Review Article

Prevalence of periodontitis in Saudi Arabia: A systematic review and meta-analysis

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ABSTRACT

Objective: The aim of this systematic review was to assess the prevalence of periodontal disease among Saudi Arabian adults based on studies conducted from 1992 to 2023.
Methods: The study protocol was registered in PROSPERO. Three databases (MEDLINE, EMBASE and Cochrane library) and the Saudi Dental Journal were searched for published literature up to June 2023 using prespecified search strategy. Quality of included studies was checked using the risk of bias in population-based prevalence studies tool.
Results: The systematic review included 15 studies that assessed the prevalence of periodontal disease in Saudi Arabia. Most of the studies used non-confident case definitions. The pooled estimate of periodontal disease prevalence in Saudi Arabia based on the data of 14 which included 6,596 individuals is 51% (95% CI: 35.99, 73.05).
Conclusion: Periodontal disease is a significant public health issue in Saudi Arabia, with a substantial prevalence among the included participants. Nevertheless, the existing studies exhibit methodological disparities and regional limitations. Therefore, while the results shed light on the pressing nature of periodontal disease in Saudi Arabia, further comprehensive research is imperative. A more accurate estimate, coupled with effective strategies, can be achieved through broader, multidisciplinary collaborations and the prioritization of a national oral health survey in Saudi Arabia.

1. Background

Periodontal disease is a chronic, destructive inflammatory disease of the tissues that support the teeth, it is caused by a complex interaction between harmful oral microorganisms and the immune response of the body (Newman et al., 2006). Gingivitis, a reversible condition with improved oral hygiene, can progress into periodontitis—a chronic, irreversible inflammatory disease causing tissue detachment and bone loss that may lead to tooth loss if untreated (Lang et al., 2021). Lifestyle factors like smoking, poor oral hygiene, obesity, and diets low in calcium and vitamin D are risks for periodontal disease, which can be mitigated with appropriate care. Genetics also play a role in susceptibility. Early risk factor detection is crucial for prevention and treatment, as

periodontal disease is associated with systemic conditions like diabetes, pregnancy complications, COPD, heart disease, arthritis, and osteoporosis (Genco and Borgnakke, 2013, Nazir et al., 2020).

Approximately 20–50 % of people worldwide have periodontal disease (Nazir, 2017). According to the Global Burden of Disease (GBD) 2015 study, severe chronic periodontitis affected 538 million individuals between 1990 and 2015 (Kassebaum et al., 2017). Over the last few decades, there has been a considerable increase in the prevalence of periodontal disease (Vos et al., 2017). In Saudi Arabia, periodontal disease prevalence varies due to differing study designs and populations. The inconsistency highlights the need for standardized epidemiological practices and the influence of varying case definitions, diagnostic criteria, and sampling methods (Irfan et al., 2001, Dye,

2012).

A comprehensive assessment of periodontal health in Saudi Arabia is still lacking, possibly due to the absence of a uniform national surveillance system for periodontal disease prevalence and severity (Alshammari and Wahi, 2019). For effective oral health planning in Saudi Arabia, foundational data is needed, yet no studies on periodontal disease prevalence have used a nationally representative sample. Therefore, this systematic review aims to analyze the available data from previously published studies to determine the prevalence of periodontal disease nationwide in Saudi Arabia, identify any gaps in baseline information, and suggest areas for future research.

2. Methods

All of the authors designed the protocol for this systematic review, which was then submitted to the National Institute for Health Research PROSPERO, the International Prospective Register of Systematic Reviews (https://www.crd.york.ac.uk/PROSPERO, ID Number: CRD42023445193). We followed the updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and the Cochrane Handbook of Systematic Reviews of Interventions guidelines (O'Connor et al., 2008) (Supplementary file 1).

2.1. Type of studies, type of intervention, and inclusion criteria

The review included observational studies, specifically cross-sectional studies and longitudinal studies, that reported the prevalence of periodontitis among individuals aged 18 years old or older in Saudi Arabia with no publication date restrictions. case-control studies were excluded because they are not reliable for estimating prevalence due to sampling issues (Belbasis and Bellou, 2018).Studies were excluded if they used self-reported case definitions of periodontitis, were pre-clinical studies, did not present periodontal data separately for Saudi populations, did not have extractable data or prevalence data, were case reports, or were literature reviews.

2.2. Primary outcome

The main outcome of this systematic review was the prevalence of periodontal disease reported in any area or city in Saudi Arabia.

2.3. Information sources search

The search strategy aimed to find all studies that have observational study designs that were suitable for assessing periodontal disease prevalence in Saudi Arabia between 1992 and 2023.

The search for all eligible studies was conducted in three electronic databases: MEDLINE/PubMed, Scopus/Embase, and Cochrane Library. Additionally, the Saudi Dental Journal was hand-searched. The systematic review encompassed all studies that have observational designs that were suitable for assessing periodontal disease prevalence. Therefore, no study design filter was applied to the search. There were no restrictions regarding the geographical coverage of the study (i.e., local community setting, town, city, province, or country-wide) nor the characteristics of the participants. Grey Literature was searched using google scholar and OpenGrey. A reference list was created that identified all eligible studies. This list was uploaded to Rayyan SoftWare (Ouzzani et al., 2016) and shared among all authors. (MeSHs) and keywords were used to create the following search algorithm in MEDLINE/PubMed: "Periodontal Diseases [MH:noexp] OR gingival diseases [MH:noexp] OR gingival disease* [tw] OR Gingival Recession*[tw] OR Gingivitis [tw] OR Gingival Pocket* [tw] OR periodont*[TW] OR Periodontitis [mh] OR Periodontitis [tw] OR Plaque [tw] OR Oral Hygiene [tw]) AND Prevalence AND Saudi Arabia" The search strategy was modified according to the remaining databases.

2.4. Study selection

The process for selecting studies for our evaluation involved two reviewers (HH and AA) analyzing the titles and abstracts of all the references obtained through electronic searches, to identify studies that may meet our inclusion criteria. The exclusion criteria considered during the title and abstract screening process were: Studies that did not directly address the research question, those not within the scope of the defined population (not conducted among adults aged 18 years or older in Saudi Arabia) and outcomes (Prevalence of periodontal disease), and any that were not original research (e.g., editorials, commentaries, and reviews). If any eligible or potentially eligible studies are identified, the full texts were obtained, and additional reviewers (NA, RT, and FK) assessed them to ensure they meet the inclusion criteria. Any disagreements were settled through discussion with (FFH), and a consensus decision was made.

2.5. Data extraction

All the data that we extracted were recorded in an Excel spreadsheet describing the study characteristics (i.e., study unique reference number, last name of the first author, year and place of publication, study setting, sampling design, and sample size calculations), participant characteristics (i.e., total number of participants in the study, mean age, parameters of periodontal disease, and definition of cases) and outcome measures (i.e. prevalence of periodontitis (%)). The study's methodological risk of bias was addressed later. Due to the effect of case definitions on prevalence estimates (Holtfreter et al., 2015), we divided case definitions into confident and non-confident categories, as described below, using the same methodology adopted by previous periodontitis prevalence systematic reviews (Munoz Aguilera et al., 2020, Trindade et al., 2023).

2.5.1. Confident case definition of periodontitis

- Interdental clinical attachment loss (CAL) in two or more teeth that are not next to each other, or buccal or oral CAL measuring three millimeters or more with periodontal pocket depth (PPD) greater than three millimeters detectable in at least two teeth, as defined by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP)(Tonetti et al., 2018).
- Generalized chronic periodontitis (having at least 30 % of sites with CAL) greater than 4 mm according to the Armitage, 1999 definition of periodontitis(Armitage, 1999).
- At least 2 sites on different teeth with a CAL of 6 mm or more, and at least one site with a PPD of 4 mm or more, according to the CDC/AAP 2007 definition of periodontitis(Page and Eke, 2007).
- The presence of proximal attachment loss of more than 3 mm in two or more non-adjacent teeth, or more than 5 mm in over 30 % of teeth present according to AAP/EFP 2005 definition of periodontitis (Tonetti and Claffey, 2005).
- At least 5 sites with a CAL greater than 6 mm CDC/AAP 2009 definition of periodontitis (Nibali et al., 2013).

2.5.2. Non-confident case definition of periodontitis

- CAL that is equal to or greater than 1 mm.
- Minimum of one site with PPD > 4 mm.
- Community Periodontal Index of Treatment Needs (CPITN)/ CPI score of 3 and 4 in at least one quadrant, following the GBD study (Kassebaum et al., 2014).

2.6. Risk of bias assessment

Two independent reviewers (LA. and FFH.) assessed the methodological quality of the included studies using the "Assessing risk of bias in

population-based prevalence studies" tool (Hoy et al., 2012). Disagreement were resolved through discussion. The tool consists of 10 items, divided into two domains: external validity (item 1; representation of the target population, item 2; representation of the sampling frame, item 3; randomization process, item 4; non-response bias) dealing with selection and non-response bias, and internal validity (items 5; direct data collection from the subjects, item 6; acceptable case definitions, item 7; validity and reliability of the study instruments, item 8; consistent mode of collection, item 9; length of the shortest prevalence period, item 10; numerators and denominators) addressing measurement bias and bias related to analysis. Each item is rated as "yes" (low risk of bias) or "no" (high risk of bias). Items with insufficient information were classified as "no" (high risk of bias). Articles were rated for bias as "High" (0–3 low-risk items), "Moderate" (4–8), or "Low" (9 +).

2.7. Statistical analysis

Data extracted from included manuscripts were organized into tabulated summaries. Due to the existence of multiple prevalence categories and case-definitions for periodontitis and potential study weight imbalances affecting the *meta*-analysis, a double arcsine transformation technique was applied (Barendregt et al., 2013). Given the challenges in assuming true effect sizes due to regional variations and population differences, a random-effects methodology, previously delineated, was chosen (Schwarzer et al., 2015). All *meta*-analyses involving random-effects and associated forest plots were performed using Stata version 18 (StataCorp. 2023. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC.) via the Metaprop function (Nyaga et al., 2014). The results are presented as percentage prevalence (p * 100 %) with corresponding 95 % confidence intervals (CI). Heterogeneity was assessed using the I^2 index ($p < 0.1$) along with the $\chi 2$ test for overall homogeneity (Higgins et al., 2019). All tests were two-tailed, with α set at 0.05.

3. Results

3.1. Study selection

The process of identifying studies for the systematic review, as shown in the PRISMA flow chart (Fig. 1). A total of 713 records were identified after databases search and hand search of The Saudi Dental Journal After deduplication and screening by title and abstract, 625 records

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only
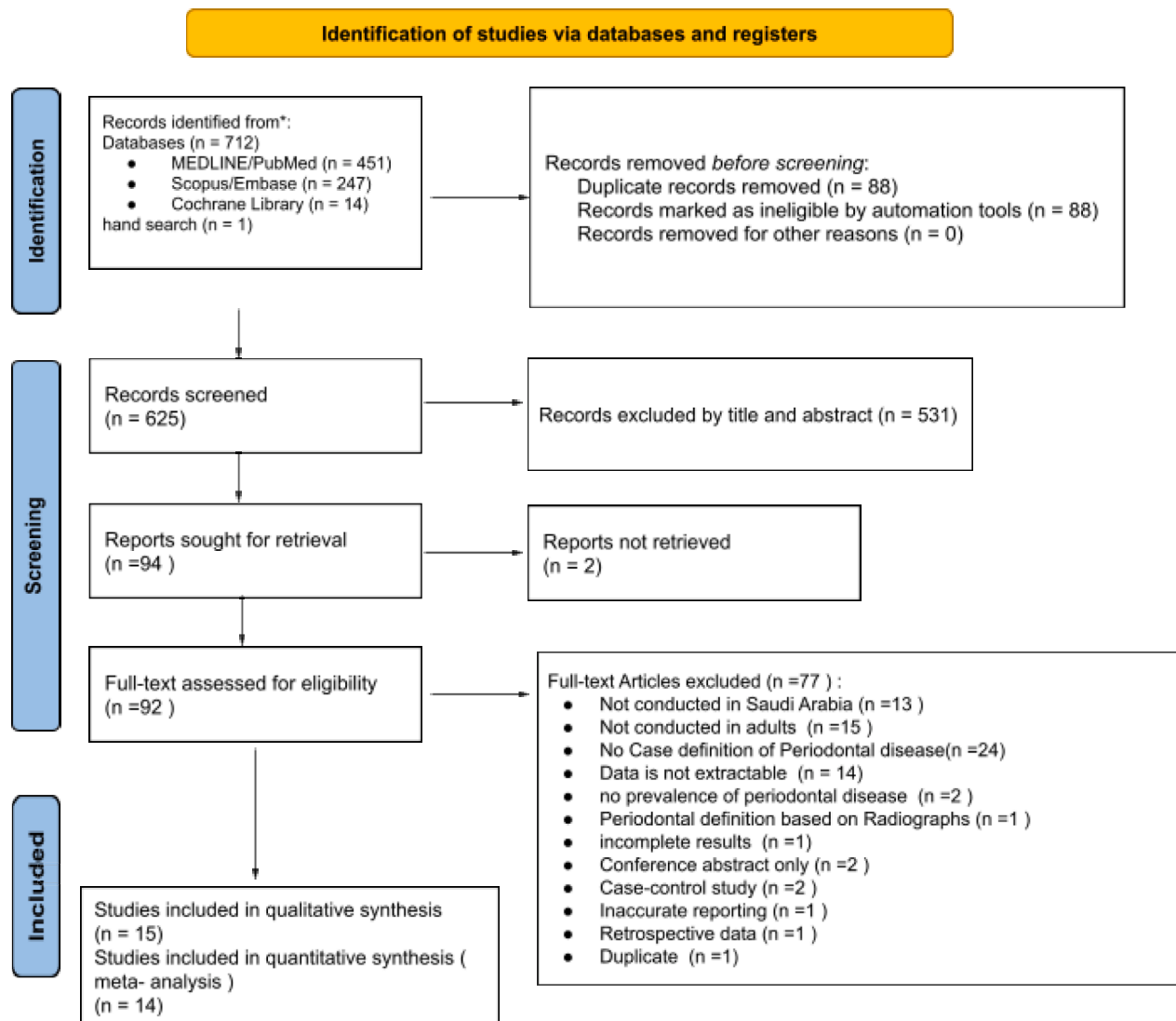

Fig. 1. PRISMA flowchart depicting the process of systematic review inclusion and exclusion.

remained, with 94 advancing; however, two were unattainable despite exhaustive efforts. The full text of the 92 records was retrieved and assessed for eligibility. The full list is presented in (Supplementary file 2). Of these, 77 were excluded, leaving 15 studies to be included in the systematic review.

3.2. Study characteristics

The 15 studies included are summarized in Table 1. The included studies were conducted between 1992 and 2022. All studies were published in English and used a cross-sectional study design. A vast majority 60 % of the studies were conducted in Riyadh, with the remaining studies conducted in (Jeddah, Al Madinah Al-Munwarrah, Abha, and Zulfi). Most of the studies (80 %) were hospital-based, with only two studies being community-based(Guile, 1992, Farsi, 2010). The specific characteristics of the study populations varied widely. Most studies used convenience sampling methods, with sample sizes ranging from 40 to 1238 participants. The mean age of participants ranged from 28.4 to 38.34 years. A variety of periodontal case definitions were used in the studies, with the CPITN being the most predominantly used (40 %), followed by CPI (20 %). Other studies used the AAP/EFP 2018 classification (Alawaji et al., 2022, Alahmari et al., 2023) the AAP/CDC 2012 case definitions (Ahmad et al., 2019, Alawaji et al., 2022) and AAP 1989 (Almas and Awartani, 2003). The overall prevalence of periodontal disease ranged from a lowest of 3.69 % to a height of 92.5 %.

3.3. Synthesis of results

A random-effects *meta*-analysis of 14 studies revealed a pooled estimate of periodontal disease prevalence of 51 % (95 % CI: 0.36, 0.65) in 6,596 participants. The results also demonstrated significant heterogeneity among the prevalence estimations, with an I^2 statistic of 99.63 % (p < 0.01), as shown in (Fig. 2). The overall prevalence of periodontal disease in Saudi Arabia based on 11 studies that used non-confident case definition is 48 % (95 % CI: 0.30, 0.65), whereas the three studies that used confident case definition yielded a higher prevalence of periodontal disease of 60 % (95 % CI: 0.31, 0.89).

3.3.1. Subgroup analysis on special characteristics of the studies samples

Three studies of diabetic patients reported a pooled periodontal disease prevalence of 52 % (95 % CI: 0.13, 0.92). A sole study of drug addiction recovery patients yielded a considerably higher prevalence of 79 % (95 % CI: 0.68, 0.90). Four studies of young adults generated a collective prevalence of 35 % (95 % CI: 0.01, 0.70). Samples lacking special characteristics possessed a prevalence of 51 % (95 % CI: 0.31, 0.72). As shown in (Supplementary file 3).

3.3.2. Subgroup analysis based on case-definition of the studies samples

Two studies applying AAP\EFP 2018 showed a pooled prevalence of 60 % (95 % CI: 0.11, 1.10). While implementation of CPITN/CPI signified a prevalence of 42 % (95 % CI: 0.21, 0.64), as shown in (Supplementary file 4).

3.3.3. Subgroup analysis based on examination protocol of the studies samples

Four studies that employed full-mouth examinations calculated a pooled prevalence of periodontal disease of 63 % (95 %CI: 0.38, 0.88). In contrast, the six studies utilizing partial-mouth assessments reported a lower aggregate prevalence of 36 % (95 % CI: 0.14, 0.59). A third group of three studies that did not specify their examination modality produced a prevalence of 59 % (95 % CI: 0.31, 0.87). As shown in (Supplementary file 5).

3.4. Quality assessment

Table 2 provides an overview of the included studies' quality

assessment, as per the criteria established by Hoy et al. (Hoy et al., 2012). The majority of the studies demonstrated a moderate risk of bias. Notably, deficiencies were predominantly observed in the domains of Selection, Representativeness, and Randomization. It's worth noting that two studies attained a low risk of bias (Guile, 1992, Farsi, 2010).

3.5. Publication and small study effect bias

Based on Egger test to detect small-study effects or publication bias (Fig. 3), there is a potential bias (p-value = 0.04), indicating that smaller studies may yield different results from larger ones, potentially due to publication bias or study selection. Moreover, the funnel plot exhibited a degree of inconsistency with the outcomes of the conducted *meta*-analyses. Nevertheless, the evaluation of publication bias and small study effect bias could be misleading due to an insufficient and limited number of included studies.

4. Discussion

This review was conducted with the objective of systematically assessing the prevalence of periodontal disease among adults in Saudi Arabia based on existing literature. The outcomes of this methodical review firmly establish periodontitis as a pressing public health issue in Saudi Arabia, evidenced by a substantial pooled prevalence of 51 % drawn from 14 studies conducted among Saudi Arabian adults from 1992 to 2023. Notably, the CPITN criteria emerged as the predominant means of defining periodontal disease, while the CDC/AAP 2007 criteria stood out as the prominent confident definition in use.

We identified and analyzed 14 studies reporting on the prevalence of periodontal disease in Saudi Arabia. These studies exhibited a wide-ranging prevalence, varying from 3.6 % to an extensive 92.5 %. By aggregating data from these studies, involving a total participant count of 6,596, we conducted a comprehensive *meta*-analysis to offer a more holistic perspective on the burden of periodontal disease within the Saudi Arabian population. The outcome of this *meta*-analysis revealed an estimated overall prevalence rate of approximately 51 %. This substantial prevalence aligns with observations from earlier systematic reviews conducted in India (Janakiram et al., 2020) and Vietnam (Tran et al., 2023), where reported rates were 51 % (95 %CI: 41.9–60.1) and 64.9 % (95 % CI: 45–81 %), respectively, highlighting a comparable estimates of periodontal disease prevalence in those respective nations. However, this estimate was higher than the United States (42 %), which was derived from a nationally representative survey conducted in 2009–2014. It should be noted that the periodontal examination was based on a comprehensive periodontal examination collecting PD and CAL from full mouth (Eke et al., 2018). In the subgroup analysis, the combined estimate for confident case definitions surpassed that of non-confident case definitions. This suggests that adopting a stricter periodontal disease definition could yield a higher estimated prevalence. This finding aligns with earlier systematic reviews on periodontal disease prevalence in dentate adults and the link between periodontal disease and cardiovascular conditions (Munoz Aguilera et al., 2020, Trindade et al., 2023). However, it's important to acknowledge the challenge posed by the multitude of periodontal disease case definitions. This complexity hampers interpretation and study comparisons, potentially contributing to the broad spectrum of prevalence rates documented in the literature (Frencken et al., 2017).

Despite efforts for broad inclusion, the limited number of studies underscores the need for more research to fully grasp periodontal disease's impact in Saudi Arabia, necessitating a multidisciplinary approach and a comprehensive oral health survey for better preventive and treatment strategies (Watt, 2005). By conducting a nation-wide survey, involving collaboration between dental professionals, epidemiologists, public health officials, and governmental bodies, Saudi Arabia can obtain precise and up-to-date data on oral health status, risk factors, and disparities across different segments of the population. This survey

Table 1
Included studies characteristics.

	First author	Year	Study design	Location	Type of population	Special characteristics	Sampling techniques	Number of participants	Mean age	Age group	Females %	Periodontal assessment/ parameters	Case definition	Examination protocol	Overall prevalence
1	Farsi	2010	Cross-sectional	Jeddah	Community based	Young adults	Stratified random sampling	1761	NR	16–24	56,8%	PD	CPITN score	Partial mouth	3.69 %
2	Habib	2009	Cross-sectional	Al Madinah Al-Munwarrah (Ohud Hospital)	Hospital based	Pregnant females with gestational diabetes,	Convenience sample	250	31.7 ± 5.29	NR	100 %	PD	CPITN score	Full-mouth	29.2 %
3	Almas	2001	Cross-sectional	Riyadh (College of Dentistry, King Saud University)	Hospital based	20 Diabetic patients and 20 nondiabetic patients	Convenience sample	40	NR	20–70	NR	PD and CAL	CPITN score	NR	92.5 %
4	Awartani	1999	Cross-sectional	Riyadh (College of Dentistry, King Saud University)	Hospital based	Smokers and non-smokers	Convenience sample	174	38.34 ± 9.45	25–55	50 %	PD and CAL	CPITN score	Partial mouth	65.3 %
5	Guile	1992	Cross-sectional	Riyadh (Central Saudi Arabia)	Community based	N/A	Random cluster sample	1238	NR	15–64	NR	PD, BOP, calculus	CPITN score	Partial mouth	34.2 %
6	Alawaji	2022	Cross-sectional	Riyadh (College of Dentistry, King Saud bin Abdul-Aziz University)	Hospital based	N/A	Purposive sampling	431	35.4 ± 13.3	NR	57,50 %	PD and CAL	Prevalence CDC/AAP 2012	Partial mouth	78.4 %
7	Alawaji	2022	Cross-sectional	Riyadh (College of Dentistry, King Saud bin Abdul-Aziz University)	Hospital based	N/A	Purposive sampling	431	35.4 ± 13.3	13–80	57,50 %	plaque scores, PD, CAL, BOP	AAP/EFP 2018, CDC/AAP 2012/2007	Full mouth	(AAP/EFP 85.4 %) (CDC/AAP 78.4 %)
8	Alahmari	2023	Cross-sectional	Abha (Center at King Khalid University and Aseer Central Hospital)	Hospital based	Diabetic patients	Convenience sample	499	Median 37 years (IQR 28–50)	NR	68,70 %	PD and CAL	AAP/EFP 2018	NR	34.9 %
9	Ahmad	2019	Cross-sectional	Riyadh (Elm University)	Hospital based	Dental students	Convenience sample	296	NR	NR	44,90 %	GI, PD and CAL	CDC/AAP 2012/2007	Full mouth	60 %
10	Almas	2003	Cross-sectional	Riyadh (Teaching hospital, King Saud University)	Hospital based	Healthy and medically compromised patients (patient with periodontal disease)	Convenience sample	743	41	18–64	77,43 %	NR	AAP 1989	NR	74.4 %
11	Thomas	2020	Cross-sectional	Zulfi (College of Dental Science)	Hospital based	Obese young adults = 30 BMI or more	Convenience sample	307	28.4 ± 7.1	18–40	46,60 %	PD and loss of attachment (LOA) / debris index and calculus index	CPI	Partial mouth	71.3 %

(*continued on next page*)

Table 1 (*continued*)

	First author	Year	Study design	Location	Type of population	Special characteristics	Sampling techniques	Number of participants	Mean age	Age group	Females %	Periodontal assessment/ parameters	Case definition	Examination protocol	Overall prevalence
12	Farsi	2008	Cross-sectional	Jeddah (School of dentistry, King Abdulaziz University)	Hospital based	N/A	Stratified random sampling	312	NR	19–40	57,37 %	NR	CPI	Partial mouth	37.4 %
13	Kayal	2014	Cross-sectional	Jeddah (Al-Amal Hospital (drug rehabilitation center)	Hospital based	Drug addiction recovery patients	Convenience sample	57	NR	NR	0 %	PD and CAL (PI, BOP, Gingival recession)	CAL (moderate (3–4 mm) or severe (≥5mm))	Full mouth	79.9 %
14	Dhaifallah	2019	Cross-sectional	Riyadh (Al-Farabi Dental College)	Hospital based	Dental student	Convenience sample	308	24.0 ± 3.1	21–35 years	50 %	Plaque index - Plaque index - CPI -PD	CPI	Partial mouth	8.1 %
15	Almas	1996	Cross-sectional	Riyadh (College of Dentistry, King Saud bin Abdul-Aziz University)	Hospital based	N/A	Convenience sample	180	38.34 ± 9.45	25–55	50 %	PD	CPITN score	NR	65 %

PD: Pocket depth, CAL: Clinical attachment loss, BOP: Bleeding on probingIQR: Interquartile range, NR: Not reported. N/A: Not applicable.
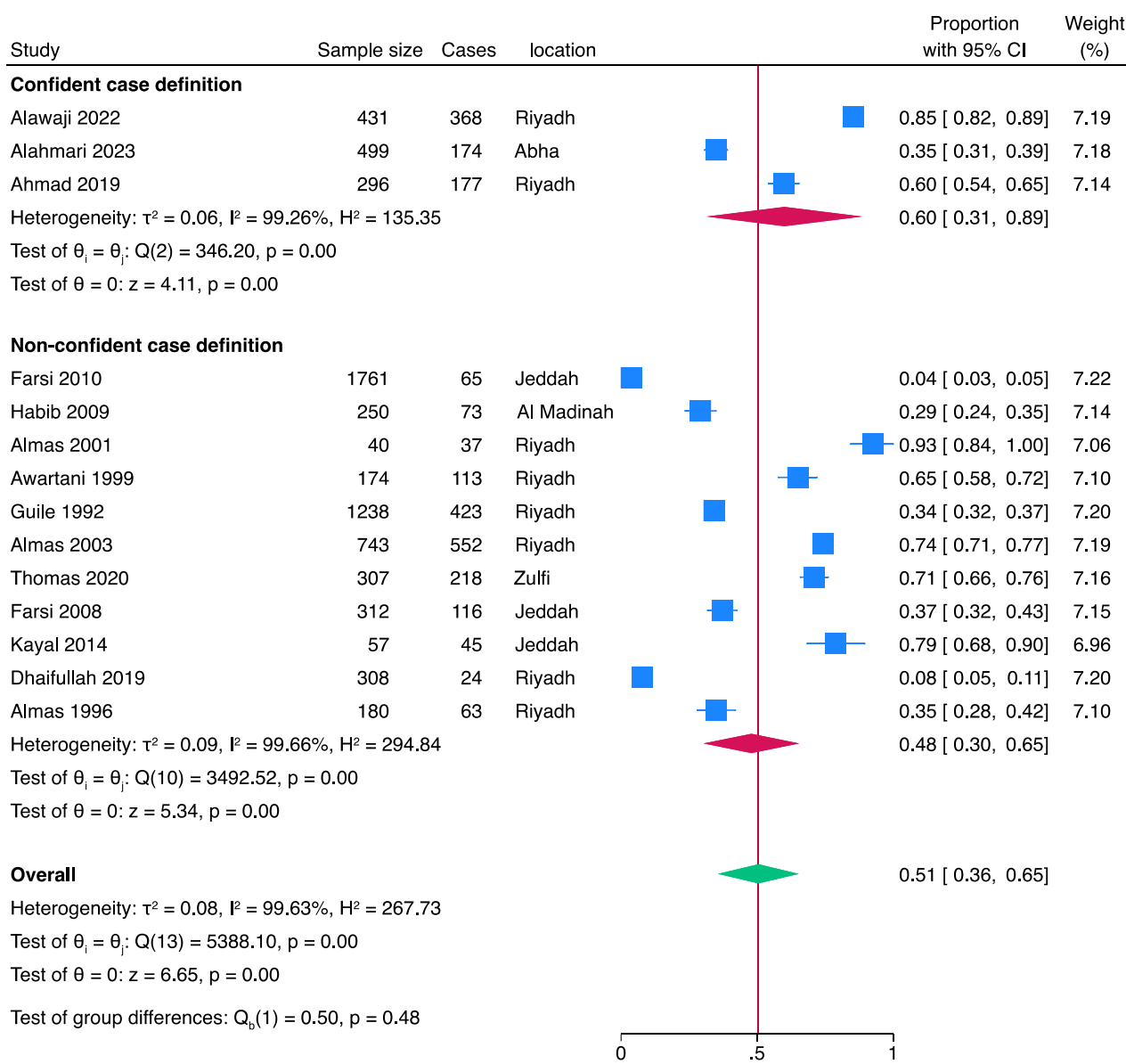
would provide invaluable insights that would inform evidence-based policies, facilitate early intervention, and ultimately lead to improved oral health outcomes for all residents of Saudi Arabia.

The high prevalence of periodontal disease in Saudi Arabia can be attributed to a multitude of factors. Societal habits such as widespread consumption of tobacco usage, and limited awareness or practice of proper oral hygiene play a significant role in exacerbating the situation. Cultural factors and limited accessibility to preventive dental care could also contribute to this high incidence. Moreover, with the demographic shift towards an aging population in Saudi Arabia (Salam, 2023), the problem is expected to persist or even grow. As the population ages, there is a trend towards retaining natural teeth for longer periods (Slade et al., 2014). The retention of natural teeth into old age, combined with other age-related systemic health issues, makes the older adults more susceptible to periodontal diseases. This evolving demographic profile, juxtaposed with existing societal and healthcare challenges, suggests that the high prevalence of periodontal disease will likely remain a significant public health concern for the foreseeable future in the country.

The assessment of this systematic review's strengths and limitations predominantly revolves around the varying methodological quality of the included studies. Nevertheless, we adhered to cutting-edge guidelines throughout the preparation, execution, and reporting of the review (Higgins and Green, 2008, Page et al., 2021), while also meticulously examining the level of confidence associated with the employed periodontal case definitions which might introduce bias into the prevalence of periodontal disease following previous systematic reviews (Munoz Aguilera et al., 2020, Trindade et al., 2023). This review comes with certain limitations that warrant acknowledgment and consideration. Firstly, the included studies exhibited a range of methodologies, especially regarding the definition of periodontal disease cases. Such methodological disparities could potentially introduce bias and hinder the generalizability of the findings. Secondly, the majority of the studies featured in this review were conducted within hospital settings. This approach might lead to an overrepresentation of specific population segments, such as individuals actively seeking oral healthcare services or those with particular health conditions. Consequently, the general population might be underrepresented, and the reported prevalence rates may not accurately mirror the actual occurrence of periodontal disease in Saudi Arabia. Third, most of the studies did not include clear information on the prevalence of periodontal disease stratified by gender, and age groups which limited our ability in conducting additional subgroup analysis to explore potential variations in periodontal disease prevalence among different demographic groups. Fourth, we only identified studies from four regions in Saudi Arabia, thus, it is hard to generalize the findings to the whole country. We recognize that the inclusivity of our research question, the heterogeneity in examination protocols and periodontal assessments, and the diversity in case definitions across studies may introduce variability, potentially impacting the generalizability and interpretation of the prevalence rates, which has been acknowledged as a limitation of this analysis. However, to our knowledge, this is the first attempt to systematically estimate the prevalence of periodontal disease in Saudi Arabia and its findings hold significant potential to inform local authorities and contribute to the enhancement of public oral health. Furthermore, we stress the importance of ongoing epidemiological surveillance, both at national and regional levels, utilizing appropriate diagnostic methods such as confident periodontal case definitions using full mouth screening protocols. This approach is vital for conveying precise estimates and facilitating the generation of comprehensive *meta*-analytical national insights.

5. Conclusion

Based on the available literature, periodontal disease is a public health problem in Saudi Arabia with a high prevalence. However, given the limited number of studies and the varying methodological quality

Study	Sample size	Cases	location	Proportion with 95% CI	Weight (%)
Confident case definition					
Alawaji 2022	431	368	Riyadh	0.85 [0.82, 0.89]	7.19
Alahmari 2023	499	174	Abha	0.35 [0.31, 0.39]	7.18
Ahmad 2019	296	177	Riyadh	0.60 [0.54, 0.65]	7.14
Heterogeneity: $\tau^2 = 0.06$, $I^2 = 99.26\%$, $H^2 = 135.35$				0.60 [0.31, 0.89]	
Test of $\theta_i = \theta_j$: Q(2) = 346.20, p = 0.00					
Test of $\theta = 0$: z = 4.11, p = 0.00					
Non-confident case definition					
Farsi 2010	1761	65	Jeddah	0.04 [0.03, 0.05]	7.22
Habib 2009	250	73	Al Madinah	0.29 [0.24, 0.35]	7.14
Almas 2001	40	37	Riyadh	0.93 [0.84, 1.00]	7.06
Awartani 1999	174	113	Riyadh	0.65 [0.58, 0.72]	7.10
Guile 1992	1238	423	Riyadh	0.34 [0.32, 0.37]	7.20
Almas 2003	743	552	Riyadh	0.74 [0.71, 0.77]	7.19
Thomas 2020	307	218	Zulfi	0.71 [0.66, 0.76]	7.16
Farsi 2008	312	116	Jeddah	0.37 [0.32, 0.43]	7.15
Kayal 2014	57	45	Jeddah	0.79 [0.68, 0.90]	6.96
Dhaifullah 2019	308	24	Riyadh	0.08 [0.05, 0.11]	7.20
Almas 1996	180	63	Riyadh	0.35 [0.28, 0.42]	7.10
Heterogeneity: $\tau^2 = 0.09$, $I^2 = 99.66\%$, $H^2 = 294.84$				0.48 [0.30, 0.65]	
Test of $\theta_i = \theta_j$: Q(10) = 3492.52, p = 0.00					
Test of $\theta = 0$: z = 5.34, p = 0.00					
Overall				0.51 [0.36, 0.65]	
Heterogeneity: $\tau^2 = 0.08$, $I^2 = 99.63\%$, $H^2 = 267.73$					
Test of $\theta_i = \theta_j$: Q(13) = 5388.10, p = 0.00					
Test of $\theta = 0$: z = 6.65, p = 0.00					
Test of group differences: $Q_b(1) = 0.50$, p = 0.48					

0   .5   1

Random-effects REML model

Fig. 2. Forest plots for periodontal disease prevalence in the Saudi population during the 1992–2023.

and heterogeneity among the studies, further research is needed to obtain a more precise estimate of the prevalence of periodontal disease in Saudi Arabia and improve oral health among the Saudi population.

Ethical approval

As this study is a systematic review, it did not involve primary data collection from human participants, and hence, ethical approval was not required. The protocol for this review was registered with PROSPERO, ensuring transparency and adherence to recognized review methodologies.

CRediT authorship contribution statement

Faisal F. Hakeem: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision. **Lina AlQobaly:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Hatem Hazzaa Hamadallah:** Conceptualization, Methodology, Data curation, Writing – original draft. **Aseel Mohammed Aloufi:** Conceptualization, Methodology, Data curation, Writing – original draft. **Raneem Ahmad Tarawah:** Conceptualization, Methodology, Data curation, Writing – original draft. **Nujud Ghazai Aloufi:** Conceptualization, Methodology, Data curation, Writing – original draft. **Feras Ahmad Khaleefah:** Conceptualization, Methodology, Data curation, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 2
Assessing risk of bias in prevalence studies (Hoy et al., 2012).

|	Articles	External Validity				Internal Validity						Overral RoB
		Selection and non-response bias domains				Measurement bias and bias related to the analysis domains						
		1	2	3	4	5	6	7	8	9	10	
1	Farsi, 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low RoB
2	Habib 2009	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
3	Almas et al., 2001	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Moderate RoB
4	Awartani and Al-Jasser 1999	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Moderate RoB
5	Guile, 1992	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low RoB
6	Alawaji et al., 2022	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
7	Alawaji et al., 2022	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
8	Alahmari et al., 2023	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
9	Dhaifullah et al., 2019	No	No	No	No	No	Yes	No	Yes	Yes	Yes	Moderate RoB
10	Ahmad et al., 2019	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
11	Almas and Awartani, 2003	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Moderate RoB
12	Thomas et al., 2020	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
13	Farsi et al., 2008	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Moderate RoB
14	Kayal et al., 2014	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Moderate RoB
15	Almas K 1996	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Moderate RoB
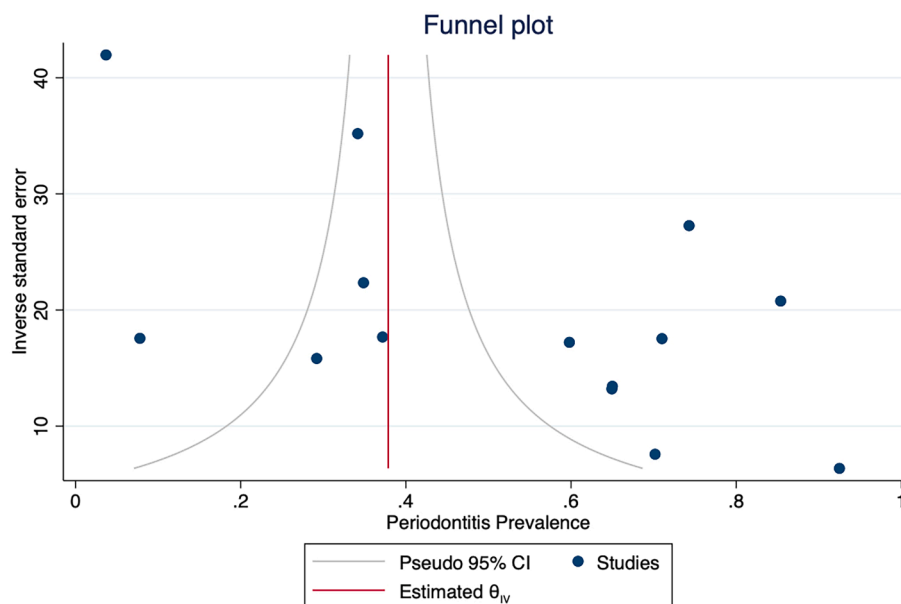
Fig. 3. Funnel plot for the *meta*-analysis of periodontal disease prevalence in the Saudi population during the 1992–2023.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2023.11.022.

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