

Evaluation of prosthetic restorations in patients receiving dental implants according to patient demographics and treatment variables

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ABSTRACT

Aims: Patients receiving dental implant treatment may undergo rehabilitation with both implant-supported and conventional prosthetic restorations. Evaluating the distribution of these restorations according to demographic characteristics and implant number may help characterize prosthetic treatment patterns in clinical practice. This retrospective cross-sectional study aimed to evaluate the types and counts of prosthetic restorations provided to patients who completed prosthetic rehabilitation following dental implant treatment at a university clinic between 2023 and 2024 and to examine their associations with age, gender, and implant number.

Methods: This retrospective cross-sectional study analyzed the digital records of 514 adult patients who completed prosthetic rehabilitation following dental implant treatment at a university clinic between 2023 and 2024. Age, gender, implant number, and prosthetic restoration types and counts were recorded. Restorations included implant-supported crowns, implant-supported overdentures, tooth-supported metal-ceramic crowns, conventional complete dentures, and conventional removable partial dentures. Differences across age groups and between genders were assessed using the Kruskal-Wallis and Mann-Whitney U tests, respectively. Post hoc pairwise comparisons were performed using Dunn's test with Bonferroni adjustment. Associations between variables were evaluated using Spearman's rank correlation analysis and simple linear regression. Statistical significance was set at $p < 0.05$.

Results: The study included 514 patients with a mean age of 51.18 ± 13.50 years. Significant differences across age groups were observed in implant number and counts of all evaluated prosthetic restoration types ($p < 0.05$). Young adults had fewer implants, whereas the middle-aged group had higher counts of implant-supported crowns and tooth-supported metal-ceramic crowns. Implant-supported overdentures and conventional complete dentures had higher counts in the elderly group. A strong positive correlation was observed between implant number and implant-supported crown count ($\rho = 0.791$, $p < 0.001$), and a moderate positive correlation was found between age and implant-supported overdenture count ($\rho = 0.409$, $p < 0.001$). Males were significantly older than females ($p = 0.003$), whereas implant and prosthetic restoration counts did not differ significantly between genders ($p > 0.05$).

Conclusion: The distribution of prosthetic restorations among patients receiving dental implants differed significantly across age groups. These findings indicate an association between age and prosthetic treatment patterns and may inform treatment planning in conjunction with individual clinical needs.

Keywords: Dental implants, prosthetic rehabilitation, implant-supported prostheses, overdentures, age distribution

INTRODUCTION

Dental implants are widely used to replace missing teeth because of their high survival rates and predictable long-term clinical outcomes.^{1,2} Implant-supported single crowns and fixed dental prostheses are established options for the rehabilitation of single-tooth loss and partial edentulism.³

In patients with complete edentulism of the maxilla, fixed full-arch prostheses and implant-supported overdentures provide alternative approaches to prosthetic rehabilitation.⁴ Implant-supported fixed prostheses provide a reliable option for prosthetic rehabilitation, with high survival rates

reported in clinical studies.^{5,6} Nevertheless, biological and technical complications may occur over time, highlighting the importance of prosthetic design and maintenance.^{6,7} For completely edentulous patients, implant-supported overdentures offer a removable treatment option that can improve prosthesis stability, oral function, and patient satisfaction compared with conventional complete dentures.⁸ For patients with complete mandibular edentulism, overdentures retained by two implants placed in the anterior mandible have been recommended as the first-choice standard of care by the York and McGill consensus statements.^{8,9}

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Long-term clinical evidence also supports this approach, with a 10-year clinical trial reporting favorable outcomes for mandibular two-implant overdentures.¹⁰

Although the clinical outcomes and complication rates of implant-supported single crowns and fixed dental prostheses have been extensively investigated,^{3,5-7} these outcomes do not fully describe the distribution of prosthetic restorations provided to patients receiving dental implants in routine clinical practice. Evaluating both implant-supported and conventional restorations within this patient population may provide a broader understanding of prosthetic rehabilitation patterns in university clinics. Examining their distribution according to age, gender, and the number of implants may help characterize differences in treatment provision and provide information relevant to clinical planning.

Therefore, this retrospective cross-sectional study aimed to evaluate the types and counts of prosthetic restorations provided to adult patients who completed prosthetic rehabilitation following dental implant treatment at a university clinic between 2023 and 2024. Specifically, the study examined differences in implant number and prosthetic restoration counts across age groups and between genders, as well as associations among age, implant number, and prosthetic restoration counts. The null hypotheses were that implant number and prosthetic restoration counts would not differ significantly across age groups or between genders and that no significant correlations would exist among age, implant number, and prosthetic restoration counts.

METHODS

Ethics

Ethical approval was obtained from the İnönü University Health Sciences Scientific Researches Ethics Committee (Date: 24.02.2026, Decision No: 2026/9438). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design

This retrospective cross-sectional study was conducted by reviewing the digital records of patients who completed prosthetic rehabilitation following dental implant treatment at the Department of Prosthodontics, Faculty of Dentistry, İnönü University, between 2023 and 2024. The study evaluated both implant-supported and conventional prosthetic restorations provided to these patients.

Study Population

The study population comprised adult patients aged 18 years or older who completed prosthetic rehabilitation following dental implant treatment during the specified study period. A total of 514 patients meeting the inclusion criteria were included in the analysis.

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they were aged 18 years or older, received dental implant treatment between 2023 and 2024, and completed prosthetic rehabilitation. Patients with incomplete digital records or unfinished prosthetic treatment were excluded.

Data Collection and Variables

Data were retrospectively extracted from the digital patient record system. Demographic variables included age and gender. Treatment-related variables included implant number and the types and counts of prosthetic restorations provided to each patient. Both implant-supported and conventional restorations were evaluated using the following categories:

- **Implant-supported crowns:** Single-unit crowns and individual units of implant-supported fixed bridges. Each bridge unit was counted separately rather than counting the entire bridge as one restoration.
- **Implant-supported overdentures:** Removable overdentures supported by dental implants.
- **Tooth-supported metal-ceramic crowns:** Conventional metal-ceramic restorations supported by natural teeth.
- **Conventional complete dentures:** Complete dentures without implant support.
- **Conventional removable partial dentures:** Removable partial dentures without implant support.

For age-group comparisons, patients were categorized as young adults (18-44 years), middle-aged adults (45-59 years), and older adults (≥ 60 years). These study-specific categories were used to describe and compare prosthetic treatment patterns across adult age groups.

Statistical Analysis

All data analyses were performed using IBM SPSS Statistics, version 27 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro-Wilk test. Descriptive statistics were presented as mean (standard deviation) and median [interquartile range (IQR)] to provide a comprehensive summary of the distributions, particularly for count variables with skewed distributions and a high proportion of zero values. Categorical variables were expressed as frequencies (n) and percentages (%). Means with standard errors (SE) were also presented for age-group and gender comparisons.

The Kruskal-Wallis test was used to compare the numbers of implants and prosthetic restorations across age groups. When statistically significant differences were identified, post-hoc pairwise comparisons were performed using the Dunn-Bonferroni procedure, with Bonferroni adjustment for multiple comparisons. The Mann-Whitney U test was used to compare age, implant number, and prosthetic restoration numbers between genders. Associations among age, implant number, and prosthetic restoration variables were assessed using Spearman's rank correlation coefficient (ρ). Simple linear regression analyses were performed to examine the relationships between selected variables. Four separate models were constructed: (1) age as the dependent variable and implant-supported overdenture count as the independent variable; (2) implant number as the dependent variable and implant-supported crown count as the independent variable; (3) implant-supported overdenture count as the dependent variable and implant-supported crown count as the independent variable; and (4) implant-supported overdenture count as the dependent variable and conventional complete denture count as the independent variable. Regression results were reported using unstandardized regression coefficients (B), SE, standardized regression coefficients (β), 95% confidence intervals for B, and coefficients of determination



(R^2). All tests were two-sided, and statistical significance was set at $p < 0.05$.

RESULTS

A total of 514 patients were included in the study (Table 1). The middle-aged group accounted for the largest proportion of patients (40%), whereas the elderly group accounted for the smallest proportion (29.37%) (Table 2).

Table 1. Descriptive statistics of patient age, implant number, and prosthetic restoration counts

Variable	n	Median (IQR)	Mean (SD)
Age (years)	514	52(19)	51.18 (13.50)
Number of implants	514	3(3)	3.92 (3.11)
Implant-supported crowns	514	3(6)	5.03 (6.07)
Implant-supported overdentures	514	0 (0)	0.19 (0.43)
Tooth supported metal-ceramic crowns	514	0 (4)	2.76 (4.64)
Conventional complete dentures	514	0 (0)	0.12 (0.33)
Conventional removable partial dentures	514	0 (0)	0.02 (0.15)

Data are presented as median (IQR) and mean (SD). IQR: Interquartile range, SD: Standard deviation

The number of tooth-supported metal-ceramic crowns differed significantly across age groups. The middle-aged group had a significantly higher mean count than the other two groups ($p < 0.05$) (Table 2).

The number of conventional complete dentures differed significantly across age groups. All three groups differed significantly from one another ($p < 0.05$), with the lowest mean count in young adults and the highest in the elderly group (Table 2).

The number of conventional removable partial dentures differed significantly across age groups. Young adults had a significantly lower mean count than elderly patients ($p < 0.05$) (Table 2).

Age differed significantly between genders, with males being older than females ($Z=2.95$; $p=0.003$; $r=0.13$). No significant differences were observed between genders in the numbers of implants or prosthetic restorations ($p > 0.05$) (Table 3).

Correlation analysis revealed a moderate positive association between age and the number of implant-supported overdentures ($p < 0.001$) (Table 4).

Table 2. Comparison of implant and prosthetic restorations according to age groups

	Age groups	n	Mean (SE)	Kruskal-Wallis H	p-value	η^2
Number of implants	Young adult	155	2.66 (0.17) A	52.67	<0.001	0.09
	Middle-aged	208	4.46 (0.23) B			
	Elderly	151	4.48 (0.27) B			
Implant-supported crowns	Young adult	155	3.36 (0.29) B	17.53	<0.001	0.03
	Middle-aged	208	5.98 (0.44) A			
	Elderly	151	5.42 (0.58) B			
Implant-supported overdentures	Young adult	155	0.01 (0.01) A	90.51	<0.001	0.17
	Middle-aged	208	0.13 (0.03) B			
	Elderly	151	0.45 (0.05) C			
Tooth supported metal-ceramic crowns	Young adult	155	1.58 (0.30) A	19.10	<0.001	0.03
	Middle-aged	208	3.68 (0.35) B			
	Elderly	151	2.72 (0.37) A			
Conventional complete dentures	Young adult	155	0.01 (0.01) A	56.82	<0.001	0.11
	Middle-aged	208	0.10 (0.02) B			
	Elderly	151	0.28 (0.04) C			
Conventional removable partial dentures	Young adult	155	0.01 (0.01) A	6.62	<0.05	0.01
	Middle-aged	208	0.01 (0.01) AB			
	Elderly	151	0.05 (0.02) B			

Different superscript letters (A, B, C, etc.) within the same variable indicate statistically significant differences between age groups based on Dunn-Bonferroni post-hoc pairwise comparisons following the Kruskal-Wallis test (adjusted $p < 0.05$). SE: Standard error

The number of implants differed significantly across age groups. Post-hoc comparisons indicated significantly lower implant counts in young adults than in middle-aged and elderly patients (adjusted $p < 0.001$) (Table 2).

The number of implant-supported crowns also differed significantly across age groups. Post-hoc comparisons identified significant differences between the middle-aged group and both other age groups (adjusted $p < 0.05$) (Table 2).

Significant differences were observed in the number of implant-supported overdentures across age groups. All three groups differed significantly from one another ($p < 0.05$), with the highest mean count in the elderly group and the lowest in the young adult group (Table 2).

A strong positive association was observed between the number of implants and implant-supported crowns ($\rho=0.791$, $p < 0.001$) (Table 4).

A strong negative association was found between the numbers of implant-supported overdentures and implant-supported crowns ($p < 0.001$) (Table 4).

In the linear regression model, implant-supported overdenture count explained 14.4% of the variance in age ($R^2=0.144$; $p < 0.001$) (Table 5).

In the model with implant number as the dependent variable and implant-supported crown count as the independent



Table 3. Comparison of age, implant number and prosthetic restorations according to gender

	Gender	Patients treated, n (%)	Mean (SE)	p-value
Age (years)	Male	202 (100.0)	53.05 (1.00) ^A	0.003
	Female	312 (100.0)	49.96 (0.73) ^B	
Number of implants	Male	202 (100.0)	3.98 (0.24)	0.476
	Female	312 (100.0)	3.88 (0.17)	
Implant-supported crowns	Male	172 (85.1)	5.21 (0.46)	0.725
	Female	261 (83.7)	4.90 (0.33)	
Implant-supported overdentures	Male	32 (15.8)	0.18 (0.03)	0.584
	Female	56 (17.9)	0.19 (0.02)	
Tooth supported metal-ceramic crowns	Male	85 (42.1)	2.45 (0.31)	0.434
	Female	135 (43.3)	2.97 (0.27)	
Conventional complete dentures	Male	22 (10.9)	0.11 (0.02)	0.389
	Female	42 (13.5)	0.13 (0.02)	
Conventional removable partial dentures	Male	5 (2.5)	0.02 (0.01)	0.673
	Female	6 (1.9)	0.02 (0.01)	

Different superscript letters (A, B) indicate statistically significant differences between genders according to the Mann-Whitney U test ($p < 0.05$). Percentages were calculated within each gender group. Mean counts and standard errors include patients with zero restorations. p-values refer to comparisons of age or implant and prosthetic restoration counts, rather than treatment proportions. SE: Standard error

Table 4. Correlation analyses between age and implant and prosthetic variables

Variable	Age (years)	Number of implants	Implant-supported crowns	Implant-supported overdentures	Tooth-supported metal-ceramic crowns	Conventional complete dentures	Conventional removable partial dentures
Age (years)	1.00	0.286**	0.028	0.409**	0.076	0.336**	0.114**
Number of implants	0.286**	1	0.791**	-0.069	0.283**	-0.162**	0.031
Implant-supported crowns	0.028	0.791**	1	-0.595**	0.360**	-0.525**	-0.035
Implant-supported overdentures	0.409**	-0.069	-0.595**	1	-0.246**	0.780**	0.178**
Tooth-supported metal-ceramic crowns	0.076	0.283**	0.360**	-0.246**	1	-0.298**	0.087*
Conventional complete dentures	0.336**	-0.162**	-0.525**	0.780**	-0.298**	1	-0.056
Conventional removable partial dentures	0.114**	0.031	-0.035	0.178**	0.087*	-0.056	1

Correlation coefficients are presented as Spearman's ρ . * $p < 0.05$; ** $p < 0.01$ (two-tailed)

Table 5. Results of simple linear regression analyses

Model	Dependent variable	Independent variable	B	SE	β	95% CI	p-value	R ²
1	Age	Implant-supported overdenture count	11.790	1.271	0.379	9.292-14.287	<0.001	0.144
2	Number of implants	Implant-supported crowns	0.457	0.01	0.891	0.437-0.477	<0.001	0.794
3	Implant-supported overdenture count	Implant-supported crowns	-0.024	0.003	-0.332	-0.030-(-0.018)	<0.001	0.110
4	Implant-supported overdenture count	Conventional complete denture count	0.891	0.043	0.678	0.807-0.975	<0.001	0.460

In the linear regression model, implant-supported overdenture count explained 14.4% of the variance in age ($R^2 = 0.144$; $p < 0.001$). B: Regression coefficient, SE: Standard error, β : Standardized coefficient, CI: Confidence interval

variable, the coefficient of determination was $R^2 = 0.794$ ($p < 0.001$) (Table 5).

In the model with implant-supported overdenture count as the dependent variable and implant-supported crown count as the independent variable, the coefficient of determination was $R^2 = 0.11$ (Table 5).

In the model with implant-supported overdenture count as the dependent variable and conventional complete denture count as the independent variable, the coefficient of determination was $R^2 = 0.46$ ($p < 0.001$) (Table 5).

DISCUSSION

This retrospective cross-sectional study evaluated the distribution of implant-supported and conventional prosthetic

restorations in patients who completed rehabilitation following dental implant treatment between 2023 and 2024. Significant differences were observed across age groups in implant number and prosthetic restoration counts, whereas these variables did not differ significantly between genders. Associations were also identified among age, implant number, and several restoration types. Accordingly, the null hypotheses were partially rejected. These findings describe treatment patterns within the study population rather than patient preferences.

Young adults had significantly fewer implants than patients in the other age groups. This finding may reflect more localized tooth loss and less extensive rehabilitation needs in younger patients. However, the extent and distribution of edentulism



were not recorded, and this explanation therefore remains tentative. Implant-supported single crowns and fixed partial dental prostheses provide treatment options for single-tooth loss and partial edentulism.³

The strong positive correlation between implant number and implant-supported crown count indicates that patients with more implants generally received more fixed restoration units. Because the crown variable included single crowns and individual units of fixed bridges, this association should be interpreted in terms of restored units rather than as a one-to-one relationship between implants and crowns.

The middle-aged group had significantly higher numbers of implant-supported crowns and tooth-supported metal-ceramic crowns than the other groups. This pattern suggests that fixed rehabilitation involving both implants and natural teeth was more extensive in this age group. The condition of the remaining dentition, the distribution of edentulous spaces, and the suitability of available abutments may have contributed to these differences. Clinical studies have reported high survival rates for implant-supported fixed complete prostheses, although technical complications and maintenance requirements remain relevant.^{6,7} These findings provide context for fixed rehabilitation but do not directly explain its age-related distribution in the present study. Moreover, restoration survival and complications were not evaluated, so higher restoration counts should not be interpreted as evidence of better clinical outcomes.

Implant-supported overdentures were significantly more frequent in elderly patients, and age showed a moderate positive correlation with implant-supported overdenture count. More extensive tooth loss and differences in the feasibility of fixed rehabilitation may contribute to this pattern. Nevertheless, bone availability, edentulism patterns, and treatment indications were not documented. The York and McGill consensus statements recommend mandibular two-implant overdentures as a first-choice standard of care for edentulous patients.^{8,9} Favorable long-term clinical outcomes have also been reported in a 10-year trial.¹⁰ These sources support the clinical role of implant-supported overdentures but do not establish that age alone determines their provision.

Patient satisfaction and functional outcomes are also relevant when considering removable implant rehabilitation. Scarano et al.¹¹ evaluated satisfaction with mandibular mini-implant-retained overdentures, while Srinivasan et al.¹² systematically reviewed oral function following implant-supported rehabilitation in completely edentulous patients. Their findings provide context for the potential benefits of implant-supported rehabilitation. However, the present study did not measure satisfaction or oral function, and the higher implant-supported overdenture count in elderly patients cannot be interpreted as evidence of greater benefit in this age group. Differences in implant dimensions, attachment systems, and treated arches also limit direct comparison with specific overdenture protocols. Attachment selection is a separate treatment consideration addressed by the systematic review of Sutariya et al.¹³

Conventional complete dentures were more frequent in elderly patients. Their strong positive correlation with implant-supported overdenture counts may reflect the provision of different removable prostheses in opposing arches, although arch-specific treatment combinations were unavailable. The

negative correlation between implant-supported crown and implant-supported overdenture counts may reflect different rehabilitation strategies rather than patient preferences or treatment substitution.

Young adults had fewer conventional removable partial dentures than elderly patients. These restorations remained part of rehabilitation for some patients receiving dental implants. Remaining dentition, anatomical limitations, and financial circumstances may contribute to this pattern, but these factors were not recorded.

Males were significantly older than females, whereas implant and prosthetic restoration counts did not differ significantly between genders. These findings do not indicate gender-specific treatment preferences, and the comparisons did not account jointly for age and other clinical characteristics.

The present study evaluated treatment distribution rather than implant prognosis. Boboeva et al.¹⁴ investigated factors associated with implant loss across age groups, an outcome distinct from the prosthetic restoration counts assessed here.

Bayındır et al.¹⁵ examined the distribution of tooth-supported, implant-supported, and removable prosthetic treatments in a university clinic and reported the highest treatment volume among patients aged 50-64 years. Although their age categories and study population differed from ours, their findings provide a relevant comparison for the greater fixed restoration counts observed in middle-aged patients. Vemulapalli et al.¹⁶ also reported associations between complete edentulism in older adults and socioeconomic characteristics and chronic conditions. These findings highlight factors that may contribute to differences in rehabilitation needs but were not recorded in the present study.

Evidence on implant loss or survival does not directly explain demographic differences in prosthetic treatment provision.

Limitations

Strengths of this study include its sample of 514 patients and the evaluation of both implant-supported and conventional restorations in routine university practice. Limitations include the retrospective, single-center design and unavailable information on socioeconomic status, systemic diseases, bone quality, patient preferences, edentulism patterns, treated arches, implant locations, and treatment indications. Restoration counts do not fully capture treatment complexity, maintenance needs, or clinical outcomes, and the observed associations do not establish causality.

Future multicenter prospective studies should incorporate clinical characteristics and patient-reported outcomes, reporting both restoration counts and treatment proportions to clarify age-related rehabilitation patterns.

CONCLUSION

This retrospective cross-sectional study identified age-related differences in implant number and the distribution of implant-supported and conventional prosthetic restorations. Young adults had fewer implants, middle-aged patients had more implant-supported and tooth-supported metal-ceramic crowns, and elderly patients had more implant-supported overdentures and conventional complete dentures. Implant and prosthetic restoration counts did not differ significantly between genders.



Implant number was positively correlated with implant-supported crown count, whereas implant-supported crown and implant-supported overdenture counts were negatively correlated. Within the limitations of this single-center study, these findings describe prosthetic treatment patterns and may inform planning alongside individual clinical needs, without establishing causal relationships or patient preferences.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study was approved by the İnönü University Health Sciences Scientific Researches Ethics Committee (Date: 24.02.2026, Decision No: 2026/9438).

Informed Consent

This retrospective study used pre-existing anonymized patient data. No additional intervention was performed, and there was no direct patient contact. The study was approved by the Ethics Committee, and the requirement for written informed consent was waived by the ethics committee.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

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Author Contributions

Concept: AK; Design: AK; Control: AK; Resources: AK, FÖ; Materials: AK; Data Collection and/or Processing: AK, FÖ; Analysis and/or Interpretation: AK; Literature Review: AK; Writing the Article: AK, FÖ; Critical Review: AK, FÖ. All authors have read and approved the final version of the manuscript.

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