Clinical practice guidelines for oral health care during pregnancy: a systematic evaluation and summary recommendations for general dental practitioners

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Objective: To evaluate and summarize clinical practice guidelines on the prevention, diagnosis, and treatment of dental diseases during pregnancy, and to provide summary recommendations for general dental practitioners involved in the dental care of pregnant women. **Method and materials:** Using keywords related to prenatal dental care in combination with guidelines or consensus statements, online databases, websites of professional organizations, and evidence-based practice platforms were searched. Published guidelines or consensus statements that met the inclusion criteria were selected and evaluated with the Appraisal of Guidelines for Research & Evaluation Instrument II (AGREE-II) tool. Key recommendations were summarized and assessed for consistency across the guidelines. **Results:** A total of 15 guidelines or consensus statement documents for oral health care during pregnancy were found after the initial search, of which 7 documents met the inclusion criteria; these were analyzed with AGREE-II. These guidelines were developed by expert panels and consensus meetings after comprehensive review of the best available evidence, and consistently deliver clear messages that preventive, diagnostic, restorative, and periodontal procedures and tooth extractions are safe throughout pregnancy and effective in improving and maintaining the oral health of mothers and their children. Dental diseases should be treated in a timely manner and dental emergency treatments can be provided at any time during pregnancy. Dental examination and prophylaxis should be conducted every 6 months to maintain the oral health of pregnant women. **Conclusion:** Published clinical guidelines are consistent in delivering clear messages and providing guidance to dental practitioners for timely and effective dental care during pregnancy. Prevention, diagnosis, and treatment of oral diseases are safe throughout the pregnancy.
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Key words: clinical guidelines, consensus statements, dental care, oral health, pregnancy

Pregnancy is a special period in a woman's life. Changes in female hormone levels[1-4] and immune system[5,6] during pregnancy may increase the susceptibility of pregnant women to infectious oral diseases such as gingivitis, periodontitis, and caries. Periodontitis during pregnancy has long been considered a potential risk factor that may be associated with adverse pregnancy outcomes such as preterm birth and low birth weight.[7] Interventional trials for periodontal disease during pregnancy have shown that periodontal treatments could reduce the quantity of pathogenic bacteria in the oral cavity, relieve symptoms of periodontal infections,[8,9] and improve the overall oral health status of pregnant women.[10] The oral health status of a mother is also closely related to the dental disease burdens in her children. For example, one study showed that untreated severe caries in mothers was associated with doubling of the prevalence of severe caries in their children.[11] Controlling oral diseases in pregnant women could reduce the transmission of oral bacteria from mother to child, thereby reducing the risk of early childhood caries,[12] and improving the long-term oral health in their children.[13,14]

Oral health is an integral component of overall health. High oral disease burdens are often associated with poor general

health status.[15,16] Periodic dental exams and preventive dental care are important strategies for oral health maintenance and dental disease prevention.[17,18] Preventive dental care during pregnancy has been recognized as an important part of prenatal care to reduce the risks of dental diseases in pregnant women.[19,20] However, it has been reported that utilization of preventive and therapeutic dental care is low in pregnant women,[21-23] and that reluctance in treating pregnant women exists among some dental professionals.[24,25] The lack of professional guidelines for dental treatment during pregnancy has been cited by some dental practitioners as one of the barriers for providing dental care to pregnant women,[26] despite being aware that the prevalence of oral diseases such as periodontal disease and caries is high in pregnant women amongst their patient population.[27] Many reports have shown that delaying dental care may cause severe harms to pregnant women and their unborn children.[28-30]

Evidence-based clinical practice guidelines or consensus statements are important guidance documents for health care professionals providing direct patient services in the community. A "clinical practice guideline" is usually produced by a comprehensive review of scientific evidence for the best practice for diagnosis, prevention, or treatment of diseases or clinical conditions, and often includes assessments of benefits and risks of alternative options.[31,32] A "consensus statement" is usually developed by an independent, multidisciplinary expert panel convened to assess existing literature in an evidence-based manner in order to arrive at a conclusion that reflects the common understanding of the best evidence for a clinical issue, procedure, or protocol.[32] The purpose of both clinical practice guidelines and consensus statements is the same: providing practice recommendations for clinical practitioners to improve the quality of patient care based on the best available scientific evidence.[32,33] Timely and quality dental care for pregnant women is of vital importance as they are in a vulnerable stage of their lives during which their oral health status may affect both their own and their children's wellbeing. Clinical practice guidelines or consensus statements for oral health care during pregnancy will facilitate the provision of optimized care for this special patient population.

In the process of providing dental care for pregnant women, it has come to the present authors' attention that multiple clinical practice guidelines for oral health care during pregnancy are available at national and regional levels for dental practitioners in the United States,[20,34,35] but no other guidelines from other countries or international organizations could be identified, other than a recent document from the European Federation of Periodontology.[36] The methodologic quality and consistency in practice recommendations of published guidelines has not been studied in the past. During international dental forums and academic exchanges, it was also found that official guidelines are not available for dental practitioners who care for pregnant women in many other countries, which may result in the delay or avoidance of vital care for these patients.[19,37] In this context, the aim of the present study was to evaluate the methodologic quality and content consistency of published clinical guidelines for oral health care during pregnancy, and to summarize the key practice recommendations from these guidelines, which may be used as evidence-based tools for dental practitioners involved in prevention, diagnosis, and treatment of dental diseases in pregnant women.

Method and materials

Literature search strategies

Using different combinations of keywords such as dental care, oral health care, oral health, dental treatments; and pregnancy, pregnant women, prenatal; and guidelines, consensus statement, recommendations, public databases including PubMed, Embase, Web of Science, Guidelines International Network, SinoMed, CNKI, and Google Scholar were searched, as well as websites and databases of national and regional professional dental organizations and evidence-based practice platforms for published guidelines or consensus statements related to prevention, diagnosis, and treatment of dental diseases during pregnancy.

Inclusion criteria

The guidelines or consensus statements had to be:

- intended for dental practitioners for the prevention, diagnosis, or treatment of oral diseases during pregnancy
- developed by a national or regional public health department or a national or regional dental professional organization or society
- produced following comprehensive evidence-based literature reviews by expert panels.

Exclusion criteria

The guidelines or consensus statements were excluded if they were:

- older versions of the guidelines
- translated versions of the guidelines or interpretation articles

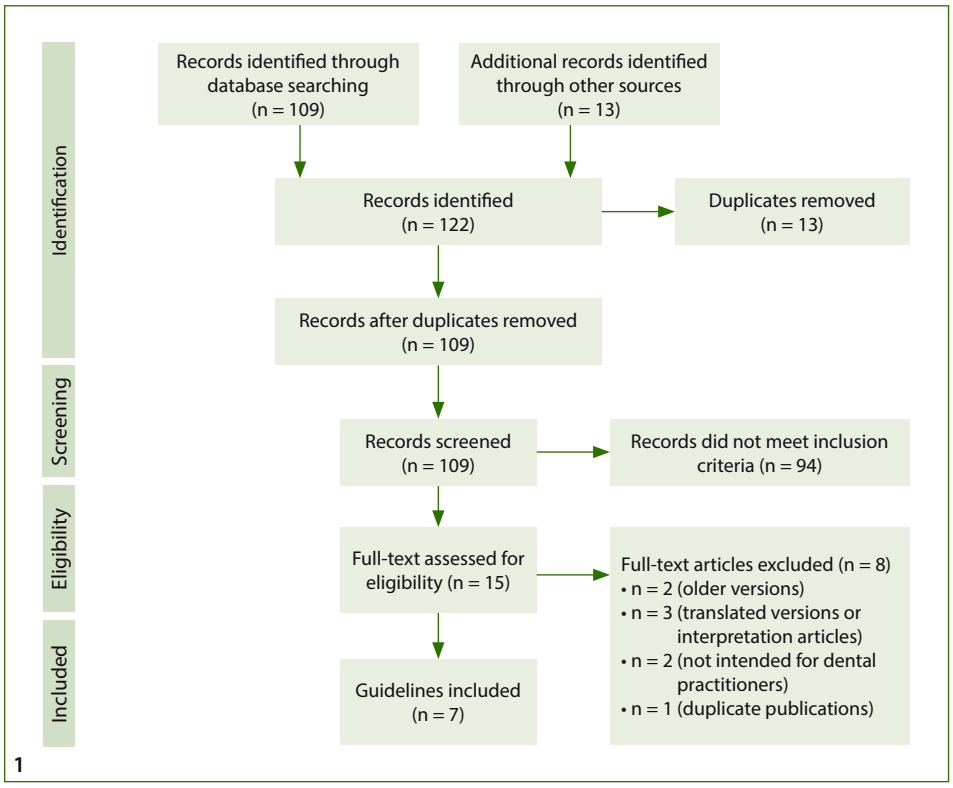

Fig 1 Flowchart illustrating the process of guideline search following the inclusion and exclusion criteria.

- were not intended for dental practitioners
- duplicate publications.

Literature screening and selection

Two researchers (JB and XH) screened the retrieved documents according to the inclusion and exclusion criteria, and initially evaluated the documents that met the criteria for inclusion. They then convened to determine the final selection of guidelines or consensus statements (Fig 1). If the two researchers had different opinions on the included or excluded literature after initial discussions, a third researcher was asked to evaluate the literature and make the final selection decision.

Quality assessments of selected clinical practice guidelines

Two investigators (JB and XH) independently extracted data from the selected clinical practice guidelines, and the methodologic quality of the guidelines was assessed using the Appraisal of Guidelines for Research & Evaluation Instrument II (AGREE-II).[38] The AGREE-II scores the quality of the guidelines based on six domains that include 23 items:

- Scope and purpose (3 items)
- Stakeholder involvement (3 items)
- Rigor of development (8 items)
- Clarity and presentation (3 items)
- Applicability (4 items)
- Editorial independence (2 items).

The investigators were first trained using the online training instruments created by the AGREE-II developers to achieve familiarity and consistency in the scoring methodology.[39] Each item in the six domains was scored from 1 (completely disagree) to 7 (strongly agree), with the higher scores indicating higher quality. If the scores of the two investigators disagreed, the final score was determined after consultation with a third investigator to reach a consensus. The total score of each domain is the sum of item scores in the domain, and expressed as the percentage of the highest possible score in that domain.[38]

Key practice recommendations and consistency evaluations

The selected clinical practice guidelines could be classified into three categories based on their focus areas: comprehensive guidelines for all dental professionals, specific guidelines for dental professionals who provide perinatal dental care for children and pregnant adolescents, and specific guidelines for periodontal treatments for pregnant women. Though the latter two categories were developed by specialty dental associations, their contents are fully applicable to general dental practitioners who may treat young expectant mothers or provide their patients with preventive or therapeutic periodontal interventions. To evaluate the consistency of recommendations across the included guidelines, from each guideline the key practice recommendations on four aspects of clinical practice were extracted: dental disease prevention, diagnosis, treatment, and oral health maintenance during pregnancy. These recommendations were compared to identify potential inconsistencies or contradictions across the guidelines.

The key practice recommendations of the included guidelines were summarized into a table to facilitate their use as a reference tool during clinical practice for preventive care, diagnosis, treatment, and oral health maintenance decisions involving pregnant women.

Results

Literature search and selections

After the keyword combination search and preliminary screening, a total of 15 clinical practice guidelines or consensus statements that may meet the inclusion criteria were selected for further evaluations. After further full-text evaluation by two reviewers, a total of seven clinical practice guidelines or consensus statements were included in the final analysis. The literature search, screening, and selection process are shown in Fig 1.

Characterizations of the included literature

All seven included guideline documents were published in English language by dental professional organizations or national or regional governmental health agencies in the US or Europe (Table 1).[20,34-36,40-42] Among them are four comprehensive guideline documents intended for all dental professionals,[20,34,35,40] two guideline documents for dental professionals involved in perinatal care for children or pregnant adolescents,[41,42] and one guideline document for dental professionals involved in periodontal treatments of pregnant women.[36] Six of the seven documents included in the present study were characterized as "guidelines" or "practice guidelines" in their titles and texts, and one was described as a "consensus statement." For simplicity, the term "guidelines" was chosen to encompass all guideline and consensus statement documents included in the present study, bearing in mind that they serve the same purpose of providing clinical practice recommendations based on the best available evidence.[32,33] The four comprehensive guidelines were formulated and formed by committees composed of multidisciplinary experts from obstetrics and gynecology, midwives, general dentistry, and specialty dentistry (including dental public health experts), social workers, and health policy experts; these comprehensive guidelines were adopted, approved, and finalized at consensus meetings.[20,34,35,40] Four of the seven guidelines included recommendations for prenatal health professionals such as obstetrics and gynecology,[20,34,35,40] and four included recommendations for child health professionals such as pediatricians.[20,34,36,40] The basic characteristics of the included guidelines are shown in Table 1 and described in more detail below.

Comprehensive guidelines for all dental professionals

A multidisciplinary panel of experts convened by the New York State Department of Health developed the first clinical guidelines for dental care during pregnancy in 2006 following the most comprehensive review of clinical literature at the time.[20] The expert panel believed that although there was a lack of randomized controlled clinical trials owing to the vulnerability of this special patient population, there was sufficient scientific research evidence to support the development of a consensus guideline to improve the quality of dental care for pregnant women. This guideline was the first to clearly assert that prevention, diagnoses, and treatments of dental diseases are safe during pregnancy, and provides clear recommendations for the dental care of pregnant women, including prenatal oral health education, types of dental treatments that can be safely provided during pregnancy, timing of dental treatments, choice of antibacterial drugs and local anesthetics, as well as recommendations for the dental care of infants. This guideline was groundbreaking and has contributed to improved dental care for pregnant mothers and their children.[25,43]

The evidence-based guidelines for dental care during pregnancy developed later by the California Dental Association Foundation and American College of Obstetricians and Gynecologists[34] and the Massachusetts Department of Public Health[40] reviewed additional new evidence and updated the literature

Table 1 Basic characteristics of included guidelines for oral health care during pregnancy

Clinical guidelines	Developer	Year	Development method	Intended users
Oral health care during pregnancy and early childhood practice guidelines[20]	New York State Department of Health	2006	Comprehensive review and expert panel consensus meetings	All dental professionals, physicians, and other health care workers involved in perinatal care of women and children
Oral health during pregnancy and early childhood: evidence-based guidelines for health professionals[34]	California State Dental Association Foundation and American College of Obstetricians and Gynecologists	2010	Comprehensive review and expert panel consensus meetings	All dental professionals, physicians, and other health care workers involved in perinatal care of women and children
Oral health care during pregnancy: a national consensus statement[35]	National Maternal and Child Oral Health Resource Center	2012–2020	Comprehensive review and expert panel consensus meetings	All dental professionals, physicians, and other health care workers involved in perinatal care of women
Massachusetts oral health practice guidelines for pregnancy and early childhood[40]	Massachusetts Department of Public Health	2016	Comprehensive review and expert panel consensus meetings	All dental professionals, physicians, and other health care workers involved in perinatal care of women and children
Perinatal and Infant Oral Health Care (2021 edition)[41]	American Academy of Pediatric Dentistry	2021	Comprehensive review and expert panel consensus	Dental professionals involved in the treatment of pregnant women and infants
Oral Health Care for the Pregnant Pediatric Dental Patient (2021 edition)[42]	American Academy of Pediatric Dentistry	2021	Comprehensive review and expert panel consensus	Dental professionals involved in the treatment of pregnant adolescents
The relationship between oral health and pregnancy: guidelines for oral-health professionals[36]	European Federation of Periodontology.	2020	Comprehensive review and expert consensus	Dental professionals involved in periodontal treatments of pregnant women

from previous guidelines. These guidelines emphasize that pregnancy should not be used as a reason for delaying routine dental care or treatment of dental diseases, and further clarify that prevention, diagnosis, and treatments of oral diseases, including diagnostic x-ray examinations and local anesthesia, are very beneficial to pregnant women compared to no treatment.

Based on comprehensive literature review and consensus development conferences by large multidisciplinary expert panels, the National Maternal and Child Oral Health Resource Center in the US published its national consensus statement on oral health care during pregnancy for the first time in 2012,[35] and has since continued to supplement and update the consensus on an annual basis using the latest clinical research evidence.[44] This consensus statement provides specific recommendations for dental professionals in assessing oral health and providing oral health advice and dental treatments during pregnancy, and a list of medications that can be safely used to treat dental diseases during pregnancy (Table 2). The national consensus once again emphasized that the prevention, diagnosis, and timely treatment of oral diseases can effectively maintain and promote the oral health of pregnant women, and is safe throughout the pregnancy cycle.

Guidelines for perinatal and infant dental care and for pregnant adolescents

From 2007 to 2021, the American Academy of Pediatric Dentistry (AAPD) published and updated several perinatal dental care guidelines[41] and guidelines for oral health care for the pregnant pediatric dental patient.[42] The AAPD perinatal and infant dental care guidelines points out that oral health care of pregnant mothers is not only beneficial to their own health, but also helps to minimize mother-to-child transmission of oral diseases and reduce the risk of early childhood caries in infants and young children.[42] This guideline confirms the safety of dental treatments and local anesthetics containing epinephrine during pregnancy, and emphasizes that delays in the treatment of dental diseases may cause harm to the fetus, and that the harms caused by oral infection itself are far greater than potential risks associated with the treatments. Pregnant teenagers (under 19 years of age) are a special vulnerable group with high risk. The dental practitioners involved in their dental care should conduct a comprehensive dental examination and caries risk assessment of these patients, and treat caries and periodontal diseases in a timely manner to prevent possible complications.

Table 2 Guidelines for medication use for dental treatments during pregnancy[35]

Category	Medications	Recommendations
Analgesics	Acetaminophen	Non-opioids can be used to relieve oral pain during pregnancy. If opioids are used, the lowest dose should be prescribed in the shortest time (usually less than 3 days). To reduce the risk of dependence, repeated prescribing should be avoided.
	Acetaminophen with codeine	
	Hydrocodone or oxycodone	
	Codeine	
	Pethidine	
	Morphine	
	Aspirin*	Can be used for a short period of time (48 to 72 hours) during pregnancy. Avoid use in the first and last trimester of pregnancy.
	Ibuprofen	
	Naproxen	
Antibiotics	Amoxicillin	Can be used during pregnancy.
	Cephalosporin	
	Clindamycin	
	Metronidazole	
	Penicillin	
	Ciprofloxacin	Avoid use during pregnancy.
	Clarithromycin	
	Levofloxacin	
	Moxifloxacin	
	Tetracycline	Contraindicated during pregnancy.
Anesthesia	Local anesthetics containing epinephrine eg, bupivacaine, lidocaine, mepivacaine	Can be used during pregnancy.
	Nitrous oxide (N_2O, 30%), intravenous anesthesia, general anesthesia	Consult a prenatal care professional before use.
Antimicrobials	Cetylpyridinium chloride mouthwash	Can be used during pregnancy.
	Chlorhexidine mouthwash	
	Xylitol	

*American College of Obstetricians and Gynecologists clinical guidelines (2020 edition) recommend the use of oral low-dose aspirin for pregnancies with high risk of preeclampsia from weeks 12–16 to weeks 34–36 of gestation.[45]

The guidelines affirm the safety of diagnostic radiographs and emphasize that dental professionals can follow the principle of "as low as reasonably achievable" (ALARA) to perform radiographic examinations on pregnant adolescents.[42]

Guidelines for the diagnosis and treatment of periodontal diseases during pregnancy

The European Federation of Periodontology published clinical guidelines on the relationship between oral health and pregnancy in March 2020.[36] This guideline mainly provides guidance to dental professionals involved in the treatment of periodontal diseases. Its core content includes treatment options for gingivitis and periodontitis, timing of the treatments, and guidelines for the use of radiography and anesthesia. It recommends timely nonsurgical treatments for periodontal diseases at any time during pregnancy to minimize potential risks of advanced infections on pregnancy outcomes, and states that necessary surgical treatments for periodontitis should be scheduled in the second trimester if possible. The guideline reaffirms that most therapeutic periodontal interventions are safe during pregnancy and delay in necessary treatments for gingivitis and periodontitis is detrimental to the health of both pregnant mothers and their children. However, elective and extensive traumatic surgeries should be delayed until after childbirth.

Table 3 AGREE II scores (%) in the six domains of guideline assessment

Clinical guidelines	Scope and purpose	Stakeholder involvement	Rigor of development	Clarity and presentation	Applicability	Editorial independence
Oral health care during pregnancy and early childhood practice guidelines[20]	94.4	77.8	29.2	91.7	50.0	25.0
Oral health during pregnancy and early childhood: evidence-based guidelines for health professionals[34]	100.0	94.4	52.1	91.7	61.1	25.0
Oral health care during pregnancy: a national consensus statement[35]	88.9	66.7	29.2	91.7	55.6	25.0
Massachusetts oral health practice guidelines for pregnancy and early childhood[40]	100.0	88.9	20.8	91.7	61.1	25.0
Perinatal and Infant Oral Health Care (2021 edition)[41]	83.3	27.8	41.7	75.0	22.2	0.0
Oral Health Care for the Pregnant Pediatric Dental Patient (2021 edition)[39]	88.9	38.9	35.4	75.0	27.8	0.0
The relationship between oral health and pregnancy: guidelines for oral-health professionals[36]	83.3	44.4	20.8	75.0	33.3	25.0
Mean (standard deviation)	91.3 (6.5)	62.7 (24.1)	32.7 (10.5)	84.5 (8.2)	44.4 (15.1)	17.9 (11.3)

Quality of methodology assessment with AGREE-II

The results of AGREE-II quality assessment of selected guidelines are shown in Table 3. Among the six domains of AGREE-II, Scope and purpose, Stakeholder involvement, and Clarity and presentation had the highest average scores (91.3%, 62.7%, and 84.5%, respectively); and Rigor of development, and Applicability had relatively low average scores (32.7% and 44.4%). The lower score of Rigor of development was due to the lack of randomized controlled clinical trials and the lag in scheduled periodic updates of some guidelines. The relatively low average score for Applicability was related to the missing application tools for dissemination and ease of application in clinical practices or for lacking monitoring mechanisms to assess the effectiveness of the guidelines. In the Applicability domain, the average score of the four comprehensive guidelines for all dental professionals (57.1%) was significantly higher than the three specialized guidelines (27.8%) for pediatric or periodontal treatments (Table 3). These comprehensive guidelines included rich resources to facilitate the application of the guidelines through referral forms, brochures, visual guides, and online tools.[20,34,35,40] The Editorial independence domain of AGREE-II requires that the guideline document include statements that the sponsor of the guidelines will not affect the content, and that authors of the guidelines declare any conflicts of interest. With the exception of the guidelines for treatment of periodontal diseases during pregnancy by the European Federation of Periodontology,[36] which were funded by a commercial oral hygiene product company through a non-restricted grant, all other guidelines were developed by national or regional health agencies or independent expert panel groups from dental professional organizations independent of commercial sponsors. Therefore, the risk of bias associated with commercial sponsors should be low in these guidelines, though the average score was low (17.9%) in this domain due to lack of written declarations of conflicts of interest.

Key practice recommendations and consistency across guidelines

No inconsistent or contradictory recommendations were found across the guidelines on key clinical practice recommendations for dental disease prevention, diagnosis, treatments, and oral health maintenance during pregnancy. Though the intended users of the comprehensive and specific guidelines varied slightly and they covered different spectrum of clinical practices, the clinical practice recommendations were remarkably consistent across guidelines. The key practice recommendations are summarized in Table 4, which can be used a reference tool for prevention, diagnosis, and treatment of dental diseases and oral health maintenance during pregnancy.

Discussion

Current clinical practice guidelines agree that prevention, diagnosis, and treatment of dental diseases, including diagnostic

Table 4 Summary recommendations for prevention, diagnosis and treatment of oral diseases and for oral health maintenance during pregnancy

Dental care stage	Recommendation
Dental disease prevention	Prenatal visits should include oral examination[20,34-36,40-42]
	Oral examination every 6 months[20,34-36,40-42]
	Brush your teeth twice a day with a soft toothbrush, fluoride toothpaste, and floss every day[20,34,35,40-42]
	Limit high-sugar foods,[20,35,40] and limit the intake of sugary foods to meal times[34,35]
	Limit the intake of carbonated drinks and fruit juices[20,35,40]
	Chew sugar-free gum or chewing gum containing xylitol after meals[20,34,35,40-42]
	Rinse your mouth with baking soda solution after vomiting (1 teaspoon of baking soda in a glass of water)[20,34,35,40-42]
	Do not brush your teeth within 1 hour after vomiting[40-42]
	Use non-alcoholic fluoride mouthwash as needed to rinse your mouth[20,34,35,40-42]
Diagnosis	Reasonable diagnostic and treatment measures during pregnancy are safe[20,34-36,40-42]
	Diagnostic radiographic examinations are safe (protect the abdomen and neck)[20,34-36,40-42]
Treatment	Emergency dental treatments can be provided at any time during pregnancy[20,34,35,40-42]
	Deep and symptomatic caries should be treated promptly[20,34,35,40,41]
	Restorative and endodontic treatments are safe[20,34,40]
	Use rubber dam during endodontic and restorative treatment[20,34,35,40-42]
	Tooth extractions are safe[20,34,36,40]
	Nonsurgical periodontal treatments (cleaning, scaling and root planing) are safe for treating periodontal diseases[20,34,36,40,41]
	Avoid extensive traumatic interventions (periodontal surgeries), but necessary periodontal surgeries can be performed in the second trimester[36]
	Pregnancy pyogenic granuloma should be treated after delivery[36]
	Reasonable amounts of local anesthetics containing epinephrine are safe[20,34-36,40,41]
	Indications for antibiotic prophylaxis for subacute bacterial endocarditis are the same as general populations[20]
	Consult with prenatal caregivers for the use of nitrous oxide sedation,[20,34,35,41,42] or for treatment of pregnant women with serious systematic diseases[20,34,35,40]
	Fixed partial denture and esthetic restorations should be postponed till after delivery[20]
	For comfort, keep her head higher than her feet, and put a small pillow under her right hip, or make her lean to the left at late stages of pregnancy[20,34,35,40]
Oral health maintenance	Schedule periodic oral examinations every 6 months[20,34,35,40]
	Schedule prophylaxis (teeth cleaning) every 6 months[20,36,40,42]

radiographs, analgesics, local anesthesia, operative treatment for caries, root canal therapies, scaling and root planing for periodontitis, and tooth extractions, are not only safe but necessary when indicated throughout the pregnancy. Dental practitioners should treat active dental and periodontal diseases in a timely manner during pregnancy and provide emergency treatments such as root canal therapy or tooth extraction at any time when needed. Delay in the treatment of oral diseases not only affects the oral and general health of the pregnant women, but may also cause harm to the unborn children. The consistency of clinical practice recommendations is very high across the guidelines, and they contain no inconsistent or contradictory recommendations.

The supporting evidence underlining the clinical practice recommendations in these guidelines was gathered from comprehensive literature reviews and assessed by multidisciplinary expert panels. The expert panels recognized and acknowledged that there was a lack of randomized controlled clinical trials testing the risks of dental interventions during pregnancy, which may undermine the quality and rigor of evidence, as reflected by the low AGREE-II scores in this domain. Expert panels also emphasized that evidence from observational and non-randomized clinical studies had consistently shown that common dental treatments are safe for pregnant mothers and their unborn children.[20,25,34,35,46] Considering that it is very unlikely that clinical trials to gather more definitive evidence will ever be performed

in pregnant women due to bioethical limitations and feasibility problems, multiple expert groups involved in the formulation of these clinical guidelines agreed that the best available evidence is already sufficient in providing clear guidance for clinical practices.[20,34,35,40,46] The present authors therefore believe that the evaluation and summary of existing clinical guidelines will help dental professionals improve the prevention, diagnosis, and treatment of dental diseases in pregnant women, especially in countries where such guidelines remain lacking.

The American Dental Association approved two policy resolutions in 2014 based on the consensus of experts at the time:

- calling on all pregnant women and women of childbearing age to have regular oral examinations
- affirming that preventive, diagnostic, and restorative dental treatments are safe throughout pregnancy and effective in improving and maintaining the oral health of pregnant mothers and their children.[44,47]

Such policy guidance is nonexistent in many other countries. The present authors examined a series of official textbooks from one BRIC (Brazil, Russia, India, and China) country's dental schools in China and found that the contents related to diagnosis and treatment of dental diseases during pregnancy deviate significantly from existing practice guidelines for optimal dental care during pregnancy. Misconceptions and misinformation in these texts reflect the not too long ago teaching in the USA and elsewhere, including that dental treatments in the first trimester should be limited to emergency treatment only and radiographic examinations should be avoided; dental treatments should be avoided in the third trimester of pregnancy, and if dental diseases occur, invasive treatments such as tooth extractions or root canal treatments should be avoided to prevent preterm birth; and when dental emergency treatment has to be done, local anesthetics should contain no vasoconstrictive agents such as epinephrine.[48] There was no supporting evidence for any of these claims and recommendations though they obviously contradict existing clinical practice guidelines. The present authors believe that it is important for all countries to develop or adopt evidence-based guidelines to avoid delays in the treatment of dental diseases in pregnant women in order to fully protect their and their children's rights and interests for oral health.

The overarching theme of all the guidelines is that oral health care, including dental disease prevention, diagnosis, and treatment, is safe throughout the pregnancy.[20,34-36,40-42] Specifically, these guidelines state that necessary diagnostic radiographic examinations[20,34-36,40-42] and local anesthetics containing epinephrine[20,34-36,40,41] are safe to use for pregnant women. For symptomatic dental, pulpal, and periodontal diseases, dental restorations, root canal therapies, tooth extractions, periodontal cleaning, and scaling and root planing can be safely carried out during pregnancy.[20,34-36,40] There is no evidence that necessary dental radiography examinations, tooth extractions, and root canal treatments at any stage of pregnancy have any adverse effects on the fetus or on pregnancy outcomes.[20,34-36,40] In contrast, evidence from meta-analytic reviews have shown that untreated oral infections may have a clear correlation with adverse pregnancy outcomes.[7,49]

Another common theme in all the guidelines is that necessary treatment for dental diseases can be safely provided at any time during pregnancy. Some guidelines suggest that the ideal timing for dental treatments is between 14 and 20 weeks of gestation, that is, the second trimester.[20] The reasoning behind this suggestion is that in the early stages of pregnancy, pregnant women's psychology and physiology undergo major changes, and they have not yet fully adapted to the series of changes brought about by pregnancy. In addition, many pregnant women do have severe morning sickness symptoms in the first trimester,[34] which may make dental treatment more difficult. As the fetus becomes much heavier in the third trimester, it may become more difficult for pregnant women to lie on the dental chair for an extended period of time, thus increasing the difficulty of complex dental treatments. Pregnant women lying supine at this stage may also experience orthostatic hypotension, which can be mitigated by placing the pregnant woman in a semi-recumbent position or frequently changing positions.[50] Therefore, the suggestion for treatment during the second trimester is mainly for psychologic or physical comfort considerations; it by no means implies that dental treatments are contraindicated during the first and third trimesters. The timely treatment of dental diseases and infections is beneficial to pregnant women in all stages of pregnancy. Pregnancy should not be a reason to delay dental emergency treatments at any trimester because acute dental pain or infections may cause severe negative consequences in pregnant women and their unborn children.[28-30]

The AGREE-II tool was used to evaluate the quality of the clinical guidelines, and found that quality scores are high in items associated with the purpose, applicable population, stakeholder participation, intended users, and clarity of the guidelines. These guidelines provide clear guidance for dental professionals to provide timely and effective dental treatments for pregnant women. As discussed earlier, the Rigor of development score was affected by the quality of available evidence due to

the lack of randomized clinical trials. But the scientific foundations for these guidelines are solid as they represent the best evidence that could be possibly gathered for this patient population. Compared to the more specialized guidelines for pediatric and periodontal patients, the comprehensive guidelines provided lists of practice recommendations supplemented with a variety of tools that promote the application of the guidelines, including brochures, referral forms, and online resource libraries, which significantly increase their applicability scores.[20,34,35,40] Since the AGREE-II tool was designed to evaluate the quality of clinical guidelines for the diagnosis and treatment of a specific disease, it focuses on scientific evidence related to the effectiveness of specific diagnostic and therapeutic methods.[38] In contrast, the guidelines included in the present study addressed a much wider range of issues, including the timing and safety of the prevention, diagnosis, and treatment of various oral diseases during pregnancy. The main purpose of these guidelines is to provide guidance for dental professionals to actively treat dental diseases in pregnant women. As the effectiveness of the diagnostic or therapeutic methods for dental diseases was not in question, the six domains and 23 items included in the AGREE-II may not be fully applicable for this type of clinical practice guidelines.[38] In addition, the scoring of AGREE-II items is based on seven-point scales that could be affected by the scorers' subjective judgment of the guideline contents. The scorers should be adequately trained to familiarize themselves with the scoring methodology before applying the AGREE-II tool.[39] Despite its limitations, it was found that AGREE-II was very helpful for practitioners to systematically assess the development process and overall quality of clinical guidelines, and understand the quality of evidence, clarity, applicability, and academic independence of the guidelines before adopting them in clinical practices.[51] The AGREE-II tool may not only facilitate quality assessment for existing clinical guidelines, but also provide important guidance for the development of high-quality standardized clinical guidelines in the future.[38,52]

During the literature search, screening, and evaluation, it was found that in addition to clinical guidelines for dental professionals, many countries and regions have also developed oral health care guidelines during pregnancy for obstetrics and gynecology (Ob/Gyn).[46,53-55] The transdisciplinary health care model between Ob/Gyn and dentistry promotes and improves the oral and general health of pregnant women.[56] A committee statement issued by the American College of Obstetricians and Gynecologists in 2013 affirmed the safety and necessity of preventing, diagnosing, and treating oral diseases (including diagnostic radiographs and epinephrine-containing local anesthesia) during pregnancy.[46] The committee emphasized that oral health is an important component of overall health, and proposed that Ob/Gyn professionals should actively participate in the maintenance of oral health during pregnancy and various stages of a woman's life cycle, and promote interprofessional collaborations between Ob/Gyn and dentistry for the prevention, diagnosis, and treatment of oral diseases during pregnancy. Other countries have also published clinical guidelines on oral health care during pregnancy for Ob/Gyn professionals,[53,55] affirming their roles in oral health knowledge promotion, preliminary dental examination, and dental referral for pregnant women. The present authors believe that such transdisciplinary and interprofessional collaborations will further improve the oral health of pregnant women and their children.

Conclusions

Practice recommendations for dental care during pregnancy are consistent across all clinical guidelines. These guidelines deliver clear messages to dental professionals based on comprehensive review of the best available evidence and provide guidance on timely and effective dental care during pregnancy. The overarching themes of the guidelines are that prevention, diagnosis, and treatment of oral diseases are safe throughout the pregnancy, and necessary dental treatments should be done at any time during pregnancy. The key practice recommendations summarized in Table 4 could be used as a reference tool for dental practitioners involved in the oral health care of pregnant women.

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