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Blood Glucose Levels and Their Association with Periodontitis Severity in Patients with Diabetes Mellitus: A Hospital-Based Cross-Sectional Study

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ABSTRACT Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia and is associated with an increased risk of periodontal disease and greater periodontal tissue destruction. However, the relationship between blood glucose levels and the severity of periodontitis among patients with diabetes mellitus requires further evaluation in specific clinical settings. This study aimed to determine the association between blood glucose levels and periodontitis severity among patients with diabetes mellitus attending the Periodontic Polyclinic of Dr. Ramelan Naval Central Hospital, Surabaya. An analytical observational study with a cross-sectional design was conducted among 30 patients with diabetes mellitus selected using a total sampling approach. Blood glucose data were obtained from fasting or random blood glucose records documented within the preceding three months, while periodontal status was assessed clinically using the Community Periodontal Index of Treatment Needs (CPITN). Descriptive statistics were used to characterize the participants, and the association between blood glucose levels and periodontitis severity was analyzed using the Chi-square test with a significance level of 0.05. Among the participants, 17 (57%) had uncontrolled blood glucose levels, whereas 13 (43%) had controlled levels. Moderate periodontitis was the most frequently observed condition, affecting 14 participants (47%), followed by severe periodontitis in 9 (30%) and mild periodontitis in 7 (23%). The Chi-square analysis demonstrated a statistically significant association between blood glucose levels and periodontitis severity ($p < 0.001$). Patients with uncontrolled blood glucose levels were more frequently observed in the moderate-to-severe periodontitis categories. In conclusion, blood glucose control was significantly associated with periodontitis severity in patients with diabetes mellitus. These findings support the importance of integrating glycemic monitoring with routine periodontal assessment as part of comprehensive diabetes management.

INDEX TERMS Diabetes Mellitus, Blood Glucose Levels, Periodontitis Severity, Glycemic Control, Periodontal Health.

I. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, impaired insulin action, or a combination of both mechanisms [1], [2]. The increasing prevalence of DM has become an important public health concern, including in Indonesia, where the disease contributes substantially to morbidity and mortality [3]. Beyond systemic complications, diabetes is also associated with oral health problems, particularly periodontal disease. Recent epidemiological and systematic-review evidence indicates that individuals with diabetes have a greater risk of developing periodontitis and may experience more severe periodontal destruction than individuals without diabetes [4]–[7].

Periodontitis is a chronic inflammatory disease affecting the supporting structures of the teeth and is characterized by progressive periodontal tissue destruction. Although microbial

dysbiosis and dental plaque are major initiating factors, systemic conditions such as diabetes can modify the host response and influence disease progression [8], [9]. Persistent hyperglycemia may impair immune function, increase oxidative stress, promote the accumulation of advanced glycation end products, and intensify inflammatory responses within periodontal tissues [10]–[12]. Conversely, chronic periodontal inflammation may contribute to systemic inflammatory burden and insulin resistance, creating a bidirectional relationship between periodontitis and diabetes [13], [14]. Recent evidence further indicates that the severity of periodontal disease is associated with metabolic control and that improvement in glycemic control may be accompanied by improvements in periodontal inflammatory parameters [15], [16].

The current state of the art has predominantly focused on the bidirectional relationship between diabetes and

periodontal disease, the underlying biological mechanisms, and the effects of periodontal treatment on glycemic control. Systematic reviews and meta-analyses have reported that hyperglycemia is significantly associated with periodontal indices and that periodontal treatment can produce modest improvements in glycemic control [17]–[19]. Recent clinical evidence has also demonstrated that glycemic management may influence periodontal inflammatory status, supporting the importance of considering oral and systemic health together [16]. However, much of the existing literature has concentrated on longitudinal associations, periodontal interventions, or HbA1c-based metabolic assessment rather than evaluating routinely documented blood glucose levels in relation to clinically categorized periodontitis severity in a hospital-based population.

This represents a research gap because evidence from specific hospital populations remains limited, particularly regarding the relationship between routinely recorded blood glucose status and the clinical severity of periodontitis among patients with diabetes mellitus. The present study therefore aimed to determine the association between blood glucose levels and periodontitis severity among patients with diabetes mellitus attending the Periodontic Polyclinic of Dr. Ramelan Naval Central Hospital, Surabaya. Preliminary observations at the study site identified 93 patients with diabetes mellitus attending the clinic during June–August 2025, of whom 75 were diagnosed with periodontitis, providing a clinical rationale for further investigation [20].

The contributions of this study are threefold: (1) it provides hospital-based evidence regarding the association between blood glucose status and clinically assessed periodontitis severity among patients with diabetes mellitus; (2) it describes the distribution of glycemic status and periodontal severity within the study population using routinely available clinical information and CPITN assessment; and (3) it provides evidence that may support integrated monitoring of glycemic and periodontal health in diabetes management. The study employed a cross-sectional analytical design with blood glucose records and clinical periodontal assessment, followed by Chi-square analysis to evaluate the association between the variables [21]. The remainder of this article is organized as follows: Section II describes the research methods, including study design, setting, participants, data collection, analysis, and ethical considerations; Section III presents the study results; Section IV discusses the findings in relation to previous evidence, limitations, and clinical implications; and Section V provides the conclusion and recommendations for future research.

II. METHOD

A. STUDY DESIGN AND SETTING

This study employed an analytical observational design with a cross-sectional approach. The design was selected because the exposure variable, blood glucose level, and the outcome variable, periodontitis severity, were assessed within the same study period without experimental intervention. The study followed the general reporting principles for cross-sectional observational research, including clear specification of the

study population, eligibility criteria, variables, measurement procedures, sample size, and statistical analysis [22]. The design was non-randomized because participants were not allocated to intervention or comparison groups. Instead, eligible patients attending the study site during the specified period were recruited using a total sampling procedure.

The research was conducted at the Periodontic Polyclinic of Dr. Ramelan Naval Central Hospital, Surabaya, Indonesia. Data collection was performed from June to August 2026. The study period included participant recruitment, retrieval of blood glucose records, clinical periodontal examination, data recording, data processing, and statistical analysis. The observational design allowed the periodontal condition of patients with diabetes mellitus to be evaluated in relation to their documented blood glucose status without modifying their clinical treatment or glycemic management. The use of a clinical setting was also consistent with the established role of periodontal assessment in patients with diabetes mellitus [23].

B. STUDY POPULATION AND PARTICIPANTS

The target population consisted of patients diagnosed with diabetes mellitus who attended the Periodontic Polyclinic of Dr. Ramelan Naval Central Hospital during the data-collection period. The clinic received approximately 30–40 patients per month. A total sampling technique was applied; therefore, all patients who fulfilled the predetermined eligibility criteria during the study period were considered for inclusion. This approach was used because the accessible study population was limited and could be completely recruited during the research period.

Participants were eligible if they had a confirmed diagnosis of diabetes mellitus, provided written informed consent, were able to undergo periodontal examination, had the required index teeth for periodontal assessment, and had documented fasting or random blood glucose measurements obtained through routine monitoring within the preceding three months. Patients were excluded if they were receiving ongoing advanced periodontal treatment, had systemic conditions considered capable of affecting periodontal health, including pregnancy or immunosuppressive therapy, or were unable or unwilling to cooperate with the examination. The eligibility criteria were applied before data analysis to ensure that the included participants corresponded to the predefined study population.

The final sample consisted of 30 respondents. No randomization, matching, or experimental allocation was performed because the study was observational and aimed to evaluate the association between naturally occurring blood glucose status and periodontal condition.

C. VARIABLES AND OPERATIONAL DEFINITIONS

The primary exposure variable was blood glucose level, obtained from patients' existing medical records. Fasting or random blood glucose measurements recorded during the three months preceding the periodontal examination were used. Based on the study protocol, blood glucose status was categorized into controlled and uncontrolled groups. Controlled blood glucose was defined as a value below 200

mg/dL, whereas uncontrolled blood glucose was defined as a value of 200 mg/dL or higher. The categorization was applied consistently to all eligible participants. Importantly, these measurements represented routine blood glucose monitoring and were not substituted with HbA1c measurements.

The primary outcome variable was periodontal condition, which was assessed clinically using the Community Periodontal Index of Treatment Needs (CPITN). CPITN is a standardized periodontal screening index that can be used to characterize periodontal conditions according to probing findings [24], although its partial-mouth approach has recognized limitations compared with comprehensive attachment-level assessment [25]. In this study, the CPITN assessment was used as specified in the research protocol to classify periodontal severity.

D. INSTRUMENTS AND DATA COLLECTION PROCEDURE

Three main sources or instruments were used: a structured data-recording form, patients' medical records, and a WHO periodontal probe. The recording form was used to document participant characteristics, blood glucose measurements, and periodontal findings. Blood glucose data were obtained retrospectively from existing clinical records, whereas periodontal status was assessed prospectively during the participant's clinical examination. Thus, the study combined secondary laboratory-record data with primary clinical examination data within a cross-sectional observational framework.

After institutional permission was obtained, eligible patients were informed about the research objectives and procedures. Written informed consent was obtained before clinical examination. Blood glucose information was subsequently extracted from the medical records for the preceding three months. The periodontal examination was then performed using a WHO periodontal probe according to the CPITN assessment procedure. The use of standardized periodontal probing procedures is consistent with recent clinical studies evaluating periodontal status in patients with diabetes [26], while CPITN has also been used in cross-sectional periodontal research involving diabetic populations [27].

All collected information was entered into the structured recording form, coded, and checked for completeness before statistical analysis. Personal identifiers were not included in the analytical dataset to maintain participant confidentiality.

E. DATA ANALYSIS

The collected data were processed using statistical software (SPSS). Descriptive analysis was first performed to summarize participant characteristics, blood glucose categories, and periodontitis severity using frequencies and percentages. Categorical variables were subsequently cross-tabulated to examine the distribution of periodontal severity according to blood glucose status.

The association between blood glucose category and periodontitis severity was tested using the Chi-square test. A significance level of $\alpha = 0.05$ was applied. A p-value below

0.05 was interpreted as evidence of a statistically significant association between the two categorical variables. No multivariable adjustment or subgroup analysis was performed because the study was based on a small sample of 30 participants and the analysis was limited to the prespecified association between blood glucose status and periodontal severity. Recent observational research similarly emphasizes transparent specification of variables, measurement procedures, sample selection, and statistical methods when reporting cross-sectional studies [22], while studies of diabetes and periodontal status have used categorical periodontal indices and Chi-square-based analyses to evaluate associations [27], [28].

F. ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Research Ethics Committee of Dr. Ramelan Naval Central Hospital, Surabaya, Indonesia, under Approval No. 43/EC/KEP/2026. Written informed consent was obtained from every participant before enrollment. Participant confidentiality and anonymity were maintained throughout data collection, processing, and reporting. The study was conducted in accordance with the ethical principles for medical research involving human participants established by the Declaration of Helsinki [29].

III. RESULTS

This study was conducted in June to August 2026 at the Periodontic Clinic of dr. Ramelan Naval Central Hospital. The clinic is a specialized unit within the Department of Dentistry and Oral Health that provides diagnosis, prevention, and treatment of diseases affecting the periodontal tissues, including the gingiva, periodontal ligament, root cementum, and alveolar bone. As a Type A naval referral hospital and a major healthcare center in Eastern Indonesia, dr. Ramelan Naval Central Hospital is equipped with comprehensive facilities and professional healthcare personnel to support the management of periodontal diseases.

TABLE 1
Distribution of Respondents by Age Group in Periodontic Polyclinic of dr. Ramelan Naval Central Hospital.

Age	Frequency	%
30-39	2	7%
40-49	9	30%
50-59	10	33%
60-69	5	17%
70-79	3	10%
80-89	1	3%
Total	30	100%

TABLE 2
Distribution of Respondents by Gender in Periodontic Polyclinic of dr. Ramelan Naval Central Hospital.

Gender	Frequency	%
Female	10	33%
Male	20	67%
Total	30	100%

According to the information in [TABLE 1](#), presents the age distribution of the respondents. Most participants were aged 50–59 years (33%), followed by those aged 40–49 years

(30%) and 60–69 years (17%). The fewest respondents were in the 80–89 years age group (3%).

According to the information presented in [TABLE 2](#), shows the distribution of respondents by gender. Male participants represented the majority of the study population, with 20 individuals (67%), whereas female participants accounted for 10 individuals (33%).

TABLE 3

Distribution of Respondents by Blood Glucose Level in Periodontic Polyclinic of dr. Ramelan Naval Central Hospital.

Criteria	Frequency	%
Controlled (<200mg/dl)	13	43%
Uncontrolled (≥200mg/dl)	17	57%
Total	30	100%

According to the information presented in [TABLE 3](#), indicates that most respondents had uncontrolled blood glucose levels (57%), whereas 43% had controlled blood glucose levels, suggesting a predominance of poor glycemic control among the study participants.

TABLE 4

Distribution of Respondents by Periodontitis Severity in Periodontic Polyclinic of dr. Ramelan Naval Central Hospital.

Criteria	Frequency	%
Mild	7	23%
Moderate	14	47%
Severe	9	30%
Total	30	100%

According to the information presented in [TABLE 4](#), illustrates the distribution of respondents based on periodontitis severity. Moderate periodontitis was the most frequently observed condition, affecting 14 respondents (47%), followed by severe periodontitis in 9 respondents (30%) and mild periodontitis in 7 respondents (23%). Overall, moderate periodontitis represented the largest proportion of cases in the study population.

TABLE 5

Analysis Results of the Association Between Blood Glucose Levels and Periodontitis Severity Among Patients with Diabetes Mellitus in Periodontic Polyclinic of dr. Ramelan Naval Central Hospital.

Glucose Level \ CPITN	Mild	Moderate	Severe	Total	p-value
Controlled	7 (23%)	6 (20%)	0 (0%)	13 (43%)	0,000
Uncontrolled	0 (0%)	8 (27%)	9 (30%)	17 (57%)	
Total	7 (23%)	14 (47%)	9 (30%)	30 (100%)	

As shown in [TABLE 5](#), the Chi-square analysis yielded a p-value of 0.000, which was below the significance threshold of 0.05. These findings indicate a statistically significant association between blood glucose levels and periodontitis severity among patients with diabetes mellitus. Respondents with uncontrolled blood glucose levels tended to exhibit more severe periodontal conditions compared with those whose blood glucose levels were controlled.

IV. DISCUSSION

A. INTERPRETATION OF STUDY RESULTS

The primary objective of this analytical observational study was to evaluate the association between blood glucose levels and the severity of periodontitis among patients diagnosed with diabetes mellitus at the Periodontic Polyclinic of dr. Ramelan Naval Central Hospital, Surabaya. The univariate analysis revealed that out of 30 total respondents, 17 individuals (57%) presented with uncontrolled blood glucose levels (≥ 200 mg/dL), whereas 13 individuals (43%) maintained controlled blood glucose levels (< 200 mg/dL). Evaluation of periodontal health status using the Community Periodontal Index of Treatment Needs (CPITN) demonstrated that moderate periodontitis was the most predominant severity category, affecting 14 respondents (47%), followed by severe periodontitis in 9 respondents (30%), and mild periodontitis in 7 respondents (23%).

A cross-tabulation of the clinical data revealed distinct structural patterns of periodontal destruction based on glycemic management. Notably, all 7 respondents (23%) categorized with mild periodontitis belonged to the controlled blood glucose group, while 6 respondents (20%) in the controlled group exhibited moderate periodontitis, and 0 respondents (0%) presented with severe periodontitis. Conversely, within the uncontrolled blood glucose cohort ($n = 17$), 0 respondents (0%) exhibited mild periodontitis, 8 respondents (27%) presented with moderate periodontitis, and 9 respondents (30%) suffered from severe periodontitis. The Chi-Square statistical analysis yielded a p -value of 0.000, which is significantly lower than the standard significance threshold ($\alpha = 0.05$). This statistical result confirms a highly significant association between glycemic status and periodontitis severity in patients with diabetes mellitus.

The underlying biological mechanisms explaining this association are closely tied to the physiological alterations induced by chronic hyperglycemia within the periodontal microenvironment. Sustained high levels of circulating blood glucose elevate glucose concentration within the gingival crevicular fluid, altering the oral microbial flora and favoring the proliferation of anaerobic periodontal pathogens. Systemic hyperglycemia impairs host immune defense mechanisms primarily by compromising polymorphonuclear neutrophil (PMN) function, reducing their chemotactic response, adherence, and phagocytic capacity. This impaired cellular defense diminishes the host's ability to clear subgingival bacterial plaque, leading to exacerbated tissue destruction. Furthermore, prolonged hyperglycemia promotes the non-enzymatic glycation of proteins and lipids, resulting in the progressive accumulation of Advanced Glycation End Products (AGEs) within the periodontal tissues. The interaction of AGEs with their specific cell surface receptors (RAGE) on endothelial cells, monocytes, and macrophages triggers sustained intracellular oxidative stress and hyper-inflammatory signaling pathways. This cascade induces the persistent expression of pro-inflammatory cytokines, impairs localized collagen synthesis, accelerates extracellular matrix breakdown, and stimulates osteoclast activity, ultimately

leading to advanced alveolar bone resorption and periodontal attachment loss.

B. COMPARISON WITH PRIOR RESEARCH

The empirical findings of this study strongly align with established paradigms in periodontal medicine and metabolic research, demonstrating notable similarities while highlighting important context-specific variations. The highly significant correlation ($p = 0.000$) between poor glycemic control and aggravated periodontal breakdown reinforces the comprehensive review published by Isola et al. [30], which identified systemic metabolic dysregulation as a critical biological modifier that accelerates the progression of periodontal destruction. Furthermore, the high concentration of moderate (47%) and severe (30%) periodontitis observed among uncontrolled diabetic participants in our study mirrors the consensus findings of Herrera et al. [31], who demonstrated that systemic hyperglycemia drives localized tissue destruction through the enhanced expression of pro-inflammatory mediators such as TNF- α , IL- β , and IL-6. The progressive alveolar bone destruction and attachment loss observed in this hospital-based sample are also consistent with the results of Utami [32], who reported that diabetes mellitus acts as a major independent contributor to severe periodontal breakdown and reduced oral-health-related quality of life among older adults.

However, subtle operational contrasts become evident when comparing these results with broader epidemiological literature. Investigations by Zhang et al. [34] and Alvaro et al. [35] emphasized daily oral self-care behaviors, plaque accumulation, and tooth brushing frequency as dominant mediating variables capable of mitigating the destructive impact of systemic hyperglycemia on periodontal structures. While individual oral hygiene maintenance remains an essential local etiological factor, the strong statistical significance observed in our cohort indicates that systemic glycemic control exerts an overarching biological influence on host tissue susceptibility. This intricate mutual interaction is further supported by Shi et al. [36], who described the bidirectional nature of periodontitis and diabetes: elevated blood glucose levels compromise periodontal immune responses and tissue healing, whereas severe chronic periodontal inflammation contributes to elevated systemic inflammatory burden, thereby worsening glycemic control and increasing insulin resistance. The strong alignment of our data with these international studies underscores the universal pathological role of glycemic dysregulation in accelerating periodontal breakdown across diverse clinical settings.

C. STUDY LIMITATIONS AND CLINICAL IMPLICATIONS

Despite the clear clinical findings, several methodological limitations must be acknowledged when interpreting the results of this investigation. First, the observational cross-sectional design collects exposure and outcome data simultaneously at a single time point, which inherently prevents the establishment of definitive causal relationships or temporal sequence between blood glucose fluctuations and periodontitis progression. Second, blood glucose status was

evaluated using fasting or random blood glucose levels recorded from patient medical records over the preceding three months, rather than glycated hemoglobin (*HbA1c*) laboratory testing, which serves as a more stable marker for long-term glycemic control. Third, the study utilized a total sampling approach within a single tertiary referral center, resulting in a limited sample size of 30 respondents, which may restrict the direct generalizability of the findings to broader community settings or non-hospitalized diabetic populations. Finally, potential confounding lifestyle parameters, such as smoking status, mechanical plaque removal efficacy, and exact duration of diabetes mellitus, were not controlled within the statistical model.

Notwithstanding these limitations, the practical implications of this study are highly relevant for clinical dentistry and interprofessional metabolic care. The clear link between uncontrolled blood glucose levels and severe periodontal tissue destruction highlights the urgent need to integrate regular oral health screenings into standard diabetes management guidelines. Interprofessional collaboration between endocrinologists, general practitioners, and dental specialists is vital to achieving optimal patient outcomes. Providing patient education regarding the importance of maintaining strict glycemic control alongside comprehensive oral hygiene routines can prevent severe periodontal complications, preserve natural dentition, and interrupt the detrimental bidirectional cycle linking metabolic disease and oral inflammation.

V. CONCLUSION

This analytical observational study with a cross-sectional design aimed to evaluate the association between blood glucose levels and periodontitis severity among patients with diabetes mellitus attending the Periodontic Polyclinic of dr. Ramelan Naval Central Hospital, Surabaya. The clinical evaluation confirmed a statistically significant relationship between blood glucose levels and the severity of periodontal tissue breakdown ($p = 0.000$, $p < 0.05$). Specifically, among the 30 total respondents evaluated, 17 patients (57%) presented with uncontrolled blood glucose levels (≥ 200 mg/dL), whereas 13 patients (43%) maintained controlled blood glucose levels (< 200 mg/dL). Assessment of periodontal health using the Community Periodontal Index of Treatment Needs (CPITN) demonstrated that respondents with uncontrolled glycemic status exhibited a significantly higher burden of periodontal disease, comprising 8 patients (27%) with moderate periodontitis and 9 patients (30%) with severe periodontitis. Conversely, all 7 patients (23%) diagnosed with mild periodontitis belonged to the controlled blood glucose group, accompanied by 6 patients (20%) with moderate periodontitis, while 0 patients (0%) in the controlled group presented with severe periodontitis. These empirical findings demonstrate that suboptimal glycemic regulation is strongly associated with aggravated periodontal tissue destruction, attributable to hyper-inflammatory responses and tissue damage driven by sustained hyperglycemia. Based on these insights, future works should employ prospective cohort or longitudinal study designs to track long-term disease

progression and establish clear temporal causal relationships between glycemic dynamics and periodontal tissue destruction. Furthermore, upcoming research should expand the sample size across multicenter healthcare settings, utilize glycated hemoglobin (*HbA1c*) testing to provide a more precise three-month glycemic profile, and integrate comprehensive clinical evaluations of confounding variables, including daily oral hygiene status, smoking habits, duration of diabetes, and systemic inflammatory biomarkers.

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DATA AVAILABILITY

Supporting data for the findings reported in this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional considerations.

AUTHOR CONTRIBUTION

Nopi Nekawati conceived and designed the study, coordinated the research process, and was responsible for data collection, analysis, and interpretation. Sri Hidayati contributed to the study design, provided methodological guidance, and participated in the interpretation of the findings. Ratih Larasati assisted in data analysis, literature review, and manuscript preparation. Isnanto contributed to data interpretation, critically reviewed the manuscript, and provided important intellectual input. All authors participated in the revision of the manuscript, approved the final version for publication, and agreed to be accountable for the accuracy and integrity of all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

The present study complied with ethical requirements governing research involving human participants and was approved by the Research Ethics Committee of Dr. Ramelan Naval Central Hospital, Surabaya, Indonesia (Approval No. 43/EC/KEP/2026). Written informed consent was secured from each participant before inclusion in the study. Participant confidentiality and anonymity were rigorously maintained, and all study procedures were performed in accordance with applicable ethical regulations and the Declaration of Helsinki.

CONSENT FOR PUBLICATION PARTICIPANTS

All participants voluntarily provided written informed consent for inclusion in the study and for the publication of anonymized data derived from the research.

COMPETING INTERESTS

The authors report no conflicts of interest or personal relationships that may have affected the conduct or reporting of this research.

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