INPLASY

The Microbiome as a Mediator Between Biocompatibility and Inflammation in the Peri-Prosthetic Tissues of the Diabetic Patient: A Systematic Review

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ADMINISTRATIVE INFORMATION

Support - Self support.

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 5 November 2025 and was last updated on 5 November 2025.

INTRODUCTION

Review question / Objective The role of the oral microbiome as a mediator between biocompatibility and inflammatory responses in peri-prosthetic tissues among insulin-dependent diabetic patients, improving medical outcomes by standardizing care and lowering treatment costs.

Rationale The increasing prevalence of type 1 diabetes mellitus has prompted growing concern in oral rehabilitation, particularly with respect to implant-supported prostheses. Diabetic patients often experience suboptimal implant outcomes due to systemic metabolic instability, impaired angiogenesis, and a heightened pro-inflammatory state that compromises tissue integration
Emerging evidence suggests that microbial dysbiosis in the diabetic oral cavity alters host–biomaterial interactions through enhanced biofilm formation and immune activation. In diabetic individuals, altered subgingival microbiota, dominated by pathogenic genera such as Porphyromonas, Fusobacterium, and Prevotella exhibit greater adherence and biofilm development on titanium surfaces, accompanied by an amplified local immune response [3, 4].
Given these multifactorial mechanisms, a comprehensive review of the interplay between diabetes-induced microbial dysbiosis, immune modulation, and biomaterial surface interactions is critically important. Such an analysis provides an integrated understanding of how systemic metabolic disturbances translate into local peri-implant complications, bridging the gap between endocrinology, microbiology, and implantology. Moreover, elucidating these pathogenic pathways may inform the development of targeted surface modifications, antimicrobial coatings, and personalized treatment protocols aimed at improving implant success rates in diabetic populations. This review therefore contributes to a growing body of evidence that emphasizes the necessity of a multidisciplinary approach to oral rehabilitation in patients with metabolic disorders.

Diabetic patients exhibit increased susceptibility to peri-implant inflammation and implant failure due to systemic metabolic dysfunction and altered immune responses. The oral microbiome is increasingly recognized as a critical factor in this pathological process, acting at the interface between biomaterial biocompatibility and chronic inflammation.

Condition being studied The role of the oral microbiome as a mediator between biocompatibility and inflammatory responses in peri-prosthetic tissues among insulin-dependent diabetic patients, improving medical outcomes by standardizing care and lowering treatment costs.

METHODS

Search strategy A systematic search of PubMed and Scopus databases was conducted to identify relevant studies published between January 2000 and July 2025. Inclusion criteria encompassed clinical, histological, microbiological, and immunohistochemical studies involving diabetic patients with dental implants or prostheses. The PRISMA 2020 guidelines were followed in reporting the study selection process and data synthesis.

Participant or population Clinical, histological, microbiological, and immunohistochemical studies involving diabetic patients with dental implants or prostheses. Studies published between January 2000 and July 2025.

Intervention Non applicable.

Comparator Non applicable.

Study designs to be included These included a diverse range of experimental designs: clinical, in vivo, in vitro, and histological investigations, providing a comprehensive overview of the multifactorial relationship between diabetes, dysbiosis, and biomaterial interactions. Comparative clinical study; Cross-sectional clinical; Retrospective cohort; Prospective clinical; In vitro biofilm model; In vitro / cell culture; In vivo experimental ; Retrospective case–control.

Eligibility criteria (a) populations involving insulin-dependent diabetic patients (Type 1 or poorly controlled Type 2) undergoing dental implant or prosthetic rehabilitation;
(b) analysis of the oral microbiome, biofilm formation, or microbial adhesion to biomaterial surfaces;
(c) comparison with non-diabetic or healthy control groups;
(d) assessment of inflammatory biomarkers, histological changes, or implant success/failure;
(e) publication in English;
(f) publication dates between 2000 and 2025.

Information sources
Databases/Registers: PubMed, MEDLINE, and Scopus
Search dates (last run): 01 march 2025 to 30 august 2025.
Coverage window: Publications from 2000–2025.
Search approach: Combination of keywords, using Boolean operators (“AND/OR”), truncation, and wildcards. Comprehensive literature search across PubMed (MEDLINE) and Scopus databases.

Main outcome(s) This systematic review demonstrates that the oral microbiome plays a crucial role in modulating the inflammatory response and biocompatibility of peri-prosthetic tissues in insulin-dependent diabetic patients. The presence of a dysbiotic microbial community, in concert with impaired immune function and altered biomaterial interactions, significantly increases the risk of peri-implant inflammation and implant failure.
Future implant strategies for diabetic patients should adopt an integrative biological approach that considers microbial composition, host immune status, and material surface properties. Personalized microbial monitoring and targeted therapies may offer new avenues to improve long-term implant success in this vulnerable population.

Data management Two independent reviewers screened all retrieved titles and abstracts for relevance, and potentially eligible full-text articles were assessed following PRISMA 2020 guidelines (Figure 1). Discrepancies between reviewers were resolved through discussion or by consultation with a third reviewer. Data extraction was performed independently by two reviewers using a standardized Excel form, capturing study characteristics, population details, implant or biomaterial type, microbial findings, and inflammatory or immunological outcomes. Given the methodological heterogeneity, a qualitative synthesis was conducted, organizing findings thematically into: (1) microbiome composition in diabetic versus non-diabetic individuals, (2) biomaterial–microbe interactions, (3) histological and inflammatory responses, and (4) the impact of dysbiosis on implant outcomes. A quantitative meta-analysis was not feasible due to variability in study design and reported outcomes.

Quality assessment / Risk of bias analysis The study employed standardized frameworks to rigorously evaluate the methodological quality and risk of bias of the included studies. For non-randomized clinical studies, the ROBINS-I tool was used to assess potential biases across key domains, including confounding, participant selection, intervention classification, and outcome measurement. Experimental in vivo animal studies were evaluated using the SYRCLE risk of bias tool, which examines randomization, blinding, allocation concealment, and completeness of outcome data. Diagnostic accuracy studies were appraised with QUADAS-2, focusing on patient selection, index test methodology, and reference standards. The overall methodological quality of the included studies was synthesized narratively to account for the heterogeneity in design, sample size, and outcome measures. In addition, the PRISMA 2020 checklist was followed to ensure transparency and reproducibility in reporting the systematic review process.

Strategy of data synthesis Given the methodological heterogeneity, a qualitative synthesis was conducted, organizing findings thematically into: (1) microbiome composition in diabetic versus non-diabetic individuals, (2) biomaterial–microbe interactions, (3) histological and inflammatory responses, and (4) the impact of dysbiosis on implant outcomes.

Subgroup analysis The overall methodological quality of the included studies was synthesized narratively to account for the heterogeneity in design, sample size, and outcome measures.

Sensitivity analysis Given the heterogeneity of the included studies and potential variation in study quality, a narrative sensitivity analysis will be performed. We will assess how excluding low-quality studies or those with unclear methodology affects the overall conclusions of the review.

Language restriction Yes.

Country(ies) involved Romania.

Keywords oral microbiome; peri-implantitis; diabetes mellitus; dental implants; biocompatibility; inflammation.

Dissemination plans Journal publication: Submit the full review to a peer-reviewed journal and follow PRISMA 2020 reporting.

Contributions of each author

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