted odds ratio; CI, confidence interval.

Table 5. Sensitivity analyses for the association of posterior occlusal support with chewing discomfort (primary estimate: aOR 0.749, Model 1 of Table 3)

Specification	Prevalence %	aOR (95% CI)	*P*
Ordinal cumulative-cut models (five-point chewing scale)			
Any discomfort or worse	65.7	0.748 (0.728 - 0.768)	< 0.001
Moderate discomfort or worse	40.8	0.752 (0.736 - 0.769)	< 0.001
Marked discomfort (primary cut)	24.3	0.749 (0.732 - 0.767)	< 0.001
Very uncomfortable	5.2	0.709 (0.684 - 0.734)	< 0.001
Eichner-type categorization of posterior support			
Partial posterior support	44.2	2.541 (2.384 - 2.708)	< 0.001
No posterior support	58.3	3.152 (2.872 - 3.458)	< 0.001

aOR, adjusted odds ratio, adjusted for the same covariates as Table 3. Both analyses test the robustness of the primary posterior-support estimate (Model 1 of Table 3). In the ordinal cumulative-cut models, the outcome is dichotomized at successively more severe thresholds of the five-point chewing scale and the aOR is per additional posterior occluding pair. In the Eichner-type categorization, partial and no posterior support are compared with near-complete posterior support (reference). Prevalence values are survey-weighted and therefore correspond to the weighted overall prevalence reported in the Results. Estimates were stable across all thresholds and categorizations.

chewing discomfort. At an identical number of remaining teeth, adults who had lost posterior occlusal support reported chewing discomfort far more often than those who had preserved it, and each additional posterior occluding pair was independently associated with markedly lower odds of discomfort, whereas the total tooth count was no longer protective once support was taken into account. Posterior tooth loss, but not anterior tooth loss, drove the association, and the effect was concentrated in the molar region. These findings suggest that the functional importance traditionally attributed to tooth number is more accurately explained by posterior occlusal support: what matters functionally is whether the remaining teeth still meet in occlusion. This dependence on posterior occlusal support varied according to the extent of tooth loss, however. Among adults with only 10 - 19 remaining teeth, chewing discomfort

was high irrespective of posterior support (55.9% vs. 58.0%; Table 2), and the per-pair association was no longer significant in this stratum (Table 4). In a severely reduced dentition the masticatory deficit appears to have reached a functional ceiling, so that preserving a few posterior contacts confers little additional benefit. This ceiling effect helps define the boundary within which posterior occlusal support is most relevant.

The principal finding of this study, that posterior occlusal support outweighs the mere number of teeth, is mechanistically coherent with experimental and epidemiological work on mastication. Chewing efficiency is largely determined by the area over which food is crushed between opposing posterior teeth and by the bite force that can be generated there. In the population-based Suita study, the determinants of masticatory performance differed according to the number of occlusal support areas, and maximum bite force was the common factor across all support categories.[9] Experimentally, the amount of glucose extracted from a test gummy jelly (a direct measure of comminution) rose progressively with each additional posterior occlusal support unit.[10] Cross-sectional and longitudinal analyses likewise show that masticatory performance tracks occlusal support areas rather than tooth count alone,[11,12] and that maximum occlusal force mediates much of this relationship.[13] The classic synthesis by Gotfredsen and Walls concluded that adequate masticatory function requires not simply 20 teeth but roughly nine to ten occluding pairs, explicitly linking function to antagonistic contacts rather than to a tooth count.[6] Consistent with this, the finding that the total number of remaining teeth lost its apparent protective association once posterior occluding pairs were modeled is the population-level counterpart of these mechanistic observations: teeth without an antagonist contribute substantially less to trituration, and their inclusion in a simple count therefore overstates function.

Because posterior occluding pairs and total remaining teeth were modeled simultaneously, the coefficient for remaining teeth must be interpreted conditionally. At a fixed number of posterior occluding pairs, additional remaining teeth largely represent teeth that do not contribute to posterior occlusal support, predominantly anterior teeth. The adjusted odds ratio above unity should therefore not be read as indicating that having more teeth increases chewing discomfort; rather, it indicates that posterior occlusal support accounts for the functional benefit conventionally attributed to tooth number. Conceptually, once the number of posterior occluding pairs is held constant, each additional remaining tooth is disproportionately a non-occluding, functionally isolated tooth (for example, a tooth whose antagonist has been lost), so a higher tooth count at fixed occlusal support does not correspond to greater chewing capacity. The same conditioning logic applies to the individual tooth-group coefficients, one of which—the paradoxical inverse association for canine loss—is examined separately below. The above-unity coefficient for remaining teeth should therefore not be interpreted as implying that retaining fewer teeth improves chewing; it is an artifact of conditioning on posterior occlusal support and overall tooth count.

The contrast we observed between posterior and anterior tooth loss aligns with a consistent literature on the differential roles of tooth groups. Reviews and clinical studies report that loss of anterior teeth chiefly impairs esthetics, satisfaction, and oral-health-related quality of life, while posterior loss preferentially impairs masticatory function and even general-health perception.[6,14] Most directly, a recent analysis of the Finnish Health 2000/2011 surveys, closely paralleling our design, found that posterior occlusal support loss and posterior tooth loss, but not anterior loss, were associated with adverse outcomes in a dose-dependent manner and distinctly from the effect of dentures.[15] At the population level, reduced posterior occlusal support has likewise been linked to broader adverse outcomes, including frailty and mortality.[16,17] The tooth-level map (Fig. 1) extends this to the level of individual positions: molar loss carried the largest per-tooth odds of chewing discomfort and incisor loss only a small effect, consistent with the view that the molars, with their broad occlusal tables, bear most of the masticatory load. The per-tooth estimates were nearly symmetric between the

right and left sides (e.g., aOR ≈ 1.24 - 1.25 for the first molars), as expected under bilaterally comparable masticatory loading, supporting the internal consistency of the position-level estimates. Because chewing discomfort is a masticatory outcome, it is precisely the domain in which posterior, not anterior, teeth would be expected to dominate. In contrast to this clear anteroposterior distinction, loss in the maxillary and mandibular arches contributed almost equally (Model 3), as expected because each occluding unit requires a tooth in both arches; the functional cost of losing posterior occlusion is therefore borne jointly by the two arches rather than localized to one.

Canine loss showed a paradoxical inverse association with chewing discomfort. This should not be read as a protective effect of losing a canine. Rather, it is most plausibly a statistical artifact arising from two features of the canine and of our mutually adjusted model. First, the canine is among the most durable teeth in the arch, owing to its long root and favorable crown-to-root ratio, which give it the lowest loss rate of any tooth type, and is typically retained late, as molars and maxillary teeth are lost preferentially during long-term tooth mortality.[18] In our data the mean number of missing canines was accordingly very low, so adults who had lost a canine almost always had extensive loss elsewhere. Second, because the model entered the eight tooth-group loss counts simultaneously together with the total number of remaining teeth, the canine coefficient is estimated conditional on all other losses and on overall tooth count; at a fixed tooth count, having lost a canine implies having retained relatively more non-canine teeth, so the canine term partly absorbs the protective contribution of those retained teeth. Combined with the low frequency and consequent instability of canine loss, this collinear, collider-like structure can reverse the sign of an estimate without implying any causal benefit. The robustness of the molar and posterior-support findings, which were stable across every sensitivity analysis, indicates that this canine anomaly does not materially affect the principal conclusions.

Beyond these tooth-specific findings, the protective association appeared progressively stronger as more teeth were retained: it was negligible and non-significant among adults with only 10 - 19 teeth (aOR, 0.959) but grew steadily across the 20 - 24 and 25 - 27 tooth strata (aOR, 0.859 and 0.769). This gradient suggests that posterior occlusal support becomes increasingly important precisely when most teeth are still present and its preservation is still achievable, consistent with the ceiling effect noted above for severely reduced dentitions.

The protective association of posterior occlusal support was weaker among adults with a prosthesis than among those without, and the interaction was significant. This pattern is consistent with prosthetic rehabilitation partly restoring the occlusal contacts lost with natural teeth. Inserting or renewing removable dentures improves both objective masticatory performance and food acceptability, particularly when posterior occlusion is re-established,[19] and even artificial posterior occlusal support contributes measurably to oral function.[20] Importantly, however, the compensation is incomplete: masticatory performance with dentures remains below that supported by natural teeth, and implant-supported posterior occlusion restores function more fully than removable dentures.[10,21,22] Thus prostheses attenuate, but do not abolish, the functional penalty of lost posterior support, and posterior occlusal support accordingly remained associated with chewing discomfort even among prosthesis wearers. Because roughly one third of the sample wore a prosthesis (Table 1), this incomplete compensation is not a marginal phenomenon but applies to a substantial segment of the adult population. Clinically, this supports prioritizing the re-establishment of posterior antagonist contacts when rehabilitating partially dentate adults.

The protective association was evident at every age but was somewhat stronger in younger adults than in the oldest group. One possible explanation is that, in older adults, chewing discomfort becomes multifactorial, with reduced salivary flow, mucosal and muscular changes, ill-fitting prostheses, and reduced tongue pressure all contributing, so the relative contribution of any single factor, including posterior occlusal support, is diluted. In line with this, experi-

mental work shows that when functional tooth units and posterior support are sufficient, masticatory performance can be maintained despite age-related declines in bite force and tongue pressure.[23] In younger adults, with fewer competing sources of discomfort, posterior occlusal support approaches the dominant determinant of chewing ability, which may explain the stronger association.

Strengths include the large, nationally representative sample with standardized oral examinations, the use of complex-survey methods, and an analytic strategy that conditioned on tooth count to isolate the contribution of location. The consistency of the findings across multiple sensitivity analyses further strengthens the robustness of our conclusions. In particular, the stability of the estimates across all cumulative thresholds indicates that the association is not an artifact of dichotomizing the original five-level response. In addition, the Eichner-type categorization reproduced a clear monotonic dose-response, with the highest odds of chewing discomfort among adults who had lost all posterior occlusal support; this categorical pattern converges with the continuous per-pair estimate, reinforcing that progressively poorer posterior occlusion entails progressively greater masticatory burden.

Several limitations should be acknowledged. First, the design is cross-sectional, so temporality and causation cannot be established; reverse pathways, such as the extraction of painful teeth, are possible. In particular, KNHANES does not record the cause or sequence of tooth loss, so we cannot distinguish whether tooth loss led to chewing discomfort or whether pre-existing chewing problems prompted extractions; longitudinal or registry-linked data capturing the timing and indication of each extraction would be needed to resolve this directionality. Second, the outcome was self-reported chewing discomfort rather than an objective masticatory test; although self-reported and measured masticatory function correlate well,[24] misreport is possible. Third, KNHANES does not record occlusal contacts directly, and we approximated antagonist pairs by matching tooth positions, which may misclassify occlusion in malposed or drifted dentitions. Fourth, the survey does not capture the quality, fit, or implant support of prostheses in detail. Notably, the prosthesis variable does not distinguish prosthesis type—removable partial or complete dentures versus fixed prostheses—even though fixed and removable prostheses differ substantially in the masticatory support they provide and thus in their likely effect on chewing discomfort. Our prosthesis term should therefore be regarded as a crude marker of rehabilitation rather than a measure of its adequacy, and the attenuation we observed among prosthesis wearers may understate the benefit of well-fitting fixed or implant-supported restorations. Future studies linking KNHANES to detailed prosthodontic or claims records, or using cohorts with prosthesis-type information, could disentangle these effects. Finally, residual confounding by general health and socioeconomic factors cannot be excluded despite adjustment.

These findings have practical implications for surveillance and clinical care. Epidemiological monitoring based solely on the number of remaining teeth may misclassify functional status, because two individuals with the same tooth count can differ substantially in masticatory function depending on their posterior occlusal support. Incorporating a simple count of posterior occluding pairs into routine assessment may improve identification of adults at risk of impaired mastication and may better target preventive and prosthodontic interventions toward preserving or re-establishing posterior occlusion. Future epidemiologic studies should therefore consider incorporating posterior occlusal support alongside tooth count when evaluating functional oral health. In practice, clinicians can operationalize this by charting the number of posterior occluding pairs at routine examinations, using it to identify patients with intact tooth counts but deficient posterior occlusion who might otherwise be overlooked, and prioritizing the restoration of posterior contacts—through fixed or implant-supported prostheses where feasible—when planning rehabilitation. At the population level, adding a simple posterior-occluding-pair count to oral-health surveys and screening programs could improve the targeting of preventive and prosthodontic resources toward those at greatest risk of impaired mastication.

Conclusion

In a large national sample, posterior occlusal support, rather than the number of remaining teeth alone, was independently associated with chewing discomfort: the loss of posterior occlusal support and of molars, but not of anterior teeth, accounted for chewing discomfort over and above the tooth count, and prosthetic rehabilitation only partly compensated. Tooth count alone underestimates functional impairment when posterior antagonist contacts are lost. Preventive and prosthodontic efforts to preserve or re-establish posterior occlusal support, rather than tooth number alone, may be central to maintaining masticatory function in adults. These findings support shifting both epidemiologic surveillance and prosthodontic treatment planning from simple tooth counts toward the preservation and restoration of posterior occlusal support.

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한국 성인에서 잔존치 수 이상으로 후방교합지지가 주관적 저작 불편에 미치는 영향: 국민건강영양조사 2007 - 2018

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목적: 잔존치 수는 구강 기능 지표로 널리 쓰이나, 같은 수라도 상실된 치아의 위치에 따라 기능이 다를 수 있다. 본 연구는 치아 상실 위치, 특히 후방교합지지가 잔존치 수와 독립적으로 저작 불편과 연관되는지 보았다.

연구 재료 및 방법: 국민건강영양조사(2007 - 2018)의 만 19세 이상 유치악 성인 60,306명을 분석하였다. 후방교합지지는 상하악 소구치와 대구치의 후방 교합쌍 수로 정량화하였다. 복합표본 로지스틱 회귀로 잔존치 총수와 공변량을 보정해 저작 불편의 보정 교차비(adjusted odds ratio, aOR)를 추정하였다.

결과: 같은 잔존치 수에서도 후방교합지지에 따라 저작 불편 유병이 뚜렷이 달랐다(잔존치 20 - 24개에서 30.9% 대 45.9%). 후방교합쌍이 하나 늘 때마다 저작 불편 오즈가 독립적으로 낮아졌고(aOR 0.749), 교합지지 보정 후 잔존치 총수는 기대된 보호적 연관성을 보이지 않았다. 구치 상실은 오즈를 높였으나(aOR 1.126) 전치 상실은 그렇지 않았으며, 보철은 연관을 부분적으로 약화시켰다.

결론: 치아 상실 위치, 특히 후방교합지지는 잔존치 수와 독립적으로 저작 불편과 연관되는 주요 결정 요인으로 보인다. 잔존치 수만 늘리기보다 후방교합 접촉을 보존하거나 다시 회복하는 것이 저작 기능 유지에 중요할 수 있다.

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주요어: 단면 연구; 삶의 질; 의치; 저작; 교합; 치아 상실

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