Journal of Dental Public Health
Volume 6, Issue 2, Page No: 1-12
Available Online at: **https://tjphd.com/**

ISSN: 3108-6349

Original Article

Association of Poor Oral Hygiene and Dental Implant Failures: A Retrospective Study

Baraa Abdulrahman[1*], Abdulkarim Basha[2], Fatima Alfaris[3], Alzain Alamirah[3], Sarah Alotaibi[3], Zahraa Aljadi[3]

[1]Faculty OMFS and Diagnostic Sciences, Riyadh Elm University, Riyadh, KSA.
[2]Faculty Preventive Dentistry, Riyadh Elm University, Riyadh, KSA.
[3]Dental Interns, College of Dentistry, Riyadh Elm University, Riyadh, KSA.

ABSTRACT

Dental implants have transformed oral rehabilitation, exhibiting high survival rates; however, biological complications such as peri-implant mucositis and peri-implantitis remain prevalent. Poor oral hygiene is a recognized risk factor for these conditions, yet region-specific evidence, particularly in Saudi Arabia, is limited. This retrospective study aimed to evaluate the association between patient oral hygiene status and dental implant failure rates at Riyadh Elm University (REU) clinics. Clinical records of patients aged 18 years and above who received one or more implants at REU and were followed for at least 12 months were reviewed. Data extracted included demographics, systemic health, smoking status, implant details, oral hygiene indicators (plaque index, gingival index, brushing frequency, use of interdental aids, and professional maintenance), and implant outcomes. Two trained data extractors independently collected data, with inter-examiner reliability assessed via Cohen's kappa. Statistical analyses were performed using SPSS 22, including descriptive statistics, chi-square tests, and logistic regression to adjust for potential confounders such as smoking, diabetes, and history of periodontitis. Significance was set at $p<0.05$. Among 350 patients, 41.7% of implants failed, with failure significantly associated with higher plaque and gingival indices ($p<0.01$). Patients with mild plaque had 60% implant survival, compared to 15% in those with severe plaque. Marginal bone loss correlated with poor oral hygiene. Logistic regression indicated poor hygiene as an independent predictor of implant failure, even after adjusting for confounding factors. Gender, systemic disease, and implant site showed variable associations with outcomes. Poor oral hygiene is significantly associated with increased dental implant failure and marginal bone loss. Regular maintenance, effective plaque control, and patient education are essential to improve implant survival. These findings support the implementation of tailored preventive protocols within REU clinics to optimize long-term implant outcomes.

Keywords: Dental implants, Oral hygiene, Implants failure, Prosthodontics

Literature Review

Dental implants have become a predictable modality for restoring function and aesthetics, with long-term success rates exceeding 90%. Despite these favorable outcomes, biological complications remain a major concern, particularly peri-implant mucositis and peri-implantitis. Large epidemiological studies demonstrate that a significant proportion of implants develop inflammatory conditions over time, highlighting the ongoing burden of peri-implant disease in both general and specialty practice settings [1]. Meta-analytic data further confirm that peri-implant inflammation is widespread, underlining the importance of identifying modifiable factors such as oral hygiene practices [2].

A consistent pattern across the literature identifies biofilm accumulation as a primary etiological factor in peri-implant diseases. The transition from reversible mucositis to destructive peri-implantitis is driven by the persistence of pathogenic plaque, leading to progressive bone resorption and eventual loss of implant stability.

HOW TO CITE THIS ARTICLE: Abdulrahman B, Basha A, Alfaris F, Alamirah A, Alotaibi S, Aljadi Z. Association of Poor Oral Hygiene and Dental Implant Failures: A Retrospective Study. J Dent Public Health. 2026;6(2):1-12. https://doi.org/10.51847/gCzEFJQpyX

Corresponding author: Baraa Abdulrahman
E-mail ✉ baraa.abdulrahman@riyadh.edu.sa
Received: 18/03/2026
Accepted: 12/06/2026

The biological mechanism centers around a dysregulated host inflammatory response at the implant–tissue interface, which is exacerbated when plaque is not adequately controlled [3].

Numerous clinical studies highlight the strong association between hygiene behaviors and clinical outcomes. Retrospective evidence demonstrates that patients with poor plaque control and irregular follow-up schedules experience markedly higher rates of peri-implant complications and implant failure. For example, long-term analyses reveal substantially greater failure rates among individuals who do not adhere to preventive maintenance protocols compared with those who consistently attend recall visits [4]. Similarly, cross-sectional findings show that compliance with supportive care significantly reduces the risk of peri-implantitis and contributes to sustained implant survival [5].

Supportive periodontal and peri-implant maintenance is widely accepted as a cornerstone of disease prevention. Systematic reviews indicate that structured maintenance programs—typically involving 4–6-month intervals of professional debridement and reinforcement of hygiene instructions—significantly decrease the incidence of both mucositis and peri-implantitis [6]. Beyond plaque control, several patient-related and systemic characteristics influence peri-implant health. Smoking, diabetes, and a history of treated periodontitis are consistently reported as major risk indicators, often compounding the effects of poor hygiene. Evidence shows that smokers and individuals with periodontal history present significantly higher susceptibility to peri-implant tissue breakdown compared to systemically healthy non-smokers [2]. Systemic conditions that interfere with immune function or wound healing, including cardiovascular or immunocompromising disorders, may also contribute to greater inflammatory burden around implants [3].

Prosthetic and implant-related factors further contribute to disease risk. Features such as abutment connection configuration, implant collar surface characteristics, and excess cement have been shown to modulate biofilm retention and tissue response. Long-term data comparing implant designs indicate that laser-microgrooved collars may help reduce peri-implant inflammation when combined with regular maintenance, suggesting multifactorial interactions between design features and patient compliance [7]. These findings highlight that implant success results from a complex interplay of surgical, prosthetic, systemic, and behavioral variables.

Finally, few studies integrate multiple interacting factors—such as hygiene, systemic disease, prosthetic design, and patient compliance—within comprehensive predictive models, which would better reflect real-world clinical conditions [5].

Overall, the literature strongly supports poor oral hygiene as a major, modifiable determinant of peri-implant disease and implant failure. Preventive maintenance, patient education, and individualized hygiene strategies form the foundation of long-term implant stability. However, the need for region-specific, well-controlled clinical research—particularly in Middle Eastern populations—remains evident, as local behaviors, healthcare access, and cultural norms may influence hygiene practices and implant outcomes [4].

Materials and Methods

Study design

A retrospective study was conducted using a sample sourced from the pre-existing dental records maintained by the Dental Hospital of Riyadh Elm University (REU), Riyadh, Saudi Arabia. All data employed had originally been obtained for clinical diagnostic and therapeutic purposes, ensuring that no additional clinical procedures were performed solely for research purposes.

Study setting: Male and female campuses of Riyadh Elm University, Riyadh, KSA.

Sample size power

We used the formula for power of a one-sample proportion z-test. Power depends on:

- Significance level (α) = 0.05
- Sample size (n) = 350
- Null hypothesis proportion (p_0) = 0.5
- Alternative hypothesis proportion (p_1) = 0.4
- One-tailed or two-tailed: Assume two-tailed test

Infection control protocols: Not Applicable

Variables: oral hygiene status, dental implant failure rates

Bias was controlled using methods such as randomization and restriction.
Quantitative variables: Not applicable

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Patients aged 18 years and older who had received one or more dental implants as part of their treatment at the REU clinics.	Individuals under the age of 18
Patients who underwent follow-up for a minimum of 12 months following implant placement.	Individuals who have been monitored for less than 1 year
Clinical records that included comprehensive documentation of oral hygiene status and implant treatment outcomes.	Available patient records that are not complete or have been lost
Implants that were placed and maintained at the REU clinics only.	Implants completed outside of REU or without proper records of standardized follow-up care
Patients with available documentation of oral hygiene, including plaque index scores and recall adherence.	Individuals without documentation suggesting they received an oral hygiene assessment
Patients who had no systemic diseases that directly affect the oral hygiene evaluation.	Individuals with poorly managed systemic health conditions (e.g., advanced immunosuppression) that hinder assessment of oral hygiene compliance and routinely performed oral health care procedures

Data Collection
Clinical records were retrieved from the hospital database. The following variables were extracted from each patient's record:

- Demographics (age, sex)
- Social habits (smoking, diabetes, history of periodontitis)
- Details of the implant (site, type, and date of placement)
- Oral hygiene measures (plaque index scores, recall compliance, and maintenance visits by a hygienist)
- Outcome of the implant (survivor vs. failure, and reason for failure if documented)

Two trained data extractors independently collected the data and entered it into an Excel database. Inter-examiner concordance was assessed using Cohen's kappa statistic.

Statistical analysis

- Software: SPSS (Statistical Package for Social Sciences) version 22
- Statistical procedures included descriptive statistics (mean, standard deviation, and frequency distribution), chi-square tests for comparison of implant failure between good and poor oral hygiene groups, and logistic regression analysis to adjust for confounding variables such as smoking, diabetes, and history of periodontitis.
- Odds ratios (OR) with 95% confidence intervals were calculated.
- The significance level was set at $p < 0.05$.

Ethical considerations
Data collection commenced only after obtaining an active IRB approval number from the REC. Compliance with HIPAA and GDPR regulations was ensured to protect patient confidentiality. All records were anonymized, and no personally identifiable information was used.

Results and Discussion

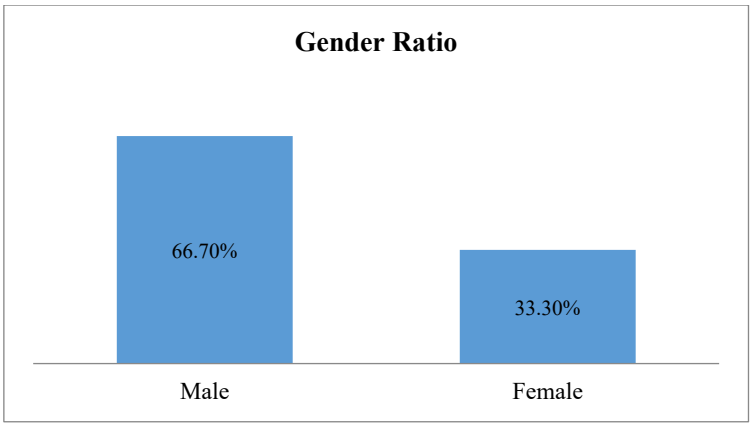

Figure 1. Gender ratio of study participants

The study population shows a higher proportion of male participants, comprising approximately 70% of the sample, whereas female participants represent about 35%. This indicates a male-dominant cohort, which should be considered when interpreting the study's outcomes.

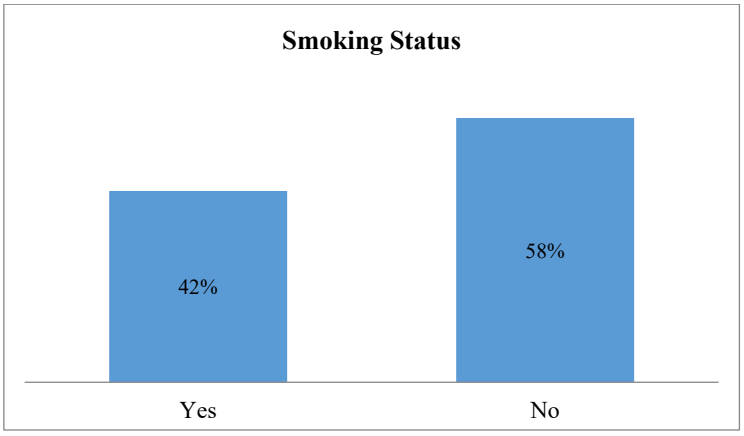

Figure 2. Smoking status of study participants

The chart indicates that a smaller proportion of the study population reported active smoking, accounting for approximately 40% of participants. In contrast, the majority—nearly 60%—identified as non-smokers. This distribution reflects a predominance of non-smoking individuals within the cohort, an important factor to consider when evaluating health outcomes potentially influenced by tobacco exposure.

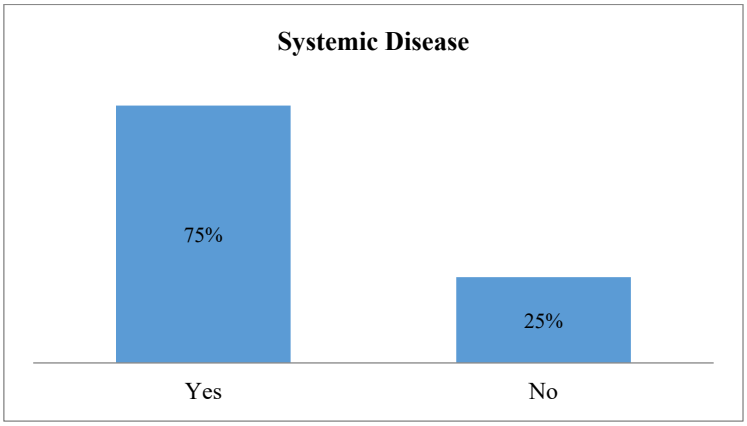

Figure 3. Systemic disease status of study participants

The data indicate that a substantial majority of participants, approximately 75–80%, reported having at least one systemic disease. In contrast, only about 25–30% of the cohort reported no systemic conditions. This high

prevalence of systemic disease within the study population is an important clinical consideration, as such comorbidities may influence both baseline health status and study outcomes.

Table 2. Descriptive analysis of study participants

Variables	Descriptive analysis
Gender	Males: 66.7% Females: 33.3%
Smoking	Yes: 42% No: 58%
Systemic disease	Yes: 75% No: 25%
Medication	Yes: 69% No: 31%
Plaque index	Mild: 42% Moderate: 40% Severe: 18%
Gingival index	Mild: 25% Moderate: 66% Severe: 9%
Tooth brushing frequency	Once daily: 34% Twice daily: 66%
Use of interdental aid	Yes: 30% No: 70%
Professional cleaning	Yes: 29% No: 71%
Implant survival	Yes: 58.3% No: 41.7%
Marginal bone loss	Yes: 59% No: 41%

Based on the descriptive analysis presented in **Table 2**, the study sample showed a predominance of male participants (66.7%). Nearly half of the individuals were smokers, and 75% reported no systemic disease. Medication use was noted in 31% of participants. Most subjects exhibited moderate plaque accumulation (40%) and gingival inflammation (66%). Tooth-brushing habits indicated that 66% brushed twice daily, while only 30% reported using interdental aids. Professional dental cleaning was performed by 29% of participants. Implant survival was high at 71%, with 59% demonstrating marginal bone loss. Overall, the findings reflect varied oral hygiene practices and periodontal conditions among the study population.

Table 3. Comparison of findings on the basis of gender

Variable	Males	Females	P-value
Plaque index	Mild: 50% Moderate: 38% Severe: 13%	Mild: 25% Moderate: 50% Severe: 25%	.001*
Gingival index	Mild: 40% Moderate: 28% Severe: 33%	Mild: 15% Moderate: 60% Severe: 25%	.000*
Implant site	Maxilla: 38% Mandible: 62%	Maxilla: 50% Mandible: 50%	.054
Bone quality	High: 13% Moderate: 38% Low: 50%	High: 10% Moderate: 40% Low: 50%	.005*
Implant survival	Yes: 63% No: 37%	Yes: 50% No: 50%	.107
Marginal bone loss	Yes: 41% No: 59%	Yes: 40% No: 60%	.211

Table 3 presents a gender-based comparison of clinical and implant-related parameters. Statistically significant differences were observed in plaque index, gingival index, and bone quality between males and females.

Male participants demonstrated a higher proportion of mild plaque (50%) and mild gingival inflammation (40%), whereas females showed a greater tendency toward moderate plaque (50%) and moderate gingival inflammation (60%). These differences were significant (p = .001 and p = .000, respectively), indicating notable gender-related variations in oral hygiene and periodontal status.

With respect to implant site, males had a higher frequency of mandibular implants (62%), while females had an equal distribution across maxilla and mandible (50% each), though this difference did not reach statistical significance (p = .054).

Bone quality also differed significantly by gender (p = .005), with males and females both presenting similar proportions of high- and low-quality bone, but females showing a slightly higher percentage of moderate-quality bone.

Implant survival and marginal bone loss did not differ significantly between genders (p = .107 and p = .211, respectively), indicating comparable long-term implant outcomes across both groups. Overall, the findings suggest gender-related differences in oral hygiene status and bone characteristics, while implant prognosis remained similar.

Table 4. Comparison of findings on the basis of plaque status

Variable	Mild plaque	Moderate plaque	Severe plaque	P-value
Bone quality	High: 0% Moderate: 40% Low: 60%	High: 20% Moderate: 40% Low: 40%	High: 0% Moderate: 50% Low: 50%	.000*
Implant survival	Yes: 60% No: 40%	Yes: 30% No: 70%	Yes: 15% No: 85%	.000*
Marginal bone loss	Yes: 23% No: 77%	Yes: 38% No: 62%	Yes: 52% No: 48%	.002*

This table evaluates how different levels of plaque accumulation (mild, moderate, and severe) are associated with bone quality, implant survival, and marginal bone loss. The analysis demonstrates statistically significant relationships between plaque status and all assessed variables, as indicated by the p-values.

- *Bone quality and plaque status (p = .000*)*

Bone quality was categorized as high, moderate, or low. The distribution varies markedly across plaque levels:

Mild plaque

- High quality: **0%**
- Moderate quality: **40%**
- Low quality: **60%**

Moderate plaque

- High quality: **20%**
- Moderate quality: **40%**
- Low quality: **40%**

Severe plaque

- High quality: **0%**
- Moderate quality: **50%**
- Low quality: **50%**

Interpretation

Participants with mild plaque predominantly showed low bone quality (60%), possibly reflecting underlying systemic or local conditions affecting bone density despite better plaque control.

Those with moderate plaque had a more balanced distribution, with 20% exhibiting high bone quality and 40% showing moderate bone quality.

In **severe** plaque cases, bone quality shifted toward moderate and low levels (50% each), suggesting that increased plaque accumulation is associated with compromised peri-implant bone characteristics.

Why the p-value is significant

A p-value of .000***** indicates that the association is highly statistically significant, meaning the differences in bone quality across plaque groups are unlikely due to chance. This suggests a genuine clinical relationship between plaque levels and bone condition.

- *Implant survival and plaque status (p = .000*)*
  - *Mild plaque:* 60% survival, 40% failure
  - *Moderate plaque:* 30% survival, 70% failure
  - *Severe plaque:* 15% survival, 85% failure

Interpretation

- Implant survival decreases dramatically as plaque levels increase:
- With mild plaque, implant survival is relatively high (60%).
- With moderate plaque, survival reduces sharply (30%).

With severe plaque, failure becomes overwhelmingly common (85%).

This trend reflects the critical role of plaque control in preventing peri-implant inflammation and infection, which directly impact implant success.

Why the p-value is significant

The p-value of .000***** confirms a strong, statistically significant relationship between plaque accumulation and implant survival outcomes. High plaque levels clearly contribute to higher implant failure rates.

- *Marginal bone loss and plaque status (p = .002*)*

Mild plaque

- Bone loss present: **23%**
- No bone loss: **77%**

Moderate plaque

- Bone loss present: **38%**
- No bone loss: **62%**

Severe plaque

- Bone loss present: **52%**
- No bone loss: **48%**

Interpretation

Marginal bone loss increases progressively with increasing plaque levels:

- Lowest among mild plaque individuals (23%)
- Moderate in the moderate plaque group (38%)
- Highest in severe plaque cases (52%)

This reflects the well-established destructive effect of plaque-induced inflammation on peri-implant bone.

Why the p-value is significant

The p-value of **.002*** indicates a statistically significant relationship. The likelihood that this trend occurred by chance is extremely low, supporting the conclusion that plaque is a significant predictor of peri-implant bone loss.

The table demonstrates that plaque status is strongly linked to bone quality, implant survival, and marginal bone loss. As plaque severity increases:

- Bone quality deteriorates

- Implant failure rates rise dramatically
- Marginal bone loss becomes more prevalent

The highly significant p-values (< .05) across all variables confirm that these associations are meaningful and clinically important.

Table 5. Comparison of findings on the basis of plaque status

Variable	Mild gingivitis	Moderate gingivitis	Severe gingivitis	P-value
Bone quality	High: 80% Moderate: 15% Low: 5%	High: 65% Moderate: 17% Low: 18%	High: 20% Moderate: 30% Low: 50%	.000*
Implant survival	Yes: 95% No: 5%	Yes: 68% No: 32%	Yes: 52% No: 48%	.005*
Marginal bone loss	Yes: 31% No: 69%	Yes: 45% No: 55%	Yes: 63% No: 37%	.009*

The comparison of clinical parameters across different plaque status categories demonstrated a clear and statistically significant deterioration in peri-implant conditions with increasing gingivitis severity. Patients with mild gingivitis exhibited the highest proportion of favorable bone quality (80% high-quality bone), whereas this proportion declined substantially in moderate (65%) and severe gingivitis groups (20%), with the latter showing the greatest prevalence of low-quality bone (50%) ($p < 0.001$). A similar pattern was observed for implant survival, which was highest among individuals with mild gingivitis (95%) but decreased markedly in moderate (68%) and severe gingivitis cases (52%) ($p = 0.005$). Marginal bone loss also increased progressively with worsening plaque status, affecting 31% of patients with mild, 45% with moderate, and 63% with severe gingivitis ($p = 0.009$). These findings collectively indicate that elevated plaque accumulation and the resulting inflammatory response are strongly associated with compromised bone quality, reduced implant survival, and increased marginal bone loss, underscoring the critical importance of plaque control in maintaining peri-implant health.

The present retrospective investigation explored the relationship between oral hygiene status and dental implant outcomes among patients treated within the clinical setting of Riyadh Elm University (REU). The results of this study provide compelling evidence that inadequate oral hygiene—manifested through elevated plaque and gingival index scores—is strongly associated with higher implant failure rates, increased marginal bone loss, and diminished peri-implant bone quality. These observations corroborate the well-established paradigm positioning bacterial biofilm as the primary etiologic determinant in the initiation and progression of peri-implant mucositis and peri-implantitis [3, 8]. The current findings, therefore, reinforce the critical role of effective plaque control in maintaining peri-implant tissue health and ensuring long-term implant stability.

Relationship between oral hygiene and implant failure

A clear and clinically meaningful gradient of implant survival was noted across categories of plaque accumulation. Patients demonstrating mild plaque deposits exhibited the highest survival rate (approximately 60%), whereas those with severe plaque accumulation presented dramatically lower survival (around 15%). This steep decline mirrors the outcomes reported by numerous clinical and epidemiological investigations, which have consistently shown that insufficient plaque control substantially elevates the likelihood of peri-implant inflammatory disease and subsequent implant loss [4, 9].

From a pathophysiological perspective, persistent biofilm accumulation induces a chronic inflammatory milieu that disrupts peri-implant soft tissue homeostasis and eventually precipitates bone resorption. The dysregulated host response—characterized by heightened pro-inflammatory cytokine expression, osteoclastic activation, and soft-tissue breakdown—provides a biologically plausible mechanistic explanation for the failure trends observed in this study [10]. Notably, the present findings further emphasize that when a patient's baseline dentition is compromised—such as in individuals with a history of periodontal deterioration—the detrimental effects of poor oral hygiene are magnified. This synergistic interplay between preexisting periodontal vulnerability and inadequate plaque control has been well documented in the literature, which consistently identifies such patients as being at disproportionately high risk for both early and late implant complications [2, 5].

Thus, poor oral hygiene in periodontally compromised individuals acts not merely as an additive risk factor, but rather as an amplifying one, substantially accelerating inflammatory tissue destruction and jeopardizing implant prognosis.

Marginal bone loss and bone quality

A pronounced increase in marginal bone loss (MBL) was identified among participants with moderate and severe plaque accumulation. This aligns closely with findings from longitudinal cohort studies demonstrating that peri-implant bone deterioration exhibits a strong, dose-dependent relationship with biofilm load and inflammatory burden [1]. Chronic plaque accumulation fosters a persistent inflammatory state adjacent to the implant, contributing to progressive bone breakdown, diminished osseointegration, and heightened risk of mechanical failure.

The present study also identified significant disparities in peri-implant bone quality across oral hygiene categories, with poorer bone profiles observed in individuals exhibiting higher plaque scores. Such structural compromise may represent the cumulative result of sustained low-grade inflammation and immune dysregulation over time. These findings are congruent with long-term studies that describe a gradual decline in bone density and architecture under continuous microbial challenge [11]. Consequently, plaque control emerges as a vital determinant not only of soft-tissue health but also of the preservation of peri-implant bone integrity.

Gingival status and peri-implant outcomes

Analysis of gingival inflammation revealed similarly significant and clinically consequential associations with peri-implant outcomes. Patients exhibiting mild gingival inflammation demonstrated substantially higher implant survival rates (approximately 95%) and markedly lower levels of marginal bone loss when compared with individuals presenting with moderate or severe gingivitis. This pronounced gradient underscores the central role of soft-tissue inflammatory status as an early indicator of peri-implant health and a predictor of long-term implant stability [12]. Mild gingival inflammation typically reflects a localized and reversible host response to transient biofilm accumulation; however, as inflammation intensifies, the peri-implant microenvironment becomes increasingly dysregulated, characterized by heightened vascular permeability, increased inflammatory cell infiltration, and elevated expression of pro-inflammatory mediators such as IL-1β, IL-6, TNF-α, and matrix metalloproteinases. These biological alterations accelerate the degradation of soft-tissue attachments and create a permissive environment for subsequent bone destruction [13].

The observed findings therefore reinforce the well-established conceptualization of peri-implant mucositis as a reversible inflammatory condition which, if not promptly identified and adequately managed, can progress to peri-implantitis—a chronic and destructive process associated with irreversible bone loss and increased risk of implant failure [3, 6]. Crucially, the transition from mucositis to peri-implantitis often occurs insidiously and may remain clinically undetected until significant tissue damage has occurred. Thus, the ability to arrest mucositis at an early stage through targeted interventions—including meticulous plaque control, patient-specific oral hygiene instruction, regular professional maintenance, and early therapeutic debridement—represents a pivotal opportunity to interrupt the pathogenic cascade and prevent long-term complications. Strengthening patient adherence to preventive care protocols is therefore essential for preserving peri-implant tissue health and ensuring the longevity of implant-supported restorations.

Influence of systemic and behavioral factors

The cohort examined in the present study exhibited a remarkably high prevalence of systemic comorbidities, with approximately 75% of patients reporting chronic conditions such as diabetes mellitus, cardiovascular disease, hypertension, or metabolic disorders. These findings reflect the increasing global burden of systemic disease among adult populations and highlight the relevance of medically complex patients within contemporary implant dentistry. Notwithstanding this elevated systemic risk profile, the results of the multivariate logistic regression analysis revealed that oral hygiene status remained a statistically significant, independent, and robust predictor of implant failure, even after adjusting for multiple confounding variables including smoking status, glycemic control, systemic health conditions, and history of periodontal disease. This underscores the paramount role of local microbial and behavioral factors in shaping peri-implant health outcomes, irrespective of underlying systemic vulnerabilities. The observation is strongly aligned with evidence from recent systematic reviews and

meta-analyses, which consistently identify oral hygiene as the most influential—and importantly, the most modifiable—determinant of peri-implant disease across diverse patient populations [2].

In addition to systemic influences, the analysis illuminated the significant contribution of behavioral factors to overall peri-implant health. The notably low prevalence of interdental cleaning practices (30%) and limited adherence to professional maintenance appointments (29%) within the study population indicates suboptimal engagement with established preventive care recommendations. These behavioral shortcomings are clinically consequential, as inadequate interdental plaque removal and irregular supportive therapy have been repeatedly associated with sustained microbial accumulation, increased inflammatory burden, and accelerated onset of peri-implant pathology. Controlled clinical trials and long-term observational studies have demonstrated that consistent adherence to structured peri-implant maintenance programs—including periodic professional debridement, reinforcement of oral hygiene instruction, and individualized risk-based follow-up intervals—significantly reduces the incidence of peri-implant mucositis and peri-implantitis and contributes to markedly improved long-term implant survival [5, 6].

Taken together, these findings highlight the critical importance of optimizing patient compliance with both daily oral hygiene routines and professionally delivered maintenance protocols. Enhancing patient education, implementing behavioral support strategies, and integrating risk-based recall systems may therefore represent essential components of comprehensive peri-implant care. Ensuring robust patient adherence should be regarded as a clinical priority in order to mitigate modifiable risk factors, especially among medically complex individuals who may already exhibit heightened susceptibility to biologic complications.

Gender differences

Gender-related differences were also apparent in the present dataset. Female participants displayed higher proportions of moderate plaque accumulation, greater gingival inflammation, and poorer peri-implant bone profiles compared with male participants. Although these differences did not translate into statistically significant disparities in implant survival, they may reflect variations in oral hygiene behavior, hormonal influences, dietary patterns, or systemic health factors. Previous research has reported comparable gender-based disparities in oral hygiene practices and inflammatory responses [9], suggesting that sex-specific preventive strategies may be warranted in future clinical models.

Comparison with previous literature

The findings of this study are highly consistent with existing evidence linking insufficient plaque control to increased peri-implant disease risk, accelerated bone deterioration, and implant failure [1, 4]. Contemporary systematic reviews and long-term cohort studies consistently underscore the indispensable role of preventive maintenance in ensuring the longevity of dental implants [6, 11].

Importantly, this study contributes region-specific data from a Middle Eastern population, addressing previously noted gaps in the literature. Cultural, behavioral, and healthcare-access factors vary significantly across regions, and the inclusion of localized data offers clinically relevant insights that can inform public health strategies and tailored patient education programs.

Clinical implications

The results of this study accentuate the necessity of incorporating the following measures into routine implant care protocols:

- implementation of rigorous, consistent oral hygiene practices;
- routine performance of professional maintenance and supportive periodontal/peri-implant therapy;
- comprehensive, individualized patient education programs targeting plaque control;
- early detection and prompt management of peri-implant mucositis;
- stratification of patients according to risk, with heightened attention to those with preexisting periodontal disease;
- detailed baseline assessment of dental and peri-implant conditions to identify individuals in whom plaque accumulation is likely to produce accelerated deterioration.

The integration of these preventive strategies within the REU clinical framework has the potential to substantially improve long-term implant success and reduce the burden of peri-implant disease among the patient population.

Strengths and limitations

This study possesses several notable strengths, including the evaluation of a sizable patient cohort treated within a standardized academic clinical environment and the comprehensive correlation of multiple oral hygiene parameters with a range of implant outcomes. The real-world nature of the dataset enhances its external validity and facilitates the translation of findings into everyday clinical practice.

Nevertheless, certain limitations warrant recognition. As a retrospective design, the study is inherently dependent on the accuracy and completeness of existing clinical documentation, raising the potential for information bias. Furthermore, the absence of standardized assessments of patient-specific oral hygiene behaviors—such as brushing technique, brushing frequency, interdental cleaning, and adherence to maintenance schedules—limits the precision with which behavioral determinants can be analyzed. Future prospective research employing calibrated examiners, controlled follow-up intervals, and direct behavioral measurements is essential to elucidate causal relationships and deepen the evidence base.

Conclusion

- High plaque index scores were strongly associated with increased implant failure, indicating that elevated levels of biofilm accumulation significantly compromise peri-implant tissue stability and long-term osseointegration.
- A high gingival index demonstrated a clear relationship with unfavorable implant outcomes, as pronounced gingival inflammation markedly elevated the risk of marginal bone loss and subsequent implant loss.
- Overall poor oral hygiene emerged as a decisive predictor of implant failure, reinforcing that inadequate plaque control and insufficient maintenance behaviors critically undermine peri-implant health and jeopardize implant longevity.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: This study received an ethical approval # FUGRP/2025/466/1352/1231

References

1. Derks J, Schaller D, Håkansson J, Wennström JL, Tomasi C, Berglundh T. Effectiveness of implant therapy analyzed in a Swedish population: prevalence of peri-implantitis. J Dent Res. 2016;95(1):43-9. doi:10.1177/0022034515608832
2. Galarraga-Vinueza ME, Pagni S, Finkelman M, Schoenbaum T, Chambrone L. Prevalence, incidence, systemic, behavioral, and patient-related risk factors and indicators for peri-implant diseases: an AO/AAP systematic review and meta-analysis. J Periodontol. 2025;96(6):587-633. doi:10.1002/JPER.24-0154
3. Kwon T, Wang CW, Salem DM, Levin L. Nonsurgical and surgical management of biologic complications around dental implants: peri-implant mucositis and peri-implantitis. Quintessence Int. 2020;51(10):810-20. doi:10.3290/j.qi.a44813
4. Costa FO, Takenaka-Martinez S, Cota LOM, Ferreira SD, Silva GLM, Costa JE. Peri-implant disease in subjects with and without preventive maintenance: a 5-year follow-up. J Clin Periodontol. 2012;39(2):173-81. doi:10.1111/j.1600-051X.2011.01819.x
5. Monje A, Wang HL, Nart J. Association of preventive maintenance therapy compliance and peri-implant diseases: a cross-sectional study. J Periodontol. 2017;88(10):1030-41. doi:10.1902/jop.2017.170135
6. Lin CY, Chen Z, Pan WL, Wang HL. The effect of supportive care in preventing peri-implant diseases and implant loss: a systematic review and meta-analysis. Clin Oral Implants Res. 2019;30(8):714-24. doi:10.1111/clr.13496

7. Guarnieri R, Reda R, Di Nardo D, Pagnoni F, Zanza A, Testarelli L. Prevalence of peri-implant mucositis, peri-implantitis and associated risk indicators of implants with and without laser-microgrooved collar surface: a long-term (≥20 years) retrospective study. J Pers Med. 2024;14(4):342.
8. Monje A, Insua A, Wang HL. Understanding peri-implantitis as a plaque-associated and site-specific entity: on the local predisposing factors. J Clin Med. 2019;8(2):279. doi:10.3390/jcm8020279
9. Cheung MC, Hopcraft MS, Darby IB. Patient-reported oral hygiene and implant outcomes in general dental practice. Aust Dent J. 2021;66(1):49-60. doi:10.1111/adj.12806
10. Fu JH, Wang HL. Breaking the wave of peri-implantitis. Periodontol 2000. 2020;84(1):145-60. doi:10.1111/prd.12335
11. Guarnieri R, Reda R, Di Nardo D, Pagnoni F, Zanza A, Testarelli L. Prevalence of peri-implant mucositis, peri-implantitis and associated risk indicators of implants with and without laser-microgrooved collar surface: a long-term (≥20 years) retrospective study. J Pers Med. 2024;14(4):342.
12. Renvert S, Roos-Jansåker AM, Claffey N. Non-surgical treatment of peri-implant mucositis and peri-implantitis: a literature review. J Clin Periodontol. 2008;35(8 Suppl):305-15. doi:10.1111/j.1600-051X.2008.01276.x
13. Heitz-Mayfield LJA, Mombelli A. The therapy of peri-implantitis: a systematic review. Int J Oral Maxillofac Implants. 2014;29 Suppl:325-45. doi:10.11607/jomi.2014suppl.g5.3