LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374 E-ISSN:1855-363X
VOL. 23, NO. S6(2025)

DIABETES AND PERIODONTAL DISEASE IN SAUDI ARABIA: A SYSTEMATIC REVIEW OF CLINICAL EVIDENCE AND PATIENT AWARENESS ACROSS THE LIFESPAN

[1]Abdulmajeed O. Alotaibi, [2]Sarah Ali Almajaishi, [3]Mada abdulqader barnawi, [4]Nour Mohammed Almarshadi, [5]Alya Khalid Alfayez, [6]Abdullah Othman AlAsafirah, [7]Noor Jamal Almujil, [8]Hussain Adel Alghafli, [9]Leena M. Omar, [10]Mohammed Saleh Althagafi, [11]Ameera F. Abdulfattah, [12]Raghad Ahmed Bahubail, [13]Hatem D. Alshammari

[1]Taif University, Master of dental surgery, assistant professor
ORCID iD: 0009-0005-6731-6899
[2]Alsundos Dental Clinic, Saudi Arabia, Jeddah
[3]Alsundos Dental Clinic, Saudi Arabia, Jeddah
[4]Alsundos Dental Clinic
[5]Alsondos Dental Clinic
[6]King Faisal University, ORCID: 0009-0000-3973-5926
[7]Alsundos Dental Clinic
[8]King Faisal University, ORCID: 0009-0007-9579-2221
[9]King Abdulaziz University
[10]Bachelor of Dental medicine and surgery, North Jeddah Speciality Dental Center, Jeddah, Saudi Arabia
[11]King Abdulaziz University
[12]BDS, king abdulazize university
[13]Assistant Professor, Hail University. Consultant Periodontics

Abstract
Background: The relationship between diabetes mellitus and periodontal disease remains an overlooked public health concern. In Saudi Arabia, the prevalence of diabetes has risen sharply, now affecting an estimated 4.6 million adults around 21.3% of the population. At the same time, more than 85% of adults are reported to suffer from some form of periodontal disease. Although awareness of the connection between these two conditions is gradually increasing, there is still a lack of thorough research into clinical evidence and patient understanding within the Saudi context.
Methods: Following PRISMA 2020 guidelines, we conducted a bibliographic search of PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar from January 2000 to July 2025. The criteria involved studies with a Saudi population of all ages who had a clinical assessment of periodontitis and had their diabetes status documented. The screening, data extraction, and risk of bias assessment were carried out by two independent reviewers. Owing to methodological diversity, we undertook a narrative synthesis.
Results: Twelve studies met inclusion criteria, comprising 4739 participants. Among the adult population, the uncontrolled diabetes mellitus (defining it if the associated HbA1c >6.5%) was associated with periodontitis (OR: 2.779, 95% CI: 1.425-5.419, $p=0.003$) and periodontitis had a significantly higher periodontitis risk. There were significant diabetes-hypertension comorbidity and radiographic bone loss ($p=0.004$) relationships. The T1DM pediatric population had a greater prevalence of gingivitis ($p<0.05$) and oral health-related quality of life impacts ($P=0.003$) than other populations. The results of the awareness assessment showed that the respondents had considerable knowledge gaps because only 21.8% of the diabetic patients were aware of the two-way relationships of gum disease and glucose control.
Conclusions: The findings of this systematic review provide strong clinical proof of the association between diabetes and periodontal disease for the Saudi populations. The periodontitis risk for uncontrolled diabetes was found to be 2.78-fold higher, thus reinforcing gaps in critical diabetes patient awareness. This indicates that there is an undue burden of risk for optimum control of disease management strategies. There is an immediate need for more optimum integrated health care strategies, improved patient education on changes in behavior, and more diabetes research focusing on standardized glycemic control definitions in the context of Saudi Arabia.

Keywords: diabetes mellitus, periodontal disease, periodontitis, Saudi Arabia, glycemic control, HbA1c, patient awareness, systematic review

Introduction

The coexistence of diabetes mellitus and periodontal disease together has become a complex bidirectional phenomenon and has received a lot of importance by scientists and clinicians [1]. Their association goes beyond mere comorbidity and has pathophysiological mechanisms involving inflammatory mediators, advanced

glycation end products, and impaired host immune responses [2]. Globally, an estimated 30–50% of adults are affected by periodontal disease [3]. Meanwhile, diabetes mellitus has reached epidemic proportions, impacting around 537 million adults in 2021, with projections suggesting this number could rise to 783 million by 2045, according to the International Diabetes Federation [4]. In Saudi Arabia, national surveys indicate similarly high rates, with approximately 21.3% of adults aged 18–70 years living with diabetes mellitus [5]. This prevalence has increased over the last 30-year period and has quintupled in number, rendering diabetes one of the foremost public health predicaments in the Kingdom [6]. Simultaneously, however, periodontal disease still thrives, with localized studies showing high prevalence rates of gingivitis (85 to 90%) and chronic periodontitis (30 to 40%) in adults [7]. The pathophysiological foundation involves multiple mechanisms: (1) the greater vulnerability to bacterial infections due to functional, or complete, neutrophil deficiency [8]; (2) the abnormally high levels of advanced glycation end products (AGEs) which modify collagen metabolism [9]; (3) the excessive production of some inflammatory cytokines which, together with hyperglycemia, disrupts the homeostatic balance and periodontitis, and cytokine dysregulation associated with glucose dysregulation [2]; and (4) the unhealthy changes in the flow and composition of saliva which adversely affect oral health and hygiene [10]. Over time, these mechanisms set in motion a cycle of declining health that may become ever more difficult to escape.

Evidence indicates that severe periodontitis may result in poor glycemic control and has been linked to mean HbA1c levels that are 0.4–0.8% higher in periodontitis sufferers as compared to those who do not have periodontitis [11]. On the other hand, the report of HbA1c levels in the range of greater than 8.0% add statistically 2–3-fold greater risk to the progression of periodontitis to poorly controlled diabetes [12]. In the Saudi context, there are several factors which worsen this relationship, namely, (1) cultural dietary habits that are high in carbohydrates [13]; (2) low levels of exercise and high levels of inactivity [6]; (3) an inherited tendency to both conditions [14]; and (4) barriers to health care access [15]. Diabetes and oral health-related social determinants such as individual and household socioeconomic status, the highest education level attained, and attained health literacy disproportionately influence the potential of both better diabetes control and improved oral health practices [16]. Despite the increased awareness around the globe, the population-based multidimensional assessment of the available evidences in Saudi Arabia remains poorly documented. Most previous records have primarily dealt with the prevalence of single conditions. The status of knowing the impact of the Saudi health care system on patient awareness and its clinical correlates is very much in need, as the Kingdom is pursuing health care transformation plans in the Vision 2030 business strategy [18]. Most of the studies done have been on adult populations, which have prompted many unfilled knowledge gaps about the pediatric side [19]. This bias focusing on adults has been shown to impact the understanding on the consequences of diabetes developed at an early age on the oral health of children, especially with T1DM [20]. The relationship between pediatric diabetes and periodontal disease is one that has certain features that make it particularly troublesome.

Adolescents usually become chronic patients of Type 1 Diabetes Mellitus (T1DM) as compared to Type 2 Diabetes Mellitus (T2DM) which patients develop at much older ages, and as a result, such patients usually require lifelong insulin therapy [20]. With the onset of the disease at such an early age, patients develop distinct disease burden patterns which in this case correspond to developing oral tissues hyperglycemia and subsequently exposed to sustained hyperglycemia [21]. Factors which determine the association with children are: 1) the age intake prevalence of T1DM, distinct metabolic types are formed and a dominant phenotype [20]; (2) during children [22]; (3) the impact of the disease in the absence of formed immune systems, their impact differ within the age groups [21]; (4) the impact of the disease on the growing human remains insufficiently studied in the case of craniofacial development [20]. Research shows that within the population of Saudi Arabia; little is known regarding the differences attributable to gender. Most of the studies formed were in single-gender cohorts, mostly paying more focus to women [23,24]. This disproportionate balance is usually a result of sociocultural barriers which inhibit providing access to research and primary data collection [15]. Literature to do with Saudi Arabia is limited, however in this case, patients do not realize the impact which exists between diabetes and periodontal disease. There is very little research attention to Saudi Arabia patients in comparison to global studies with the

same objectives and conclusions, which highlight the importance of the lack of evidence. There is the need to develop strategies which are culturally suitable and tailored to the Saudi population, and this can better be done by understanding the patients' perceptions and views [16]. Most of the studies which have been conducted lack precise definitions regarding glycemic control, focus more on the generic classification of diabetes without specific values of the HbA1c [25]. This lack of consistency regarding methodology makes it very difficult to draw precise conclusions, which in turn, inhibits deriving best practice recommendations regarding the level of glycemic control which need to be maintained [26].

Review Objectives

This systematic review synthesizes current Saudi evidence focusing on: (1) associations between uncontrolled diabetes (defined by HbA1c criteria) and periodontitis across age groups; (2) patient awareness and knowledge regarding the diabetes–periodontitis relationship; (3) pediatric-specific findings related to T1DM and oral health; and (4) modifying factors including smoking, oral hygiene practices, and comorbidities. This review aims to support evidence-based clinical practices and public health policies while outlining prospective research by integrating clinical behavioral evidence and targeting objective glycemic control across all age groups.

Methods

To make sure the review is both transparent and reproducible, the design and writing of this systematic review follows the PRISMA 2020 guidelines [27] and registered in Prospero "Number". The review protocol was aimed at systematically gathering and synthesizing the available evidence on the diabetes–periodontal disease relationship, particularly focusing on the clinical associations and the levels of awareness in various age groups of the Saudi population. An exhaustive and systematic electronic search was performed in the following four major databases: PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar through the period from January 2000 to July 2025. The search was designed using the (MeSH) systems, free-text keywords, and a systematic and purposeful blending of both English and Arabic terms concerning diabetes mellitus, periodontal disease, and Saudi Arabia. Additional manual searches of reference lists of included studies and some pertinent review articles were carried out to discover studies that might meet the eligibility criteria. The review also included some unpublished literature such as these, conference abstracts, and government documents. All computer-based searches were undertaken by two individual researchers and in the case of disagreement, which was not uncommon, discussion and agreement was reached [27,28].

Eligibility Criteria

Inclusion criteria: (a) the population is limited to Saudi residents irrespective of their ages (adults ≥18 years and children <18 years); (b) primary research studies involving human subjects; (c) assessment of clinical periodontics using standard methods or validated self-reported outcomes for awareness studies; (d) determination of diabetes status with explicit type of diabetes and, preferably, glycemic control defined by any threshold of HbA1c reporting; (e) reporting outcomes on the prevalence, severity and/or extent of, or patient awareness/knowledge about diabetes–periodontitis; (f) studies with cross-sectional, case-control, cohort (prospective or retrospective) and randomized controlled trials; (g) published in English or Arabic [29,30].

Exclusion criteria: (a) narrative reviews, editorials, commentaries and systematic reviews without primary data; (b) studies conducted outside Saudi Arabia or with mixed populations without analysis of Saudi subgroups separately; (c) studies with imprecise definitions of periodontal or diabetes outcomes; (d) research using animals or in vitro techniques; and (e) duplicate publications with identical datasets reporting [27].

Study Selection Process

The first stage of the review produced 3,798 records from four different databases. More than 3,700 records remained after the removal of duplicates. This subset was then later analyzed in a study. At this stage, 3,730 records were taken out because they did not fulfill the inclusion requirements. This left a selection of 31 records to undergo full-text assessments. Nineteen of these were removed subsequently due to studying the wrong target population (n=6), a design sufficient (n=6), a lack of materials (n=5), and linguistic challenges (n=2). The final number of papers for review was twelve. The absence of a meta-analysis was due to the significant differences in

definitions, inclusion criteria, study outcomes, and approaches to analysis. The selection process has also been highlighted in a PRISMA flow diagram, shown in Figure 1.

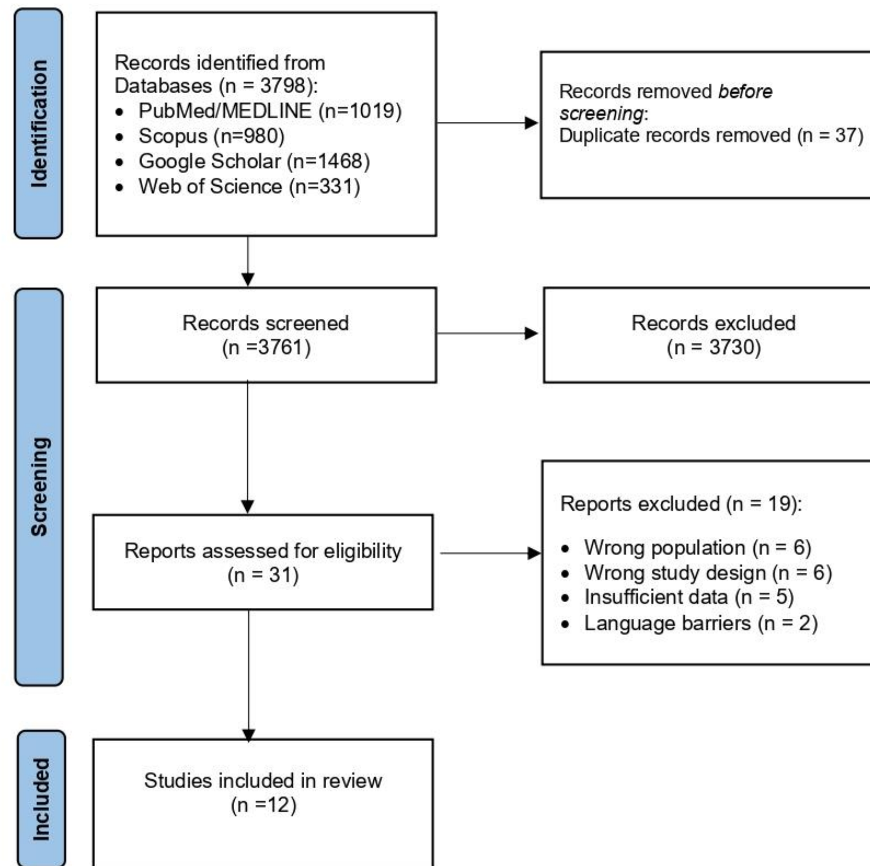

Figure 1. PRISMA 2020 Flow Diagram

Data Extraction and Management

Two independent reviewers utilized a pilot-tested extraction form to capture pertinent information. Data that was extracted included: a description of the study including its identifier, design, and location; demographic details of the sample and its population; the definition of diabetes exposure; assessments of diabetes and its complications; utilized instruments; key co-factors and confounders; used statistical techniques; main effect estimates; conclusions, and the identified limitations of the work [27].

Diabetes and periodontitis precise associations (primary outcomes). Diabetes mellitus, particularly uncontrolled diabetes as determined by the HbA1C and its consequences on periodontal disease, including: (1) determining the periodontitis within the diabetic population using the clinical criteria and diagnostic methods [25,29,30]; (2) determining the level of periodontal disease as severity through the assessment of continuous variables; and (3) comparing the prevalence of certain periodontal diseases within diabetic and non-diabetic subjects [25,26].

Secondary outcomes: (1) the level of awareness and knowledge of the patients [16]; (2) oral hygiene and smoking as modifiable risk factors; (3) the presence of periodontal disease and the relationship of its complications [26]; (4) the level of life satisfaction [31]; (5) differences attributable to the variation of gender [23,24]; (6) the history of associations of diseases with patient's knowledge over time [16].

Risk of Bias Assessment

Bias risk evaluation was done through the ROBINS-E tool [32] for observational studies. Each study was evaluated by two independent reviewers in dealing with many types of bias such as confounding, participant

selection, exposure classification, lost data, outcome measurement, and outcome reporting and selective reporting. Most studies showed low to moderate risk of bias across the reviewed domains.

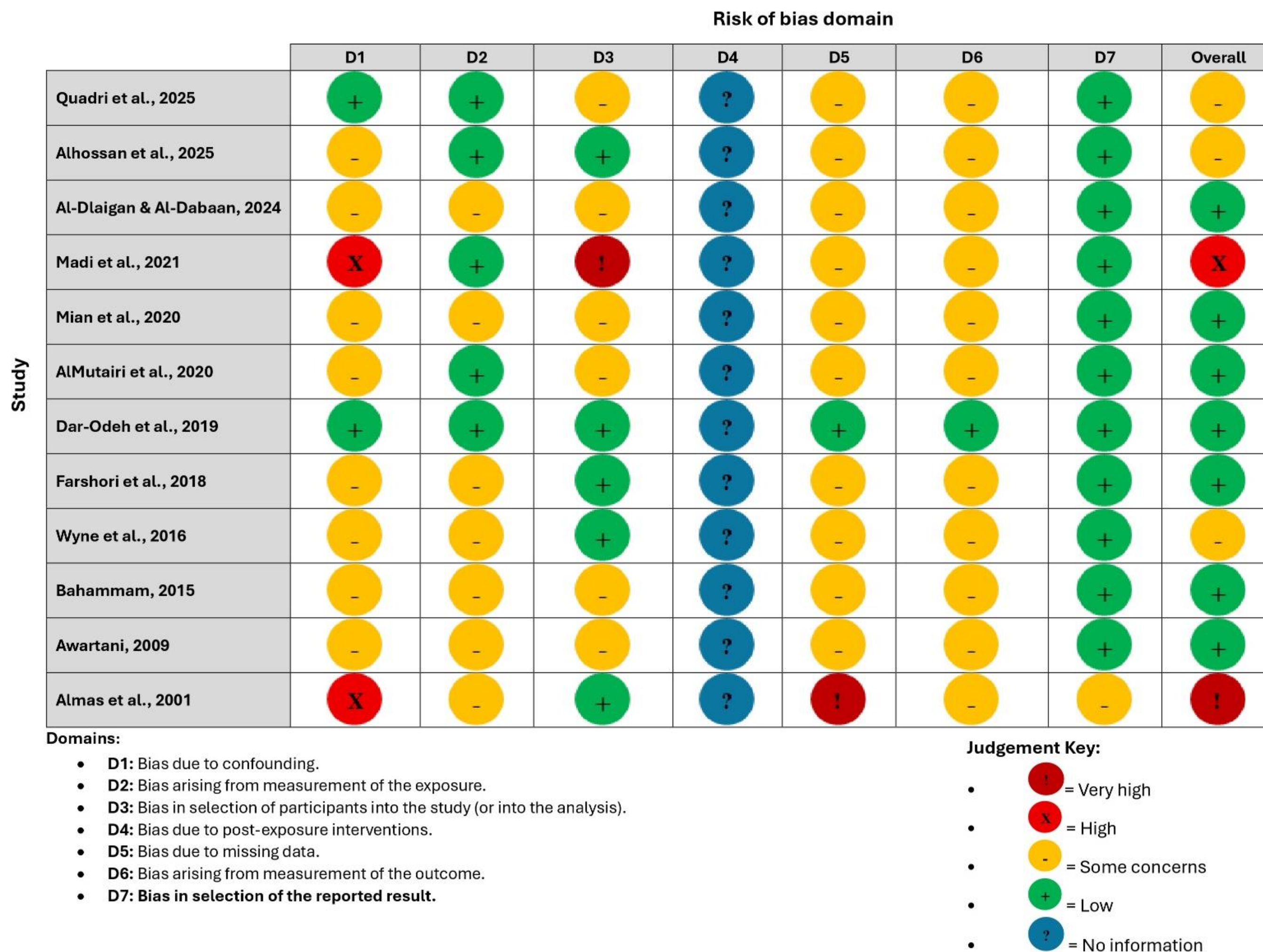

Figure 2. Risk of Bias Analysis of Selected Studies

Figure 2 illustrates risk of bias analysis across all twelve studies on relative scales with ROBINS-E. The risk of bias assessment for the twelve studies which were included was performed using a custom tool designed for non-randomized studies. The assessment for all seven domains showed a body of evidence with serious methodological issues mostly caused by confounding. Most of the studies (9 out of 12. 75.0%) proved to be high risk of bias across the study as a whole. The most chronic problem was in Domain 1 (Bias due to confounding), in which 10 studies (83.3%) were classified as high risk or in high risk and no information, which meant that study was poorly designed and thus fails to control for socioeconomic status, smoking, or poor oral hygiene. Virtually none of the studies cumulating to 9 (75.0%) in which D3 were Pass and thus offered assessment showed high risk were in risk zones for participant selection, outcome measurement, and reporting outcome selection. Interestingly, in these studies Quadri et al. 2025 and Dar-Odeh et al. 2019 were outliers and thus the lowest risk in bias in all domains thus conducting the most methodologically poor evidence of the whole review. The study which was most risked was by Almas et al 2001. It was high risk in the most cases no information, high confounding and high risk in all domains.

Data Synthesis

Due to significant heterogeneity across included studies, within the studies included, the pooling of results using meta-analysis was deemed inappropriate. A narrative synthesis of the results was undertaken, organizing findings

thematically according to primary and secondary outcomes, along with a critical appraisal of study quality embedded within the interpretation [27].

Results

Study Characteristics

Table 1 presents the findings of twelve studies carried out in Saudi Arabia investigating the intricate relations between diabetes and periodontal diseases. The studies in aggregate captured a sample of 4739 participants and bordered between the years 2001-2025. In the geographic dimension, 5 studies (33.3%) were carried out in Riyadh, 3 studies (25%) in the central region, and the remaining smaller fractions in the other Bordering Saudi cities including in Jazan, Dammam, Hail, Jeddah, and Al Madinah. The available study designs were predominantly cross-sectional (7 studies, 41.7%) case-control (2 studies, 16.7%), comparative (2 studies, 16.7%), and single study employing retrospective cohort design. The sample composition also varied widely from 40 subjects in the smaller comparative studies to 1,768 subjects in the retrospective studies with a median sample size of 202 subjects. The samples also displayed a disproportionate gender composition with 8 studies (66.7%) investigating only female subjects, 3 studies (25%) mixed adult populations, and 3 studies (25%) aimed at children with Type 1 diabetes mellitus. In the studies examining the different types of diabetes, Type 2 diabetes was the most common (6 studies, 50%) in the studies of mixed T1DM/T2DM populations in diabetes awareness studies, while the pediatric studies were solely T1DM.

Five primary areas of focus were researched: associations of uncontrolled diabetes with some periodontal outcomes (3 studies, 25%); patient knowledge and awareness (3 studies, 25%); comparisons of oral health status (2 studies, 16.7%); interactions of comorbidity (1 study, 8.3%); and assessments of quality of life (1 study, 8.3%). The methodological approaches used for this research were standardized criteria for periodontal assessment which assessed Clinical Attachment Loss (CAL), Probing Depth (PD), and Community Periodontal Index (CPI/CPITN), and differing definitions for glycemic control from simple diabetes diagnosis categories to specific HbA1c thresholds (>6.5% or 48.8mmol/mol). The main outcomes were unrelentingly high periodontal disease burdens for diabetics regardless of their degree of control, with effect sizes modest ratio associations (odds ratios 1.5-3.0) to strong relationships (adjusted odds ratio 5.630 for poor oral hygiene). Patient awareness studies found major knowledge deficits, with 21.8% to 56.6% prevalence of recognition among diabetics for the bi-directional association to diabetes and periodontal disease. The range of statistical significance of studies varied from highly significant associations (>0.001) to the descriptive analysis of smaller studies, with the greatest evidence coming from well-controlled case-control studies which used objective definitions of glycemic control accompanied by comprehensive periodontal assessments done by calibrated examiners with standardized protocols.

Multiple studies have sought to understand the impact of diabetes on the outcome of periodontal disease, the most advanced studies employing some definition for control of glycemic parameters. Quadri et al. provided the most compelling evidence through a case-control study (n=498) conducted in Jazan of advanced type 2 diabetes mellitus and its association with periodontitis where it was determined that the case group displayed periodontitis 2.78 times (OR: 2.779, 95% CI: 1.425–5.419, p=0.003) more than the control group advanced type 2 diabetes mellitus and the control group did not (34). Uncontrolled diabetes was defined using rigorous parameters and controlled diabetes was defined using HbA1c parameters (>48.8 mmol/mol or >6.5%) and was controlled to the maximum available. The poor hygiene practices were the most prevalent and the most poorly utilized strategies that have been shown to lower the diabetes–periodontitis relationship confounding factors smoking (p=0.046) and p<0.001. Lack of hygiene in the above constructs was the strongest predictor with a poor adopted (5.630, 95% CI: 3.514–9.021), reinforcing the evidence that people with diabetes need to actively engage in better oral hygiene practices.

The diabetics' periodontal condition in relation to the level of glycemic control was studied by Awartani in Riyadh with a cohort of 126 participants. There is a statistically significant association between the level of control of diabetes and certain periodontal indices. In diabetics with poorly controlled diabetes, there is a much greater

prevalence of calculus (35.5 ± 15 vs. 43.0 ± 17.2, p.<0.05) and of probing depths ≥ 4 mm (40.7% vs. 45.7%) [35]. The association is strongest for calculus levels and glycemic control status (p=0.000).
The importance of the pattern of comorbidities was first addressed by Madi et al. in a detailed research work, which was dedicated to the interrelations of various comorbidities with the severity of periodontal disease. In this work, the diabetes-hypertension commodity increased the risk of radiographic bone loss by more than 2.82 (p=0.004) and the mean bone loss measurement is 2.82 (95% CI: 0.89–4.75) [36]. There is a particularly severe impact of combined morbidity on periodontal condition, which illustrates the importance of systemic disease on oral health, particularly for populations suffering from multiple chronic conditions.
Studies investigating gender differences within the Saudi population have shown a persistent concentration of periodontal disease burden on female diabetic patients, although the comparative works have remained scant due to the lack of male researchers in the field. Farshori et al. have helped bridge some of that gap with their thorough case-control study (n=318) in which they concentrated on the female Hail population with Type 1 (29%) and Type 2 (71%) diabetes mellitus. This study showed that the prevalence of periodontitis in diabetic women (65%) was significantly greater than in the control participants (31.6%), and it was more than doubled in the disease burden (p<0.05) [23]. Farshori et al's findings shed light on the longitudinal effect of diabetes on the rate of total tooth loss. They reported that total tooth loss was significantly greater in diabetic participants than in the non-diabetic controls (Z=-2.055, p=0.039) [23]. Further support for the gender differences came from the study of Dar-Odeh et al. who, with a research arm (n= 1,768) in the diabetes-tooth loss decade, focused on women of reproductive age. The stronger connection between diabetes and the presence of teeth was observed (p=0.009) in this population regardless of any other systemic diseases which substantiate the pattern of tooth loss due to diabetes among women population [24].
Despite being scant, evidence gathered about the Saudi population showed that children suffering from Type 1 diabetes mellitus had substantial oral health concerns and thus, did not align with standard beliefs about diabetes in relation to oral health. The most complete comparative analysis on children with T1DM in the city of Riyadh is available from Wyne et al, and the data showed that there is a disparity between the local and global literature on dental caries in T1DM children. Diabetic children had less primary caries, but more permanent caries than the age matched controls, along with a greater oral hygiene deficiency, paired with poorer gingival health, and more frequent diabetes [22]. Research conducted by Al-Dlaigan & Al-Dabaan also corroborates the evidence on children with diabetes residing in Riyadh, which showed caries prevalence of 53% and the results of oral hygiene in children with diabetes prove that there is a statistically significant difference (p=0.024) between children with caries and those who are caries-free. The results also showed that there are higher more caries-free diabetics than caries-affected diabetics (p=0.010) which strengthens the hypothesis of interrelated oral health issues in children with diabetes [37]. AlMutairi et al. focused on the other side of the coin by studying the impact of T1DM on the children's oral health related quality of life. In comparison with peer diabetic children and healthy controls using the Arabic version of Child Oral Health Impact Profile (COHIP-SF-19). Diabetic children had much lower scores in the Oral Health Impact Domain (P=0.003) than the healthy controls [38].
Understanding people with diabetes concerning the interrelationship between diabetes and periodontal diseases was not only incomplete, but there also appeared to be differences in the approaches used to measure the understanding as well as the timelines on which the understanding was assessed. This relates to Alhossan et al who derived data from cross-sectional studies on the population of Saudi Arabia and sought to determine the level of knowledge and awareness that the patients had of diabetes. One of the findings from that study was that knowledge was based on demographics, where the respondent was classified as having high knowledge (38.5%), moderate knowledge (38.8%) and low knowledge (22.7%), and there was a significant difference between these categories with respect to age (P=0.015), marital status (P=0.0001), education level (P=0.026), and income level (P=0.003). in diabetes, there is a two-way relationship with periodontal disease which is recognized by 84.2% of the respondents but only 56.6% of the respondents were aware that diabetes could lead to periodontal disease [39]. Bahammam was the first to provide a quantitative estimate concerning the lack of awareness of diabetes and

gums in Jeddah and found that 21.8% of people were aware of gum disease and its relation to diabetes. This awareness was proven to be dependent on the level of education and the number of times the person visited the dentist. The difference in the findings by Bahammam and Alhossan et al could indicate that there is some increase in the knowledge that the patients have as time goes on, with the caveat that differences in methods and study population must be kept in mind [40].

One of the earliest comparative studies included in this review, conducted by Almas et al. (2001) in Riyadh, provided preliminary descriptive evidence for the association in a Saudi cohort [33]. Under study, 20 adults diabetic and 20 adults non-diabetic were compared, and it was found that the CPITN (Community Periodontal Index of Treatment Needs) was higher among the diabetic participants, as was the fasting and random blood glucose level, in comparison to non-diabetic individuals. Furthermore, the authors described a trend where glucose level elevations corresponded to increases in the severity of periodontal disease. Nonetheless, the small sample size restricted the findings to the descriptive level, and the absence of a formal statistical analysis showcased the methodological flaws in this field of research.

Discussion

This systematic review talks about the importance of the relationship between diabetes and periodontal disease among Saudi citizens and how diabetes and periodontal disease and their relations to each other might be different in Saudi Arabia compared to other countries [1,25]. Objective studies defining glycemic control have yielded the most convincing results, particularly Quadri et al. s [34] documentation of a 2.78-fold increase in periodontitis among uncontrolled diabetics. This effect size is consistent with other international compilations of observational studies [41]. Aspects of comorbidity, particularly the diabetes and hypertension relationship documented by Madi et al. [36], correspond with the general literature describing the multiplicative burden of chronic diseases on oral health and the common risk factors within Saudi Arabia poor nutrition and lack of physical activity [8,13,6,14]. Although the volume of pediatric evidence is small, its findings on T1DM and oral health offer a glimpse into more complex realities that surface in defiance of orthodox expectations. The findings on caries in T1DM children, particularly the paradox of fewer caries in primary dentitions and more in permanent dentitions, indicate that diabetes is not monolithic and can be expressed differently in various contexts, and with different teeth and developmental stages [19,22,37]. The impact on the oral health-related quality of life is more pronounced than other clinical indicators, attesting the lack of integration of the phenomenon with other disciplines, as has been reported in the literature on the OHQoL [31,42].

This discrepancy reflects both the methodology utilized in investigating certain attitudes and the assessment heterogeneity within and outside the studies. More specifically, the gulf indicates a troubling absence of focused educational programs in the healthcare systems of Saudi Arabia and primary healthcare programs. Gaps indicate the need for gaps to be filled in culturally sensitive educational materials and programmed pathways of accessibility for differing socioeconomic strata [16,44]. The association between the frequency of dental visits and the level of awareness of certain topics suggests that dental care itself could be a significant means of delivering educational material [40,44,45]. More integrated approaches to medical and dental care, which reinforce the relationship between diabetes and periodontal disease, support the integration of diabetes and periodontal care [25,46].

The differences in knowledge from the rest of the population align with established patterns of health literacy and the primary patient s journey [47,16]. Future research needs to examine the association between low health literacy and high levels of educational attainment to reassess socio-political structures which tend to reinforce both vertical and horizontal integration [33]. The bulk of studies within this review exhibited the same drawback, which, in this case, means the absence of interval or ratio scales. Cross-sectional studies were the most common, owing to simplistic approaches which do not take into account the intricate web of biomedical and psychosocial components within diabetes and associated psychosocial disorders [48].

The dental gaps in health statistics: low knowledge, and knowledge-attitude gaps, along with limited contact with the dental health educational network, indicate insufficient attention to the non-tooth components of periodontal

disease within rural populations [7,24,49]. These results have implications for the Saudi Arabia Vision 2030 Health transformation agenda, which promotes interdisciplinary, integrative, and patient-centered approaches to care [18]. The documentation of periodontal and systemic diseases justifies the need for integrated medical-dental practices, which may enhance clinical outcomes and lower the cost of care [11, 25]. The gaps in patient knowledge suggest that patient education programs need to be implemented more rigorously in the primary care and endocrinology settings, diabetes self-management education and support guidance, and expanded to include comprehensive oral health education [16, 25, 43, 46].
The limitations outlined in this report highlight important areas for further research. Longitudinal cohort studies with consistent definitions for periodontal and glycemic control are essential to define temporal relationships and causal pathways [26, 48]. Adding studies that span different regions and population subgroups will improve the generalizability of results and enhance the identification of population-based risk factors [7]. The creation and evaluation of tailored patient education resources, derived from health behavior theories, should demonstrate changes in knowledge, practices, and clinical outcomes to be considered effective [16, 44].

Conclusions

This systematic review sets a strong record for significant diabetes periodontal disease associations for Saudi populations and links uncontrolled diabetes with greatly increased periodontitis risk. The consolidation of a dozen studies suggests this patient's awareness, which was described as critical always represents a shortcoming of this branch of health. The populations of children with T1DM experience fluctuations in certain clinical indicators and their overall quality of life. This evidence stressed the need for dental care integrated with medicine in accordance with the unfinished goals of Vision 2030 and improved patient education, as well as continuous research employing uniform definitions of glycemic control. These evidence gaps can be strategically addressed with coordinated policy reforms, as with policy shifts could greatly improve oral and systemic health in Saudi Arabia.

Abbreviations: CAL = Clinical Attachment Loss; PD = Probing Depth; DMFT/dmft = Decayed, Missing, and Filled Teeth (permanent/primary); OR = Odds Ratio; CI = Confidence Interval; DM = Diabetes Mellitus; T1DM = Type 1 Diabetes Mellitus; T2DM = Type 2 Diabetes Mellitus; HTN = Hypertension; CHD = Coronary Heart Disease; RBL = Radiographic Bone Loss; OHRQoL = Oral Health–Related Quality of Life; MeSH= Medical Subject Headings.

References

1. Preshaw PM, Alba AL, Herrera D, et al. Periodontitis and diabetes: a two-way relationship. Diabetologia. 2012;55(1):21–31. doi:10.1007/s00125-011-2342-y.
2. Taylor JJ, Preshaw PM, Lalla E. A review of the evidence for pathogenic mechanisms that may link periodontitis and diabetes. J Periodontol. 2013;84(4 Suppl): S113–S134. doi:10.1902/jop.2013.134005.
3. Petersen PE, Ogawa H. The global burden of periodontal disease: towards integration with chronic disease prevention and control. Periodontol 2000. 2012;60(1):15–39. doi:10.1111/j.1600-0757.2011.00425.x.
4. International Diabetes Federation. IDF Diabetes Atlas, 10th edn. Brussels: International Diabetes Federation; 2021. Available from: https://diabetesatlas.org
5. Alqurashi KA, Aljabri KS, Bokhari SA. Prevalence of diabetes mellitus in a Saudi community. Ann Saudi Med. 2011;31(1):19–23. doi:10.4103/0256-4947.75773.
6. Alotaibi A, Perry L, Gholizadeh L, Al-Ganmi A. Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. J Epidemiol Glob Health. 2017;7(4):211–218. doi:10.1016/j.jegh.2017.10.001.
7. Hakeem FF, AlQobaly L, Hamadallah HH, et al. Prevalence of periodontitis in Saudi Arabia: a systematic review and meta-analysis. Saudi Dent J. 2024;36(3):395–403. doi:10.1016/j.sdentj.2023.11.022.
8. Genco RJ, Borgnakke WS. Diabetes as a potential risk for periodontitis: association studies. Periodontol 2000. 2020;83(1):40–45. doi:10.1111/prd.12270.

9. Schmidt AM, Weidman E, Lalla E, et al. Advanced glycation endproducts (AGEs) induce oxidant stress in the gingiva: a potential mechanism underlying accelerated periodontal disease associated with diabetes. J Periodontal Res. 1996;31(7):508–515. doi:10.1111/j.1600-0765.1996.tb01417.x.
10. Mealey BL, Ocampo GL. Diabetes mellitus and periodontal disease. Periodontol 2000. 2007;44:127–153. doi:10.1111/j.1600-0757.2006.00193.x.
11. Simpson TC, Weldon JC, Worthington HV, et al. Treatment of periodontal disease for glycaemic control in people with diabetes mellitus. Cochrane Database Syst Rev. 2022;4(4):CD004714. doi:10.1002/14651858.CD004714.pub4. .
12. Tsai C, Hayes C, Taylor GW. Glycemic control of type 2 diabetes and severe periodontal disease in the US adult population. Community Dent Oral Epidemiol. 2002;30(3):182–192. doi:10.1034/j.1600-0528.2002.300304.x.
13. Al-Rethaiaa AS, Fahmy AE, Al-Shwaiyat NM. Obesity and eating habits among college students in Saudi Arabia: a cross-sectional study. Nutr J. 2010;9:39. doi:10.1186/1475-2891-9-39.
14. Beck JD, Papapanou PN, Philips KH, Offenbacher S. Periodontal medicine: 100 years of progress. J Dent Res. 2019;98(10):1053–1062. doi:10.1177/0022034519846113.
15. Chowdhury S, Mok D, Leenen L. Transformation of health care and the new model of care in Saudi Arabia: Kingdom’s Vision 2030. J Med Life. 2021;14(3):347–351. doi:10.25122/jml-2021-0070.
16. Poudel P, Griffiths R, Wong VW, et al. Oral health knowledge, attitudes and care practices of people with diabetes: a systematic review. BMC Public Health. 2018;18:577. doi:10.1186/s12889-018-5485-7.
17. Alshammari FR, Alamri H, Aljohani M, Sabbah W, O’Malley L, Glenny A-M. Dental caries in Saudi Arabia: A systematic review. J Taibah Univ Med Sci. 2021;16(5):643–656. doi:10.1016/j.jtumed.2021.06.008.
18. Saudi Arabia Vision 2030. Health sector transformation program. Available from: https://www.vision2030.gov.sa/en/explore/programs/health-sector-transformation-program
19. Ismail AF, McGrath CP, Yiu CKY. Oral health status of children with type 1 diabetes: a comparative study. J Pediatr Endocrinol Metab. 2017;30(11):1155–1159. doi:10.1515/jpem-2017-0053.
20. Robert AA, Al-Dawish A, Mujammami M, Dawish MAA. Type 1 diabetes mellitus in Saudi Arabia: a soaring epidemic. Int J Pediatr. 2018;2018:9408370. doi:10.1155/2018/9408370.
21. Lalla E, Papapanou PN. Diabetes mellitus and periodontitis: a tale of two common interrelated diseases. Nat Rev Endocrinol. 2011;7(12):738–748. doi:10.1038/nrendo.2011.106.
22. Wyne AH, Chohan AN, Al-Sharari RI. Caries, oral hygiene and gingival health status in Type 1 diabetic Saudi children. Pak Oral Dent J. 2016;36(3):421–425. Available from:
23. Farshori MP, Alnaafa M, Al Ibrahim IK, et al. Prevalence of gingivitis and periodontitis and significant tooth loss in diabetic females of Hail region in Saudi Arabia. Int J Curr Res Life Sci. 2018;7(8):2513–2521. Available from:
24. Dar-Odeh N, Borzangy S, Babkair H, et al. Association of dental caries, retained roots, and missing teeth with physical status, diabetes mellitus and hypertension in women of the reproductive age. Int J Environ Res Public Health. 2019;16(14):2565. doi:10.3390/ijerph16142565.
25. Sanz M, Ceriello A, Buysschaert M, et al. Scientific evidence on the links between periodontal diseases and diabetes: consensus report and guidelines of the joint workshop by the IDF and EFP. J Clin Periodontol. 2018;45(2):138–149. doi:10.1111/jcpe.12808.
26. Genco RJ, Graziani F, Hasturk H. Effects of periodontal disease on glycemic control, complications, and incidence of diabetes mellitus. Periodontol 2000. 2020;83(1):59–65. doi:10.1111/prd.12271.
27. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi:10.1136/bmj.n71.
28. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ. 1996;312(7023):71–72. doi:10.1136/bmj.312.7023.71.

29. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol. 1999;4(1):1–6. doi:10.1902/annals.1999.4.1.1.
30. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: framework and proposal of a new classification and case definition. J Periodontol. 2018;89(S1):S159–S172. doi:10.1002/JPER.18-0006.
31. Baiju RM, Peter E, Varghese NO, Sivaram R. Oral health and quality of life: current concepts. J Clin Diagn Res. 2017;11(6):ZE21–ZE26. doi:10.7860/JCDR/2017/25866.10110.
32. Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). Environ Int. 2024;186:108602. doi:10.1016/j.envint.2024.108602.
33. Almas K, Al-Qahtani M, Al-Yami M, Khan N. The relationship between periodontal disease and blood glucose level among type II diabetic patients. J Contemp Dent Pract. 2001 Nov 15;2(4):18–25. doi:10.2174/1874210601913010288.
34. Quadri MFA, Fageeh HI, Ibraheem W, Jessani A. A case-control study of type 2 diabetes mellitus and periodontitis in Saudi Arabian adults. J Multidiscip Healthc. 2020;13:1741–1748. doi:10.2147/JMDH.S288681.
35. Awartani FA. Evaluation of the relationship between type 2 diabetes and periodontal disease. Saudi Med J. 2009;30(7):902–906. PMID:19618004.
36. Madi M, Abuohashish HM, Attia D, AlQahtani N, Alrayes N, Pavlić V, Bhat S. Association between periodontal disease and comorbidities in Saudi's Eastern Province. Biomed Res Int. 2021;2021:5518195. doi:10.1155/2021/5518195.
37. Al-Dlaigan YH, Al-Dabaan RA. Dental health status of children with diabetes in Riyadh, Saudi Arabia. Saudi Dent J. 2024;36(6):926–931. doi:10.1016/j.sdentj.2024.03.012.
38. AlMutairi FFJ, Pani SC, Alrobaie FM, Ingle NA. Relationship between type-I diabetes mellitus and oral health status and oral health-related quality of life among children of Saudi Arabia. J Fam Med Prim Care. 2020;9(2):647–651. doi:10.4103/jfmpc.jfmpc_1160_19.
39. Alhossan AS, Otifi YS, Alshahri HA, et al. Knowledge and awareness level of periodontal diseases among diabetic patients in Saudi Arabia. Cahiers Magellanes-NS. 2025:696–712. Available from:
40. Bahammam MA. Periodontal health and diabetes awareness among Saudi diabetes patients. Patient Prefer Adherence. 2015;9:225–233. doi:10.2147/PPA.S79543.
41. Borgnakke WS, Ylöstalo PV, Taylor GW, Genco RJ. Effect of periodontal disease on diabetes: systematic review of epidemiologic observational evidence. J Periodontol. 2013;84(4 Suppl):S135–S152. doi:10.1902/jop.2013.1340013.
42. John MT, Reissmann DR, Feuerstahler L, et al. Exploratory factor analysis of the Oral Health Impact Profile. J Oral Rehabil. 2014;41(9):635–643. doi:10.1111/joor.12192.
43. Powers MA, Bardsley JK, Cypress M, et al. Diabetes self-management education and support in adults with type 2 diabetes: a consensus report. Diabetes Care. 2020;43(7):1636–1649. doi:10.2337/dci20-0023.
44. Allam E, Alshibani N, Alshibani Y, Alkattan R. Evaluation of the knowledge and awareness of dental patients in Saudi Arabia on periodontal health and diseases. Open Dent J. 2020;14(1):459–464. doi:10.2174/1874210602014010459.
45. Mian RI, Rashidi FFH, Alshammary TA, et al. Oral health-related knowledge and assessment of oral health status of diabetic patients attending dental clinic at College of Dentistry, Hail, Kingdom of Saudi Arabia. J Contemp Dent Pract. 2020;21(1):78–82. doi:10.5005/jp-journals-10024-2729.
46. Casanova L, Hughes FJ, Preshaw PM. Diabetes and periodontal disease: a two-way relationship. Br Dent J. 2014;217(8):433–437. doi:10.1038/sj.bdj.2014.907.

47. Allen EM, Ziada HM, O'Halloran D, Clerehugh V, Allen PF. Attitudes, awareness and oral health-related quality of life in patients with diabetes. J Oral Rehabil. 2008;35(3):218–223. doi:10.1111/j.1365-2842.2007.01760.x.
48. Wu CZ, Yuan YH, Liu HH, et al. Epidemiologic relationship between periodontitis and type 2 diabetes mellitus. BMC Oral Health. 2020;20(1):204. doi:10.1186/s12903-020-01180-w.
49. Aldossari KK, Aldiab A, Al-Zahrani JM, et al. Prevalence of prediabetes, diabetes, and associated risk factors among males in Saudi Arabia: a population-based survey. J Diabetes Res. 2018;2018:2194604. doi:10.1155/2018/2194604.