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Review

Oral Diseases and Adverse Pregnancy Outcomes in Sub-Saharan Africa: A Scoping Review

Ezekiel Taiwo Adebayo [1,2,*], Olunike Rebecca Abodunrin [1,3], Ifeoluwa E. Adewole [1,4], Abideen Olurotimi Salako [1,5], Joanne Lusher [1,6], Folahanmi Tomiwa Akinsolu [1,4], Maha El Tantawi [1,7], Omolola Titilayo Alade [1,8], George Uchenna Eleje [1,9], Oliver Chukwujekwu Ezechi [1,4,5] and Morénikẹ́ Oluwátóyìn Fọ́láyan [1,10]

1 Oral Health Initiative, Nigeria Institute of Medical Research, Yaba, Lagos 101212, Nigeria; abodunrinolunike@gmail.com (O.R.A.); theifeoluwa@gmail.com (I.E.A.); salako.abideennaheem@gmail.com (A.O.S.); lusherj@regents.ac.uk (J.L.); folahanmi.tomiwa@gmail.com (F.T.A.); maha_tantawy@hotmail.com (M.E.T.); otalade@oauife.edu.ng (O.T.A.); georgel21@yahoo.com (G.U.E.); oezechi@yahoo.co.uk (O.C.E.); toyinukpong@yahoo.co.uk (M.O.F.)
2 Department of Oral and Maxillofacial Surgery, University of Medical Sciences, Ondo 351104, Nigeria
3 Department of Planning and Research, Lagos State Health Management Agency, Ikeja 100212, Nigeria
4 Department of Public Health, Faculty of Basic Medical and Health Sciences, Lead City University, Ibadan 110115, Nigeria
5 Clinical Science Department, Nigerian Institute of Medical Research, Yaba, Lagos 101212, Nigeria
6 Provost's Group, Regent's University, London NW1 4NS, UK
7 Department of Paediatric Dentistry and Dental Public Health, Faculty of Dentistry, Alexandria University, Alexandria 21527, Egypt
8 Department of Preventive and Community Dentistry, Obafemi Awolowo University, Ile-Ife 220282, Nigeria
9 Effective Care Research Unit, Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University, Awka 420102, Nigeria
10 Department of Child Dental Health, Obafemi Awolowo University, Ile-Ife 220282, Nigeria
* Correspondence: taiwoadebayoife@gmail.com

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Abstract: This scoping review mapped and critically reviewed the extant literature exploring associations between oral disease status and adverse pregnancy outcomes among women residing in sub-Saharan Africa. A literature search was conducted in July 2023 using PubMed, Cochrane Library and Google Scholar. The articles selected were those published in the English language between 1990 and 2022. After screening 833 potential studies, 15 articles met the inclusion criteria. Among these, 12 (80.0%) adopted a descriptive research design, while 3 (20.0%) used experimental methodologies. Eight (53.3%) studies were conducted in East Africa, fourteen (93.3%) studies were hospital-based, and one (6.7%) study was community-based. Periodontitis was linked with low birth weight, preterm birth, preterm birth and low birthweight, stunting, wasting, and underweight in most studies. Periodontitis was, however, not linked with adverse pregnancy outcomes in four studies. Caries was not linked with adverse pregnancy outcomes, but its sequalae was linked with low birth weight, preterm birth, neonatal stunting, and small head circumference. Two studies showed that periodontal diseases were linked with preeclampsia and chorioamnionitis. Maternal poor oral hygiene was linked with stunting. Two other studies showed no links between maternal periodontal disease and preterm premature rupture of membranes, eclampsia, spontaneous abortion, and vaginal bleeding. Furthermore, two intervention studies found that the treatment of periodontal diseases during pregnancy reduced the risk of adverse pregnancy outcomes. Further studies are needed to fully elucidate the effect size of the links observed between oral diseases and adverse pregnancy outcomes in sub-Saharan Africa.

Keywords: oral health; oral diseases; periodontitis; pregnancy; sub-Saharan Africa; low birth weight; preterm; dental caries

1. Introduction

Maintaining optimal oral health for pregnant women is critical due to the profound hormonal and physiological shifts that are experienced by women during this period. For example, studies from the United States have documented dental concerns among many pregnant women [1], while in Mali, the lack of dental examinations among most pregnant women was observed, with around half afflicted by severe dental ailments [2]. Pregnancy-associated dental complaints encompass issues such as periodontitis, tooth mobility, pregnancy epulis, and gingivitis [3]. The implications of poor oral health extend beyond the mouth, complicating systemic conditions like diabetes mellitus, cardiovascular diseases, and compromised pregnancy outcomes [4]. Reports further indicate a connection between suboptimal oral health and adverse pregnancy outcomes. Adverse pregnancy outcome is a comprehensive term encompassing health issues that affect either the mother, the newborn, or both throughout the phases of pregnancy, labor and delivery, and the postpartum period [5]. It includes premature delivery, fluctuating birth weights, and preeclampsia [6,7]. A systematic review of the global literature underscores the potential risk of periodontal disease as a contributor to preterm low-birth-weight infants. However, it emphasizes the necessity for more precise investigations into this relationship [8].

Sub-Saharan Africa faces unique health challenges with limited access to comprehensive healthcare services [9]. Exploring the association between oral diseases and adverse pregnancy outcomes in this region is essential for improving maternal and child health [10]. Despite a growing body of research into the relationship between oral diseases and pregnancy outcomes, most studies have so far been conducted in high-income countries. Therefore, disparities in the findings are likely to be present with implications in the context of sub-Saharan Africa due to the differences in healthcare infrastructure, socioeconomic factors, cultural practices, and oral health awareness.

Whilst few studies in sub-Saharan Africa consider the oral and dental conditions that occur in pregnant women, the prevalence of adverse birth outcomes has been reported in up to 30% of cases in the region [11]. Unfortunately, the oral care of expectant mothers in this region tends to be neglected, and this adds to the issue's complexity [2]. Given the fragmented and disjointed nature of understanding concerning the interplay between oral and dental diseases and pregnancy outcomes in sub-Saharan Africa, a scoping review that consolidates the existing data is imperative. Consequently, this scoping review aimed to explore the available literature from the population of sub-Saharan Africa on the association between oral diseases and adverse pregnancy outcomes to identify gaps in the published research and make recommendations for the future. The objective of this scoping review was to map the link between oral diseases and adverse pregnancy outcomes in sub-Saharan Africa.

2. Materials and Methods

The methodology adopted for this scoping review follows the method described by Arksey and O'Malley [12].

2.1. Identifying Research Questions

The following questions guided the review: (i) What oral diseases are linked to adverse pregnancy outcomes? (ii) What indicators/indices were used to measure oral diseases in pregnant women?

2.2. Eligibility Criteria

Publications were included if they studied links between pregnancy outcomes and oral diseases, and the study was conducted in sub-Saharan Africa. The oral disease conditions were described according to any indicator, modality, or index and which were published in English from 1990 to 2022. Articles with participants outside sub-Saharan Africa or on non-pregnant women were excluded. Articles on adverse pregnancy outcomes without relating them to the oral and dental disease conditions of pregnant women or where the

oral and dental conditions were not described based on any criteria, method, or index were excluded. Also excluded were articles whose full text could not be accessed, commentaries on studies, and letters to the editor. Narrative reviews that did not relate to the defined oral and dental disease conditions of pregnant women in sub-Saharan Africa with adverse pregnancy outcomes were also excluded.

The Population, Exposure, and Outcomes (PEO) framework was used in identifying eligible studies. The population was defined as pregnant women residing in sub-Saharan Africa, the exposure was oral and dental disease conditions reported in the pregnant women, and the outcomes were the adverse pregnancy events associated with maternal oral diseases. Oral and dental diseases included dental caries, periapical infections, gingivitis, and periodontitis and its sequelae, such as periodontal pocketing and tooth mobility. Adverse pregnancy events included maternal conditions, like hypertensive disorders of pregnancy (gestational hypertension, preeclampsia, and related disorders) and gestational diabetes. Child-related adverse pregnancy events included preterm birth (PTB), low birth weight (LBW), preterm low birth weight (PTLBW), stunting, and overweight.

2.3. Search Strategy

The systematic search of literature was conducted by two of the authors, E.T.A. and O.R.A., in July 2023 for relevant articles published in English from 1990 to 2022 in PubMed, Cochrane Library, and Google Scholar. The search strings for PubMed and, Cochrane Library are found in Appendix A. Google Scholar was searched using the keywords. A search of related citations and references was also carried out. Non-English articles were excluded if no English translation was available.

2.4. Study Selection

Identified studies were downloaded into Endnote and imported into Rayyan, and duplicates were removed. Records were assessed for eligibility based on information contained in the title, abstract, and keywords/MeSH heading independently by two of the authors (E.T.A. and O.R.A.), after which the pre-defined inclusion and exclusion criteria were applied. Articles were selected when there was concurrence among the two researchers and cases of disagreement were resolved by a third co-author (M.O.F.). The two researchers (E.T.A. and O.R.A.) had an inter-observer reliability score of 0.70 during the earlier pilot phase, indicating an acceptable reliability. The two researchers conducted individual assessments of the complete texts of the selected articles, and supplementary searches were manually performed on the reference compilations of potentially pertinent publications.

2.5. Data-Charting Process

Two of the co-authors (E.T.A. and O.R.A.) developed a data-charting form for extracting pertinent variables, and then individually performed data extraction for each study included in the review. The data extracted included the name of the author(s), the year of the publication of the study, the country in which the study was conducted, the sample size, the type of study, and the study setting. The oral diseases reported, the criteria/method/index of the measurement, and the adverse pregnancy events reported were charted. The study limitations and research gaps identified were also recorded. Assessment of methodological quality and statistical analysis of the included studies were not conducted in this scoping review.

2.6. Data Analysis

A descriptive analysis was conducted, reporting on the period of the manuscript publications, the sub-region where the study was conducted, the study design, and the tools used to measure the oral diseases. The oral diseases studied were sorted into three categories (oral hygiene, caries and its sequalae, and periodontal diseases). Adverse preg-

nancy events were categorized into child-related and maternal-related adverse pregnancy events. The links between the oral diseases and adverse pregnancy events were tabulated.

3. Results

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist was adopted for presenting our search results [13]. The search yielded 1002 citations, as shown in Figure 1.

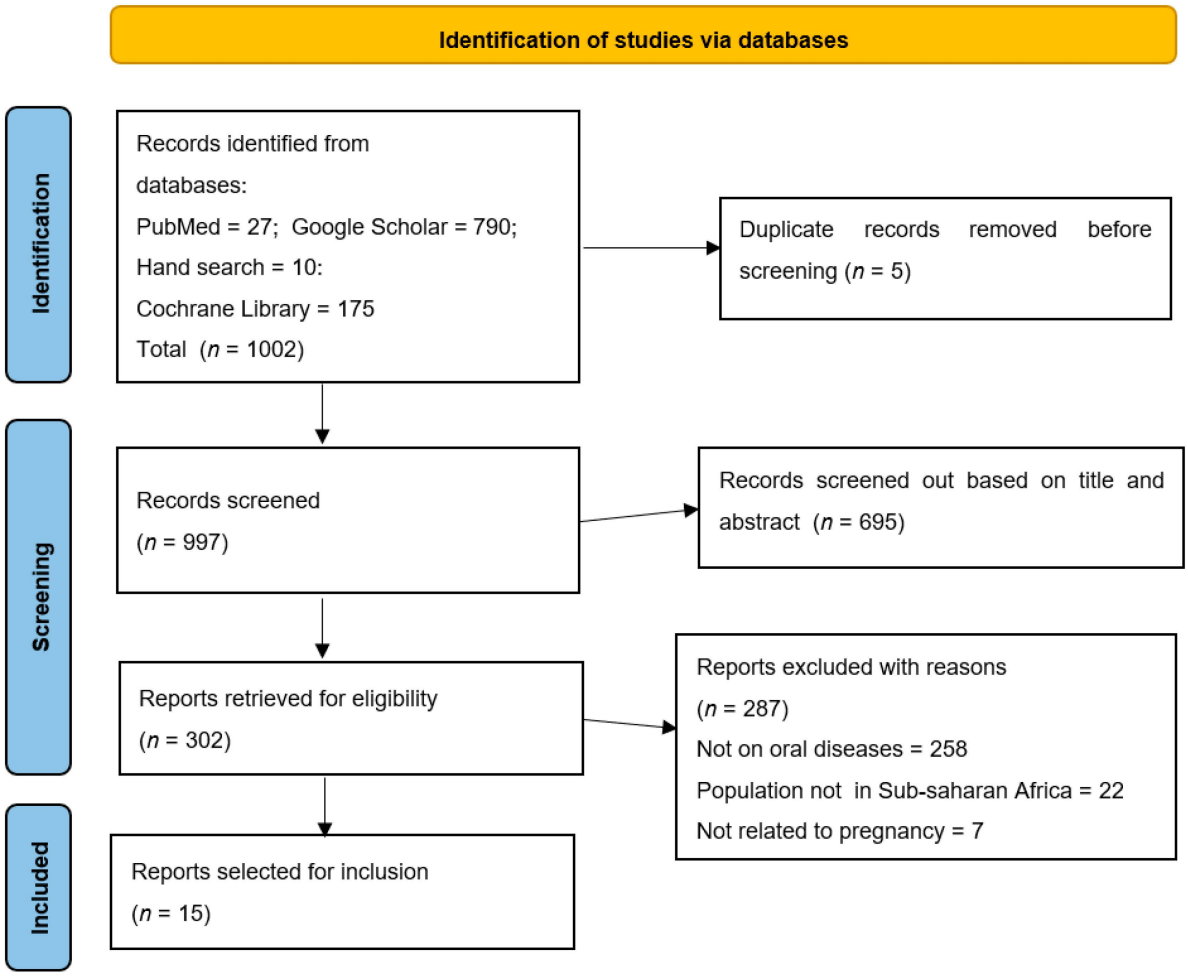

Figure 1. PRISMA-ScR chart showing studies selected for the scoping review on the association between oral diseases and pregnancy events in sub-Saharan Africa.

Five duplicated articles were removed before the screening. From the 997 articles screened, 695 were screened out based on the title and abstract, and 302 were found eligible for full screening. Of the eligible articles, 287 were excluded based on the inclusion and exclusion criteria. Subsequently, 15 articles were included in this scoping review, and their characteristics are listed in Table 1. Of these, six were cross-sectional studies [14–19], four were case-control studies [20–23], two were cohort studies [24,25], and three were clinical trials [26–28]. One study was a published dissertation [23].

Table 1. Characteristics of the studies included in the scoping review (N = 15).

Author/Year of Publication	Study Design	Study Population/ Sample Size	Study Objective	Pregnancy Status	Oral Disease Status	Study Events
Turton et al., 2017/South Africa [14]	Cross-sectional	Patients attending antenatal care clinics in one hospital/443	To test the hypothesis that BANA, a diagnostic test for periodontal diseases, can predict the risk of adverse pregnancy outcomes in mothers attending antenatal clinics	LBW: 24.6% PTB: 32.0% PTLBW: 16.0%	Periodontal disease severity Absent: 7.8% Mild: 43.5% Moderate: 18.3% Severe: 10.4%.	Highly significant differences in PTB and LBW of children born of BANA-positive and BANA-negative mothers. LBW and PTB increased significantly with periodontal disease severity.
Harjunmaa et al., 2015/Malawi [15]	Nested cross-sectional study.	Patients attending antenatal clinics in four hospitals/1024	To test the hypothesis that mothers who have dental caries, periapical infection, or periodontitis have associated adverse pregnancy outcomes.	PTB: 7.9% LBW:12.0% Neonatal stunting:12.0% Small head circumference:3.8%	Caries: 63.1% Pulpal exposure:27.8% Periapical infection:23.5%; Periodontitis: 31.9%	Periapical infection was associated with PTB, LBW, neonatal stunting, and smaller head circumference. Caries and pulpal exposure had no association.
Mumghamba and Manji, 2007/Tanzania [20]	Case-control	Postpartum mothers attending one national hospital/373	To examine the relationship between oral disease status (periodontal disease and carious pulpal exposure) and preterm low-birth-weight infant deliveries	PTLBW: 150 cases TNBW: 223 cases	PTLBW vs. TNBW Gingival bleeding on gentle probing (37.3% vs. 36.3%) Gingival recession (42.7% vs. 36.3%) Periodontal pocket 4 + mm (28.7% vs. 30.0%) Periodontal pocket 6 + mm (3.3% vs. 2.7%) Severity of periodontal disease (0.13 vs. 0.11) Carious pulpal exposure (18.7% vs. 19.7%)	No association between oral parameters and PTLBW.
Gesase et al., 2018/Tanzania [16]	Cross-sectional	Pregnant women at the labor ward of one university hospital/1117	To determine the relationship between periodontal disease and adverse pregnancy outcomes	pPROM: 9.0% Preeclampsia:9.9% Eclampsia: 1.4% PTB: 9.8%, LBW: 11.0%, Overweight: 4.7%,	Periodontal disease: 14.2%	Periodontal disease was significantly associated with preeclampsia, PTB, and LBW but not with pPROM, eclampsia, and overweight.
Uwambaye et al., 2021/Rwanda [21]	Case control	Postpartum women with singleton delivery at multiple hospitals/555	To assess the association between periodontitis and premature birth.	PTB: 185 cases TNBW: 370 cases	Cases vs. control Periodontitis (83.2% vs. 8.1%)	Women with periodontitis had a six-fold higher risk of PTB than women without periodontitis.

Table 1. *Cont.*

Author/Year of Publication	Study Design	Study Population/ Sample Size	Study Objective	Pregnancy Status	Oral Disease Status	Study Events
Soroye et al., 2015/Nigeria [26]	Clinical trial S&P + root planning +OHI before delivery (intervention) vs. S&P + root planning +OHI after delivery (control 1) vs. no periodontal disease (control 2)	Pregnant women attending antenatal clinic at a university hospital/423	To evaluate the association between periodontal disease and pregnancy outcomes like preterm birth and low birth weight	PTB: 12.5% LBW: 12.1% Spontaneous abortion: 1.4%.	Intervention vs. control 1 vs. control 2 Oral hygiene (0.86 vs. 2.62 vs. 2.34) Pockets (1.3% vs. 5.5% vs. 0.0%) Periodontal status measured by CPI score 3 (9.2% vs. 32.6% vs. 0.0%)	PTB was significantly higher among mothers in control group 1 (31.2%) than those in control group 2 (5.0%) compared to the intervention group (1.4%). LBW was significantly higher among mothers in control group 1 (28.4%) compared to those in control group 2 (7.8%) than those in the intervention group (0%).
Turton and Africa, 2017/South Africa [17]	Cross-sectional	Pregnant women attending antenatal clinics/443	To investigate the relationship between oral disease status and the adverse pregnancy outcomes of mothers	TNBW: 68.0% PTB: 32.0% LBW: 75.5% in	Clinical attachment loss: 1.7 mm Severe periodontal disease: 10.1% DMFT: 7.2 Plaque index: 2.2 Gingival index: 2.4	Periodontal disease severity was significantly associated with PTB and LBW. The Gingival index was significantly associated with LBW. DMFT and Plaque index were not associated with pregnancy events.
Umoh et al., 2013/Nigeria [27]	Clinical trial S&P done before delivery (test group) vs. S&P done after delivery (control group)	Primigravida women, singleton, and spontaneous vaginal delivery at a university hospital/288	To determine the association between maternal gingivitis and adverse pregnancy outcome.	PTB: 11.8% LBW: 12.3%	Test group vs. control Gingival bleeding at 12 weeks intrapartum test group 63.3%; control group 43.1%; Gingival bleeding at 28 weeks intrapartum test group 29.1%.	Gingival bleeding was not associated with PTB. The test group with reduced gingival bleeding did not have LBW. All LBWs were from the control.
Umoh et al., 2021/Nigeria [28]	Clinical trial S&P done before delivery (test) vs. S&P done after delivery (control)	Primigravida women, singleton, and spontaneous vaginal delivery at a university hospital/288	To evaluate the effect of maternal periodontal disease on the birth weight of babies and the effect of intervention during periodontal disease on the birth weight of babies	LBW: 6.2%	Test group vs. control CPI grade (2.2% vs. 7.6% at 28 weeks)	Significantly lower number of LBWs in the test group
Miranda-Ruis et al., 2021/Tanzania [18]	Laboratory study	Placentae collected from postpartum women with singleton pregnancy at a hospital/36	To relate microbial profiles in human placentae with the risk of adverse pregnancy outcomes and maternal periodontal disease status	Microbial composition of the placenta using 16 S rRNA metagenomicsHistologic assessment for chorioamnionitis: 27.8%	Periodontitis: 10 cases	Chorioamnionitis was more frequent in the placentae of mothers with periodontitis but the difference was not significant.

Table 1. *Cont.*

Author/Year of Publication	Study Design	Study Population/ Sample Size	Study Objective	Pregnancy Status	Oral Disease Status	Study Events
Muwazi et al., 2014/Uganda [19]	Cross-sectional	Postpartum women with singletons who delivered in two hospitals/400	To assess the association between periodontal diseases in postpartum mothers and the incidence of PTB and LBW.	PTB:48.5% LBW:8.7% pPROM: 3.8% Vaginal bleeding:3% Features of chorioamnionitis	Gingivitis: 26% Periodontal pockets ≥ 4 mm:33%; Calculus and plaque:86.0%Gingival recession: 9%	- Gingival recession was significantly correlated and associated with LBW. - Probing pocket depth, bleeding on probing, and calculus with plaque deposits were not associated with LBW. - Other periodontal indices were not associated with PTB. Features of chorioamnionitis were significantly correlated and associated with LBW and PTB.
Wandera et al., 2012/Uganda [24]	Clinical trial	Multi-center community recruitment of women at seven months of gestational age/877	To study the connection between periodontal issues at seven months of pregnancy and the anthropometric measurements of the infants	Wasting: 2.0%, Stunting: 10.0%, Underweight: 6.9%	CPI ≥ 1 = 67.0% Fair to poor oral hygiene:12.1% Severe periodontal symptoms: 65.4%	CPI ≥ 1 was significantly associated with stunting and wasting. Oral hygiene scores >1.2 are significantly associated with stunting.
Cisse et al., 2015/Senagal [22]	Case-control	Postpartum women at a "kangaroo unit" hospital with babies with LBW/378	To study the connection between women's periodontal disease during their pregnancy and the weight of newborn infants.	LBW: 126 cases Control: 252 cases	Case vs. control Periodontitis (70% vs. 33%) Gingival index	Periodontitis and Gingival index were significantly associated with increased odds of LBW. The plaque index was not significantly associated with LBW.
Wanjohi 2020/Uganda [23]	Case-control	Postpartum women who delivered singleton via spontaneous vaginal delivery at a hospital/235	To determine whether there is an association between maternal periodontal disease and PTLBW.	PTLBW: 61 cases Control: 174 cases	Case vs. control Periodontitis (19.7% vs. 27.0%) Gingivitis (59.0% vs. 71.8%)	Gingivitis and periodontitis were not associated with PTLBW
Pockpa et al., 2022/Ivory Coast [25]	Cohort	Pregnant women attending antenatal care at a university hospital/338.	To determine the association between maternal periodontitis and PTB.	PTB 18.3%	Prevalence of Periodontitis 59.4% Stage I: 41.4%; Stage II: 11.2%; Stage III/IV: 6.8%	PTB was significantly higher among pregnant women with periodontitis. Periodontitis is a risk factor for PTB.

Periodontal disease diagnosis threshold: the presence of both the periodontal probing pocket depth of 4 + mm in four sites or more and gingival bleeding on gentle probing in 30% or more of the examined sites. Abbreviations: BANA—N-benzoyl-DL-arginine-2-naphthylamide; BMI—body mass index; CPITN—Community Periodontal Index of Treatment Needs; CPI—Community Periodontal Index; DMFT—Decayed, Missing, and Filled Teeth; LBW—low birth weight; OHI-S—Simplified Oral Hygiene Index; PD—periodontal disease; pPROM—preterm premature rupture of membranes; PTB—preterm birth; PTLBW—preterm low birth weight; TNBW—term average birth weight.

3.1. Study Characteristics

As can be seen in Table 1, the 15 studies included in the current scoping review were published between 2007 and 2022. There were eight (53.3%) studies conducted in East Africa, namely: Tanzania [16,18,20], Uganda [19,23,24], Rwanda [21], and Malawi [15]. Five (33.3%) studies were conducted in West Africa, namely: Nigeria [26–28], Senegal [22] and the Ivory Coast [25]; two (13.3%) studies were conducted in South Africa [14,17].

Fourteen (93.3%) of the fifteen studies were hospital-based studies. The participants were recruited from antenatal clinics [14–17,21,23–28], labor wards [22], and postpartum care [18,20]. Participants were recruited from single [16,20,23–28] and multiple hospitals [14,15,17,21], and the community [19]. One of the studies was a multi-center community-based behavioral study [19].

Twelve (80%) studies were observational in design and ranged from cross-sectional studies [14–19] to case-control [20–23] and cohort [24,25] studies. Three (20%) studies were clinical trials [26–28]. Four studies generated their results from the same study sample—one from South Africa [14,17] and the other from Nigeria [27,28]. A total of 5845 pregnant women were included in 13 studies.

3.2. Oral Disease Conditions Assessed for the Association with Adverse Pregnancy Events

Figure 2 is a diagrammatic illustration of the oral disease conditions assessed in the articles reviewed. Oral hygiene was assessed through the quantity of plaque [19,26] and calculus [19,23,24,26], while oral diseases were assessed using various criteria/indicators.

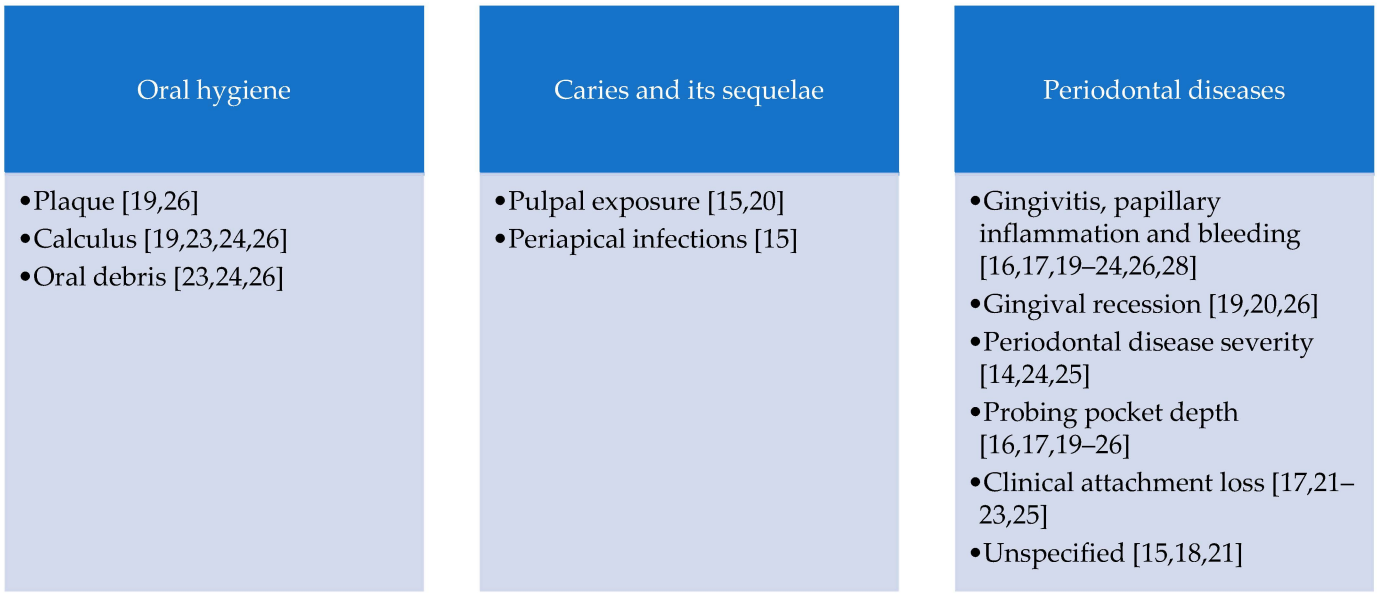

Figure 2. Oral disease status assessed among pregnant women with adverse events in sub-Saharan Africa.

3.3. Indices Used to Measure Oral Disease Status

The indices used to measure oral disease status ranged from the Community Periodontal Index/Community Periodontal Index of Treatment Needs [16,19,20,22–24,26–28] to the Gingival/Papillary Bleeding index [17,22,23,28], the Plaque index [17,22], the Decayed, Missing, and Filled Teeth (DMFT) index [17], and the Oral Hygiene Index-Simplified [24,26]. One study utilized the new 2018 European Federation of Periodontologists/American Association of Periodontology classification of periodontal and peri-implant diseases and conditions [25].

3.4. Adverse Pregnancy Events Observed

Adverse pregnancy events identified could be maternal- or child-related. Child-related events were low birth weight (LBW) [14–17,22–24,26,28], preterm birth (PTB) [14–17,21,23,25,26], preterm and low birth weight (PTLBW) [14,20,23], neonatal stunting [15], stunting [24], wasting [24], underweight [24], overweight [16], and small head circumference [15]. Maternal-related events were preterm premature rupture of membranes [16,19], preeclampsia [16], eclampsia [16], spontaneous abortion [26], vaginal bleeding [19], and chorioamnionitis [18,19].

3.5. Links between Oral Disease Status and Child-Related Pregnancy Events

The 15 studies assessed the links between oral diseases and adverse child-related pregnancy events. Poor oral hygiene was associated with stunting [24]. Periodontitis was linked with LBW [14,17,21,22,26,28], PTB [14,16,17,21,25,26] and PTLBW [14], stunting [24], wasting [24], and underweight [24]. It was, however, not linked with adverse pregnancy events in four studies: PTB [27], LBW [19] and PTLBW [20,23],

Caries was not linked with adverse pregnancy events [15,20] but its sequalae was linked with LBW [15], PTB [15], neonatal stunting [20,24], and small head circumference [15]. Gingival recession was linked to LBW [19].

3.6. Links between Oral Disease Status and Maternal-Related Pregnancy Events

Of the 15 studies, four (26.6%) found associations between oral disease status and adverse maternal-related pregnancy events [16,18,19,26]. Periodontal diseases were associated with preeclampsia [16] and chorioamnionitis [18]. No links were found between periodontal disease and preterm premature rupture of membranes [16], eclampsia [16], spontaneous abortion [26], and vaginal bleeding [19].

3.7. The Effect of Oral Health Interventions on Adverse Pregnancy Events

Three reports from the two intervention studies [26–28] showed that the test group treated for moderate to severe periodontal disease by scaling and polishing before delivery had a lower risk of having children with LBW and PTB [26–28]. The control groups that received oral hygiene instruction before delivery [26] or had scaling and polishing done after delivery [27,28] had a higher risk than the test group.

3.8. Point-of-Care Diagnostic Measure

A point-of-care diagnostic measure—N-benzoyl-DL-arginine-2-napththylamide (BANA)—was used to test pregnant women during routine antenatal examination to detect the presence of periodontopathogens in dental plaque [14]. BANA was sensitive and predictive of pregnant women at risk of PTB, LBW, and PTLBW, and thereby effective in screening for pregnant mothers who will benefit from periodontal therapy as a way of reducing adverse pregnancy events [14].

Table 2 shows that: (1) no study found an association between dental caries, pulpal exposure, and adverse pregnancy events; (2) moderate and severe periodontal disease and periapical infection were associated with LBW and PTB; (3) gingivitis and gingival recession were associated with LBW; (4) periodontitis was associated with preeclampsia, neonatal stunting, wasting, being underweight, and chorioamnionitis. Not all of the studies identified associations between periodontitis and adverse pregnancy events in sub-Saharan Africa.

Table 2. Summary of the findings on the links between oral disease status and adverse pregnancy events.

Adverse Pregnancy Events	Gingivitis	Moderate and Severe Periodontal Disease	Probing Pocket Depth	Calculus	Gingival Recession	CAL	Periapical Infections	Caries	Pulpal Exposure	Oral Hygiene Status
LBW	X	X/-	X		X	X	X	-		
PTB	-	X/-	X	-	-	X	X	-		
PTLBW	-	X/-			-				-	
Neonatal stunting		X					X	-		X
Wasting		X								
Underweight		X								
Overweight										
Small head circumference							X	-		
pPROM										
Preeclampsia		X								
Eclampsia										
Spontaneous abortion										
Vaginal bleeding										
Chorioamnionitis		X			X					

Abbreviations: LBW—low birth weight; PDS—periodontal disease severity; pPROM—preterm premature rupture of membranes; PTB—preterm birth; PTLBW—preterm low birth weight; CAL—clinical attachment loss; x: association found; -: no association found. Gray colour—variables were not studied.

3.9. Gaps in Knowledge on the Link between Oral Disease Status and Adverse Pregnancy Events

Gaps identified in knowledge included a limited understanding of how oral disease conditions affected pregnancy events [15,16,18–20,22,24,28], and the need for clinicians managing pregnant women to be aware of the link between oral diseases and adverse pregnancy events to improve their patients' management [21,22,25,28].

Recommendations for future research include prospective studies on the effect of treating periodontal disease following screening with BANA on the risk of PTLBW [14]; the relationship between periodontitis and adverse pregnancy events in rural sub-Saharan African communities [15]; the mediating role of gingivitis, periodontitis, and periapical conditions in adverse pregnancy events [16,20,27]; the role of the microbiota in pregnancy events [16,27]. Two studies advocated epidemiological studies with larger sample sizes [19,24].

4. Discussion

This study aimed to map research investigating the connection between oral diseases and adverse pregnancy events, focusing on oral hygiene status, periodontitis, and caries and its sequelae. While many studies identified statistically significant associations between periodontitis and adverse events, a few reported no statistically significant links. Consensus on the associations between caries and child-related adverse maternal events was also lacking. Poor oral hygiene was associated with stunting, and interventions eliminating poor oral hygiene during pregnancy appeared to reduce the risk for LBW and PTB.

To our knowledge, this is the first scoping review mapping the connections between oral diseases and adverse pregnancy events in sub-Saharan Africa—a region marked by a heightened prevalence of poor oral health [29], a significant incidence of maternal challenges [8,11], and notable rates of infant morbidity and mortality [11] during the perinatal period. However, the review is not without its limitations. Firstly, it exclusively considered literature published in English, overlooking the linguistic diversity prevalent in sub-Saharan Africa, and possibly excluded non-anglophone, but pertinent, studies. Secondly, the scope was confined to mapping rather than assessing the robustness of associations between adverse pregnancy events and oral diseases in sub-Saharan Africa. Thirdly, our search was limited to the databases to PubMed, Google Scholar, and Cochrane Library databases. Despite these potential limitations, the current review illuminates crucial findings.

First, we observed that there were very few publications in English on the link between oral disease conditions and adverse pregnancy events in sub-Saharan Africa. Yet, adverse child-related pregnancy events are leading causes of neonatal morbidity and mortality, and maternal morbidity and mortality, in the region [30]. The limited number of studies on the relationship between oral health and adverse maternal and child events during pregnancy limits the ability to quantify how large a contribution oral health makes to maternal and child morbidity and mortality, as well as how much resources need to be invested in tackling the problem. The few studies conducted had also recognized some of the gaps created by limited information on the topic [15,16,18–20,22,24,28].

Yet, context-specific studies are important to enable the planning and implementation of context-specific responses. Most countries in sub-Saharan Africa are low-to-middle income, with populations facing unique health challenges due to widespread poverty, limited access to comprehensive healthcare services [9], and high prevalence rates of oral diseases [2]. Although reports of studies conducted in high-income countries indicate a connection between suboptimal oral health and adverse pregnancy events [6,7], and the current study suggests there is such plausibility, the pathophysiological pathways may differ by context. Understanding these context-specific differences will help with the planning of appropriate responses when such need is identified. Like past studies [6,8], the current study also advocates for studies that generate conclusive evidence on the link between oral diseases and adverse pregnancy events, the pathophysiology of oral-health-related adverse pregnancy events, and models for scaling up interventions to mitigate the risk for oral-health-related poor pregnancy events among others. Studies on the effectiveness of point-of-care screening devices that are simple to use, cheap, and time-efficient, like BANA [31–33], for the community-based screening of pregnant women at risk for adverse pregnancy events are also welcome.

Future studies would, however, need to be guided with methodological approaches to enhance the comparability of the study findings. The current study indicates that there are diverse tools used for assessing similar phenomena. Studies on the relationship between oral disease conditions and adverse pregnancy events in sub-Saharan Africa may therefore benefit from published standardized study protocols that guide the conduct of comparable studies. The findings from this study suggest that such protocols may include assessment for maternal periodontal health using tools that check for gingivitis, probing pocket depths, and clinical attachment loss. Dental caries and its sequelae could be measured using the DMFT index, though there are increasing concerns about the diagnostic and treatment limitations associated with DMFT [34]. In addition, studies investigating the effectiveness of periodontal interventions should broaden their focus beyond assessing the impact on PTB, LBW, and PTLBW to explore their effects on chorioamnionitis and maternal vitamin D levels, as these factors potentially mediate adverse child-related pregnancy events [35–37].

Including assessments for the link between periodontal disease and adverse pregnancy events is important, as this scoping review showed that most of the studies found links between periodontal diseases and adverse pregnancy events. A systematic review of the global literature has shown an association between periodontal disease and PTB and LBW [38]. Maternal periodontal disease makes the oral environment chronically exposed to oral Gram-negative pathogens, which is a preventable and treatable risk factor for adverse neonatal events [38]. Organisms associated with oral diseases could stimulate the fetal immune and inflammatory response, accompanied by the production of IgM antibodies, and the increased secretion of inflammatory mediators, which in turn may cause PTB [39]. In addition, chronic inflammation from organisms present during periodontal disease may cause structural changes in the placenta, leading to insufficient fetal nutrient support and resulting in LBW [40,41].

Furthermore, assessment of the links between untreated dental caries and adverse pregnancy events needs to be studied further. This is because untreated dental caries during pregnancy may be found in pregnant women who are obese, have high levels of fasting blood glucose, and a sedentary lifestyle, which are risk factors for type 2 diabetes

mellitus [42–44]. Women with type 2 diabetes are more likely to give birth to children who are overweight. Cho et al. [42] found that, even after adjusting for obesity and the fasting blood glucose level, pregnant women with dental caries still had increased risk of delivering infants who were overweight and not with a LBW, as well as a poorly understood inverse relationship between the occurrence of overweight and LBW infants from women with dental caries [42]. The treatment of dental caries during pregnancy reduced the risk of the delivery of overweight infants [42], just like the treatment of periodontal disease during pregnancy reduced the risk of delivery of PTB and LBW infants [26–28]. These mechanisms highlight the intricate relationship between oral health, inflammation, and adverse pregnancy events, emphasizing the need for a comprehensive approach to studying and managing oral health during pregnancy [45].

5. Conclusions

This scoping review has revealed a paucity of studies published in the English language on the link between oral disease status and adverse pregnancy events in sub-Saharan Africa. Furthermore, the few studies were mainly conducted in East Africa, lacked multicenter representation, and predominantly adopted observational research designs. Most of the studies on the association between maternal periodontal disease and caries sequalae were linked to adverse child-related pregnancy events, and very few studies examined adverse maternal-related pregnancy events. Moreover, the mediating role of sociocultural factors on the link between oral diseases and adverse pregnancy outcomes remains to be explored. Longitudinal, experimental, and sufficiently powered studies that adhere to standardized oral health status assessment criteria are needed to bridge these knowledge gaps. By conducting such rigorous investigations, we can better inform healthcare practices in sub-Saharan Africa.

Author Contributions: All authors conceptualized the study, E.T.A., O.R.A., I.E.A., A.O.S., M.E.T. and M.O.F. prepared and finalized the study protocol while E.T.A., O.R.A. and M.O.F. undertook the literature search and selection of studies. Data analysis was carried out by E.T.A. and M.O.F. while E.T.A., I.E.A. and M.O.F. wrote the results. E.T.A., O.R.A., I.E.A., A.O.S., M.E.T., J.L., F.T.A., O.T.A., G.U.E., O.C.E. and M.O.F. read all the manuscript versions for intellectual content. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Not applicable.

Data Availability Statement: Requests for data should be addressed to the corresponding author.

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Appendix A Search Strategy for PubMed

	SEARCH STRATEGY		
#1	"oral health"[MeSH Terms] OR "dental clinics"[MeSH Terms] OR "dental health surveys"[MeSH Terms] OR "diagnosis, oral"[MeSH Terms] OR "mouth diseases"[MeSH Terms] OR "mouth rehabilitation"[MeSH Terms]		255,419
#2	"periodontitis"[MeSH Terms] OR "chronic periodontitis"[MeSH Terms] OR "aggressive periodontitis"[MeSH Terms] OR "periapical periodontitis"[MeSH Terms] OR "periapical abscess"[MeSH Terms] OR "periapical granuloma"[MeSH Terms] OR "aggressive periodontitis"[MeSH Terms]		27,217
#3	"gingivitis"[MeSH Terms] OR "gingivitis, necrotizing ulcerative"[MeSH Terms] OR "gingival diseases"[MeSH Terms] OR "granuloma, giant cell"[MeSH Terms] OR "gingival neoplasms"[MeSH Terms]		17,213
#4	"dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms] OR "dental caries"[MeSH Terms]		29,789
#5	"xerostomia"[MeSH Terms] OR "xerostomia"[MeSH Terms] OR "xerostomia"[MeSH Terms] OR "xerostomia"[MeSH Terms] OR "xerostomia"[MeSH Terms]		15,069
#6	#1 OR #2 OR #3 OR #4 OR #5	((((((((oral health[MeSH Terms]) OR (dental clinics[MeSH Terms])) OR (Dental health surveys[MeSH Terms])) OR (Diagnosis, Oral[MeSH Terms])) OR (Mouth diseases[MeSH Terms])) OR (Mouth rehabilitation[MeSH Terms])) OR (((((((Periodontitis[MeSH Terms]) OR (Chronic periodontitis[MeSH Terms])) OR (Aggressive periodontitis[MeSH Terms])) OR (Periapical periodontitis[MeSH Terms])) OR (Periapical abscess[MeSH Terms])) OR (Periapical granuloma[MeSH Terms])) OR (Periodontitis, aggressive[MeSH Terms]))) OR (((((Gingivitis[MeSH Terms]) OR (Gingivitis, necrotizing ulcerative[MeSH Terms])) OR (Gingival diseases[MeSH Terms])) OR (Granuloma, giant cell[MeSH Terms])) OR (Gingival neoplasms[MeSH Terms]))) OR ((((((((((Caries, dental[MeSH Terms]) OR (Dental cavity[MeSH Terms])) OR (Dental decay[MeSH Terms])) OR (Dental cavities[MeSH Terms])) OR (Cavities, dental[MeSH Terms])) OR (Cavity, dental[MeSH Terms])) OR (Carious lesions[MeSH Terms])) OR (Carious lesion[MeSH Terms])) OR (Lesion, carious[MeSH Terms])) OR (Lesions, carious[MeSH Terms])) OR (Decay, dental[MeSH Terms])) OR (Dental white spot[MeSH Terms]))) OR (((((Xerostomia[MeSH Terms]) OR (Hyposalivation[MeSH Terms])) OR (Hyposalivations[MeSH Terms])) OR (Mouth dryness[MeSH Terms])) OR (Dryness, mouth[MeSH Terms]))	272,124
#7	"pregnancy outcome"[MeSH Terms] OR "pregnancy outcome"[MeSH Terms] OR "pregnancy outcome"[MeSH Terms] OR "pregnancy complications"[MeSH Terms] OR "abortion, induced"[MeSH Terms] OR "live birth"[MeSH Terms] OR "stillbirth"[MeSH Terms] OR "fetal death"[MeSH Terms]		359,101

	SEARCH STRATEGY		
#8	"pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms]		24,824
#9	"premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms]		20,123
#10	"infant, premature"[MeSH Terms] OR "obstetric labor, premature"[MeSH Terms] OR (("obstetric"[All Fields] OR "obstetrically"[All Fields] OR "obstetrics"[MeSH Terms] OR "obstetrics"[All Fields] OR "obstetrical"[All Fields]) AND "obstetric labor, premature"[MeSH Terms]) OR "infant, extremely premature"[MeSH Terms]		74,368
#11	#7 OR #8 OR #9 OR #10	"pregnancy outcome"[MeSH Terms] OR "pregnancy outcome"[MeSH Terms] OR "pregnancy outcome"[MeSH Terms] OR "pregnancy complications"[MeSH Terms] OR "abortion, induced"[MeSH Terms] OR "live birth"[MeSH Terms] OR "stillbirth"[MeSH Terms] OR "fetal death"[MeSH Terms] OR ("pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms] OR "pre eclampsia"[MeSH Terms]) OR ("premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms] OR "premature birth"[MeSH Terms]) OR ("infant, premature"[MeSH Terms] OR "obstetric labor, premature"[MeSH Terms] OR (("obstetric"[All Fields] OR "obstetrically"[All Fields] OR "obstetrics"[MeSH Terms] OR "obstetrics"[All Fields] OR "obstetrical"[All Fields]) AND "obstetric labor, premature"[MeSH Terms]) OR "infant, extremely premature"[MeSH Terms])	400,414
#12	("BENIN"[Title/Abstract] OR "BOTSWANA"[Title/Abstract] OR "burkina faso"[Title/Abstract] OR "BURUNDI"[Title/Abstract] OR "cabo verde"[Title/Abstract] OR "CAMEROON"[Title/Abstract] OR "central african republic"[Title/Abstract] OR "CHAD"[Title/Abstract] OR "COMOROS"[Title/Abstract] OR (("congo"[MeSH Terms] OR "congo"[All Fields]) AND "dem rep"[Title/Abstract]) OR (("congo"[MeSH Terms] OR "congo"[All Fields]) AND "rep"[Title/Abstract]) OR "cote d ivoire"[Title/Abstract] OR "equatorial guinea"[Title/Abstract] OR "ERITREA"[Title/Abstract] OR "ESWATINI"[Title/Abstract] OR "ETHIOPIA"[Title/Abstract] OR "GABON"[Title/Abstract] OR "GAMBIA"[Title/Abstract] OR "GHANA"[Title/Abstract] OR "GUINEA"[Title/Abstract] OR "GUINEA-BISSAU"[Title/Abstract] OR "KENYA"[Title/Abstract] OR "LESOTHO"[Title/Abstract] OR "LIBERIA"[Title/Abstract] OR "MADAGASCAR"[Title/Abstract] OR "MALAWI"[Title/Abstract] OR "MALI"[Title/Abstract] OR "MAURITANIA"[Title/Abstract] OR "MAURITIUS"[Title/Abstract] OR "MOZAMBIQUE"[Title/Abstract] OR "NAMIBIA"[Title/Abstract] OR "NIGER"[Title/Abstract] OR "NIGERIA"[Title/Abstract] OR "RWANDA"[Title/Abstract] OR ("sao tome"[Title/Abstract] AND "PRINCIPE"[Title/Abstract]) OR "SENEGAL"[Title/Abstract] OR "SEYCHELLES"[Title/Abstract] OR "sierra leone"[Title/Abstract] OR "SOMALIA"[Title/Abstract] OR "south africa"[Title/Abstract] OR "south sudan"[Title/Abstract] OR "SUDAN"[Title/Abstract] OR "TANZANIA"[Title/Abstract] OR "TOGO"[Title/Abstract] OR "UGANDA"[Title/Abstract] OR "ZAMBIA"[Title/Abstract] OR "ZIMBABWE"[Title/Abstract]		283,964

	SEARCH STRATEGY		
#13	#6 AND #11 AND #12	((“oral health”[MeSH Terms] OR “dental clinics”[MeSH Terms] OR “dental health surveys”[MeSH Terms] OR “diagnosis, oral”[MeSH Terms] OR “mouth diseases”[MeSH Terms] OR “mouth rehabilitation”[MeSH Terms] OR (“periodontitis”[MeSH Terms] OR “chronic periodontitis”[MeSH Terms] OR “aggressive periodontitis”[MeSH Terms] OR “periapical periodontitis”[MeSH Terms] OR “periapical abscess”[MeSH Terms] OR “periapical granuloma”[MeSH Terms] OR “aggressive periodontitis”[MeSH Terms]) OR (“gingivitis”[MeSH Terms] OR “gingivitis, necrotizing ulcerative”[MeSH Terms] OR “gingival diseases”[MeSH Terms] OR “granuloma, giant cell”[MeSH Terms] OR “gingival neoplasms”[MeSH Terms]) OR (“dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms] OR “dental caries”[MeSH Terms]) OR (“xerostomia”[MeSH Terms] OR “xerostomia”[MeSH Terms] OR “xerostomia”[MeSH Terms] OR “xerostomia”[MeSH Terms] OR “xerostomia”[MeSH Terms])) AND (“pregnancy outcome”[MeSH Terms] OR “pregnancy outcome”[MeSH Terms] OR “pregnancy outcome”[MeSH Terms] OR “pregnancy complications”[MeSH Terms] OR “abortion, induced”[MeSH Terms] OR “live birth”[MeSH Terms] OR “stillbirth”[MeSH Terms] OR “fetal death”[MeSH Terms] OR (“pre eclampsia”[MeSH Terms] OR “pre eclampsia”[MeSH Terms] OR “pre eclampsia”[MeSH Terms] OR “pre eclampsia”[MeSH Terms] OR “pre eclampsia”[MeSH Terms]) OR (“premature birth”[MeSH Terms] OR “premature birth”[MeSH Terms] OR “premature birth”[MeSH Terms] OR “premature birth”[MeSH Terms] OR “premature birth”[MeSH Terms] OR “premature birth”[MeSH Terms]) OR (“infant, premature”[MeSH Terms] OR “obstetric labor, premature”[MeSH Terms] OR ((“obstetric”[All Fields] OR “obstetrically”[All Fields] OR “obstetrics”[MeSH Terms] OR “obstetrics”[All Fields] OR “obstetrical”[All Fields]) AND “obstetric labor, premature”[MeSH Terms]) OR “infant, extremely premature”[MeSH Terms])) AND 1990/01/01:2022/12/31[Date—Publication] AND ((“BENIN”[Title/Abstract] OR “BOTSWANA”[Title/Abstract] OR “burkina faso”[Title/Abstract] OR “BURUNDI”[Title/Abstract] OR “cabo verde”[Title/Abstract] OR “CAMEROON”[Title/Abstract] OR “central african republic”[Title/Abstract] OR “CHAD”[Title/Abstract] OR “COMOROS”[Title/Abstract] OR ((“congo”[MeSH Terms] OR “congo”[All Fields]) AND “dem rep”[Title/Abstract]) OR ((“congo”[MeSH Terms] OR “congo”[All Fields]) AND “rep”[Title/Abstract]) OR “cote d ivoire”[Title/Abstract] OR “equatorial guinea”[Title/Abstract] OR “ERITREA”[Title/Abstract] OR “ESWATINI”[Title/Abstract] OR “ETHIOPIA”[Title/Abstract] OR “GABON”[Title/Abstract] OR “GAMBIA”[Title/Abstract] OR “GHANA”[Title/Abstract] OR “GUINEA”[Title/Abstract] OR “GUINEA-BISSAU”[Title/Abstract] OR “KENYA”[Title/Abstract] OR “LESOTHO”[Title/Abstract] OR “LIBERIA”[Title/Abstract] OR “MADAGASCAR”[Title/Abstract] OR “MALAWI”[Title/Abstract] OR “MALI”[Title/Abstract] OR “MAURITANIA”[Title/Abstract] OR “MAURITIUS”[Title/Abstract] OR “MOZAMBIQUE”[Title/Abstract] OR “NAMIBIA”[Title/Abstract] OR “NIGER”[Title/Abstract] OR “NIGERIA”[Title/Abstract] OR “RWANDA”[Title/Abstract] OR (“sao tome”[Title/Abstract] AND “PRINCIPE”[Title/Abstract]) OR “SENEGAL”[Title/Abstract] OR “SEYCHELLES”[Title/Abstract] OR “sierra leone”[Title/Abstract] OR “SOMALIA”[Title/Abstract] OR “south africa”[Title/Abstract] OR “south sudan”[Title/Abstract] OR “SUDAN”[Title/Abstract] OR “TANZANIA”[Title/Abstract] OR “TOGO”[Title/Abstract] OR “UGANDA”[Title/Abstract] OR “ZAMBIA”[Title/Abstract] OR “ZIMBABWE”[Title/Abstract]) AND 1990/01/01:2022/12/31[Date—Publication] AND 1990/01/01:2022/12/31[Date—Publication])) AND (1990/1/1:2022/12/31[pdat])	27

Search Strategy for Cochrane

Oral health using Cochrane Library, with publication dates between Jan 1990 and Dec 2022, in Cochrane Reviews, Cochrane Protocols, Trials, and Clinical Answers, with 'Public Health', 'Pregnancy and Childbirth', 'Oral Health', and 'Child Health' in Cochrane Groups: 10009

#2 Periodontitis 7049
#3 Gingivitis 3912
#4 Dental cavity 3637
#5 Xerostomia 5340
#6 Pre Eclampsia 2774
#7 Birth, premature 9321
#8 Preterm birth 10,399
#9 Infant, premature 9928
#11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 45,640
#12 Pregnancy outcomes 20,252
#13 Pregnancy complications 13,636
#14 Foetal death 2615
#15 Live birth 5119
#16 Still birth 3882
#17 Infant, premature 9928
#18 Preterm births 1039
#19 Pre Eclampsia 2774
#20 Pregnancy toxemias 20
#21 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 43,347
#22 #1 OR #2 OR #3 OR #4 OR #5 26,706

#23 BENIN OR BOTSWANA OR BURKINA FASO OR BURUNDI OR CABO VERDE OR CAMEROON OR CENTRAL AFRICAN REPUBLIC OR CHAD OR COMOROS OR CONGO OR COTE D'IVOIRE OR ERITREA OR ESWATINI OR ETHIOPIA OR GABON OR GAMBIA OR GHANA OR GUINEA OR GUINEA-BISSAU OR KENYA OR LESOTHO OR LIBERIA OR MADAGASCAR OR MALAWI OR MALI OR MAURITANIA OR MAURITIUS OR MOZAMBIQUE OR NAMIBIA OR NIGER OR NIGERIA OR RWANDA OR SAO TOME AND PRINCIPE OR SENEGAL OR SEYCHELLES OR SIERRA LEONE OR SOMALIA OR SOUTH AFRICA OR SOUTH SUDAN OR SUDAN OR TANZANIA OR TOGO OR UGANDA OR ZAMBIA OR ZIMBABWE 29,060

#24 #21 AND #22 AND #23 with Cochrane Library, publication date between Jan 1990 and Dec 2022, with 'Public Health', 'Pregnancy and Childbirth', 'Oral Health', and 'Child Health' in Cochrane Groups 175

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