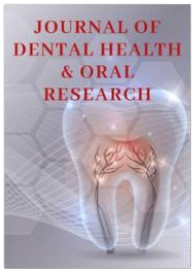

e-ISSN 3050-9432

Journal of Dental Health and Oral Research

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Investigating the Determinants of Dental Implant Failure: A Cross-Sectional Survey Analysis

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Citation: Gupta A, et al. Investigating the Determinants of Dental Implant Failure: A Cross-Sectional Survey Analysis. J Dental Health Oral Res. 2026;7(2):1-8.

https://doi.org/10.46889/JDHOR.2026.7203

Received Date: 03-03-2026

Accepted Date: 04-05-2026

Published Date: 11-05-2026

Abstract

Objectives: This study aimed to evaluate the multifactorial determinants associated with dental implant failure using a structured questionnaire, with specific emphasis on systemic health conditions, behavioral factors, implant-related variables and patient-reported outcomes.

Materials and Methods: A cross-sectional, questionnaire-based study was conducted with 48 patients who received dental implants 12-24 months prior . A 25-item validated questionnaire assessed systemic health, medications, lifestyle factors, implant characteristics, oral hygiene, clinical complications and patient perceptions. Data analyzed using SPSS 27.0 with descriptive statistics and Chi-square test ($p \leq 0.05$).

Results: Diabetes associated with early failures; hypertension with late failures Osteoporosis (25%) and bisphosphonates (31.3%) were most common. High rates of tobacco use (41.7%) and bruxism (54.2%) were observed. Upper posterior region showed highest early failure rate. Most complications occurred within 6 months. Poor oral hygiene and irregular check-ups strongly correlated with complications. Psychosocial impacts included social avoidance (62.5%) and aesthetic concerns (43.8%).

Conclusion: Dental implant failure is multifactorial, involving systemic health, behavioral patterns, oral hygiene and psychosocial factors. Pre-operative assessment, patient education and sustained follow-up are essential.

Clinical significance: This study emphasizes the need for holistic, interdisciplinary care integrating medical evaluation, behavioral modification and patient education to reduce implant failures and improve patient outcomes.

Keywords: Dental Implants; Implant Failure; Osseointegration; Peri-Implantitis; Risk Factors; Questionnaire Study

Introduction

Dental implants have revolutionized prosthodontics as a predictable and effective solution for replacing missing teeth. Their ability to restore function, esthetics and patient confidence has contributed to their widespread use. Despite high survival rates, implant failure remains a significant clinical challenge, often leading to retreatment, increased cost and patient dissatisfaction [1].

Implant failure is broadly categorized into early and late failure based on the timing of occurrence. Early failure occurs before successful osseointegration and is commonly associated with surgical trauma, overheating of bone, microbial contamination and inadequate primary stability. Systemic conditions such as uncontrolled diabetes and impaired vascularity further compromise healing and osseointegration [2-4].

Late implant failure occurs after successful osseointegration and is typically related to biomechanical overload, peri-implantitis, prosthetic complications and inadequate maintenance. These failures may develop months or years after placement and are strongly associated with patient-related factors such as poor oral hygiene and non-compliance with follow-up care [4,5].

The etiology of implant failure is multifactorial, involving systemic diseases, medications, local bone conditions and behavioral habits. Conditions such as diabetes, osteoporosis and cardiovascular disease have been associated with impaired healing and increased failure rates [6]. Additionally, medications such as bisphosphonates and corticosteroids may interfere with bone remodeling and osseointegration [7].

Behavioral factors, including smoking and bruxism, significantly influence implant outcomes. Smoking reduces blood supply and increases susceptibility to infection, while bruxism introduces excessive occlusal forces that can compromise implant stability [8,9]. Poor oral hygiene and irregular maintenance visits are strongly linked to peri-implant disease and long-term failure [10].

Given this multifactorial nature, a comprehensive evaluation of risk factors is essential. Questionnaire-based studies provide a practical method to assess systemic, behavioral and psychosocial determinants. Therefore, this study aims to investigate the contributing factors associated with dental implant failure using a structured survey approach.

Materials and Methods

The present investigation was a cross-sectional, descriptive and questionnaire-based study designed to assess the prevalence of various risk factors and their potential association with dental implant failure.

Sample Size Calculation

Sample size was determined using G*Power software (Version 3.1.9.6) with 85% power and 5% margin of error, resulting in a minimum sample size of 48 participants.

Inclusion Criteria

- Patients aged ≥18 years
- Received dental implants within 12-24 months
- Willing to participate

Exclusion Criteria

- Neurological disorders affecting pain perception
- Cognitive impairment
- Psychological disorders
- Ongoing systemic infections or malignancies

A structured 25-item questionnaire was adapted from previously validated studies assessing implant risk factors and patient-reported outcomes [6,7,16]. Content validity was confirmed by expert review (two prosthodontists and one periodontist). A pilot study was conducted on 10 patients. Internal consistency was assessed using Cronbach's alpha ($\alpha = 0.82$), indicating acceptable reliability.

The questionnaire covered:

- Systemic conditions
- Medication history
- Behavioral factors (smoking, alcohol, bruxism)
- Implant characteristics
- Oral hygiene practices
- Clinical complications
- Psychosocial impact

Data Collection

Data were collected via face-to-face interviews during outpatient visits.

Statistical Analysis

Data were analyzed using SPSS version 27.0.

- Descriptive statistics: frequency and percentage
- Chi-square test: association between variables
- Logistic regression: independent predictors

Variables with $p < 0.10$ in univariate analysis were included in regression modeling. Odds ratios (OR) with 95% Confidence Intervals (CI) were calculated. Statistical significance was set at $p \leq 0.05$.

Results

The study included 48 participants (54.2% males, 45.8% females). Osteoporosis (25%) was the most common systemic condition and 31.3% of patients reported bisphosphonate use. Approximately 35.4% had uncontrolled systemic conditions.

Behavioral analysis showed high prevalence of tobacco use (41.7%) and bruxism (54.2%). Only 29.2% of participants attended regular dental check-ups and 25% did not use any interdental aids.

Implant-related findings indicated that single implants were most common (43.8%), with the upper posterior region being the most frequent site (31.3%) and showing higher early failure rates.

Most complications (54.2%) occurred within the first 6 months. Pain during chewing (50%) and food impaction (39.6%) were the most common symptoms.

Psychosocial analysis revealed emotional stress (58.4%), social avoidance (62.5%) and aesthetic concerns (43.8%). Bruxism showed a positive trend but was not statistically significant after adjustment.

Logistic Regression Findings

Multivariate analysis identified:

- Uncontrolled diabetes → OR = 3.21 ($p < 0.05$)
- Tobacco use → OR = 2.87 ($p < 0.05$)
- Poor oral hygiene → OR = 3.65 ($p < 0.05$)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	26	54.2%
	Female	22	45.8%
Medical Conditions	Osteoporosis	12	25.0%
	Others	6	12.5%
	None	6	12.5%
Condition Control	Uncontrolled	17	35.4%
	Controlled	17	35.4%

Variable	Category	Frequency (n)	Percentage (%)
	N/A	14	29.2%
Medications	Bisphosphonates	15	31.3%
	Blood Thinners	11	22.9%
	Corticosteroids	11	22.9%
	None	5	10.4%

Table 1: Demographics and medical profile.

Variable	Category	Percentage (%)
Tobacco Use	Regular	41.7%
	Never	39.6%
Alcohol Use	Frequent	29.2%
Bruxism	Present	54.2%
Brushing Frequency	Irregular	33.3%
	Once Daily	33.3%
	Twice Daily	33.3%
Hygiene Aids	Mouthwash	45.8%
	Interdental Aids	29.2%
	None	25.0%
Dental Check-ups	Regular (3-6 mo)	29.2%
	Never	29.2%

Table 2: Behavioral and oral hygiene factors.

Variable	Category	Percentage (%)
Number of Implants	Single	43.8%
	2-3 Implants	29.2%
	> 3 Implants	27.1%
Implant Location	Upper Posterior	31.3%

Variable	Category	Percentage (%)
	Lower Anterior	27.1%
	Upper Anterior	25.0%
	Lower Posterior	16.7%
Bone Grafting	Not Sure	52.1%
	Denied	29.2%
	Confirmed	18.8%

Table 3: Implant-related characteristics.

Variable	Category	Percentage (%)
Onset of Symptoms	3-6 months	31.3%
	< 3 months	22.9%
	> 1 year	18.8%
Symptoms Reported	Pain (Chewing)	50.0%
	Food Impaction	39.6%
	Infection	37.5%

Table 4: Clinical complications and symptoms.

Variable	Finding	Percentage (%)
Diet	Vegetarian	35.4%
	Vegan	25.0%
Functional Impact	Chewing Affected	37.5%
	Aesthetics Affected	43.8%
Emotional Stress	Present (Yes + Mild)	58.4%
Social Avoidance	Yes	62.5%

Table 5: Psychosocial and lifestyle factors.

Risk Factor	Early Failure (Cases)	Late Failure (Cases)
Diabetes	5	1

Risk Factor	Early Failure (Cases)	Late Failure (Cases)
Hypertension	1	5
Bruxism	13	13
Brushing (Once Daily)	5	11
Brushing (Twice Daily)	11	5
No Hygiene Aids	2	10

Table 6: Risk factors for early vs late failure.

Risk Factor	Total Symptom Count
Regular Tobacco Users	18
No Dental Check-ups	14
Chewing Difficulties	27 (cases)
Vegetarians	14
Vegans	12

Table 7: Associations between risk factors and discomfort.

Discussion

The findings of this study confirm that dental implant failure is influenced by multiple interacting factors. Systemic conditions such as diabetes and osteoporosis were highly prevalent and significantly associated with implant failure, supporting previous studies demonstrating impaired healing and osseointegration in such patients [22]. The high prevalence of bisphosphonate use is clinically relevant, as these drugs affect bone remodeling and may increase complications. Behavioral factors such as smoking and bruxism were also prominent, consistent with literature identifying them as major contributors to peri-implant disease and mechanical overload [8,23]. Poor oral hygiene and irregular follow-up were strongly associated with late implant failures, emphasizing the importance of maintenance therapy [24]. The higher failure rates observed in the posterior maxilla can be attributed to reduced bone density and unfavorable biomechanical conditions [25]. Additionally, the study highlights the psychosocial impact of implant failure, with many patients reporting emotional stress and social withdrawal. This aligns with the growing recognition of the biopsychosocial model in oral health [27].

Limitations

This study has several limitations. The small sample size limits generalizability. The cross-sectional design prevents causal inference. Self-reported data introduce recall bias. Lack of radiographic and clinical parameters reduces diagnostic precision. Additionally, single-center recruitment may introduce selection bias. Future multicentric longitudinal studies with objective assessments are recommended.

Conclusion

Dental implant failure is a multifactorial condition influenced by systemic health, behavioral habits and maintenance practices. Uncontrolled diabetes, tobacco use and poor oral hygiene were significant contributors. Early failures were associated with systemic conditions, while late failures were linked to maintenance and behavioral factors. A comprehensive, interdisciplinary approach is essential for improving implant success rates.

Clinical Significance

Successful implant therapy requires not only surgical precision but also comprehensive patient evaluation, behavioral modification and long-term maintenance. Addressing systemic risk factors and improving patient compliance can significantly enhance treatment outcomes.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Acknowledgement

The authors have no acknowledgments to declare.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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