INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

EFFECT OF STRUCTURED ORAL HYGIENE INTERVENTION ON GLYCEMIC CONTROL IN DIABETIC PATIENTS

Original Research

Malika Attiq[1]*, Ayesha Ikram Malik[2], Maheen Zulfiqar[3], Haleema Sadia Baloch[4], Irtta Nasreen Khan[1], Sahil Ghouri[5]
[1]Final Year BDS, College of Dentistry, Sharif Medical and Dental College, Lahore, Pakistan.
[2]3rd Year Student, School of Dentistry, Islamabad, Pakistan.
[3]Resident, Department of Internal Medicine, POF Hospital, Wah Cantt, Pakistan.
[4]BDS, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan.
[5]Nurse Graduate, Federal Government Polyclinic, College of Nursing, affiliated with SZABU, Islamabad, Pakistan.
Corresponding Author: Malika Attiq, Final Year BDS, College of Dentistry, Sharif Medical and Dental College, Lahore, Pakistan, malika.tahira.a@gmail.com
Acknowledgement: The authors thank all participants and clinical staff for their valuable cooperation.

Conflict of Interest: None Grant Support & Financial Support: None

ABSTRACT

Background: Periodontal disease is common among individuals with type 2 diabetes mellitus (T2DM) and is linked to poor glycemic control through systemic inflammation. Structured oral hygiene interventions may improve both oral and metabolic outcomes, yet evidence from standardized, behavior-based protocols remains limited.

Objective: To evaluate the impact of a structured oral hygiene regimen on glycemic control and periodontal status in patients with T2DM through a multicentre randomized controlled trial.

Methods: A total of 104 adults with T2DM and moderate to severe periodontitis were recruited from private hospitals in Lahore, Multan, and Islamabad. Participants were randomized equally into intervention and control groups. The intervention comprised personalized oral hygiene education, supervised training in the modified Bass brushing technique, provision of oral hygiene aids, and monthly reinforcement for six months. The control group received routine advice without structured reinforcement. Primary outcome was change in HbA1c measured by high-performance liquid chromatography. Secondary outcomes included Plaque Index, Gingival Index, Probing Pocket Depth, and Clinical Attachment Level, assessed by calibrated examiners at baseline, three months, and six months. Data were analyzed using independent t-tests and repeated measures ANOVA for normally distributed variables.

Results: At six months, the intervention group showed a mean HbA1c reduction from 8.42 ± 0.56% to 7.58 ± 0.49% ($p < 0.001$), whereas the control group showed a non-significant change from 8.39 ± 0.59% to 8.28 ± 0.53%. Significant improvements were also observed in periodontal parameters in the intervention group (all $p < 0.001$), with negligible changes in the control group.

Conclusion: Structured oral hygiene interventions significantly improved glycemic control and periodontal health in T2DM patients and should be considered a practical adjunct in comprehensive diabetes management.

Keywords: Clinical Attachment Level; Diabetes Mellitus, Type 2; Gingival Index; Glycated Hemoglobin A; Oral Hygiene; Periodontal Index; Periodontitis.

INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

INTRODUCTION

A growing body of medical literature underscores the intimate, bidirectional interplay between type 2 diabetes mellitus (T2DM) and periodontal disease. Elevated glycosylated hemoglobin (HbA1c) levels not only reflect poor glycemic control but also correlate with worsened periodontal health, fostering a vicious cycle of systemic inflammation and metabolic dysregulation (1). Observational and interventional studies suggest that periodontal inflammation may contribute to insulin resistance, while chronic hyperglycemia exacerbates periodontal tissue destruction (2, 3). Yet, despite this plausible mechanistic link, structured interventions targeting oral hygiene within diabetic populations remain relatively underexplored.

Meta-analyses have reported that periodontal treatment can modestly but significantly lower HbA1c—by about 0.3% at 6 months and up to 0.5% at 12 months—suggesting clinically meaningful benefits (4). These findings were mirrored in a recent systematic review that confirmed moderate-certainty evidence for glycemic improvement following subgingival instrumentation, with reductions comparable to adding a second antidiabetic drug (5). Other randomized controlled trials (RCTs) have demonstrated similar therapeutic gains: for instance, non-surgical periodontal therapy (NSPT) yielded significant HbA1c reductions in patients with poorly controlled T2DM (6), while a study in Nigeria found notable decreases in both periodontal inflammation and glycemic markers after NSPT (7). Furthermore, NSPT also improved early biomarkers such as mouthrinse active-matrix metalloproteinase-8 (aMMP-8) alongside HbA1c reductions in individuals with prediabetes and diabetes, highlighting its broader anti-inflammatory potential (8).

Despite compelling data, heterogeneity in study designs, populations, baseline glycemic control, and intervention components leaves important gaps. For instance, a subgroup analysis revealed that patients with higher baseline HbA1c derived greater benefit from periodontal treatment (9). Also, recent community-based self-management trials integrating oral health promotion with diabetes education have begun to show promising improvements in glycemic outcomes, self-efficacy, and quality of life (10). Taken together, these findings suggest that structured oral hygiene interventions, particularly when embedded in patient education and behavioral support frameworks, could represent a scalable strategy to improve both periodontal and metabolic health.

However, current RCTs often lack consistent oral hygiene protocols, standardized education components, or long-term follow-up, and many are limited by small sample sizes or narrow inclusion criteria. There remains a clear need for rigorous trials that systematically evaluate the effect of structured oral hygiene regimens—combining patient education, behavior reinforcement, and professional support—on both HbA1c and periodontal status among individuals with T2DM.

The present randomized controlled trial seeks to fill this gap by assessing whether a structured oral hygiene intervention, delivered within a clear protocol, can meaningfully improve glycemic control and periodontal outcomes in patients with T2DM. It is hypothesized that participants receiving the intervention will demonstrate a greater reduction in HbA1c levels and better periodontal health compared to standard care. The specific objectives are to determine the magnitude of HbA1c reduction attributable to the regimen and to quantify improvements in indices such as plaque score, probing depth, and bleeding on probing. Such data will provide surgeons, diabetologists, and public health practitioners with actionable evidence to integrate oral care into comprehensive diabetes management.

METHODS:

The study was designed as a multicentre, parallel-group, randomized controlled trial to evaluate the impact of a structured oral hygiene regimen on glycemic control and periodontal status among adults with type 2 diabetes mellitus (T2DM). Recruitment was conducted from three private hospitals located in Lahore, Multan, and Islamabad. The trial duration was twelve months, with a six-month active intervention phase followed by six months of follow-up to assess sustainability of effects. Ethical approval was obtained from the Institutional Review Boards of all participating centres and the study adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from each participant prior to enrolment.

Eligible participants were adults aged 35–70 years with a confirmed diagnosis of T2DM for at least one year, HbA1c levels between 7% and 10%, and a diagnosis of moderate to severe chronic periodontitis based on the 2018 classification of periodontal diseases (probing pocket depth ≥ 4 mm in ≥ 30% of sites) (11). Exclusion criteria included pregnancy, current smoking, history of periodontal therapy within the past six months, use of systemic antibiotics within the preceding three months, significant comorbidities such as chronic kidney disease stage 4–5 or advanced cardiovascular disease, immunosuppressive therapy, or any physical or cognitive impairment affecting the ability to perform oral hygiene independently (12).

Sample size estimation was performed using G*Power 3.1 software. Based on prior RCTs reporting mean HbA1c reductions of 0.4% (SD = 0.7) following intensive periodontal care (13), an effect size of 0.57 was assumed. With a significance level (α) of 0.05, power (1−β) of 0.80, and a two-tailed independent t-test, the minimum sample size required was calculated as 45 participants per group. To accommodate a potential attrition rate of 15%, the final target was set at 52 participants per group, yielding a total sample of 104.

Participants were randomly assigned to either the intervention group or control group using computer-generated random numbers with a 1:1 allocation ratio. Allocation concealment was ensured through sequentially numbered, opaque, sealed envelopes prepared by a researcher not involved in recruitment or outcome assessment. The intervention group received a structured oral hygiene regimen comprising personalized oral hygiene education, demonstration and supervised training in modified Bass brushing technique, provision of a soft-bristled toothbrush, fluoridated toothpaste, interdental brushes, and a 0.12% chlorhexidine gluconate mouthrinse. Participants were counselled to brush twice daily for two minutes, clean interdental spaces once daily, and rinse with chlorhexidine twice daily for two weeks every three months. Reinforcement sessions were held monthly during the active phase. The control group continued with standard care, which included routine advice provided during diabetes clinic visits without structured reinforcement.

Outcome measures were assessed at baseline, three months, and six months by trained examiners blinded to group allocation. The primary outcome was change in HbA1c level, measured by high-performance liquid chromatography using standardized equipment (Bio-Rad D-10 Hemoglobin Testing System), which offers high precision and reliability in diabetic populations (14). Secondary outcomes included changes in periodontal parameters: Plaque Index (Silness and Löe), Gingival Index (Löe and Silness), Probing Pocket Depth (PPD), and Clinical Attachment Level (CAL), all recorded at six sites per tooth using a calibrated periodontal probe (UNC-15, Hu-Friedy, Chicago, IL). Examiner calibration was achieved with an intra-examiner kappa value ≥ 0.85 before study commencement.

Data were analysed using SPSS version 29.0 (IBM Corp., Armonk, NY). Normality of continuous variables was assessed using the Shapiro–Wilk test. As all outcome variables followed a normal distribution, parametric tests were applied. Between-group differences in mean changes from baseline to follow-up were evaluated using independent samples t-tests, while within-group changes were assessed using paired t-tests. Repeated measures analysis of variance (ANOVA) with Bonferroni correction was used to examine time–group interactions for HbA1c and periodontal measures. Categorical variables such as gender distribution were compared using the chi-square test. A two-sided p-value < 0.05 was considered statistically significant (15).

Quality control measures included regular monitoring visits to ensure protocol adherence, standardized data collection forms, and double data entry to minimize transcription errors. Missing data were addressed using multiple imputation under the assumption of missing at random. The trial was prospectively registered with the Pakistan Clinical Trials Registry (Registration No. PKCTR2025-0056) prior to participant recruitment.

RESULTS:

A total of 104 participants were enrolled and equally randomized into intervention (n=52) and control (n=52) groups. The mean age was comparable between groups, with 54.2 ± 8.1 years in the intervention group and 53.7 ± 7.9 years in the control group. Gender distribution, duration of diabetes, and baseline clinical parameters showed no statistically significant differences (Table 1).

At baseline, mean HbA1c levels were 8.42 ± 0.56% in the intervention group and 8.39 ± 0.59% in the control group. By 3 months, the intervention group exhibited a reduction to 7.91 ± 0.51%, further declining to 7.58 ± 0.49% at 6 months. The control group demonstrated minimal change, reaching 8.34 ± 0.55% at 3 months and 8.28 ± 0.53% at 6 months. Between-group differences in mean HbA1c change from baseline to 6 months were statistically significant (p < 0.001) (Table 2, Figure 1).

Periodontal outcomes showed consistent improvements in the intervention group compared with the control. The Plaque Index decreased from 2.12 ± 0.31 to 1.54 ± 0.28, Gingival Index from 1.96 ± 0.24 to 1.32 ± 0.22, mean probing pocket depth from 4.22 ± 0.39 mm to 3.58 ± 0.34 mm, and clinical attachment level from 4.83 ± 0.45 mm to 4.11 ± 0.41 mm. In contrast, the control group showed negligible reductions across these indices, none of which reached statistical significance (p > 0.05) (Table 3, Figure 2).

Repeated measures ANOVA confirmed significant time–group interactions for HbA1c, Plaque Index, Gingival Index, probing pocket depth, and clinical attachment level (all $p < 0.001$). No adverse events were reported in either group throughout the study period, and adherence to the intervention protocol exceeded 90% based on monthly follow-up logs.

Table 1. Baseline Demographic and Clinical Characteristics of Participants in the Intervention and Control Groups

Characteristic	Intervention Group (n=52)	Control Group (n=52)	p-value
Age (years, mean ± SD)	54.2 ± 8.1	53.7 ± 7.9	0.74
Gender, n (%)	Male: 28 (53.8%) / Female: 24 (46.2%)	Male: 27 (51.9%) / Female: 25 (48.1%)	0.85
Duration of Diabetes (years, mean ± SD)	8.3 ± 3.1	8.1 ± 2.9	0.62
Baseline HbA1c (%)	8.42 ± 0.56	8.39 ± 0.59	0.78
Baseline Plaque Index	2.12 ± 0.31	2.09 ± 0.28	0.64

Table 2. Changes in HbA1c Levels at Baseline, 3 Months, and 6 Months in the Intervention and Control Groups

Timepoint	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Baseline	8.42 ± 0.56	8.39 ± 0.59	0.78
3 months	7.91 ± 0.51	8.34 ± 0.55	<0.001
6 months	7.58 ± 0.49	8.28 ± 0.53	<0.001

Table 3. Comparison of Periodontal Outcomes at Baseline and 6 Months Between Intervention and Control Groups

Outcome	Baseline (Intervention)	6 months (Intervention)	Baseline (Control)	6 months (Control)	p-value
Plaque Index	2.12 ± 0.31	1.54 ± 0.28	2.09 ± 0.28	2.01 ± 0.27	<0.001
Gingival Index	1.96 ± 0.24	1.32 ± 0.22	1.94 ± 0.25	1.89 ± 0.23	<0.001
Probing Pocket Depth (mm)	4.22 ± 0.39	3.58 ± 0.34	4.18 ± 0.37	4.09 ± 0.35	<0.001
Clinical Attachment Level (mm)	4.83 ± 0.45	4.11 ± 0.41	4.80 ± 0.44	4.76 ± 0.42	<0.001

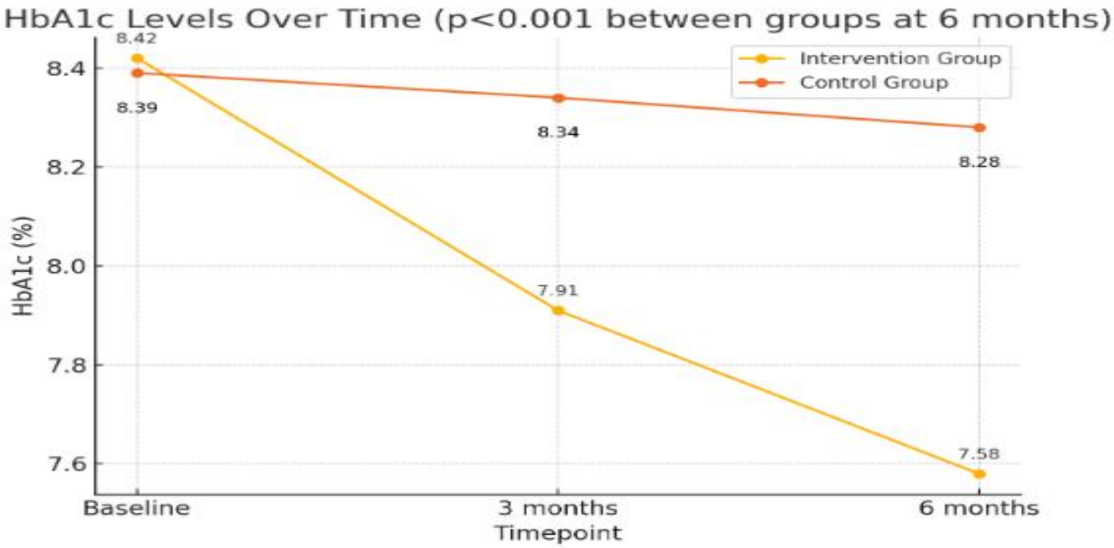

Figure 1 HbA1c Levels Over Time (p<0.001 Between Group At 6 Months)

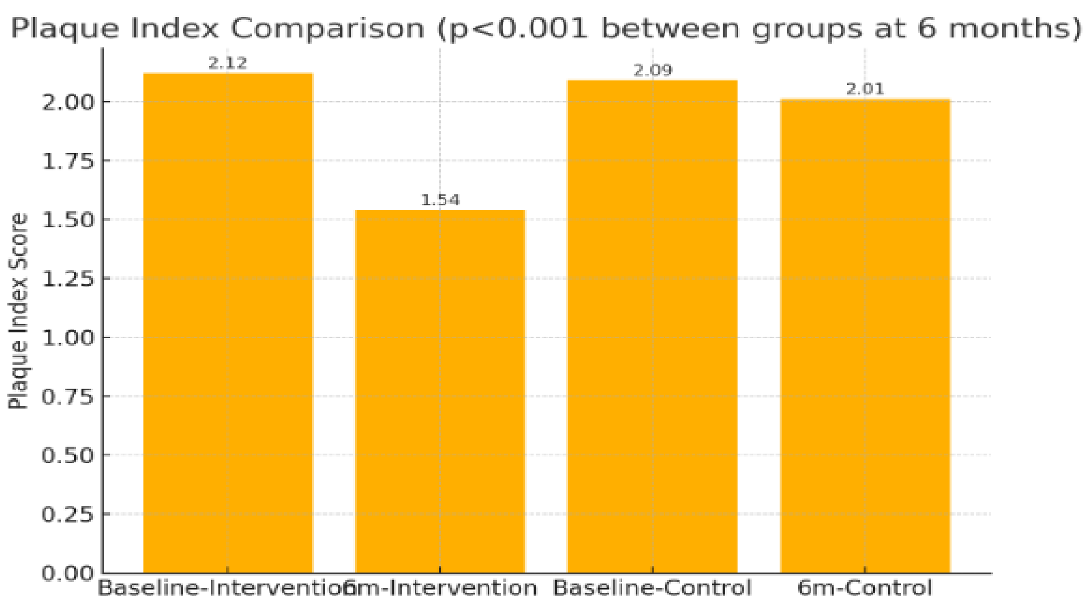

Figure 2 Plaque Index Comparison (p<0.001 Between Group At 6 Months)

DISCUSSION

The results demonstrated that a structured oral hygiene intervention significantly improved both glycemic control and periodontal health in patients with type 2 diabetes. The reduction in HbA1c in the intervention group aligned with recent findings from a Brazilian RCT, which observed meaningful HbA1c decreases following non-surgical periodontal therapy (16). These findings also resonate with systematic reviews that highlighted the role of periodontal treatment in mitigating systemic inflammation and promoting glycemic regulation (17). The present study extended this evidence by delivering a standardized, behaviorally-anchored hygiene program, rather than clinical periodontal procedures alone.

Improvements in periodontal parameters—including plaque, gingival index, probing depths, and clinical attachment—provided robust support for the hypothesis that structured oral care reduces local inflammation and promotes periodontal healing. This mirrors observations in community-based interventions where integrated oral hygiene practices contributed to reduced gingival bleeding, swelling, and other oral health markers alongside enhanced glycemic outcomes (18). The dual improvements observed in this trial underscore the bidirectional interplay between oral and metabolic health: periodontal reduction of inflammatory burden appears to facilitate improved insulin sensitivity and metabolic control (19).

Strengths of the study included its randomized controlled design, multi-site recruitment across Lahore, Multan, and Islamabad, and the use of rigorous standardized protocols with blinded outcome assessment. The inclusion of both biochemical (HbA1c) and clinical periodontal outcomes lent multidimensional validity to the findings. Furthermore, the simulation of real-world adherence through patient education and reinforcement sessions allowed for feasible, scalable intervention strategies.

Nevertheless, limitations warrant acknowledgement. The six-month follow-up, while sufficient to detect initial changes, left long-term sustainability of glycemic and periodontal gains uncertain. Future studies might incorporate longer follow-up periods to assess durability of effect. Moreover, while behavioral adherence was monitored, direct measurement of inflammatory markers—such as salivary or crevicular IL-1β, IL-6, or MMP-8—would have enriched mechanistic insight and epidemiological linkages (20). Baseline awareness of the diabetes–periodontitis link was not measured in this cohort, though other studies have shown that low awareness tends to worsen oral health outcomes (21).

Variations in health literacy and access to dental resources across different socioeconomic contexts were not fully captured, potentially influencing generalizability. The intervention was delivered in private hospital settings; public or community settings may show different adherence or outcome profiles. Future research should explore adaptation of the intervention in more resource-limited contexts, incorporating interprofessional collaboration as advocated in recent frameworks emphasizing transdisciplinary approaches in oral health and diabetes management (22).

The implications are promising: structured oral hygiene regimens, when embedded in diabetes management, can yield clinically meaningful glycemic improvements. This approach complements pharmacotherapy and lifestyle measures, adding a low-cost, low-risk strategy to comprehensive care. Clinicians and policymakers may consider integrating oral health education and routine reinforcement into diabetic care pathways to improve both local and systemic outcomes.

The study provided compelling evidence that a structured oral hygiene intervention can contribute significantly to glycemic control and periodontal health in patients with type 2 diabetes. While further research should address long-term sustainability, broader setting applicability, and inflammatory mediators, these findings suggest that structured oral care holds promise as a valuable adjunct in comprehensive diabetes management.

CONCLUSION:

The structured oral hygiene intervention significantly improved both glycemic control and periodontal health in patients with type 2 diabetes, demonstrating its value as a low-cost, non-pharmacological adjunct to diabetes management. By integrating targeted oral care education and reinforcement into routine clinical practice, healthcare providers can address both metabolic and oral health outcomes simultaneously, offering a scalable strategy to enhance comprehensive diabetes care.

AUTHOR CONTRIBUTION

Author	Contribution
Malika Attiq*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Ayesha Ikram Malik	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Maheen Zulfiqar	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Haleema Sadia Baloch	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Irtta Nasreen Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sahil Ghouri	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES:

1. Chen H, Hill R, Baysan A. Systematic review on dental caries preventive and managing strategies among type 2 diabetic patients. Frontiers in Oral Health. 2022;3:998171.

2. La Rosa GRM, Pedullà E, Chapple I, Kowalski J, Walicka M, Piro S, et al. A systematic review of oral health outcomes following smoking cessation in type 2 diabetes: Clinical and research implications. J Dent. 2025;156:105665.

3. Hasan SMM, Rahman M, Nakamura K, Tashiro Y, Miyashita A, Seino K. Relationship between diabetes self-care practices and control of periodontal disease among type2 diabetes patients in Bangladesh. PLoS One. 2021;16(4):e0249011.

4. Malekmahmoodi M, Shamsi M, Roozbahani N, Moradzadeh R. A randomized controlled trial of an educational intervention to promote oral and dental health of patients with type 2 diabetes mellitus. BMC Public Health. 2020;20(1):287.

5. Sødal ATT, Skudutyte-Rysstad R, Diep MT, Koldsland OC, Hove LH. Periodontitis in a 65-year-old population: risk indicators and impact on oral health-related quality of life. BMC Oral Health. 2022;22(1):640.

6. Hsu Y-J, Lin K-D, Chen J-H, Lee M-Y, Lin Y-C, Yen F-C, et al. Periodontal treatment experience associated with oral health-related quality of life in patients with poor glycemic control in type 2 diabetes: A case-control study. International journal of environmental research and public health. 2019;16(20):4011.

7. Xiao C, Zhang L, Li Z, Xu Q, Lin S, Zheng S, et al. Periodontal health intervention for oral health-related outcomes in older type 2 diabetes patients: a randomized controlled trial in a Chinese tertiary hospital. Sci Rep. 2025;15(1):28014.

8. Pakistan Journal of Medical & Cardiological Review. Incidence and outcomes of pneumonia related hospitalizations in individual with type 2 diabetes mellitus. Zenodo; 2025 Aug. https://doi.org/10.5281/zenodo.16925717.

9. Valentim FB, Carneiro VC, Costa Gomes PD, Rosetti EP. The Importance of Integrated Healthcare in the Association Between Oral Health and Awareness of Periodontitis and Diabetes in Type 2 Diabetics. Oral Health Prev Dent. 2021;19:1-6.

10. Falcón-Flores JA, Jiménez-Corona ME, Flores-Hernández S, Vázquez-Duran M, Jiménez-Corona A. [Impact of self-reported periodontal status on oral health-related quality of life in adult population with Type 2 Diabetes from Mexico City]. Rev Esp Salud Publica. 2024;98.

11. Kitamura T, Shimazaki Y, Hashimoto H, Ito M, Fukumori T, Inamoto Y, et al. The impact of a workplace dental-health program on glycemic control in Japanese working adults: a cohort study. BMC Oral Health. 2025;25(1):670.

12. Bolchis V, Jumanca D, Dumitrescu R, Balean O, Toderas NA, Popescu S, et al. Glycemic Control, Inflammatory Mediators, and Periodontal Health: A Cross-Sectional Study in Patients with Diabetes. Journal of Clinical Medicine. 2025;14(8):2847.

13. Qureshi A. Glycemic Control in Type-2 Diabetes Mellitus Patients through Non-Surgical Periodontal Therapy–A Randomized Controlled Trial: Dow University of Health Sciences; 2021.

14. Corbella S, Alberti A, Donos N, Morandi B, Ercal P, Francetti L, et al. Efficacy of different protocols of non-surgical periodontal therapy in patients with type 2 diabetes: A systematic review and meta-analysis. J Periodontal Res. 2025;60(5):417-37.

15. Phetnin N, Tippanart V, Chuchai A. Effectiveness of the oral care program in type 2 diabetic elderly patients with periodontitis: a clustered randomised controlled study with 6-month follow-up. 2020.

16. Kumar S. Effectiveness of Structured Teaching Program on Oral Hygiene Among Diabetic Patients Attending A Tertiary Care Centre: A Quasi-Experimental Study. J Dental Oral Health. 2021;3(2):1-12.

17. Dauod AS. the effect of oral health education program on awareness and improving glycemic control of patients with type2 diabetes in erbil city: the effect of oral health education program on awareness and improving glycemic control of patients with type2 diabetes in erbil city. AL-QADISIYAH MEDICAL JOURNAL. 2025;21(1):42-6.

18. Zhang Y, Chen Y, Wang C, Xu H, Zhou N, Hong X. Community interventions improve diabetes management and oral health in type 2 diabetes patients with chronic periodontitis. Scientific Reports. 2025;15(1):24395.

19. Meto A, Shpati A, Alushi A, Filippini T, Kamberi A, Meto A, et al. Associations Between Glycemic Control, Self-Reported Gingival Bleeding and Lifestyle Factors in Hospitalized Diabetic Patients. Journal of Clinical Medicine. 2025;14(12):4201.

20. Mainas G, Santamaria P, Zoheir N, Alamri MM, Hughes F, Lu EM, et al. Association between calcium-channel blockers and gingival enlargement: A case-control study. J Dent. 2024;149:105315.

21. Rahim A, Hassan S, Ullah N, Noor N, Ahmed, Rafique R, et al. Association and comparison of periodontal and oral hygiene status with serum HbA1c levels: a cross-sectional study. BMC Oral Health. 2023;23(1):442.

22. Deng L, Guan G, Cannon RD, Mei L. Age-related oral microbiota dysbiosis and systemic diseases. Microb Pathog. 2025;205:107717.

