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Original Article

Frequency of Patterns of Partial Edentulism in Maxillary Arch in Patients Reporting to the Department of Prosthodontics, Bacha Khan College of Dentistry

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Abstract

Background: Partial edentulism, defined as the loss of one or more teeth within a dental arch, significantly affects oral function, mastication, and aesthetics. The pattern of tooth loss, particularly in the maxillary arch, has important implications for prosthetic rehabilitation. However, region-specific data on the distribution of partial edentulism patterns and their demographic determinants remain limited.

Objective: To determine the prevalence of different patterns of maxillary partial edentulism based on Kennedy's classification and to evaluate their association with demographic and clinical variables.

Methodology: A cross-sectional study was conducted among 298 patients with maxillary partial edentulism attending the Department of Prosthodontics at Bacha Khan College of Dentistry, Pakistan. Edentulous patterns were classified using Kennedy's classification system by a calibrated examiner following Applegate's rules. Demographic variables including age, gender, BMI, education level, socioeconomic status, and duration of edentulism were recorded. Statistical analysis included chi-square tests, Fisher's exact test where appropriate, and multinomial logistic regression to identify independent predictors. A p-value of <0.05 was considered statistically significant.

Results: Kennedy Class III was the most prevalent pattern (47.7%), followed by Class I (24.8%), Class II (21.5%), and Class IV (6.0%). Significant associations were observed between edentulism patterns and age, gender, education, socioeconomic status, and duration of edentulism ($p < 0.001$). Multinomial regression analysis revealed that low socioeconomic status and older age were strong independent predictors of distal extension patterns (Class I and II). BMI showed no significant association with the pattern of edentulism.

Conclusion: Kennedy Class III predominates in maxillary partial edentulism within this population, while demographic disparities, particularly socioeconomic status and age, significantly influence the pattern of tooth loss. These findings highlight the need for targeted preventive strategies and equitable access to dental care. Further longitudinal and community-based studies are recommended to validate these associations.

Keywords: Kennedy Classification, Maxillary Arch, Partial Edentulism, Socioeconomic Factors, Tooth Loss.

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Introduction

Partial edentulism, defined as the loss of one or more teeth while retaining others within the dental arch, is a highly prevalent condition that significantly impacts oral function, mastication, speech, and facial aesthetics [1,2]. It is commonly caused by dental caries, periodontal disease, trauma, and other systemic or behavioral factors, with the maxillary arch often being particularly vulnerable to tooth loss due to anatomical and functional characteristics [3]. The consequences of partial edentulism extend beyond oral health, affecting nutritional status, quality of life, and psychosocial well-being.

Understanding the pattern of partial edentulism is essential for effective prosthetic treatment planning and rehabilitation. Among the available classification systems, Kennedy's classification remains the most widely used due to its simplicity, clinical applicability, and relevance in guiding removable partial denture design [4]. This system categorizes edentulous arches into four main classes based on the location and extent of edentulous areas, with further refinement provided by Applegate's rules to ensure accurate classification in complex cases [5].

Previous studies have consistently reported that Kennedy Class III is the most prevalent pattern of partial edentulism across diverse populations. For example, studies conducted in Pakistan and Saudi Arabia have demonstrated a predominance of Class III patterns in both maxillary and mandibular arches [2,5,6]. Similarly, systematic reviews and epidemiological studies have reinforced this trend, while also highlighting variations in distribution influenced by demographic factors such as age, gender, and socioeconomic status [7,8]. These variations emphasize the importance of population-specific data to inform clinical decision-making and public health planning.

Despite the growing body of literature, there remains a relative scarcity of studies focusing specifically on the maxillary arch, as many investigations have either combined both arches or primarily focused on mandibular edentulism [9]. This gap limits the ability to develop targeted prosthetic and preventive strategies tailored to maxillary tooth loss patterns. Furthermore, the interaction between demographic factors and edentulism patterns requires deeper exploration to understand the underlying determinants of oral health disparities.

Therefore, the present study aims to determine the prevalence of different patterns of maxillary partial edentulism using Kennedy's classification and to examine their association with key demographic variables in a regional population. The findings are expected to provide clinically relevant insights for prosthodontic treatment planning and contribute to evidence-based strategies for improving oral health outcomes.

Methodology

Study Design

This study employed a cross-sectional observational design to determine the prevalence and patterns of maxillary partial edentulism among patients presenting to a tertiary care dental facility. The cross-sectional approach was appropriate for estimating the distribution of Kennedy classification patterns and their association with demographic variables at a single point in time, without attempting to infer causality.

Ethics

Ethical approval for the study was obtained from the Ethical Review Board of Bacha Khan College of Dentistry, Mardan, following prior synopsis approval from the College of Physicians and Surgeons Pakistan (CPSP) (Ref no: CPSP/REU/DSG-2022-028-4178). All procedures adhered to ethical standards for human research. Participants were informed about the purpose, procedures, and potential benefits of the study, and written informed consent was obtained prior to enrollment.

Setting

The study was conducted in the outpatient Department of Prosthodontics at Bacha Khan College of Dentistry, Mardan, Pakistan, over a period spanning from June 2024 to November 2025. This tertiary care institution serves a diverse patient population, allowing for the inclusion of individuals from varying socioeconomic and educational backgrounds.

Participants

A total of 298 patients with maxillary partial edentulism were included in the study. Eligible participants were adults aged between 20 and 80 years, of both genders, presenting with partial edentulism in the maxillary arch. Patients were excluded if they had only mandibular edentulism, missing third molars, unerupted or congenitally missing teeth, retained root tips, or teeth indicated for extraction. These criteria ensured homogeneity in classification and avoided confounding due to developmental or pathological anomalies unrelated to typical tooth loss patterns.

Variables

The primary outcome variable was the pattern of maxillary partial edentulism classified according to Kennedy's classification system [4,5]. Independent variables included demographic and clinical factors such as age, gender, body mass index (BMI), education level, socioeconomic status, and duration of edentulism. BMI was included as a proxy for nutritional and metabolic status due to its documented association with oral health, particularly through inflammatory and periodontal pathways [10–12].

Data Sources/Measurement

Data were collected through clinical examination and structured recording forms. The classification of edentulism patterns was performed by a single calibrated examiner using Kennedy's classification, with Applegate's rules applied to ensure accurate classification based on functional and morphological characteristics of the arch. To ensure measurement reliability, intra-examiner calibration was conducted by reassessing 10% of cases after a two-week interval, yielding a Cohen's Kappa value of 0.92, indicating excellent agreement. Demographic variables were recorded through patient interviews and clinical records.

Bias

Efforts were made to minimize measurement and classification bias through examiner calibration and standardized diagnostic criteria. However, potential sources of bias included selection bias due to the hospital-based sampling approach and recall bias for self-reported variables such as duration of edentulism and socioeconomic status. Additionally, as a cross-sectional study, temporal relationships between variables could not be established.

Study Size

The sample size of 298 participants was calculated using WHO sample size software, based on a 95% confidence interval, a 2% margin of error, and an expected prevalence of Kennedy Class IV edentulism of 3.2% [9]. This ensured adequate statistical power to detect meaningful associations between variables.

Quantitative Variables

Age was categorized into clinically meaningful groups, with categories collapsed (≤40 years) where necessary to address sparse data issues and ensure statistical validity. BMI was categorized into standard WHO classifications (underweight, normal, overweight, obese). Education and socioeconomic status were grouped into ordinal categories, and duration of edentulism was categorized into three intervals (1–5 years, 6–10 years, >10 years) for analysis.

Statistical Methods

Data analysis was performed using SPSS version 20. Descriptive statistics were reported as frequencies and percentages. Associations between categorical variables and Kennedy classification were assessed using the chi-square test; Fisher's exact test was applied where expected cell counts were less than 5. Effect sizes were quantified using Cramér's V with 95% confidence intervals estimated via bootstrapping (5,000 iterations). A p-value of <0.05 was considered statistically significant.

To further evaluate independent predictors, multinomial logistic regression analysis was conducted with Kennedy Class III as the reference category. Variables significant in bivariate analysis were included in the model. Due to quasi-complete separation observed in predictors such as age and socioeconomic status, an L2-penalized (ridge) multinomial logistic regression model ($C = 0.5$) was applied to stabilize coefficient estimates. Model fit was assessed using Cox & Snell and Nagelkerke pseudo-R^2 values, along with the likelihood ratio chi-square statistic.

Results

Participants

A total of 298 patients presenting with maxillary partial edentulism were included in the final analysis. All participants met the predefined inclusion criteria, and no cases were excluded after enrollment. The study population represented both genders and a wide adult age range (20–80 years), ensuring adequate variability for assessing demographic associations with edentulism patterns. The overall recruitment and inclusion process is summarized in Table 1.

Descriptive Data

The mean age of the participants was 39.57 ± 6.7 years. Among the study population, 157 (52.7%) were males and 141 (47.3%) were females. The age distribution showed that the largest proportion of participants belonged to the 31–40 years age group (28.9%), followed by 21–30 years (26.2%), 41–50 years (23.8%), and 51+ years (21.1%).

With respect to BMI, nearly half of the participants (47.7%) had normal weight, while 35.2% were overweight, 9.7% were obese, and 7.4% were underweight. Educational status revealed that 47.0% of participants had higher education, whereas 25.2% had secondary education, 17.8% had

primary education, and 10.1% had no formal education. Socioeconomic status indicated that 54.4% of participants belonged to the low socioeconomic group, while 45.6% were categorized as high socioeconomic status.

Regarding the duration of edentulism, the majority of participants (47.7%) had experienced tooth loss for 1–5 years, followed by 32.9% for 6–10 years and 19.5% for more than 10 years. These baseline demographic and clinical characteristics are detailed in Table 1.

Outcome Data

The distribution of maxillary partial edentulism patterns, classified according to Kennedy's classification, demonstrated that Class III was the most prevalent pattern, observed in 142 patients (47.7%). This was followed by Class I in 74 patients (24.8%), Class II in 64 patients (21.5%), and Class IV in 18 patients (6.0%).

This distribution highlights a predominance of bounded edentulous spaces (Class III) within the study population. The overall pattern of distribution is illustrated graphically in Figure 1.

Main Results

Bivariate analysis revealed statistically significant associations between the pattern of maxillary partial edentulism and multiple demographic variables, including age, gender, education level, socioeconomic status, and duration of edentulism (all $p < 0.001$). Specifically, younger individuals (≤40 years) demonstrated a higher prevalence of Kennedy Class III, whereas older age groups (41–50 years and ≥51 years) showed increased proportions of Class I and Class II patterns.

Gender differences were also evident, with males predominantly exhibiting Class III patterns, while females showed relatively higher proportions of Class I, II, and IV edentulism. Education level demonstrated a significant association (Fisher's exact $p < 0.001$), with higher education strongly linked to Class III patterns, whereas lower education levels were more frequently associated with distal extension cases (Class I and II).

Socioeconomic status emerged as a particularly strong determinant, with individuals in the low socioeconomic group showing markedly higher frequencies of Class I and II edentulism compared to those in the high socioeconomic group, who predominantly exhibited Class III. Similarly, longer duration of edentulism was significantly associated with more extensive edentulous patterns (Class I and II).

In contrast, BMI did not demonstrate a statistically significant association with the pattern of edentulism ($\chi^2 = 2.29$, $p = 0.986$), suggesting that while BMI may influence overall tooth loss, it does not significantly determine the spatial distribution of edentulous areas. Detailed bivariate associations are presented in Table 2.

To further explore independent predictors, multinomial logistic regression analysis was performed using Kennedy Class III as the reference category. After adjustment for confounding variables, low socioeconomic status was identified as the strongest independent predictor of Class I (aOR = 9.42, 95% CI: 4.33–20.51, $p < 0.001$) and Class II (aOR = 10.57, 95% CI: 4.79–23.35, $p < 0.001$) edentulism.

Older age (41–50 years and ≥51 years) significantly increased the likelihood of Class I and II patterns, while female gender was associated with higher odds of Class I, II, and IV compared to Class III. Education showed borderline to moderate effects, with primary education significantly predicting Class II edentulism. Duration of edentulism (6–10 years) was also associated with increased odds of Class I and II patterns.

The regression model demonstrated strong explanatory power, with Cox & Snell pseudo-R^2 of 0.726 and Nagelkerke pseudo-R^2 of 0.798, and an overall significant likelihood ratio test (LR $\chi^2 = 385.45$, $p < 0.001$). These multivariable findings are summarized in Table 3.

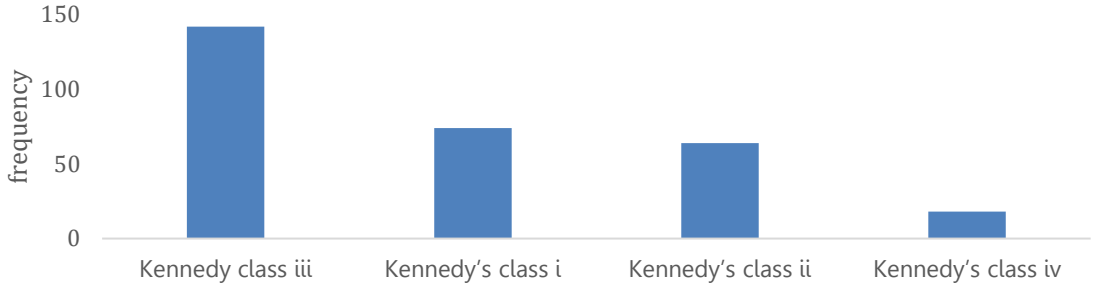


Figure 1: Bar chart showing distribution of maxillary partial edentulism according to Kennedy's classification

Table 1. Demographic Characteristics of the Study Population (n = 298)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	21–30	78	26.2
	31–40	86	28.9
	41–50	71	23.8
	≥51	63	21.1
Gender	Male	157	52.7
	Female	141	47.3
BMI	Underweight (<18.5)	22	7.4
	Normal (18.5–24.9)	142	47.7
	Overweight (25–29.9)	105	35.2
	Obese (≥30)	29	9.7
Education	No Formal Education	30	10.1
	Primary	53	17.8
	Secondary	75	25.2
	Higher Education	140	47.0
Socioeconomic Status	High	136	45.6
	Low	162	54.4
Duration of Edentulism	1–5 years	142	47.7
	6–10 years	98	32.9
	>10 years	58	19.5

Demographic characteristics of patients with maxillary partial edentulism attending the Department of Prosthodontics, Bacha Khan College of Dentistry, Mardan, Pakistan. Data are presented as frequency (n) and percentage (%).

Abbreviations: BMI = Body Mass Index; n = number of patients; % = percentage.

Table 2. Association Between Kennedy's Classification and Demographic Variables (n = 298)

Variable	Category	Class I n (%)	Class II n (%)	Class III n (%)	Class IV n (%)	Statistical Values
Age Group (ref: ≤40 years)	≤40 years	8 (2.7)	11 (3.7)	136 (45.6)	9 (3.0)	χ^2 = 192.08, df = 6, p < 0.001; Cramér's V = 0.57 (95% CI [0.53–0.62])
	41–50 years	37 (12.4)	26 (8.7)	3 (1.0)	5 (1.7)	
	≥51 years	29 (9.7)	27 (9.1)	3 (1.0)	4 (1.3)	
Gender	Male	18 (6.0)	15 (5.0)	121 (40.6)	3 (1.0)	χ^2 = 115.47, df = 3, p < 0.001; Cramér's V = 0.62 (95% CI [0.54–0.71])
	Female	56 (18.8)	49 (16.4)	21 (7.0)	15 (5.0)	
BMI	Underweight (<18.5)	4 (1.3)	6 (2.0)	10 (3.4)	2 (0.7)	χ^2 = 2.29, df = 9, p = 0.986; Cramér's V = 0.05 (95% CI [0.06–0.16])
	Normal (18.5–24.9)	35 (11.7)	30 (10.1)	69 (23.2)	8 (2.7)	
	Overweight (25–29.9)	26 (8.7)	23 (7.7)	49 (16.4)	7 (2.4)	
	Obese (≥30)	9 (3.0)	5 (1.7)	14 (4.7)	1 (0.3)	
Education	No Formal Education	14 (4.7)	9 (3.0)	4 (1.3)	3 (1.0)	Fisher's Exact p < 0.001†; Cramér's V = 0.36 (95% CI [0.32–0.43])
	Primary	20 (6.7)	22 (7.4)	10 (3.4)	1 (0.3)	
	Secondary	28 (9.4)	21 (7.0)	17 (5.7)	9 (3.0)	
	Higher Education	12 (4.0)	12 (4.0)	111 (37.2)	5 (1.7)	
Socioeconomic Status (ref: High)	High	2 (0.7)	1 (0.3)	126 (42.3)	7 (2.4)	χ^2 = 211.72, df = 3, p < 0.001; Cramér's V = 0.84 (95% CI [0.79–0.90])
	Low	72 (24.2)	63 (21.1)	16 (5.4)	11 (3.7)	
Duration of Edentulism	1–5 years	8 (2.7)	8 (2.7)	111 (37.2)	15 (5.0)	χ^2 = 134.57, df = 6, p < 0.001; Cramér's V = 0.48 (95% CI [0.42–0.54])
	6–10 years	43 (14.4)	35 (11.7)	18 (6.0)	2 (0.7)	
	>10 years	23 (7.7)	21 (7.0)	13 (4.4)	1 (0.3)	

Bivariate association between maxillary partial edentulism pattern (Kennedy's classification) and demographic variables among 298 patients. Data are presented as frequency (n) and column percentage (%). Statistical associations were assessed using the chi-square test or Fisher's exact test where appropriate. Effect size is reported as Cramér's V with 95% confidence intervals estimated via bootstrapping (5,000 iterations).

Abbreviations: SES = socioeconomic status.
† Fisher's Exact test used for Education due to expected cell counts <5.
All p-values <0.001 are reported as p < 0.001.

Table 3. Multinomial Logistic Regression Predicting Kennedy Class Membership (Reference Category: Class III)

Predictor	Comparison	Adjusted Odds Ratio (aOR)	95% CI	p-value
Age (41–50 years vs ≤40 years)	Class I vs Class III	5.97	2.36 – 15.10	<0.001
	Class II vs Class III	4.18	1.57 – 11.13	0.004
	Class IV vs Class III	2.29	0.72 – 7.31	0.161
Age (≥51 years vs ≤40 years)	Class I vs Class III	4.10	1.58 – 10.63	0.004
	Class II vs Class III	4.28	1.67 – 10.95	0.002
	Class IV vs Class III	2.79	0.89 – 8.73	0.078
Gender (Female vs Male)	Class I vs Class III	3.10	1.42 – 6.77	0.005
	Class II vs Class III	3.55	1.63 – 7.72	0.001
	Class IV vs Class III	5.15	2.35 – 11.30	<0.001
Low SES (vs High SES)	Class I vs Class III	9.42	4.33 – 20.51	<0.001
	Class II vs Class III	10.57	4.79 – 23.35	<0.001
	Class IV vs Class III	2.98	1.18 – 7.08	0.021
Duration (6–10 yrs vs 1–5 yrs)	Class I vs Class III	2.69	1.16 – 6.22	0.021
	Class II vs Class III	2.90	1.26 – 6.69	0.012
	Class IV vs Class III	0.83	0.29 – 2.36	0.731
Duration (>10 yrs vs 1–5 yrs)	Class I vs Class III	2.15	0.87 – 5.32	0.097
	Class II vs Class III	1.67	0.66 – 4.28	0.281
	Class IV vs Class III	0.71	0.23 – 2.18	0.550
Primary Education (vs Higher Education)	Class I vs Class III	2.40	0.89 – 6.46	0.083
	Class II vs Class III	2.75	1.07 – 7.09	0.036
	Class IV vs Class III	1.14	0.34 – 3.82	0.828
Secondary Education (vs Higher Education)	Class I vs Class III	2.26	0.95 – 5.37	0.066
	Class II vs Class III	2.16	0.89 – 5.21	0.088
	Class IV vs Class III	2.55	1.02 – 6.39	0.046
No Education (vs Higher Education)	Class I vs Class III	2.21	0.77 – 6.34	0.141
	Class II vs Class III	1.95	0.64 – 5.94	0.241
	Class IV vs Class III	1.63	0.51 – 5.20	0.406

Model Fit Diagnostics

Cox & Snell Pseudo-R^2 = 0.726
Nagelkerke Pseudo-R^2 = 0.798
Likelihood Ratio χ^2 = 385.45, df = 27, $p < 0.001$

L2-penalized multinomial logistic regression analysis predicting Kennedy class membership (reference category: Kennedy Class III) among 298 patients with maxillary partial edentulism. All variables significant in bivariate analysis were included. BMI was excluded due to non-significant association (p = 0.986).

Abbreviations: aOR = adjusted odds ratio; CI = confidence interval; SES = socioeconomic status; Ref = reference category; LR χ^2 = likelihood ratio chi-square.

L2 regularization (C = 0.5) was applied to address quasi-complete separation in age and socioeconomic predictors. Statistically significant values ($p < 0.05$) are considered meaningful.

Discussion

The present study evaluated the distribution and determinants of maxillary partial edentulism using Kennedy's classification and demonstrated that Kennedy Class III was the most prevalent pattern (47.7%), followed by Class I, Class II, and Class IV. This predominance of Class III, characterized by bounded edentulous spaces, is consistent with previously reported findings across diverse populations [2,5–7]. The higher prevalence of Class III may be attributed to the relatively localized nature of tooth loss in earlier stages, where adjacent teeth remain intact, allowing for more stable occlusal function and often delaying the need for extensive prosthetic intervention. [10,11]

The findings of this study align closely with earlier regional and international studies. For instance, Deeksheetha et al. reported a prevalence of 47.1% for Kennedy Class III [7], while Dwairi et al. observed a similar distribution (49.2%) in a Jordanian population [14]. Likewise, Madhankumar et al. documented Class III as the most frequent pattern (40.6%) [15]. These consistencies reinforce the notion that Class III is a globally dominant pattern, although slight variations may arise due to differences in demographic profiles, oral health behaviors, and access to dental care [1,8].

A key strength of this study is the identification of significant demographic associations with edentulism patterns. Age emerged as an important determinant, with younger individuals (≤40 years) predominantly exhibiting Class III patterns, whereas older individuals (≥41 years) were more likely to present with distal extension cases (Class I and II).[12-14] This shift reflects the progressive nature of tooth loss over time, where cumulative effects of periodontal disease, caries, and delayed treatment contribute to more extensive edentulous areas. These findings are consistent with prior epidemiological observations indicating increased severity of tooth loss with advancing age [15-18].

Socioeconomic status demonstrated the strongest association with edentulism patterns, with individuals from lower socioeconomic groups showing significantly higher odds of Class I and II patterns. This observation is supported by existing literature, which highlights disparities in oral health outcomes due to differences in access to preventive care, health literacy, and affordability of dental services [19]. Similarly, educational level was significantly associated with edentulism patterns, with higher education correlating with increased prevalence of Class III, likely reflecting better awareness of oral hygiene practices and timely dental interventions [20,21].

Gender differences observed in this study further contribute to understanding oral health disparities. Females demonstrated higher odds of Class I, II, and IV patterns compared to males, which may be influenced by a combination of biological, behavioral, and sociocultural factors [9,22]. These may include differences in healthcare utilization, hormonal influences on periodontal health, and varying patterns of health-seeking behavior.

Interestingly, BMI did not show a statistically significant association with the pattern of edentulism. This finding suggests that while BMI is linked to systemic conditions and overall tooth loss through inflammatory and metabolic pathways [10–12], it does not directly influence the spatial distribution of missing teeth as defined by Kennedy classification. This distinction is important, as it highlights the difference between determinants of tooth loss quantity and those influencing its anatomical pattern [23].

The findings of this study provide important clinical and public health insights. The strong association of edentulism patterns with modifiable socioeconomic and educational factors underscores the need for targeted preventive strategies, early intervention, and equitable access to dental care. Furthermore, these results contribute to the existing body of literature by providing region-specific data focused exclusively on the maxillary arch, which has been underrepresented in previous studies [9].

Limitations

Despite its strengths, this study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish causal relationships between demographic variables and patterns of partial edentulism. The observed associations should therefore be interpreted as correlational rather than causal.

Second, the study was conducted in a single tertiary care institution using a hospital-based convenience sample. As a result, the findings may not be fully generalizable to the broader community or rural populations, particularly those who do not seek regular dental care. Selection bias may therefore have influenced the distribution of observed patterns.

Third, certain variables, such as duration of edentulism and socioeconomic status, were based on self-reported data, which may introduce recall bias or reporting inaccuracies. Additionally, potential confounding factors such as dietary

habits, oral hygiene practices, systemic diseases, and access to dental services were not included in the analysis and may have influenced the observed outcomes.

Finally, although advanced statistical techniques such as penalized regression were used to address model instability, residual confounding cannot be entirely excluded. Future studies incorporating longitudinal designs and broader variable inclusion are recommended to better understand causal pathways.

Conclusion

This study demonstrates that Kennedy Class III is the most prevalent pattern of maxillary partial edentulism in the studied population, with significant associations observed between edentulism patterns and key demographic factors including age, gender, education, socioeconomic status, and duration of edentulism. Among these, socioeconomic status and age emerged as the strongest independent predictors of more extensive edentulous patterns (Class I and II).

Authors' Contributions:

All authors meet the ICMJE criteria for authorship.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.

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