Analysis of Patient Satisfaction and Cleansability in Dental Prosthesis Users

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1 Executive Summary

In the satisfaction analysis, patients with low overall satisfaction with their prostheses reported a higher number of soft tissue and implant-related complications compared to those with high overall satisfaction, despite having high scores across the four specific prosthesis satisfaction domains: chewing, esthetics, comfort, and speaking.

In the cleansability analysis, patients with higher plaque index scores reported higher self-perceived cleansability, revealing a counterintuitive connection between self-perceived hygiene and clinical measurements. Mixed linear regression models also indicated a statistically significant association between the number of implants, age, and plaque index, supporting the hypothesis that more implants and increasing age contribute to higher plaque accumulation.

2 Introduction

This report presents key findings from a five-year clinical analysis of 36 dental prosthesis patients, with two main objectives: (1) to assess how patient satisfaction with their prosthesis changes over time, and (2) to explore the relationship between plaque accumulation and factors such as age, number of implants, and self-reported cleansability.

Dental prostheses are essential treatments for patients experiencing tooth loss. Long-term success of the prosthesis is dependent on comfort, ease of maintenance, and the ability to support oral hygiene over time. While clinical measurements like plaque accumulation are routinely monitored, the patient's perspective on how they feel about cleaning and using their prosthesis daily is equally important.

This information can ultimately guide dental professionals in how they educate patients, recommend cleaning routines, and plan for long-term care.

3 Data Overview

This study analyzes data from a five-year clinical case series involving 36 patients who received a specific dental prosthesis. Each patient completed annual surveys evaluating their satisfaction across five domains: chewing, speaking, esthetics, comfort, and overall satisfaction. Each patient also reported how easy it was to clean their prosthesis. Each of these domains were rated on a 1-4 scale, where 1 indicated "unsatisfactory" and 4 indicated "very satisfactory".

In addition to self-reported measurements, clinical data was collected annually, including plaque index scores, which ranged from 0 to 5, where 0 indicates no plaque accumulation and 5 indicates heavy accumulation. Relevant periodontal factors and data on dental complications, such as implant failures, were also

collected. Key variables of interest include patient age, number of implants, and plaque index.

The dataset was longitudinal, containing repeated measurements for each patient over time.

4 Methodology

This analysis consisted of both visual and statistical techniques to analyze trends in patient satisfaction and oral hygiene outcomes over a five-year period. Line plots were created to visualize the changes in satisfaction over time, while box plots were used to compare the distributions across groups. Correlation matrices were used to identify potential relationships between individual satisfaction domains and overall satisfaction, as well as associations between plaque index, self-perceived cleansability, age, and number of implants.

To assess whether satisfaction scores changed significantly over time, we conducted a chi-square test for each satisfaction domain. The chi-square test is a non-parametric method for analyzing the distributions of categorical responses and how they differ across time points. For plaque index analysis, we used mixed-effects linear regression models to evaluate the influence of self-reported cleansability, number of implants, and age on plaque accumulation. This approach allowed us to handle repeated measures and individual variability over time. Model assumptions were checked to ensure valid interpretation of results.

Statistical analyses and visualizations were performed using both R and Python.

5 Results

Satisfaction Analysis Results

Figure 1: Satisfaction Correlation Matrix

We constructed a correlation matrix spanning five years to examine the relationships between the satisfaction domains: Speech, Chewing, Comfort, Esthetics, and Overall Satisfaction. Stronger correlations are indicated by higher values. Among the variables, Speech and Comfort exhibited the highest correlation, with a value of 0.6, suggesting a meaningful association between these two variables.

In relation to Overall Satisfaction, Speech was the most strongly correlated, with a value of 0.5, reflecting a moderate to strong relationship. This was followed by Chewing, Comfort, and Esthetics. These findings may suggest that patients tend to prioritize their ability to speak when evaluating their overall satisfaction with the prosthesis.

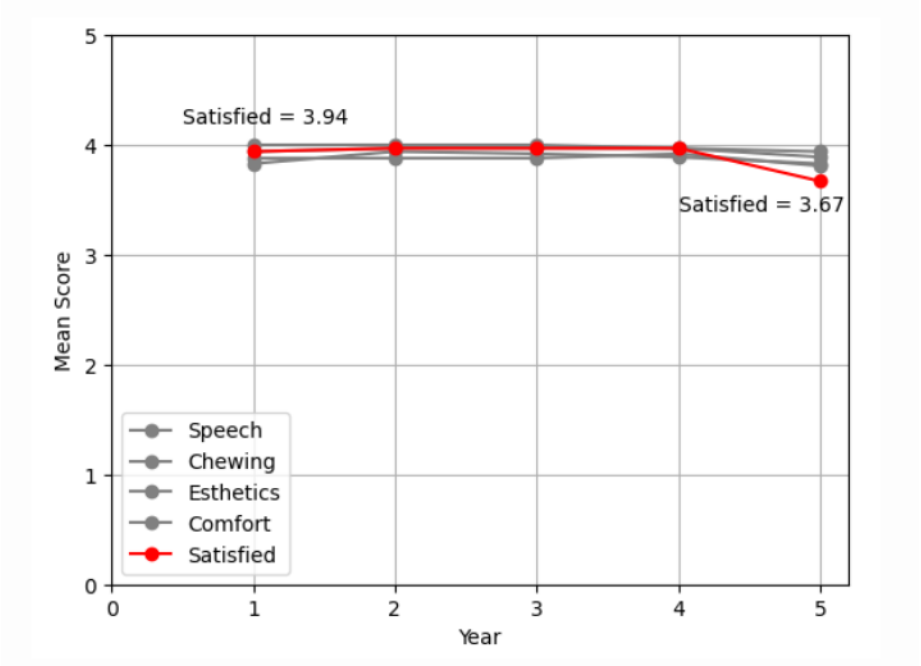

Figure 2: Trend of Patient Satisfaction Measures over 5 Years

The plot above illustrates how the average scores for each satisfaction domain changed over the five-year period. Most patients reported consistently high satisfaction with their prostheses, with minimal changes in Chewing, Speaking, Comfort, and Esthetics. These four domains have been greyed out in the plot to reflect their limited statistical significance.

By the end of the first year, the average overall satisfaction score was 3.94, indicating that nearly all patients were highly satisfied. However, by the fifth year, this average dropped to 3.67, which may be due to four outlier patients who reported low overall satisfaction (defined as a score of 1 or 2). A detailed summary of these four patients' responses is provided in Table 1 below.

Table 1: Patient Survey Outliers for Year 5

Patient #	Speech	Chewing	Esthetics	Comfort	Satisfied
12	4	4	4	4	1
17	4	4	4	4	1
34	1	1	3	1	1
36	2	4	4	3	2

Table 2: Patient Complication Outliers for Year 5

Patient #	Crown Fracture	Crown Dislodgement	Implant Failure	Soft Tissue
12	0	0	1	1
17	0	0	2	0
34 (lost prosthesis)	0	0	0	0
36	0	0	1	2

To investigate the drop in overall satisfaction, we identified four outlier patients whose responses may have impacted the Year 5 results. Patients 12 and 17 reported an overall satisfaction score of 1, despite scoring 4 across all other satisfaction domains. Patient 12 experienced one implant failure and one soft tissue complication, while Patient 17 had two implant failures, suggesting that clinical complications may strongly influence their overall satisfaction of their prosthesis.

Patient 34 reported low scores across all satisfaction domains, likely due to the loss of their prosthesis in Year 4, which may explain their dissatisfaction in Year 5. Patient 36 displayed a mix of ratings and experienced one implant failure and two soft tissue complications, which may account for their moderate overall satisfaction.

These findings support the conclusion that clinical complications, particularly implant failure and soft tissue issues, are strongly associated with lower overall satisfaction, even when the prosthesis remains functional and visually acceptable.

Table 3: Chi-Squared Analysis of Satisfaction Domains

Category Type	Year 1	Year 2	Year 3	Year 4	Year 5	Chi-Squared	p-value
Speech	33	35	35	35	34	0.0930	0.999
Chewing	36	36	36	36	35	0.0223	0.9999
Comfort	36	36	36	36	35	0.0223	0.9999
Esthetics	36	36	36	36	36	0.0000	1.000
Satisfied	36	36	36	36	32	0.3636	0.9853

A chi-square test was performed to assess whether satisfaction levels changed significantly over time across five domains: speech, chewing, comfort, esthetics, and overall satisfaction. Responses were categorized as high (scores 3–4). The chi-square test evaluates whether the distribution of these responses differed significantly across time points.

The results showed low chi-square values and high p-values (all > 0.05), indicating no statistically significant differences in satisfaction domains across the five-year period. This suggests that patients' perceptions of their prosthesis remained consistent over time. Although overall satisfaction showed slight fluctuations, these were not statistically significant or meaningful in clinical context.

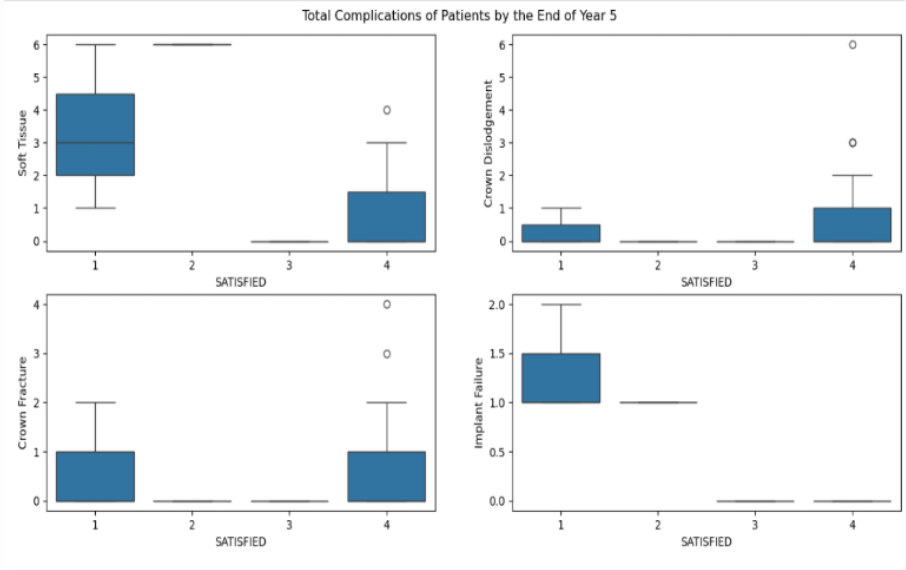

Figure 3: Distribution of Total Complications for Patients by the End of Year 5

The boxplot above illustrates the distribution of total complications reported by patients at the end of Year 5. Patients who rated their overall satisfaction as 1 or 2 experienced a higher number of soft tissue complications and implant failures. Patient 17 had the highest number of both complication types among all patients in the study, which likely explains their low satisfaction score of 1. In contrast, patients who reported high overall satisfaction experienced no implant failures, suggested there may be a strong relationship between clinical complications and patient satisfaction. For other complications, such as crown fracture and crown dislodgement, the total number of reported cases was similar between patients with high and low overall satisfaction, suggesting that they may not significantly impact patient satisfaction.

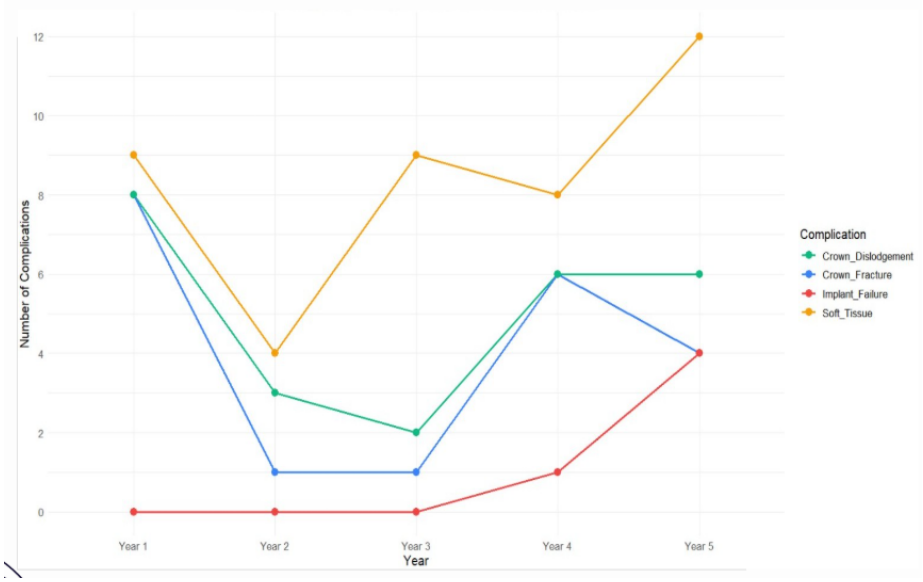

Figure 4: Line Plot of Complications over 5 Years

The plot above shows trends in prosthesis-related complications over the five-year period. From Year 1 to Year 2, total complications decreased, but began rising again after Year 2, with fluctuations and a sharp increase between Year 4 and Year 5, where cases rose from 21 to 26.

Soft tissue complications were the most frequent across all years, reaching 12 cases in Year 5. Crown dislodgements initially declined but began to rise again from Year 4 onward. Crown fractures peaked at 8 cases in Year 1, dropped to 1–2 cases, then increased again to 4 cases in Year 5. Implant failures were not observed during the first three years, but rose to 4 cases in Year 5.

Overall, soft tissue complications were the most common, while cases of implant failures became more prominent over time.

Cleansability Analysis Results

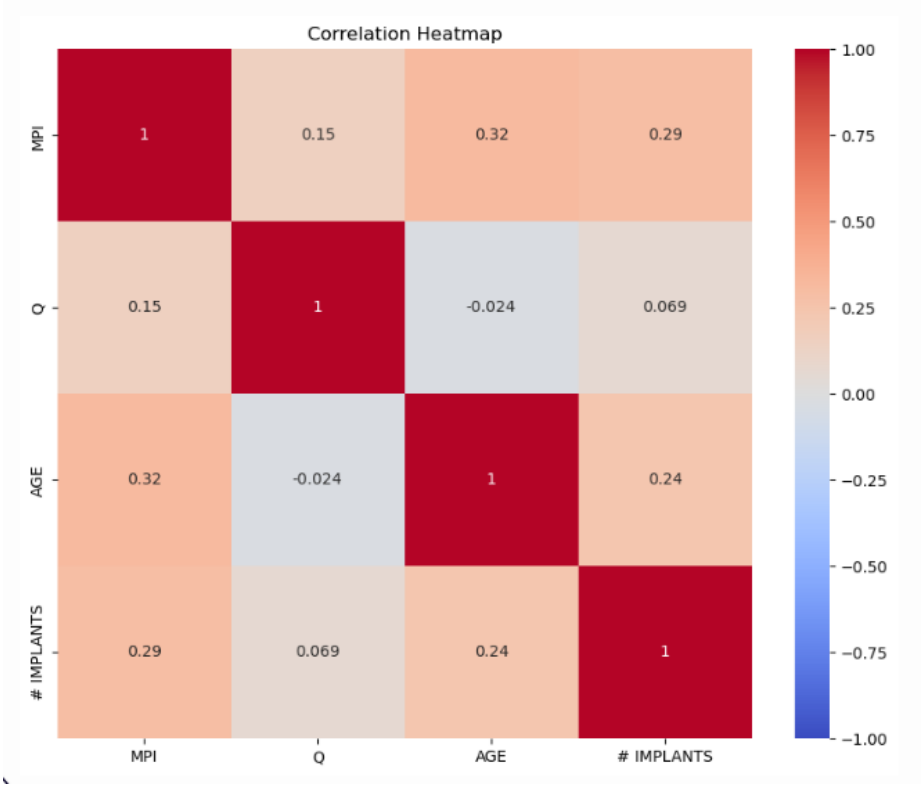

Figure 5: Cleansability Correlation Matrix

To evaluate factors associated with plaque accumulation, we constructed a correlation matrix examining the relationship between plaque index (MPI) and three variables: age, number of implants, and self-perceived cleansability (Q). The correlation matrix revealed a weak positive correlation between Q and MPI, suggesting a slight trend where higher self-perceived cleansability is associated with greater plaque accumulation, a counterintuitive finding since we were expecting to see an inverse relationship since Self-reported cleansability (Q) was rated on a scale from 1 (not easy to clean) to 4 (very easy to clean), while the Modified Plaque Index (MPI) ranged from 0 (no plaque accumulation) to 5 (high plaque accumulation). MPI was found to have a moderately positive correlation with both patient age (0.32) and number of implants (0.29). These associations suggest that older patients and those with more implants tend to exhibit higher levels of plaque accumulation.

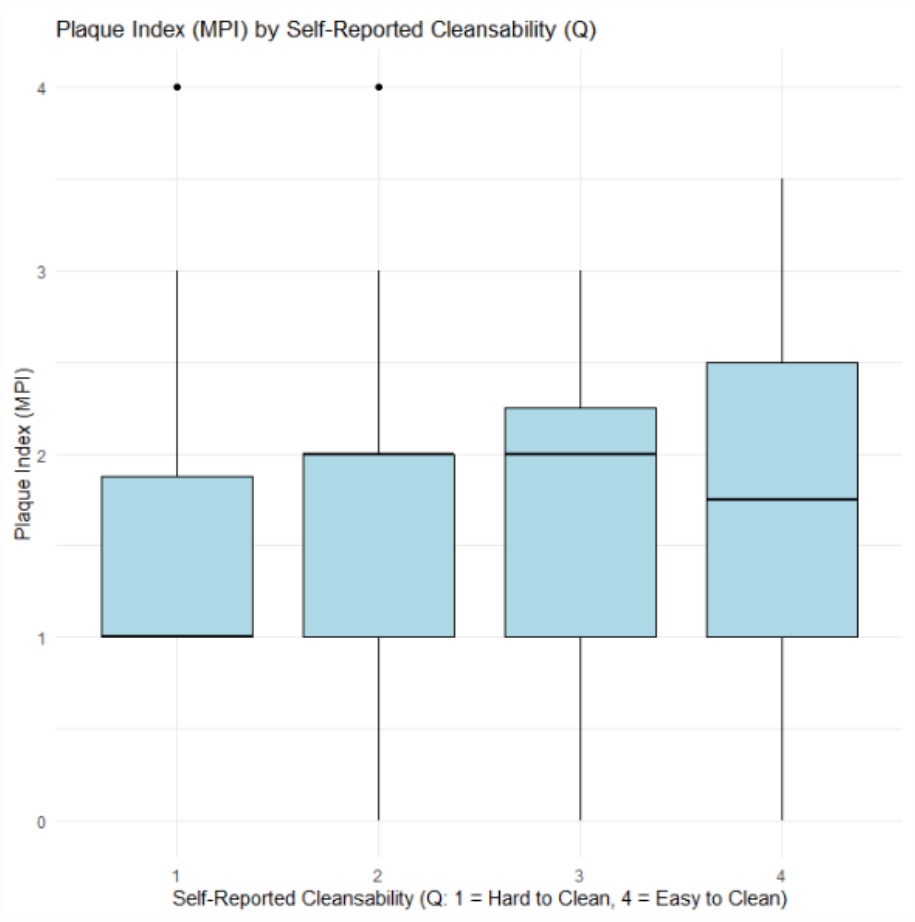

Figure 6: Distribution of MPI by Self-Reported Cleansability

The boxplots above revealed a slight upward trend in median MPI as Q increased from 1 to 4. Notably, the group with the highest self-rated cleansability (Q=4) exhibited the widest spread of MPI values. This indicates that patients who perceived their prosthesis as highly cleanable did not consistently have lower plaque accumulation. The variability and presence of increased MPO values in this group suggests that self-perceived cleansability may not align well with actual clinical measurements.

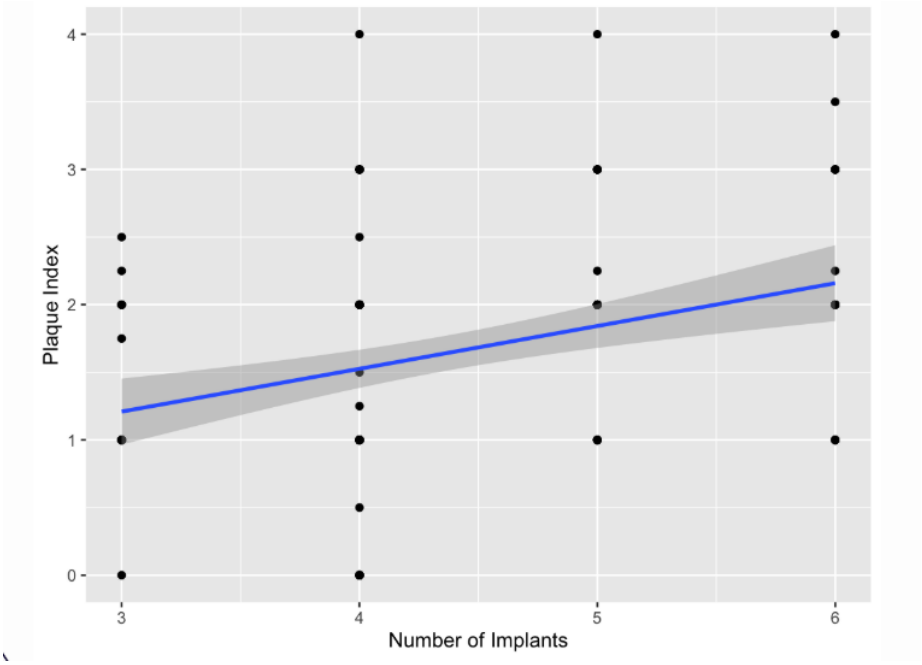

Figure 7: Trend of Plaque Index with Increasing Number of Implants

The above figure shows a scatterplot with a fitted linear regression line depicting the relationship between the number of implants and the plaque index (MPI). Each point represents an individual observation. A linear trend line with a 95% confidence interval was added to visually assess the association. The positive slope suggests that a higher number of implants may be associated with a higher plaque index, indicating a potential increase in plaque accumulation with more implants. Given this visible trend, the number of implants may be a strong predictor of interest and warrants further investigation in modeling or hypothesis testing.

Table 4: Mixed Linear Model Results

Predictor	Estimate	Std. Error	df	p-value
(Intercept)	-0.708681	0.622022	35.69	0.2622
Age	0.019472	0.007972	32.55	0.0202 *
# of Implants	0.240151	0.118478	32.65	0.0509 .
Q	0.100610	0.078521	158.79	0.2019

A mixed effects model was used to capture both the average effect of the predictors on plaque index and patient-level variability. This method allows us to

answer questions about how the number of implants influences plaque accumulation while controlling for variability across patients. We evaluated the effects of Age, Perceived Cleansability, and Number of Implants on Plaque Index (MPI). Results from the mixed effects model are summarized in Table 4. Age was found to be a statistically significant predictor of MPI (Estimate = 0.019, SE = 0.008, p = 0.020), indicating that plaque accumulation increases with age. The Number of Implants demonstrated a marginally significant positive association with MPI (Estimate = 0.240, SE = 0.118, p = 0.051), suggesting that a greater number of implants may be associated with higher plaque levels. Cleansability (Q) was not a significant predictor in this model (Estimate = 0.101, SE = 0.079, p = 0.202).

Overall, the model suggests that Age is a significant predictor of plaq ue accumulation, while the effect of Number of Implants warrants further investigation. Cleansability did not demonstrate a meaningful relationship with MPI in this sample.

Table 5: Variance Inflation Factor (VIF) Analysis

Term	VIF	VIF 95% CI	adj. VIF	Tolerance	Tolerance 95% CI
Age	1.06	[1.00, 1.80]	1.03	0.94	[0.55, 1.00]
# of Implants	1.06	[1.01, 1.77]	1.03	0.94	[0.57, 0.99]
Q	1.00	[1.00, Inf]	1.00	1.00	[0.00, 1.00]

To assess the potential for multicollinearity among predictors, we calculated Variance Inflation Factors (VIF) using a standard linear model. All VIF values were low: 1.06 for both age and number of implants, and 1.00 for perceived cleansability (Q). These results indicate low multicollinearity and confirmed that there is independence among the variables.

6 Discussion

Satisfaction Analysis

The high number of soft tissue and implant failure complications in patients scoring low overall satisfaction suggests that these two areas may be highly correlated to overall satisfaction scores. Despite patients having an overall positive experience in chewing, speaking, esthetics, and comfort, complications resulting from prostheses appeared to have played a bigger role in determining overall satisfaction. While conducting this analysis, we did not find any correlations among these patients that may have explained why they had a high total number of complications. For future studies, it may be beneficial to investigate why these implant failures may have occurred.

Cleansability Analysis

The weak positive correlation between self-reported cleansability and plaque index suggests that patients who perceive their prosthesis as easier to clean do not necessarily exhibit lower plaque accumulation. The trend toward higher plaque levels among those with higher self-perceived cleansability scores may reflect overconfidence in self-assessment or a misperception of effective hygiene practices.

Additionally, the moderate positive correlations between plaque index and both age and number of implants suggest that older patients and those with more implants may face greater challenges in maintaining prosthesis hygiene. This may be due to more complex cleaning requirements or insufficient education on proper prosthesis care.

7 Limitations

This study has several limitations that may have impacted the findings. First, the small sample size limits the generalizability of the results and reduces the statistical power to detect subtle effects. Additionally, the presence of potential outliers, including possible errors of manual data entry, may have skewed the results. The measure of self-perceived cleansability (Q) was subjective in nature, incorporating more objective cleansability metrics in future studies may enhance the accuracy of the analysis.

To assess whether the study had sufficient statistical power to detect these relationships, post-hoc power analyses were conducted. With a sample size of 36, the power to detect the weak correlation between MPI and self-perceived cleansability (Q; $r = 0.15$) was only 14.2%, indicating a high risk of Type II error, or failing to detect a true relationship. Power was also limited for detecting correlations with age ($r = 0.32$; power = 48.7%) and number of implants ($r = 0.29$; power = 41.1%). These findings suggest that the study may have been underpowered to detect small to moderate associations and support the need for larger samples in future investigations.

8 Conclusion

This analysis highlights two important insights into dental prosthesis outcomes. First, overall patient satisfaction appears to be more strongly influenced by dental complications than by domain-specific satisfaction factors. This suggests that clinical complications may outweigh positive function and esthetic experiences shaping patient satisfaction.

Second, the cleansability findings reveal a disconnect between self-perceived hygiene and clinical plaque measurements. Patients who rated their prosthesis as easy to clean often had higher plaque accumulation, indicating a discon-

nect between their perceived cleansability and actual cleanliness. Furthermore, mixed-effects regression analysis confirmed that both increased age and a higher number of implants are associated with greater plaque accumulation.

9 References

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