Ethiopian Journal of Health and Biomedical Sciences

Original article Open access

Prevalence and associated factors of periodontal disease in Ethiopia: systematic review and meta-analysis

Amare Teshome Tefera [1], Nebiyou Bekele[2], Shegaye Shumet[3], Martha Solomon[4], Tigist Mulugeta[5], Dessie Abebaw[6]*

[1]Department of Dentistry, College of Medicine and Health science, School of Medicine, University of Gondar, Gondar, Ethiopia. teferaden@gmail.com, [2] Department of Neurology, College of Medicine and Health Science, School of Medicine, University of Gondar, Gondar, Ethiopia, [3] Department of Psychiatry, College of Medicine and Health Science, School of Medicine, University of Gondar, Gondar, Ethiopia, [4] Department of Pediatrics and Child Health, College of Medicine and Health Science, School of Medicine, University of Gondar, Gondar, Ethiopia, [5] Clinical nurses, College of Medicine and Health Science, School of Medicine, University of Gondar, Gondar, Ethiopia, [6] Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Science, School of Medicine, University of Gondar, Gondar, Ethiopia

***Corresponding author: Email:** teferaden@gmail.com*

Citation: Teshome Tefera A, Bekele N, Shumet S, Solomon M, Mulugeta T, Abebaw D. Prevalence and associated factors of periodontal disease in Ethiopia: systematic review and meta-analysis. Ethiop J Health Biomed Sci. 2025;15 (1):59-72.

DOI: https://doi.org/10.20372/ejhbs.v15i1.1107

Article History

Submitted: June 18, 2025
Revised: August 1, 2025
Accepted: August 11, 2025

Key words: Dental condition; Ethiopia; Oral health; Periodontal disease; Periodontitis

Publisher: University of Gondar

Abstract

Background: *Periodontal disease, a chronic bacterial infection of the periodontium, is the major cause of tooth loss, masticatory dysfunction, and edentulism. These outcomes adversely affect nutritional status, self-esteem, and quality of life, while also contributing to significant healthcare costs and socio-economic burden. Although oral diseases affect approximately 3.5 billion people globally, with 75% residing in low- and middle -income countries, the national prevalence of periodontal disease in Ethiopia remains undetermined.*

Objective: *This review aimed to determine the pooled prevalence and associated factors of periodontal disease in Ethiopia.*

Method*: A systematic search was conducted across PubMed, Scopus, Embase, and Google Scholar to identify relevant studies on periodontal disease in Ethiopia, from inception to April 2023, with no language restrictions. Data were extracted using Microsoft Excel and analyzed in Stata version 17. The pooled prevalence and associated factors were estimated using a random-effects mode due to the high heterogeneity. Heterogeneity was assessed using the Higgs I^2 statistic and the Cochrane Q test. Subgroup and sensitivity analyses were conducted to explore source of heterogeneity. The review adhered to the PRISMA guidelines, and the protocol was registered in PROSPERO (CRD42023415994).*

Result: *Thirteen studies comprising 10,744 participants were included. The pooled prevalence of periodontal disease in Ethiopia was 35% (95% CI: 25% – 45%) with substantial heterogeneity (I^2=99.46%). The highest prevalence was reported in Addis Ababa (42%; 95% CI: 29% to 55%) and among institutionalized individuals (49%; 95% CI: 44 – 55%). Regular toothbrushing was associated with lower odds of periodontal disease (OR = 0.26; 95% CI: 0.24 – 0.28), while male gender (OR = 0.72, 95% CI: 0.64 – 0.80) and carbohydrate intake (OR = 0.54, 95% CI: 0.44 – 0.65) were significantly associated with a reduced risk of periodontal disease in Ethiopia.*

Conclusion: *Periodontal disease affects approximately one in three Ethiopians, with higher prevalence among institutionalized populations. Key determinants include inadequate oral hygiene, female gender, and dietary habits. These findings underscore the need for targeted oral health interventions, including the promotion of regular tooth brushing and dietary modification. National policies should support standardized diagnostic guidelines and integrate oral health services into broader community health programs.*

Introduction

Periodontal disease is a chronic inflammatory condition of the periodontium, leading to the progressive destruction of the periodontal ligament and surrounding alveolar bone (1, 2). According to the 2022 World Health Organization (WHO) Global Oral Health Status Report, around 3.5 billion people worldwide are affected by oral diseases, disproportionately affecting populations in low- and middle-income countries (LMICs) (75%) (3). In Ethiopia, the burden of periodontal disease is likely substantial because of poor dental services coverage and high unmet needs. Yet, it remains poorly documented due to the absence of a national surveillance system.

The Global Burden of Disease (GBD) study ranks periodontal disease as the 11th most prevalent condition globally, with prevalence ranging from 20% to 50% (4). A meta-analysis from India found that 51% of adults had periodontal disease (5), while data from the USA indicated that 47% of the adults suffer from moderate-to-severe forms of the condition (6).

Periodontal disease is the leading cause of tooth loss, posing significant public health challenges (7, 8). In its advanced stages, periodontitis contributes to multiple tooth loss, masticatory dysfunction, and edentulism, which negatively impact nutrition, self-esteem, social functioning, and quality of life, while also imposing huge socio-economic and healthcare costs (9-11). The oral cavity harbors over 800 species of bacteria, and periodontal disease arises from complex interactions between microbial biofilm and the host immune response. Poor oral health behaviors, including smoking and inadequate tooth brushing habits, often exacerbate this interaction (7, 8). Besides these behavioral factors, sociodemographic and psychosocial factors such as low income, limited education, advanced age (2, 12, 13) and psychosocial stress has been implicated as a risk factor for periodontal disease(14).

Emerging evidence highlights a bidirectional relationship between periodontal disease and several health conditions. The systemic dissemination of periodontal pathogens and inflammatory mediators has been associated with a range of systemic diseases or conditions(15), including cardiovascular disease, adverse pregnancy outcomes, cancer, respiratory diseases, diabetes mellitus, and chronic kidney disease(16-19). The biological plausibility of these associations is primarily attributed to the systemic inflammatory burden generated by periodontitis (16-19).

Despite being a largely preventable and manageable condition, the global prevalence of periodontitis is increasing. This underscores the need for enhanced strategies for early detection, prevention, and treatment. The global prevalence of severe periodontal disease is gradually increasing despite efforts to prevent and control the progression of periodontitis (20). In response, there has been a global call since 2017 to integrate periodontal care into the health systems and public health frameworks (21).

Ethiopia, a low-income country in East Africa with an estimated population of 120 million, lacks a national surveillance system for oral health, including periodontal disease. Existing data from isolated cross-sectional studies show a wide variation in prevalence, from 7% (22) to 75.8% (23), highlighting both the magnitude of the problem and the inconsistency in reporting. To date, there has been no comprehensive synthesis of the available evidence on the prevalence of periodontal disease and its associated factors in Ethiopia.

Therefore, this systematic review and meta-analysis was conducted to fill this knowledge gap. Specifically, it aims to estimate the pooled prevalence of periodontal disease in Ethiopia and identify its key associated factors. The findings address a critical knowledge gap and provide evidence to inform national oral health planning, prevention strategies, and policy integration with Ethiopia's broader health system.

Research Question

Among the Ethiopian population, what is the prevalence of periodontal disease, and what factors are associated with an increased risk?

Method

Study Design and Protocol Registration

This systematic review and meta-analysis was conducted following the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) checklist (24). We registered the protocol in the International Prospective Register of Systematic Reviews (PROSPERO) under registration ID PROSPERO database (CRD42023415994).

Information Sources and Search Strategy

We conducted a systematic search of studies using electronic databases (PubMed, Scopus, and Embase) and websites (Google and Google Scholar) covering all publications from the inception to March 2023. Search terms including combinations of Medical Subject Headings (MeSH) and keywords such as "periodontal disease" OR "Periodontitis" OR "oral disease" OR "gum disease" AND "Prevalence" OR "epidemiology" AND "determinants" OR "risk factor" AND "Ethiopia". Additionally, reference lists of included articles were manually screened to identify any relevant studies missed during the database search. We compiled the search results using EndNote reference citation management software. The article search was done from April 05 to 10/2023. No restrictions were placed on the language of publication during the search.

Eligibility criteria

Studies were included if they: (1) were conducted in Ethiopia; (2) were population/community level, institutional, or hospital-based studies; (3) included human participants; (4) with a clear definition and measurement of periodontitis; and (5) reported prevalence data or had sufficient information to estimate the prevalence.

Excluded studies were: (1) studies focused on one gender only (i.e., pregnancy-related periodontal disease); (2) conducted on animals; (3) not reporting prevalence or associated factors; or (4) were reviews, case reports, or editorials.

Study selection

All studies retrieved during the article search was imported into EndNote 20 for reference management, and duplicate records were removed. The screening process for article selection was completed in two stages. Initially, the titles and abstracts of all identified studies were screened independently by two reviewers (AT & SS) to assess eligibility based on the inclusion and exclusion criteria. In the second stage, full-text articles of potentially relevant studies were retrieved and reviewed in detail to determine final inclusion. Any disagreement between the two reviewers was resolved through discussion. When consensus could not be reached, a third investigator (NB) was consulted to make the final decision.

Data extraction

The entire potentially relevant information from the included studies was independently extracted by two investigators (AT & NB) using a pre-designed, standardized Microsoft Excel form. The data extracted includes the following variables: name of primary author, year of publication, study region, sample size, study population (institution-based or community-based), study setting (community, school, or institution), prevalence of periodontal disease, diagnostic tool of periodontitis, and possible predictor variables. In case of disagreement between the two reviewers, a third investigator (MS) was consulted to reach a consensus and made the final decision. For predictor variable assessment, we extracted effect size estimates such as odds ratios (ORs) along with their corresponding 95% confidence intervals (CIs) for each included study.

Risk of bias assessment

The quality of the included articles was evaluated using a 10 -item critical appraisal tool adapted from Hoy et al.'s risk of bias tool for prevalence studies (25). The tool consists of 10 items, of which the first four items assessed the externa validity of the study (domains are section and non-response bias), and items 5 to 10 assessed the internal validity of the study (items 5 to 9 assess the domain of measurement bias, and item 10 assesses bias related to analysis). Each study received a score ranging from 0 to 10, with a lower score indicating a higher risk of bias. Based on total score, the overall risk of bias was categorized as low risk of bias (7-10), moderate risk of bias (4-6), and high risk of bias (0-3) scores. Two reviewers (DA and SS) independently assessed the quality of each study, and they resolved any discrepancies by consulting a third reviewer (MS).

Outcome of interest

The primary outcome of this review was the pooled prevalence of periodontal disease among the Ethiopian population. The secondary outcome was the identification and synthesis of predictor variables associated with periodontal diseases reported across the included studies.

Statistical analysis and synthesis of findings

Before conducting the pooled analysis, we evaluated the presence of heterogeneity among the included studies I^2 test (Higgins' method) and Cochrane's Q test. An I^2 value greater than 75% combined with a statistically significant P-value ($P<0.05$) was considered indicative of high heterogeneity. In such cases, a random effect model was used. If heterogeny was low (or had a non-significant P-value a fixed effects model was applied.

The meta-analysis was conducted using STATA version 17 software. The pooled prevalence of periodontal disease was calculated with a 95% confidence interval (CI), based on sample size and number of periodontal patients. To explore the source of heterogeneity, subgroup analysis was done based on region and type of population. Moreover, a sensitivity analysis was done to examine the presence of potential influential studies of the pooled prevalence by sequentially excluding individual studies to identify the potential outliers or overinfluential studies. Publication bias was assessed using visual inspection of the funnel plot, Egger's regression test, and Doi plots. The Doi plots, accompanied by the Luis Furuya-Kanamori (LFK) index, is a quantitative measure of asymmetry in the Doi plots. An LFK index value within ±1 indicates no asymmetry, values between ±1 and ±2 suggest minor asymmetry, and values beyond ±2 indicate major asymmetry. Where publication bias was detected, the trim and fill method was applied to estimate and adjust for the potential impact of missing studies on the pooled prevalence estimate.

Predictor variables were analyzed using a random-effects meta-analysis model. Adjusted odds ratios (AORs) and their corresponding standard errors were log-transformed and pooled using the generic inverse variance method. Separate meta-analyses were conducted for each predictor reported in at least two studies.

Result

Selection of Included Studies

A total of 101 articles were retrieved electronically using databases and gray literature sources. Of these, 21 were duplicates and were removed using EndNote 20. The remaining 80 articles were screened based on titles and abstracts. Of these, 53 articles were found to be irrelevant to the study objectives and were excluded. The full texts of the remaining 27 articles were then assessed against the inclusion and exclusion criteria. Following the full-text review, 13 articles met all eligibility criteria and were included in the final systematic review and meta-analysis. A detailed summary of the screening and selection process is illustrated in the PRISMA flow diagram (**Figure 1).**

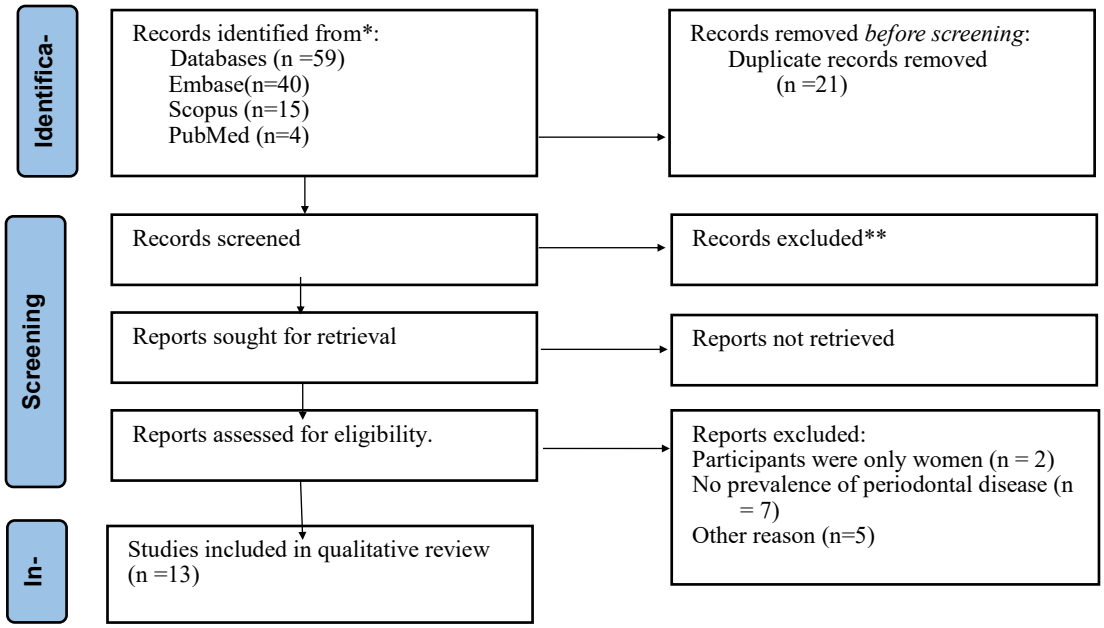

Figure 1: *PRISMA flow diagram showing the article selection process*

Characteristics of the included studies

The included 13 cross-sectional studies were conducted in three regions of Ethiopia. Five of the included studies were conducted in Addis Ababa, followed by Amhara (n=4) and Oromia (n=4). The study settings varied, including community-based studies (n=4), hospital-based studies (n=4), and institutional settings such as schools, prisons, and care homes (n=5). Of these, one study specifically targeted students living with disabilities. The sample size ranged from 132 (26) to 3,451(27) participants, with a total pooled sample of 10,744 individuals. Of these, 5,479 (50.99%) participants were male. The included studies were conducted from 1978 to 2022. The reported prevalence of periodontal disease across studies ranged from 7.0% (22) to 75.83% (23) (**Table 1**).

Table 1: Characteristics of the included studies

S. No	Author (year)	Place of the study	Study setting	Sample size	Prevalence	Risk of bias
	Vered et al., 2003 (28)	Amhara	Community-based study	487	0.1396	Low
	Zini et al., 2009(29)	Amhara	Community-based study	340	0.3647	Low
	Diro et al., 2008(30)	Addis Ababa	Hospital-based study	384	0.2317	Moderate
	Meyrema & Kedir, 2018(31)	Oromia	School-based study	422	0.4384	Low
	Duguma et al., 2019(32)	Addis Ababa	Institutionalized	182	0.5109	Moderate
	Derara et al., 2021(27)	Oromia	Hospital-based study	3,451	0.1083	Moderate
	Burnet et a, 2015(26)	Addis Ababa	Institutionalized	132	0.4696	Moderate
	Simon et al, 2003(33)	Addis Ababa	school based	1736	0.5339	Low
	Kebede et al, 2012(23)	Oromia	Hospital based	240	0.7583	Low
	Berhane & Worku, 2014(34)	Addis Ababa	Community based	658	0.3541	Low
	Olsson, 1978(22)	Oromia	Community based	1,700	0.07	low
	Tefera &Bekele, 2020(35)	Amhara	Hospital based	420	0.2761	Low
	Tefera et a, 2022l(36)	Amhara	School-based (disabled students)	443	0.2753	Low

Prevalence of periodontal disease

The overall pooled prevalence of periodontal disease in Ethiopia was found to be 35% (95% CI: 25-45). A high degree of heterogeneity was observed among studies (I^2=99.46%, P <0.001), indicating substantial variability between the included studies. Given this heterogeneity, a random-effect model was applied for the meta-analysis. Each square in the forest plot represents the prevalence estimate from an individual study, with the size proportional to the study's weight in the meta-analysis. Horizontal lines indicate 95% confidence intervals. The vertical line represents the overall pooled prevalence. The diamond at the bottom shows the pooled prevalence estimate with its 95% confidence interval using a random-effects model **(Figure 2).**

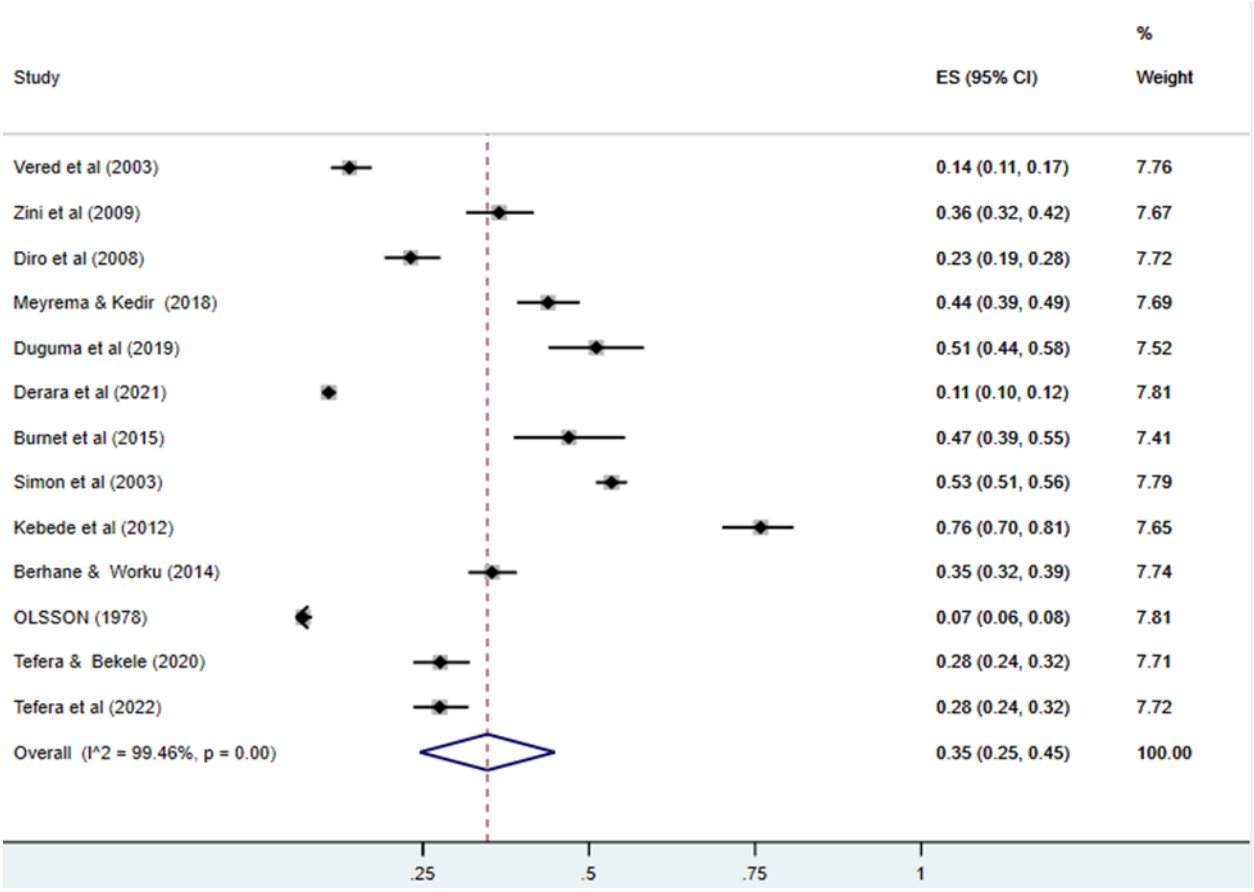

***Figure 2**: Forest plot of pooled prevalence estimates of periodontal disease in Ethiopia.*

Subgroup analysis based on region

To explore the source of heterogeneity and determine regional variation in the prevalence of periodontal disease, a subgroup analysis was done by region. The analysis revealed that the highest pooled prevalence was observed in Addis Ababa, at 42% (95% CI: 29% to 55%), while the lowest prevalence was reported in the Amhara region, at 26% (95% CI: 17% to 36%) **(Figure 3).**

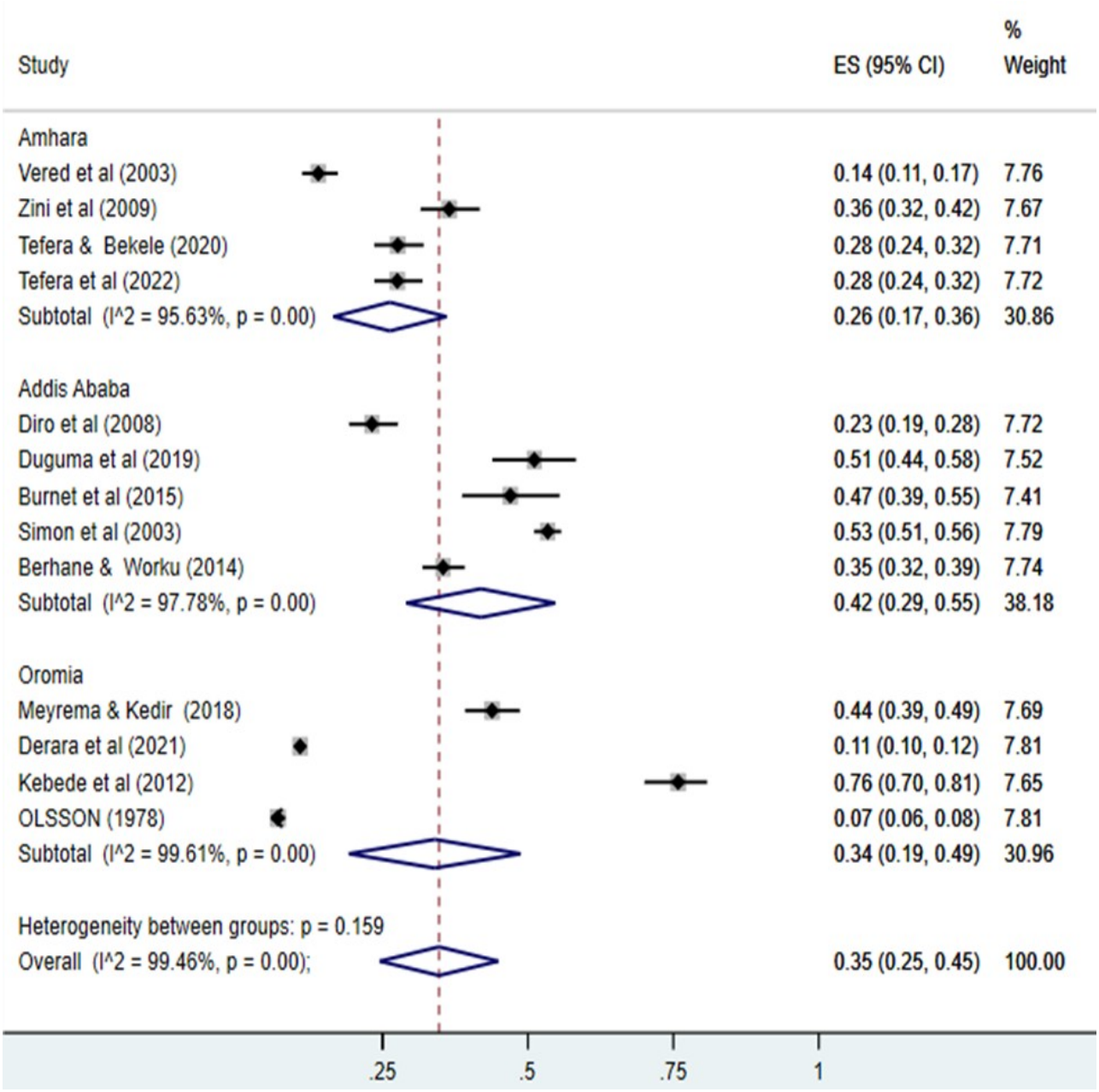

Figure 3: *Subgroup analysis of periodontal disease based on region*

Subgroup analysis was also conducted based on population type to identify differences in the prevalence of periodontal disease across various groups. The highest pooled prevalence was observed among students, at 52% (95% CI: 49% to 54%), followed by institutionalized individuals, with a prevalence of 49%. These results are illustrated in **Figure 4.**

Sensitivity analysis

Sensitivity analysis was conducted by systematically excluding one study at a time (leave-one-out method) to determine the influence of each study on the pooled estimate and to evaluate the robustness of the findings. The result indicated that no single study significantly altered the summary effect size, suggesting the findings are robust. All individual study estimates fell within the 95% confidence interval of the overall polled prevalence, as illustrated in **Figure 5.**

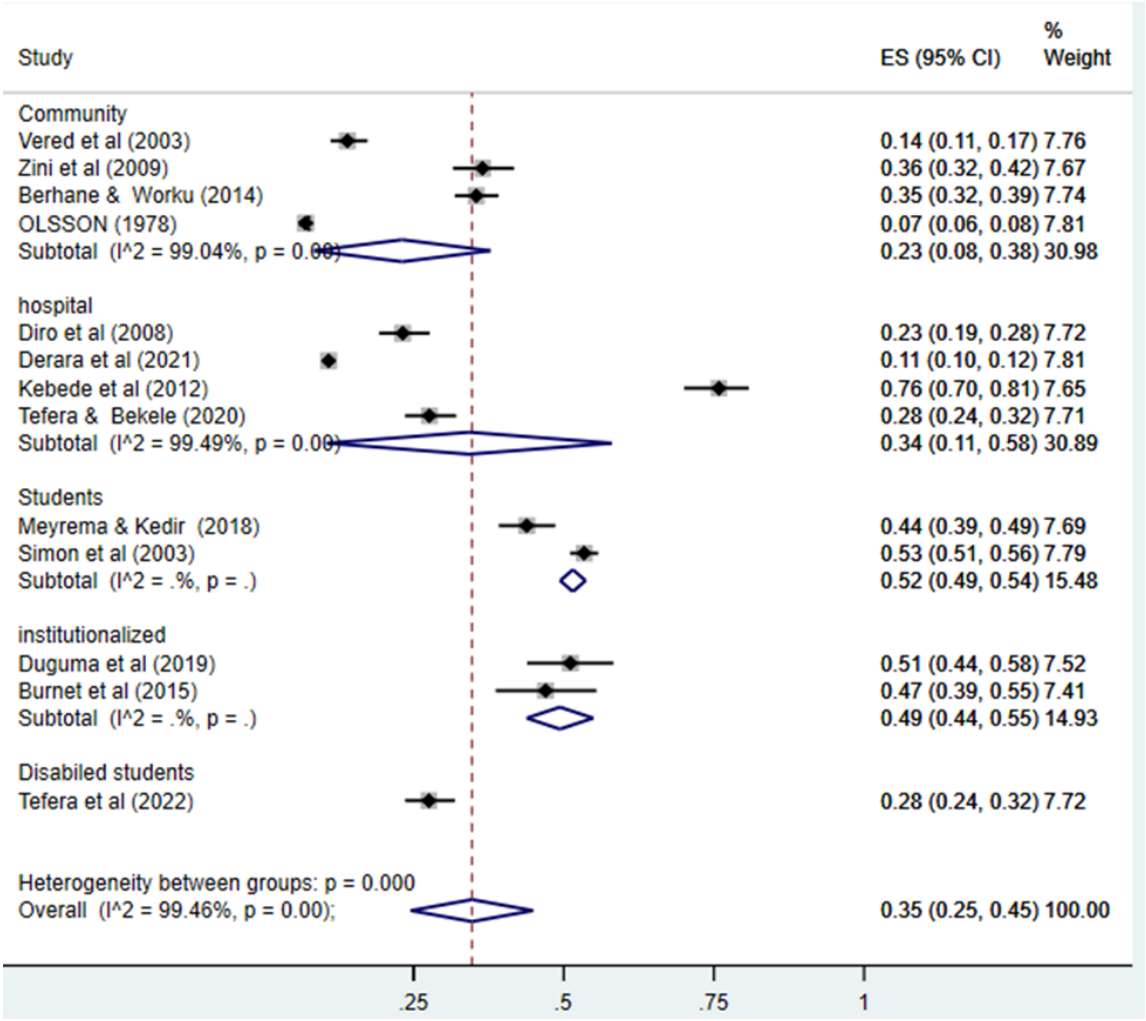

Figure 4: *Subgroup analysis based on the type of study participants.*

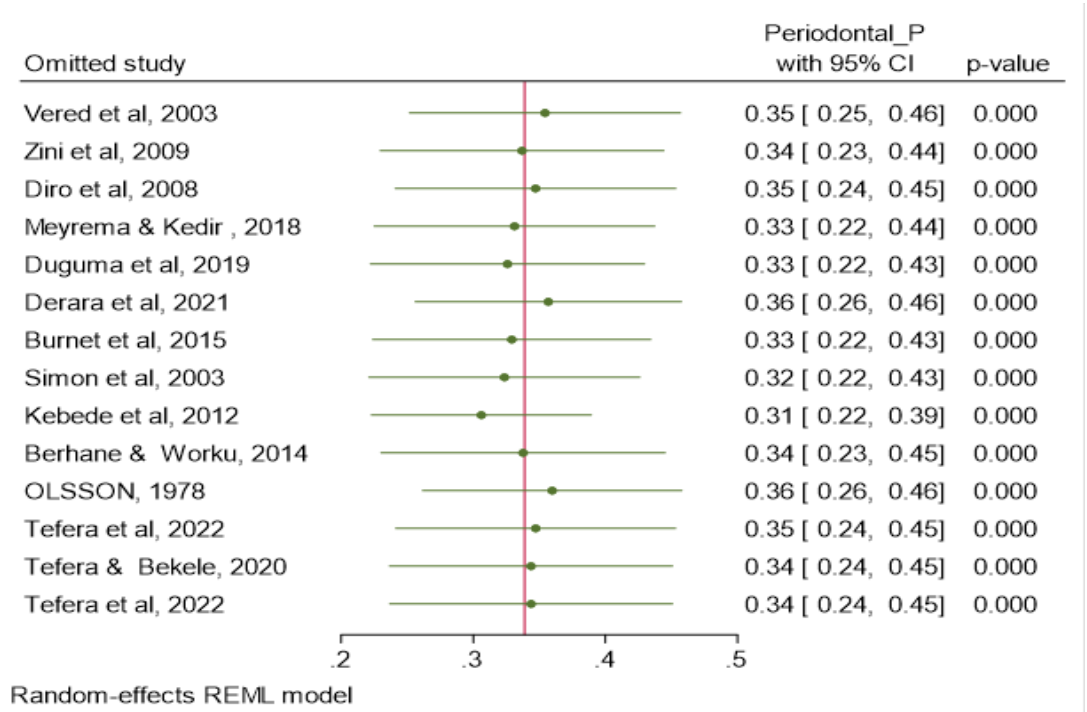

Figure 5: *Sensitivity analysis to show the influential studies of the pooled prevalence (Periodontal_P represents the prevalence of periodontal disease).*

Publication Bias and Trim-and-Fill

The funnel plot showed an asymmetrical distribution of studies, suggesting potential publication bias. This was supported by the result of Egger's regression test, which indicated statistically significant bias (P = 0.0335). In addition, the Doi plot revealed substantial asymmetry, with an LFK index of 5.16, which is more than 2, further confirming the presence of major asymmetry **(Figure 6).**

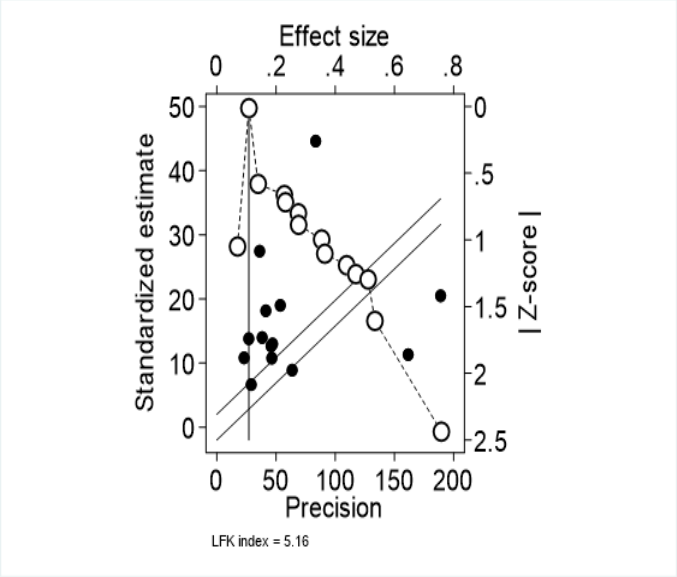

Figure 6: *DOI plot for publication bias assessment*

To address the potential publication bias identified, a trim and fill analysis was performed. This method imputed seven potentially missed studies to adjust for asymmetry in the funnel plot.. After adjusting for publication bias, the revised pooled prevalence of periodontal disease was 13.8% (95%CI: 3.2% to 24.3%), compared to the initial unadjusted estimate of 35%. This substantial difference suggests that the original estimate may have been influenced by publication bias.

Factors associated with Periodontal Disease

A total of eight variables were extracted from the included studies to explore potential predictors of periodontal disease in Ethiopia. Of these, three variables, toothbrush, gender, and carbohydrate intake were found to have a statistically significant association with periodontal disease. Accordingly, individuals who practiced regular toothbrushing had significantly lower odds of developing periodontal disease compared to those who did not brush their teeth (OR = 0.26, 95% CI: 0.24 to 0.28). Similarly, individuals with carbohydrate intake had 46% lower odds of periodontal disease compared to those without carbohydrate intake (OR = 0.54, 95% CI: 0.44 to 0.65). Male participants had 28% lower odds of developing periodontal disease compared to females (OR = 0.72, 95% CI: 0.64 to 0.80) **(Table 3).**

Table 3: Determinants of periodontal disease in Ethiopia

Predictors	Number of articles	AOR	95%CI		I^2	P-value	Q
Toothbrush (reference: No)(26, 28-31)	5	0.26	0.24	0.28	93.3%	0.00	75.12
Smoking (reference: No) (28, 30)	2	1.04	0.65	1.67	0.0	0.439	0.60
Gender (Reference: Female) (26, 27, 29-31)	5	0.72	0.64	0.80	88.7%	0.000	35.28
Carbohydrate intake (Reference: No) (26, 29-31)	4	0.54	0.44	0.65	71.1%	0.008	13.84
Comorbidity (Reference: No) (30, 31)	2	1.94	0.49	7.66	0.0%	0.922	0.01
Dental caries (Reference: No) (30, 31)	2	1.93	0.92	4.07	0.0%	0.781	0.08
Residence (Reference: Rural) (27, 30)	2	0.88	0.72	1.07	91.5%	0.1521	11.73
Income (Reference: >2500ETB) (30, 31)	2	2.16	0.94	4.96	0.0%	0.967	0.00

Risk of bias assessment

The quality of the included studies was evaluated using the Hoy et al tool, and the results were presented in **Table 4.** The risk assessment tool showed that three of the included studies had a moderate risk of bias, and the remaining studies had a low risk of bias.

Table 4: Risk of bias assessment using the Hoy et al. Critical appraisal tool (Yes =1, No=0)

Name of author	External validity				Internal validity						
	Sample representativeness	Representative sampling frame	Random selection or census	Is nonresponse bias minimal?	Data collected directly from subjects?	Acceptable case definition?	Valid and reliable tool for outcome measurement	Is the same mode of data collection for all participants?	Appropriate Length	Were the numerator and denominator appropriate?	Total
Vered et al, 2003(32)	0	1	0	0	1	1	1	1	1	1	7
Zini et al, 2009 (33)	0	1	0	1	1	1	1	1	0	1	7
Diro et al, 2008 (28)	0	0	1	1	1	0	0	1	1	1	6
Meyrema & Kedir, 2018 (34)	1	1	0	1	1	0	0	1	1	1	7
Duguma et al, 2019 (35)	0	1	0	1	1	1	0	1	0	1	6
Derara et al,2021 (27)	0	0	1	1	0	0	0	0	1	1	4
Burnet et al,2-16 (26)	0	0	1	1	1	0	0	1	1	1	6
Simon et al,2003 (29)	1	1	1	1	1	1	1	1	0	1	9
Kebede et al, 2012 (23)	0	1	1	0	1	1	1	1	0	1	7
Berhane & Worku, 2014 (36)	1	0	1	0	1	1	1	1	0	1	7
Olsson, 1978 (22)	1	1	1	1	0	1	1	1	0	1	8
Tefera & Bekele, 2020(30)	1	0	1	1	1	1	1	1	1	1	9
Tefera et al, 2022 (31)	1	0	1	1	1	1	1	1	1	1	9

Discussion

This systematic review and meta-analysis aimed to estimate the pooled prevalence and identify associated factors of periodontal disease in Ethiopia. The findings revealed that approximately **35%** (95% CI: 25%–45%) of the Ethiopian population is affected by periodontal disease, highlighting a substantial public health concern. Notably, a high level of heterogeneity was observed across the included studies (**I^2 = 99.46%**). Key predictors identified were gender, **carbohydrate intake,** and tooth brushing practice.

The prevalence found in this study is lower than reported in India,51% (5) and the United States (47%) (6). One possible explanation for this difference is the age profile of participants: over three-fourths of the Ethiopian studies involved children and young adults, while the Indian and U.S studies primarily focused on adults and elderly populations, in whom periodontal disease. As the global population ages and tooth retention increases, the burden of periodontitis is expected to rise, especially in settings where geriatric oral health services are lacking (4, 21, 37).

The current study revealed that males were less likely to develop periodontal disease compared to females. This result is inconsistent with studies done in diabetic populations, such as one that reported higher odds among males (38), and another study from Japan (39). The discrepancy may be attributed to differences in study populations, particularly the presence of systemic conditions such as diabetes mellitus, which is a well -established risk factor for periodontal disease and may modify the gender-related risk. Furthermore, in Ethiopian communities, men may use traditional oral hygiene methods like chewing sticks (locally known as Mefakia) more consistently than women (40, 41).

Regarding oral hygiene practice, our meta-analysis showed that regular tooth brushing significantly reduced the odds of periodontal disease (OR = 0.26, 95% CI: 0.24 to 0.28). This aligns with findings by Lertpimonchai et al. (42), who reported that brushing twice daily reduced the risk of periodontitis by 34%. Similarly, Zimmermann et al. found that individuals with infrequent tooth brushing practice had higher odds of periodontal disease (43). These consistent results across studies may be explained by the role of toothbrushing in preventing plaque and calculus accumulation, which are key etiological factors in the pathogenesis of periodontal disease (44).

Subgroup analysis revealed regional and population-based differences in the prevalence of periodontal disease. The highest prevalence was reported in Addis Ababa, with a pooled estimate of 42% (95%CI: 29% to 55%). This elevated prevalence may be influenced by the characteristics of the study populations in the region, as many participants were institutionalized and older adults. Similarly, institutionalized participants and students had a higher prevalence compared to community-based studies. A comparable result was reported in Italy, where prolonged institutionalization was associated with poorer oral hygiene and a higher burden of untreated periodontitis, highlighting the vulnerability of this population to periodontal conditions(45). This may be attributed to limited access to dental care, lower oral health awareness, and reduced autonomy in maintaining daily oral hygiene practices within institutional settings(46).

In interpreting the findings of this review, it is important to consider the potential influence of publication bias and study heterogeneity. Evidence of publication bias was indicated by the asymmetry in the funnel plot and confirmed by Egger's test (p = 0.0335) and the DOI plot (LFK index = 5.16), suggesting a major risk of bias. The trim-and-fill analysis imputed seven missing studies and adjusted the pooled prevalence downward to 13.8% (95% CI: 3.2%–24.3%), a substantial reduction from the original estimate. The substantial reduction in pooled prevalence after applying the trim-and-fill method suggests that the initial estimate may have been inflated due to **publication bias**, where studies reporting higher prevalence are more likely to be published.

In addition to publication bias, considerable heterogeneity was observed among the included studies (I^2 = 99.46%). This high level of inconsistency likely reflects differences in study populations, settings (e.g., community-based vs. institutionalized), and methodological approaches. Interestingly, subgroup analysis revealed minimal heterogeneity among studies conducted in institutionalized populations (I^2 = 0.02%), suggesting that participant type may be a major source of variability. The relatively uniform conditions within institutional settings may lead to more consistent findings, while community-based studies may capture a broader and more diverse range of exposures and outcomes. Given these sources of bias and variability, the overall pooled prevalence should be inter-

preted with caution. Future primary studies employing standardized methodologies and more representative samples are needed to produce more robust and generalizable estimates of periodontal disease burden in Ethiopia.

Strengths and limitations

This review has several notable strengths. First, it represents the first national-level review to synthesize available evidence on the prevalence and predictors of periodontal disease in Ethiopia, addressing a critical gap in oral health research in the country. Second, a standardized risk of bias assessment tool was employed to evaluate the quality of the included studies, which enhances the reliability of the synthesized findings.

Despite its strengths, this review has some limitations that should be acknowledged. First, there was an underrepresentation of certain regions in Ethiopia, which may limit the generalizability of the findings to the national population. Second, there was variation in the diagnostic criteria and assessment tools used across studies, which could have introduced inconsistencies in case definition and measurement of periodontal disease. Third, the lack of a national oral health surveillance system limits the ability to draw firm conclusions about the true burden of periodontal disease across the country. Fourth, data collection was conducted by both dental professionals and other healthcare workers, potentially resulting in variability in examiner reliability and diagnostic accuracy. Finally, the high level of heterogeneity observed in the meta-analysis further underscores the need for cautious interpretation and highlights the importance of standardized methodologies in future research.

Conclusion and recommendation

This systematic review and meta-analysis revealed that approximately one in three Ethiopians is affected by periodontal disease, with a pooled prevalence of 35%. The burden is particularly higher among institutionalized populations and in Addis Ababa. Key predictors of periodontal disease included poor toothbrushing habits, female gender, and lack of carbohydrate intake. The consistent association between oral hygiene practices and disease risk underscores the urgent need for targeted preventive strategies. The high heterogeneity and evidence of publication bias suggest variability in local practices and diagnostic methods, highlighting the need for standardized national guidelines and surveillance systems. Public health efforts should focus on improving oral health awareness, promoting proper oral hygiene practices such as regular tooth brushing, and encouraging healthy dietary habits.

Declarations

Author Contributions

Conceptualization: Amare Teshome, Nebiyou Bekele, Martha Solomon, Shegaye Shumet, Tigist Mulugeta

Data curation: Amare Teshome, Dessie Abebaw

Formal analysis: Nebiyou Bekele, Amare Teshome, Dessie Abebaw

Methodology development: Amare Teshome, Shegaye Shumet, Nebiyou Bekele, Dessie Abebaw, Martha Solomon, Tigist Mulugeta

Project administration: Amare Teshome

Supervision: Dessie Abebaw

Writing – original draft and preparation: Amare Teshome and Nebiyou Bekele

Writing – review and editing: Amare Teshome, Nebiyou Bekele, Martha Solomon, Shegaye Shumet, Tigist Mulugeta, Dessie Abebaw. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

Funding: This research received no specific grant from any funding agency

Competing Interests: The authors declare that they have no competing interests.

Ethical Approval and Consent to Participate: Ethical approval was not required for this study as it is a systematic review and meta-analysis of previously published data. No human participants were directly involved.

Availability of Data and Materials: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request (teferaden@gmail.com).

Reference

1. De Pablo P, Chapple IL, Buckley CD, Dietrich T. Periodontitis in systemic rheumatic diseases. Nature Reviews Rheumatology. 2009;5(4):218-24.

2. Helmi MF, Huang H, Goodson JM, Hasturk H, Tavares M, Natto ZS. Prevalence of periodontitis and alveolar bone loss in a patient population at Harvard School of Dental Medicine. BMC Oral Health. 2019;19(1):254.
3. Organization WH. Global oral health status report: towards universal health coverage for oral health by 2030. Regional summary of the Western Pacific Region: World Health Organization; 2023.
4. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390(10100):1211-59.
5. Janakiram C, Mehta A, Venkitachalam R. Prevalence of periodontal disease among adults in India: A systematic review and meta-analysis. Journal of oral biology and craniofacial research. 2020;10(4):800-6.
6. Eke PI, Dye BA, Wei L, Thornton-Evans GO, Genco RJ. Prevalence of periodontitis in adults in the United States: 2009 and 2010. Journal of dental research. 2012;91 (10):914-20.
7. Benjamin RM. Oral health: the silent epidemic. Public health reports. 2010;125(2):158-9.
8. Ashby MT, Kreth J, Soundarajan M, Sivuilu LS. Influence of a model human defensive peroxidase system on oral streptococcal antagonism. Microbiology. 2009;155 (11):3691-700.
9. Chapple IL. Time to take periodontitis seriously. British Medical Journal Publishing Group; 2014.
10. Chapple IL, Van der Weijden F, Doerfer C, Herrera D, Shapira L, Polak D, et al. Primary prevention of periodontitis: managing gingivitis. Journal of clinical periodontology. 2015;42:S71-S6.
11. Petersen PE, Ogawa H. The global burden of periodontal disease: towards integration with chronic disease prevention and control. Periodontology 2000. 2012;60(1):15-39.
12. Pihlstrom BL, Michalowicz BS, Johnson NW. Periodontal diseases. The lancet. 2005;366(9499):1809-20.
13. Anwar N, Zaman N, Nimmi N, Chowdhury T, Khan M. Factors Associated with Periodontal Disease in Pregnant Diabetic Women. Mymensingh Medical Journal: MMJ. 2016;25(2):289-95.
14. Elter JR, White BA, Gaynes BN, Bader JD. Relationship of clinical depression to periodontal treatment outcome. Journal of periodontology. 2002;73(4):441-9.
15. Hegde R, Awan K. Effects of periodontal disease on systemic health. Disease-a-month. 2019;65(6):185-92.
16. Ide M, Papapanou PN. Epidemiology of association between maternal periodontal disease and adverse pregnancy outcomes–systematic review. Journal of clinical periodontology. 2013;40:S181-S94.
17. Humphrey LL, Fu R, Buckley DI, Freeman M, Helfand M. Periodontal disease and coronary heart disease incidence: a systematic review and meta-analysis. Journal of general internal medicine. 2008;23(12):2079-86.
18. Graziani F, Gennai S, Solini A, Petrini M. A systematic review and meta-analysis of epidemiologic observational evidence on the effect of periodontitis on diabetes An update of the EFP-AAP review. Journal of clinical periodontology. 2018;45(2):167-87.
19. Chambrone L, Foz AM, Guglielmetti MR, Pannuti CM, Artese HP, Feres M, et al. Periodontitis and chronic kidney disease: a systematic review of the association of diseases and the effect of periodontal treatment on estimated glomerular filtration rate. Journal of clinical periodontology. 2013;40(5):443-56.
20. Nazir M, Al-Ansari A, Al-Khalifa K, Alhareky M, Gaffar B, Almas K. Global prevalence of periodontal disease and lack of its surveillance. The Scientific World Journal. 2020;2020(1):2146160.
21. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. Journal of clinical periodontology. 2017;44(5):456-62.
22. Olsson B. Periodontal disease and oral hygiene in Arussi province, Ethiopia. Community Dentistry and Oral Epidemiology. 1978;6(3):139-43.
23. Kebede B, Kemal T, Abera S. Oral health status of patients with mental disorders in southwest Ethiopia. PloS one. 2012;7(6):e39142.

24. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021;372.

25. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. Journal of clinical epidemiology. 2012;65(9):934-9.

26. Burnett D, Aronson J, Asgary R. Oral health status, knowledge, attitudes and behaviours among marginalized children in Addis Ababa, Ethiopia. Journal of Child Health Care. 2016;20(2):252-61.

27. Derara M, Tulu B, Bayissa B, Ameni G. Retrospective study on Oral health problems in and around Ambo town, central Ethiopia. 2021.

28. Diro E, Feleke Y, Guteta S, Fekade D, Neway M. Assessment of risk behaviours and factors associated with oral and peri-oral lesions in adult HIV patients at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. Ethiopian Journal of Health Development. 2008;22 (2):180-6.

29. Simon C, Tesfaye F, Berhane Y. Assessment of the oral health status of school children in Addis Ababa. Ethiopian Medical Journal. 2003;41(3):245-56.

30. Tefera A, Bekele B. Periodontal disease status and associated risk factors in patients attending a tertiary hospital in Northwest Ethiopia. Clinical, cosmetic and investigational dentistry. 2020:485-92.

31. Tefera AT, Girma B, Adane A, Muche A, Ayele TA, Getahun KA, et al. Periodontal status of students living with disability in Amhara region, Ethiopia: a cross-sectional study. BMC Oral Health. 2022;22(1):343.

32. Vered Y, Schwarts N, Mann J, Sgan-Cohen HD. Periodontal health among recent immigrants from Quara, rural Ethiopia and indications for periodontal health care. International dental journal. 2003;53(2):92-6.

33. Zini A, Vered Y, Sgan-Cohen HD. Are immigrant populations aware about their oral health status? A study among immigrants from Ethiopia. BMC Public Health. 2009;9(1):205.

34. Meyrema A, Kedir T. Prevalence of oral health care and problems among Rift Valley university health sciences students in Adama, South East, Ethiopia. African Journal of Oral Health. 2018;8(1):16-23.

35. Duguma FK, Abebe F, Kelemwork N. Magnitude and Determinants of Periodontal Disease Among the Geriatrics People Age â‰¥ 65 Living in Macedonia Humanitarian Association, Addis Ababa, Ethiopia, July 2018. Advances in Dentistry & Oral Health. 2019;11(2):43-52.

36. Berhane HY, Worku A. Oral health of young adolescents in Addis Ababa—a community-based study. Open Journal of Preventive Medicine. 2014;4(8):640-8.

37. Kassebaum N, Bernabé E, Dahiya M, Bhandari B, Murray C, Marcenes W. Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. Journal of dental research. 2014;93(11):1045-53.

38. Liu Y, Yu Y, Nickel JC, Iwasaki LR, Duan P, Simmer-Beck M, et al. Gender differences in the association of periodontitis and type 2 diabetes. International dental journal. 2018;68(6):433-40.

39. Abe M, Mitani A, Hoshi K, Yanagimoto S. Large gender gap in oral hygiene behavior and its impact on gingival health in late adolescence. International Journal of Environmental Research and Public Health. 2020;17 (12):4394.

40. Darout IA. Knowledge and behavior related to oral health among Jimma University Health Sciences students, Jimma, Ethiopia. European Journal of General Dentistry. 2014;3(03):185-9.

41. Gizaw Z, Demissie NG, Gebrehiwot M, Bitew BD, Nigusie A. Oral hygiene practices and associated factors among rural communities in northwest Ethiopia. BMC Oral Health. 2024;24(1):315.

42. Lertpimonchai A, Rattanasiri S, Vallibhakara SA-O, Attia J, Thakkinstian A. The association between oral hygiene and periodontitis: a systematic review and meta-analysis. International dental journal. 2017;67(6):332-43.

43. Zimmermann H, Zimmermann N, Hagenfeld D, Veile A, Kim TS, Becher H. Is frequency of tooth brushing a risk factor for periodontitis? A systematic review and meta-

analysis. Community dentistry and oral epidemiology. 2015;43(2):116-27.

44. Khoury J, Giladi HZ, Ginesin O, Gabay E, Mayer Y. The influence of radio frequency-based toothbrush on the accumulation of calculus and periodontal health: A randomized double-blind controlled prospective study. Clinical and Experimental Dental Research. 2023;9(4):574-85.

45. Angelillo IF, Nobile CGA, Pavia M, De Fazio P, Puca M, Amati A. Dental health and treatment needs in institutionalized psychiatric patients in Italy. Community Dentistry and Oral Epidemiology. 1995;23(6):360-4.

46. Ribeiro Gaião L, Leitão de Almeida ME, Bezerra Filho JG, Leggat P, Heukelbach J. Poor dental status and oral hygiene practices in institutionalized older people in Northeast Brazil. International Journal of Dentistry. 2009;2009(1):846081.