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Review article

The effect of non-surgical periodontal therapy on glycemic control in Indian diabetics with periodontal disease – A systematic review and meta-analysis

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ABSTRACT

Background: *Periodontitis is a chronic inflammatory condition that contributes to systemic complications. It is associated with an increased risk of poor glycemic control and other diabetes-related complications.* ***Purpose:*** *This review aimed to evaluate the effect of nonsurgical periodontal therapy (NSPT) on the metabolic level of diabetes (HbA1c) in diabetic patients with generalized chronic periodontitis (GCP) in the Indian population.* ***Methods:*** *Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) criteria were followed for conducting the review. PubMed-MEDLINE, Cochrane Library, Scopus, and Google Scholar were searched from inception until January 30, 2025. The Cochrane risk of bias (ROB)-2 tool for randomized controlled trials (RCT) was used to assess quality. A p value of less than 0.05 was considered statistically significant, and the standardized mean difference (SMD) was employed as a summary statistic measure using a random effect model.* ***Results:*** *Eleven studies fulfilled the eligibility criteria and were included in the qualitative synthesis, of which only six studies were suitable for meta-analysis. The pooled estimate through the SMD signifies that periodontal therapy, or NSPT, had a significant reduction in the clinical parameters assessed ($p < 0.05$). Publication bias through the funnel plot showed symmetric distribution with the absence of systematic heterogeneity.* ***Conclusion:*** *This study highlights that NSPT as a standalone therapy significantly reduces metabolic markers, specifically HbA1c, in diabetic patients. Additionally, notable improvements in clinical parameters were observed following NSPT. Therefore, periodontal therapy should be considered for patients with elevated metabolic markers (HbA1c), as it may help to reduce both the inflammatory burden and HbA1c levels associated with diabetes.*

Keywords: *glycated hemoglobin; diabetes mellitus; generalized chronic periodontitis*
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INTRODUCTION

Periodontitis is a chronic and intricate immunoinflammatory disorder that impacts the supporting structures of the teeth. It is marked by the gradual deterioration of the periodontal connective tissue and alveolar bone.[1] This condition is frequently associated with systemic health disorders such as diabetes mellitus (DM), cardiovascular disease, inflammatory bowel disease, lung disease and preterm low birth weight.[2] Elevated blood glucose levels are a primary feature in DM. Research indicates that periodontal disease exacerbates poor glycemic control, increasing the risk of diabetic complications.

Numerous global studies have reported significant reductions in probing depth (PD) and blood glucose levels following periodontal treatment. Periodontal disease is considered the "sixth complication of diabetes" because of its increased incidence and severity in diabetic patients, particularly individuals with poor metabolic control.[3]

Approximately 72.96 million individuals in India are afflicted by diabetes. Among the Indian population, those with diabetes are more susceptible to developing destructive

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generalized chronic periodontitis (GCP), which impairs the ability to regulate blood sugar levels effectively, than those without diabetes.[4] A 2016 study conducted in India found that GCP was present in 45.9% of 98 diabetic individuals compared to 35.6% of 104 non-diabetic individuals.[5] Furthermore, the risk of alveolar bone loss is 4.2 times higher in people with type 2 diabetes (T2D) and chronic periodontitis.[6]

Evidence increasingly suggests that chronic periodontitis negatively impacts metabolic control, as reflected in elevated HbA1c levels. Poor glycemic control reduces the activity of polymorphonuclear leukocytes (PMNLs), impairing the microvascular endothelium and contributing to the progression of periodontitis.

Despite significant research investigating the influence of periodontal therapy on glycemic control within the Indian population, a thorough systematic review and meta-analysis focusing on the effects of nonsurgical periodontal therapy (NSPT) on glycemic control is absent. This investigation may yield significant information into the application of NSPT as a therapeutic approach for diabetic patients suffering from periodontitis.[7–10]

Typically, patients with periodontitis and high HbA1c levels are prescribed medications to manage blood sugar, followed by periodontal therapy. This systematic review and meta-analysis attempt to determine the effectiveness of NSPT on metabolic control in diabetic patients, given that India has one of the highest diabetes prevalence rates worldwide. Raising awareness among healthcare providers about NSPT's potential benefits may lead to its inclusion as part of diabetes management for patients with generalized chronic periodontitis.[11]

If a positive correlation between NSPT and improved glycemic control is established through this review, NSPT could become an integral component of diabetes management strategies. Currently, no quantitative analysis of NSPT's impact on HbA1c levels in Indian diabetic patients with GCP has been conducted. This systematic review aims to evaluate and compare the impact of NSPT on glycemic control in this group. To do this, we have revised our research to incorporate pertinent and contemporary findings.

METHODS

Protocol development

The preferred reporting items for systematic review and meta-analysis (PRISMA) statement[12] was used to complete this review and registered in PROSPERO-CRD42023326477. The research question was formulated using the established Patient, Intervention, Comparison, and Outcome (PICO) framework: "What is the effectiveness of NSPT on diabetic patients with GCP?

Selection criteria

Study designs

Randomized controlled trials (RCTs) discussing the relationship between periodontal disease and type 2 DM (T2DM) were included. Reviews of the literature, case reports, case series, and designs of observational studies were not included. P (Participants) – Indian adult patients above 18 years presenting with GCP and diabetes. I (Intervention) – NSPT (Phase I therapy – scaling and root planing (SRP)). C (Comparison) – Nondiabetic patients with GCP. O (Outcome) – To assess the effectiveness of phase I periodontal therapy on the metabolic level of diabetes (HBA1c) in diabetic patients with GCP on the percentage of HbA1c level, reduction in PD, plaque index (PI), gingival index (GI) and gain in clinical attachment level (CAL). S (Study designs) – RCTs.

Search strategy

An extensive electronic search was conducted from inception until January 30, 2025, in the following databases: PubMed-MEDLINE, Cochrane Library, Scopus, and Google Scholar to obtain the articles. The National Institutes of Health Trials and the Clinical Trial Registry India were examined as active trial registries. Authors of unpublished research were contacted.

Boolean operators such as AND were employed to combine keywords and Medical Subject Heading (MeSH) terms. The search strategy included the following keywords and their combinations to identify relevant studies (Table 1)

In addition to the automated search, a manual search was performed, and the reference lists of selected articles were carefully examined. We also reviewed relevant literature on the subject and checked the reference lists of the identified studies to find any additional relevant research.

Screening process

The search and screening procedure was conducted by two authors. The selection of articles was undertaken according to a two-phased approach. During the initial phase, both reviewers individually evaluated the titles and abstracts of all articles, eliminating those that failed to satisfy the inclusion criteria. During the second phase, the full-text

Table 1. Keywords and their combinations

Search Combination	Keywords and MeSH Terms
Combination 1	"Chronic periodontitis" (MeSH) AND "generalized periodontitis" (MeSH)
Combination 2	"Localized periodontitis" (MeSH) AND "generalized chronic periodontitis" (MeSH)
Combination 3	"Type 2 diabetes" (MeSH) AND "glycemic control" (MeSH) AND "hyperglycemia" (MeSH)
Combination 4	"Clinical attachment level" (MeSH) AND "periodontal probing depth" (MeSH) AND "hemoglobin level"
Combination 5	"Gingival and plaque index" AND "prospective study" (MeSH)
Combination 6	"Randomized trials" AND "periodontal therapy" (MeSH)

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papers chosen in the first phase were independently evaluated and assessed by the same two evaluators. Disagreements were addressed through conversation, and if consensus was unattainable, a third reviewer was engaged to mediate resolution. Conclusive decisions were reached through consensus among the three evaluators. The respective authors of the research papers were approached via email for any additional information required.

Data extraction statistical analysis

A fixed-effects model (Mantel-Haenszel technique) was used to calculate the standardized mean difference (SMD) for continuous outcomes with 95% confidence intervals.[13] Heterogeneity was assessed using the Chi-square test and the I^2 statistic.

Quality assessment of included studies

The Cochrane Collaboration Risk of Bias-2 (ROB-2) tool was used to evaluate the methodological quality of the included studies,[14] with its signaling questions applied through the Review Manager (RevMan) 5.3 software. Each study's overall risk was categorized as low, moderate, or high based on the evaluation of specific domains and criteria. A study was rated as having a low overall risk only if all domains were assessed as low risk. If one or more domains were deemed high risk, the study was assigned a high overall risk. Studies were classified as moderate risk when one or more domains had an unknown risk, with none of the domains being rated as high risk.

Assessment of heterogeneity

The significance of any inconsistencies was determined using Cochrane's test for heterogeneity and I2 statistics. P 0.1 was regarded as the threshold for heterogeneity. In the Cochrane guide, I2 is explained as follows: The heterogeneity may not be significant for the range of 0 to 40%, moderate for the range of 30% to 60%, substantial for the range of 50% to 90%, and significant for the range of 75% to 100%.[15]

Publication bias

Publication bias was evaluated using Begg's funnel plot. The asymmetry of the funnel plot may suggest publication bias or other sample size biases. However, it may also reflect a genuine relationship between trial size and effect size.[16]

RESULTS

Study selection

A total of 456 articles were collected from multiple databases. After identifying duplicates, 193 articles remained for screening. The eligibility of the full-text articles was then determined, and those that did not fulfill the inclusion requirements were excluded. Ultimately, 11 articles met the inclusion criteria and were added to the qualitative synthesis. The meta-analysis includes six publications. A flowchart illustrating the identification, inclusion, and exclusion process of studies is presented in Figure 1.

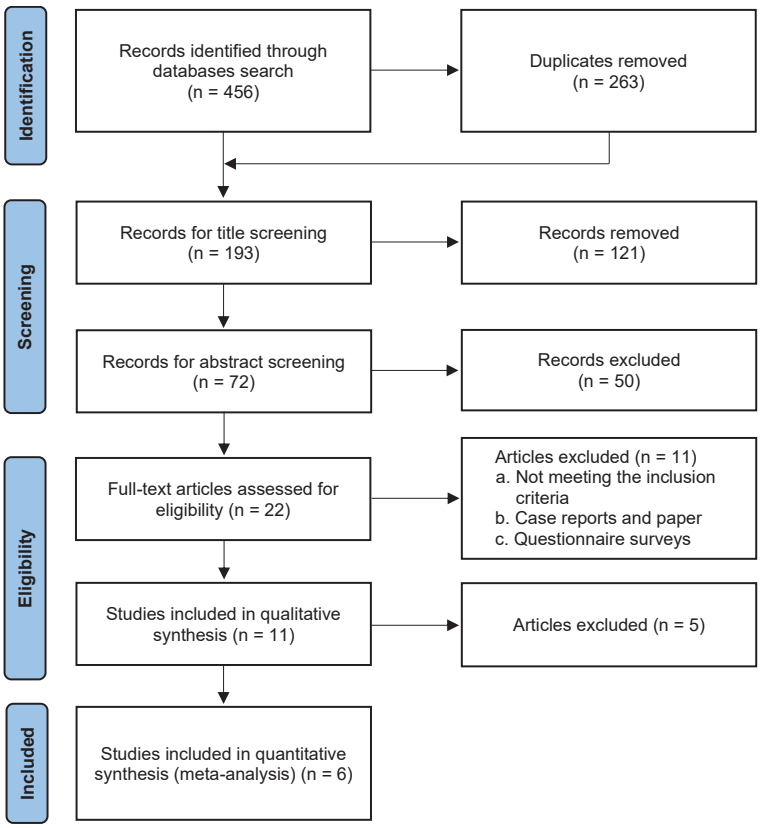

Figure 1. PRISMA flow diagram

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Table 2: Descriptive study characteristics of included studies

Authors	Year	Age group	Follow-up Duration	Clinical outcomes assessed	Systemic outcomes assessed	Conclusion
Singh et al.[8]	2008	>30 years	1 month, 3 months	PI, GI, PPD, CAL	Fasting glucose, post prandial glucose, glycated Hb	A potential association between NSPT and improved glycemic control in patients with T2D.
Telgi et al.[9]	2013	35–45 years	1 month	PPD, GI, PI	Fasting glucose, glycated Hb	Demonstrates that NSPT can significantly reduce HbA1c levels in T2DM patients already receiving medication.
Kanduluru et al.[10]	2014	35–55 years	1 month, 3 months	CAL, GR, BOP, PI, GI, PD	Fasting glucose, post prandial glucose, glycated Hb	Demonstrates that NSPT effectively reduced both glycemic levels and clinical parameters of periodontal infection, further supporting the established link between T2DM and periodontal disease.
Kumar et al.[17]	2015	> 30 years	3 months	PI, GI, PPD, CAL	TNF-α, HbA1c	An interdisciplinary approach to diabetes care, incorporating periodontal treatment, is crucial for optimal patient outcomes.
Kaur et al.[18]	2015	45–60 years	3 months, 6 months	PI, PPD, CAL	HbA1c	Periodontal therapy resulted in enhanced glycemic control and improved periodontal health parameters in patients with diabetes.
Mammen et al.[19]	2016	30–50 years	3 months	PPD, CAL	Fasting serum C-peptide, Homeostasis Assessment (HOMA) Index–insulin resistance and HOMA–insulin sensitivity	Periodontal therapy effectively reduced insulin resistance, improved periodontal health, and increased insulin sensitivity in patients with T2D and chronic periodontitis.
Gurrala et al.[20]	2013	42–81 years	1 month	CPI, PI	Glycated hemoglobin A1c (HbA1c)	A significant reduction in HbA1c levels was observed following treatment, suggesting improved glycemic control in patients with T2D and periodontal disease.
Agarwal et al.[21]	2016	40–70 years	6 months	GI, PI, SBI, PPD, CAL	Glycated hemoglobin A1c (HbA1c)	Scaling and root planing demonstrated a statistically significant reduction in both clinical periodontal parameters and HbA1c levels.
Aryal et al.[22]	2017	Not mentioned	1 month, 3 months	PI, GI. PD, CAL	Fasting glucose, glycated Hb, C-reactive protein (CRP)	Improved glycemic control and reduced CRP levels were observed in association with NSPT.
Sundar et al.[23]	2018	25–55 years	6 months	Oral hygiene status	Glycated hemoglobin A1c (HbA1c)	A significant reduction in HbA1c levels was observed among patients with T2DM and mild-to-moderate periodontitis following six months of NSPT.
Tummakomma et al.[24]	2020	> 18 years	1 week, 1 month	PI, GI, PPD, CAL	Random blood sugar	A significant correlation was observed between oral malodor levels, random blood sugar levels, and clinical periodontal parameters in the diabetic patient group.

PI – plaque index; GI – gingival index; PD – probing depth; RD – recession depth; RW – recession width; CAL – clinical attachment level; GR – gingival recession; BOP – bleeding on probing; Hb – hemoglobin; PPD: Probing pocket depth; CRP: C-reactive protein; HbA1c: Hemoglobin A1c; NSPT: Non-Surgical Periodontal therapy; SBI: Sulcus Bleeding Index; CPI: Community Periodontal Index; T2D: Type 2 Diabetes; T2DM: Type 2 Diabetes Mellitus; TNF-α: Tumor Necrosis Factor Alpha

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Study characteristics

Table 2 provides a summary of the descriptive characteristics of all included studies. Data from a total of 11 studies were evaluated.[17-24] The mean age of participants was 47.34 years, and the average follow-up duration across all studies was four months. Clinical outcomes assessed included PD, GI, PI, gingival recession (GR), and CAL, while the systemic outcome measured was HbA1c.

The findings of the studies confirmed the relationship between T2DM and periodontal disease, and that periodontal treatment could be combined with the usual practices for treatment and prevention in diabetic patients. The studies found that NSPT decreased glycemic levels and decreased clinical parameters of periodontal infection.

Assessment of methodological quality of included studies

The methodological quality of all included research was largely comparable. However, each study demonstrated a moderate to high risk of bias. Random sequence creation was found to have the largest probability of bias (selection bias), followed by blinding of result assessment (detection bias), and selective reporting (reporting bias). Risk of bias for the included studies, through the Cochrane ROB-2 tool, is depicted as shown in Figure 2 and 3.

Synthesis of meta-analysis

Meta-analysis was conducted on five parameters as shown in Figures 4–8. In meta-analyses, the SMD is employed as a summary statistic when various studies evaluate the same outcome but do so using various methods of measurement. Thus, before the results of the studies can be integrated to create a final pooled estimate, they must first be standardized to a similar scale. SMD of HbA1c -0.56 (-1.08 to 0.04) and the pooled estimates favor the experimental group. This signifies that reduction in HbA1c level, on average, is 0.56 times more compared to the control group and this difference it is statistically significant ($p < 0.04$; Figure 4).

The SMD for the PI is -4.43 (-6.67 to 2.20), with pooled estimates favoring the experimental group. This indicates that the reduction in PI is, on average, 4.43 times greater in the experimental group compared to the control group, and this difference is statistically significant ($p < 0.05$; Figure 5). The SMD for the GI is -3.77 (-4.86 to 2.68), with pooled estimates also favoring the experimental group. This suggests that the reduction in GI is, on average, 3.77 times greater in the experimental group than in the control group, and this difference is statistically significant. ($p < 0.05$; Figure 6)

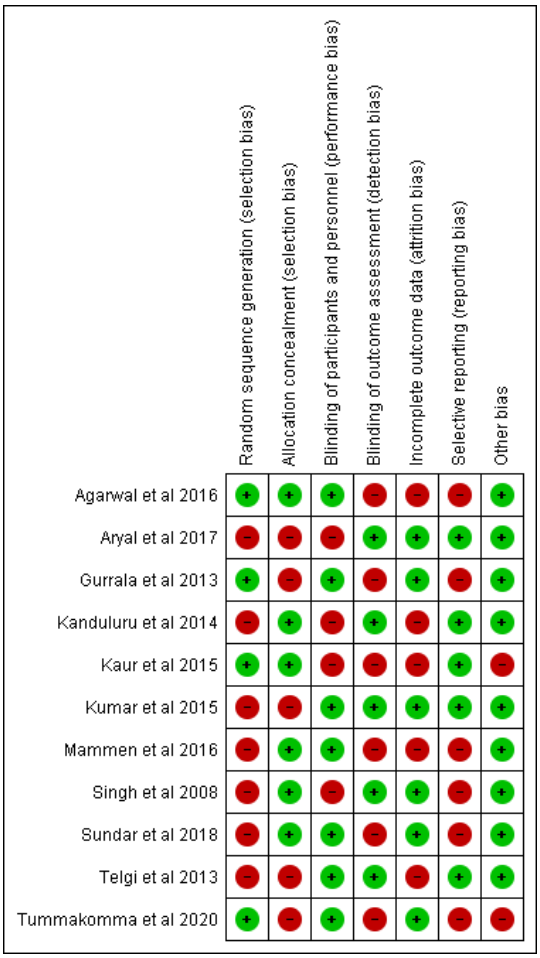

Figure 3. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

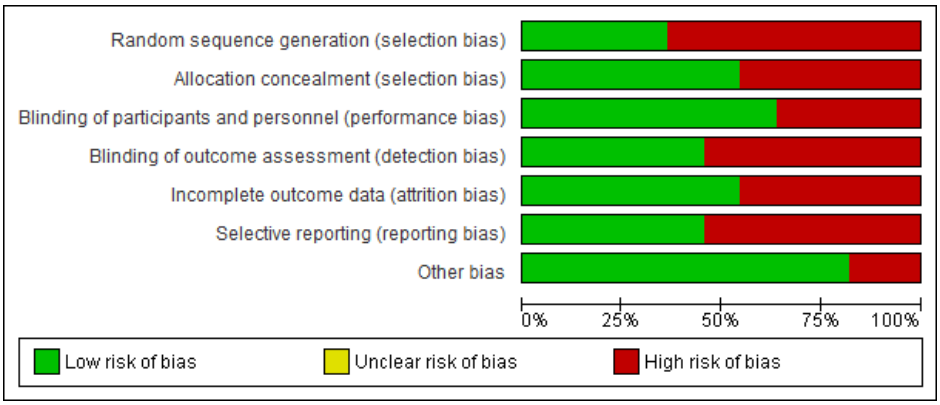

Figure 2. Risk of bias summary: review authors' judgments about each risk of bias item for each included study.

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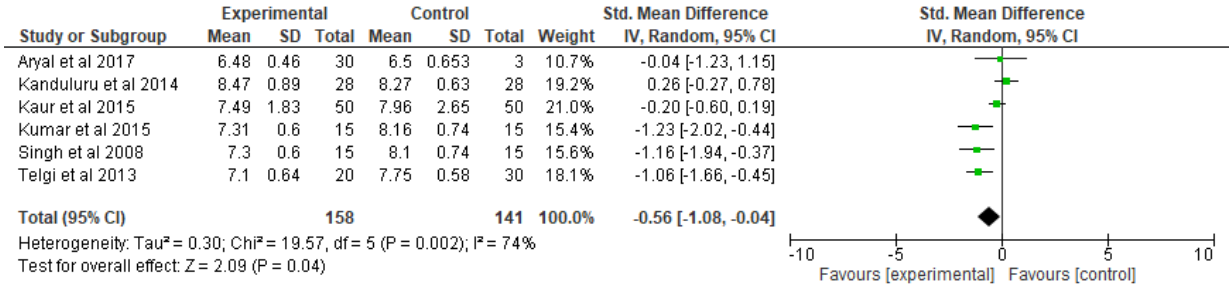

Figure 4. Effect of periodontal therapy with regard to decrease in HbA1c.

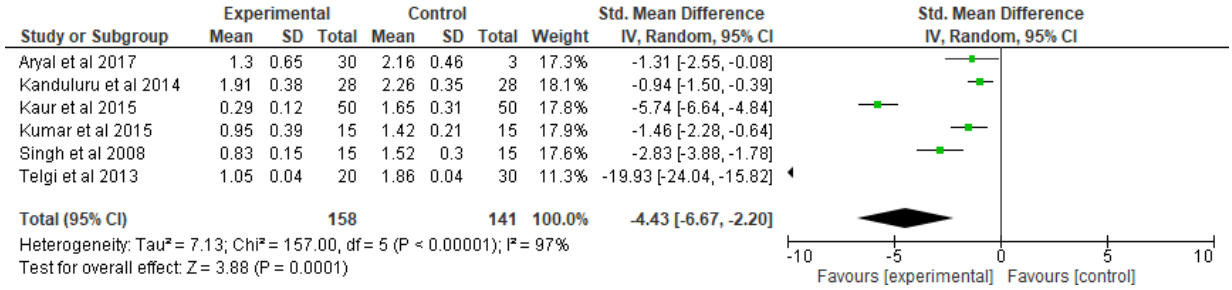

Figure 5. Effect of periodontal therapy with regard to decrease in plaque index.

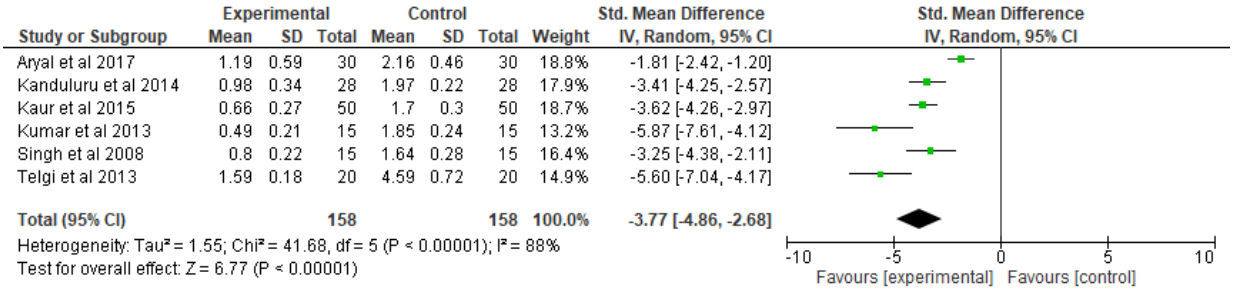

Figure 6. Effect of periodontal therapy with regard to decrease in gingival index.

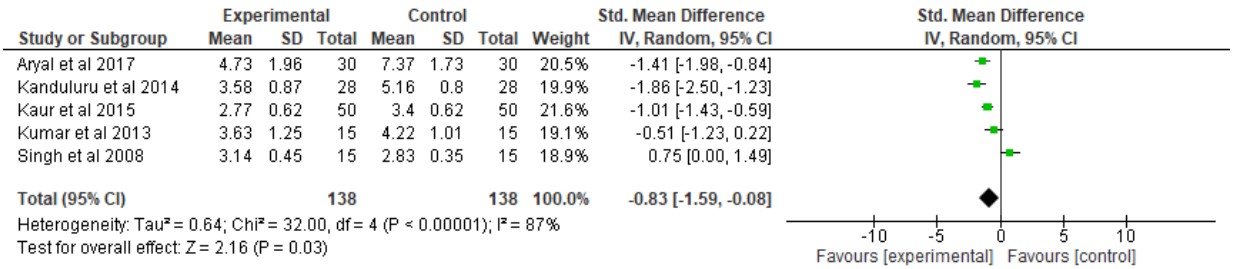

Figure 7. Effect of periodontal therapy with regard to gain in clinical attachment level.

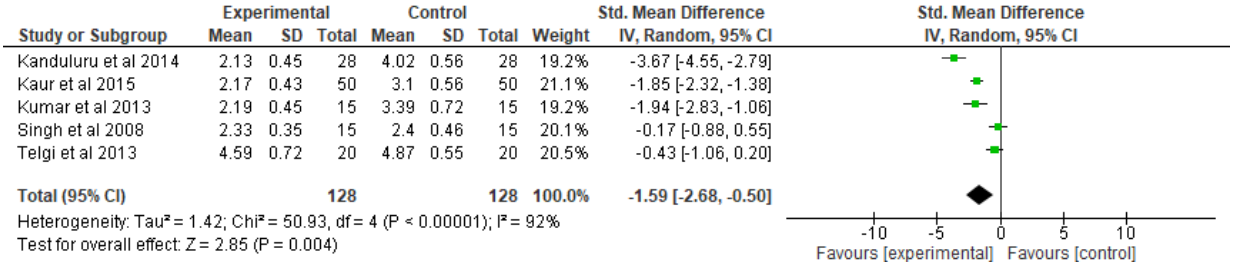

Figure 8. Effect of periodontal therapy with regard to decrease in probing depth.

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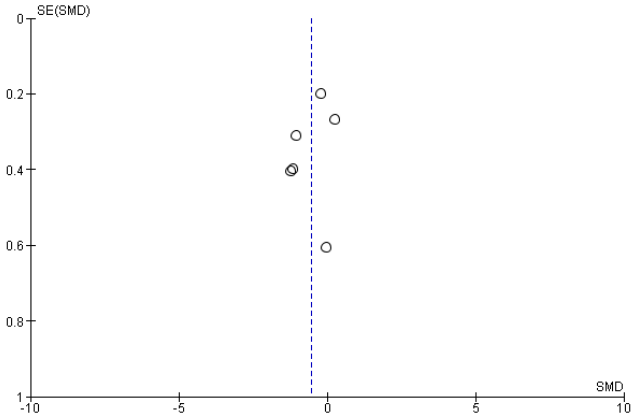

Figure 9. Begg's funnel plot with 95% confidence intervals shows a symmetric distribution without systematic heterogeneity across individual studies, relative to the standard error of each study, suggesting no evidence of publication bias.

The SMD for CAL is -0.83 (-1.59 to 0.08), with pooled estimates favoring the experimental group. This indicates that, on average, the gain in CAL is 0.83 times greater in the experimental group compared to the control group, and this difference is statistically significant ($p < 0.05$; Figure 7). The SMD for PD is -1.59 (-2.68 to 0.50), with pooled estimates again favoring the experimental group. This suggests that, on average, the reduction in PD is 1.59 times greater in the experimental group than in the control group, and this difference is statistically significant ($p < 0.05$; Figure 8). The funnel plot showed no significant asymmetry, indicating the absence of publication bias, as shown in Figure 9.

DISCUSSION

Periodontitis often leads to systemic complications such as DM, cardiovascular disease, inflammatory bowel disease, pulmonary disease, preterm low birth weight, etc. DM is a metabolic disease characterized by elevated blood glucose levels. Individuals with periodontal disease may experience an elevated risk of inadequate glycemic control and further diabetic complications.[24] Research indicates that glycemic control enhances with a decrease in PD. Periodontal disease is known as the "sixth complication of diabetes" due to its higher prevalence and severity in diabetes patients, particularly those with poor metabolic control.[25]

The findings revealed the association between T2DM and periodontal disease, suggesting that periodontal therapy may be integrated with standard treatment and care protocols for diabetic patients. Investigations indicate that NSPT diminished clinical indications of periodontal infection and lowered glucose levels. The SMD served as the summary statistic for the meta-analysis. The pooled estimate indicated that the experimental group exhibited a greater reduction in the evaluated parameters, including PD, GI, PI, CAL, and systemic outcome such as HbA1c, compared to the control group, with this difference being statistically significant ($p < 0.05$).

Corbella et al.[25] studied the impact of NSPT on fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) levels in persons with diabetes by an extensive study and meta-analysis. A total of 15 studies were included. A decrease of -0.38% in HbA1c was observed after three to four months, while a drop of -0.31% was noted after six months of follow-up. The decrease in FPG was much greater in treated patients than in control participants. Individuals with periodontitis and diabetes who received non-surgical periodontal care exhibited enhanced metabolic control.

Baeza et al.[26] performed a systematic review and meta-analysis to evaluate the impact of SRP on systemic inflammation and metabolic control in patients with T2D. Nine RCTs were incorporated into the final analysis. The research indicated that SRP effectively diminished both HbA1c and C-reactive protein (CRP) levels. The results indicate that SRP may positively influence metabolic control and systemic inflammation in individuals with T2D.

This study, unlike prior evaluations, included a greater number of papers and broadened the comparative scope to encompass not just NSPT versus no treatment but also NSPT with and without adjunctive antimicrobial medication.[27–30] This comprehensive review and meta-analysis primarily targeted the Indian population with T2DM exhibiting GCP. Patients undergoing NSPT exhibited a notable enhancement in metabolic markers relative to those who received no intervention. The incorporation of antimicrobial therapy significantly improved clinical results.

Numerous systematic studies have been undertaken to examine the impact of periodontal therapy on glycemic regulation in individuals with diabetes and periodontitis.[25,26] Periodontal therapy, as indicated by these reviews, leads to a statistically significant enhancement in glycemic control.[26,30] Previous studies found that while clinical periodontal conditions improved in those with type 2 diabetes, they did not show that periodontal therapy improved glycemic control.[31–35]

The quality of a systematic review's findings is mostly influenced by the quality of the papers it includes.[36] Given

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the importance of minimizing bias in evaluating the effectiveness of periodontal therapy, RCTs were considered the most appropriate study design for this investigation. The nature of the study does not invariably ensure the acquisition of high-quality data. As a result, clinical studies may potentially have biases that limit the achievement of precise results, discrediting our findings.

A systematic review is the best method for locating, choosing, and analyzing published or unpublished literature in order to respond to a specific research issue.[37] Systematic reviews are frequently combined with meta-analyses, which incorporate numerical data from related studies in a statistical analysis.[38] Nathania et al.[39] examined the correlation between knowledge and understanding of periodontitis in diabetes patients. Prior research has demonstrated a direct link between diabetes and poor oral health, emphasizing the negative impact of this condition on quality of life, especially in those with xerostomia and periodontitis.[40] In addition, Patients' periodontal health and their degree of compliance with antidiabetic medication were significantly correlated.[41]

The present study proposes that the NSPT as a monotherapy has significantly reduced the metabolic levels (HbA1c). There was a significant improvement in the clinical parameters like PD, GI, PI, GR, CAL, SBI and systemic outcome like HbA1c after NSPT. Hence, patients who present with higher metabolic levels (HbA1c) should be considered for periodontal therapy as it may help to reduce the inflammatory load along with the metabolic levels (HbA1c) of diabetes. SRP affect metabolic regulation and the decrease of systemic inflammation in T2D patients. To prevent complications and enhance the cardiovascular health of T2D patients, periodontal therapy may represent a unique therapeutic option. The assessment of potential public policy designs in this field necessitates the conduct of intervention and cost-effectiveness studies within the diverse contexts of national public health systems.

In conclusion, the current study indicates that NSPT as a monotherapy has markedly decreased metabolic levels (HbA1c). A notable enhancement in the clinical parameters occurred following NSPT. Therefore, patients exhibiting elevated metabolic levels (HbA1c) should be evaluated for periodontal therapy, as it may assist in diminishing both the inflammatory burden and the metabolic levels (HbA1c) associated with diabetes.

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