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Dental X- rays hazards on pregnant patient

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Abstract

Purpose: More than any other population, pregnant women have lower immunity and are more vulnerable to disease. Dental practitioners frequently utilise X-ray radiographs as practice instruments to address clinical issues and offer useful diagnostic data. Dental X-ray exams expose patients to minimal radiation levels that pose little biological risk. The International Committee on Radiological Protection, or ICRP, reports that thousands of expectant mothers are annually exposed to ionising radiation that is used in diagnostic surgical operations. Examining the safety of dental imaging for foetal wellbeing in pregnant women was the aim of this study.

Methods: In May 2023, inquiries were done through the Scopus, Pub Med, and Web of Science indexes. Inclusion requirements were investigations using phantoms to replicate imaging exams as well as both longitudinal and cross-sectional investigations analysing diagnostics images of teeth in pregnant women. Reviews, emails to the editor, books sections, and summaries from academic meetings and workshops were among the things that were excluded.

Results: 3,913 articles in total were found. 21, out of 3,892 articles, were left for full-text review after the abstracts and titles were reviewed. Eighteen of these were eliminated, and four more articles were added as cross-references. In the end, a combination of qualitative and quantitative evaluations was performed on 5 publications. Three retrospective research investigations examined dental imaging techniques performed on pregnant women. In the next four trials, radiation doses absorbed by the thyroid or uterus were represented by means of female phantoms, who served as imaging assessment simulators.

Conclusion: Based on the findings, it can be concluded that pregnant women can use antibiotics safely and effectively during their pregnancy. Furthermore, the number of dental examinations, broken down by kind that corresponded to this dosage was not provided in the examined publications. Pregnant women should not have their access to dental CT exams restricted if it is clinically needed. The ability to contest the examination and adhere to the radioprotection principle of "As Low as Diagnostics Appropriate as long as being indication-oriented and patient-specific" (ALADAIP) are ultimately requirements for professionals.

Keywords: Dental X-ray, diagnostically, dental imaging, international commission, radiological protection (ICRP), review, clinically indicated, pregnant patient, cross-sectional, radioprotection, quantitative-qualitative analysis

Introduction

Correct case diagnosis is a prerequisite for receiving an appropriate dental treatment ^[1], and this cannot be accomplished without the use of dental radiographs, a vital diagnostic tool. Dental radiographs provide important diagnostic data that helps dental professionals (dentists, radiologists, dentists, students in dentistry, and nurses) solve clinical issues ^[1, 2]. Worldwide, the use of X-ray pictures in daily life is growing. Routine dental radiography use can occasionally expose patients and practitioners to needless risks, including biological dangers. Biological hazards are classified into deterministic and stochastic effects ^[2]. The negative consequences known as deterministic effects manifest when an individual exceeds a threshold dose of a "potentially harmful" chemical. In stochastic impacts, there are no minimal dosages for biological harm. Stochastic effects are more likely to occur in dental radiology since there is less dosage exposure. Moreover, little exposure spread out over time could result in a significant total radiation dosage. To maintain mental equilibrium, nobody who is exposed to radiation - not even a dentist or a patient - can be completely safe.

Therefore, dental practitioners should carefully evaluate and implement radiation prevention methods and safety procedures [3]. The guidelines set forth by the International Commission on Radiological Protection (ICRP) include the requirement for a clinical justification and optimisation for each patient's interaction with X-ray imaging; additionally, each exposure must result in a net benefit. As Low as Reasonably Achievable, or ALARA, is a fundamental principle of radiation safety that should be adhered to by dental professionals when performing their everyday operations. Evidence, however, points to a loose use of the ALARA concept in the discipline [2, 3].

X-rays possess enough energy to ionise biological molecules and can result in harm that presents as illness. But even with its potential hazardous side effects, X-ray-based imaging is still a vital diagnostic and treatment planning tool in the medical field, including dentistry. For instance, bitewing radiographs is used to screen patients without symptoms in order to identify early caries lesions. Alternatively, intraoral periapical imaging can be used to image a patient who has a periapical abscesses. Cone Beam Computed Tomography (CBCT) may be recommended in a different clinical situation [3] to assess the interaction between an impacted mandibular third molars and the inferior alveolar canals. The decision to take radiologic images is guided by the same criteria, despite the fact that each scenario has a different precise diagnostic goal [3]. The premise of the first principle, which deals with the efficacy of imaging, is that a radiologic evaluation will probably yield information pertinent to treatment planning and diagnosis.

The oral health of expectant mothers is a major worldwide public health concern. Pregnancy carries some risks, and it is generally acknowledged that a woman should not receive dental care while she is pregnant [3]. Pregnant women who seek dental care have unique issues, thus their care may require extra consideration in order to shorten treatment times and alter the prescribed medication and dental procedures. It is important to do a suitable risk assessment for both mother and the foetus [3, 4].

A recent study found that over 43% of pregnant women experience dental health problems, such as pain and odontogenic illnesses [4, 5]. Most odontogenic infections usually proceed quickly to deep-seated infections, which ultimately compromise the oropharyngeal airway. [6] Moreover, discomfort and swelling in the mouth are frequently indicative of dental infections [6]. Recognising that oral infections acquired during pregnancy must always be treated quickly is crucial, as drug usage in place of proper dental care can have negative consequences for both the pregnant patient and the foetus [6, 7]. Endodontic treatment, which involves cleaning and extracting a patient's tooth pulp, is one of the recommended courses of action. In addition to radiologists, local anaesthetic, root cleaning, and intracranial medications such antibiotics and analgesics, Root Canal Therapy (RCT) may also involve [8].

A key component of the endodontic procedure is radiography. For the proper diagnosis, the correct blocking, the length of the procedure, and the post-treatment evaluation, radiographs are necessary. Because intraoral radiographs focuses X-rays on the mouth instead of the abdomen, it is believed to be safe for pregnancy women to undergo. Additionally, when performing radiographic [9, 10], safety precautions such filtering, high-speed film, collimation of the lead aprons, and are used.

Dental imaging is frequently utilised as an additional

examination. Intraoral radiography, panoramic radiology, and Cone-Beam Computed Tomography (CBCT) are common modalities. Each has unique radiation dosage characteristics [11]. Dental professionals have voiced concerns about the possible harm that ionising radiation may cause to the developing foetus when treating expectant patients [11, 12]. These experts ought to be aware of the harmful consequences of repeated radiation exposure and put protective measures in place for procedures involving imaging, especially CBCT [12, 13], which produces radiation doses that are comparatively higher than those of traditional radiography methods.

The ionising radiation has both deterministic and stochastic effects on biological systems. Deterministic consequences result from cellular damage causing degradation or loss of organ function. Stochastic effects, on the other hand, result from modifications in cells that maintain their ability to divide [13]. It is hypothesised that stochastic effects do not have a threshold dosage and that the probability of them manifesting increases proportionately to the amount of radiation received [13]. Accordingly, patients ought to simply be presented to radiation at the most minimal commonsense force to lessen the probability of these aftereffects [13, 14]. In spite of global rules that endorse most noteworthy dosages of radiation for pregnant ladies, dental specialists overall stay worried about the expected consequences for a creating child of lower portions of ionizing radiation that are gotten in the uterus region all through symptomatic dental imaging methods [14, 15]. In addition, opinions regarding the use of lead shielding or aprons to reduce the quantity of ionising radiation exposed to expectant mothers have long differed in the dental literature. In these cases, there is a drawn yearly radiation line of 1mSv for the hatchling of a pregnant labourer who has pronounced her pregnancy. At the point when consumed by the uterus, this dose [15] is regularly utilized in clinical radiation dosimetry as a substitute for how much radiation consumed by the hatchling or embryo [15, 16]. The typical organ dose during normal check-ups is 0.4 mSv per radiography; it has been demonstrated the way that this portion can be sliced down the middle by wearing a defensive cover.

Nonetheless, supported the use of X-rays when necessary to treat and diagnose oral emergencies at any point during pregnancy. One noteworthy aspect of dental radiography is that a significant number of X-rays are taken, which guarantees the inclusion of certain patients who are not aware that they are pregnant [16, 17].

However, endorsed the use of X-rays as required to diagnose and treat oral crises at any stage of pregnancy. One noteworthy aspect of dental radiography is that a significant number of X-rays are taken, which guarantees the inclusion of certain patients who are not aware that they are pregnant [16, 17].

Therefore, the goal of this systematic study was to address the following queries: Are dental imaging techniques like CBCT, panoramic radiography, and periapical radiography safe for expecting mothers to have done? [20] What level of radiation is safe for a pregnant lady to receive? And lastly, how many safe dental imaging exams may a pregnant woman have?

Methods

This systematic review has been registered with the National Institute of Health Study's PROSPERO database under the protocol identifier CRD42019131649. It also adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Studies on diagnostic dental imaging that accurately mirrored imaging tests on expectant

mothers were included in this study [21]. CBCT, panoramic radiology, and intraoral radiography were the imaging modalities that were taken into consideration [21, 22]. Furthermore, utilising standards established by international

dental radiology organisations, the general agreement about radiation dose and radiography techniques for expectant mothers was evaluated [22].

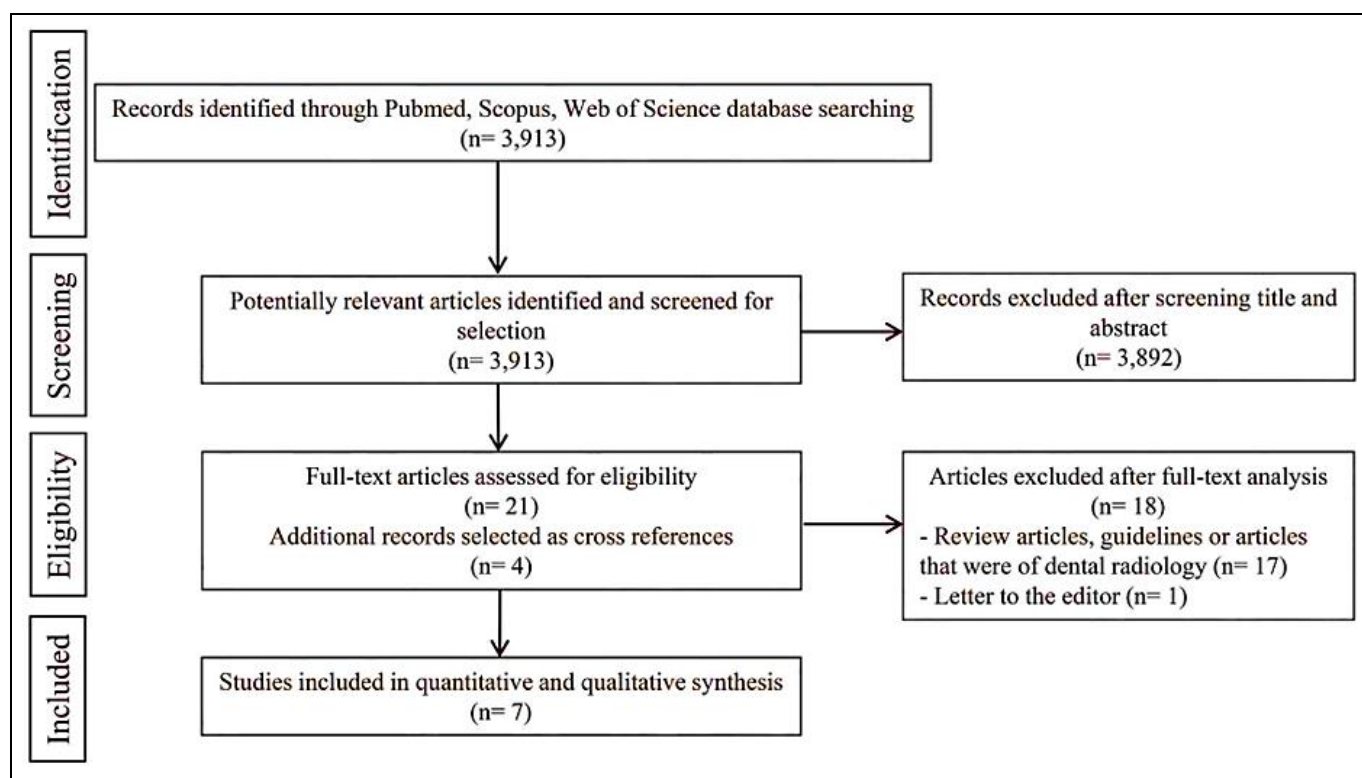


Fig 1: Study selection process that complies with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure. [22]

Finding publications that could address the research topics given was the aim of the systemic review. Therefore, some study kinds were judged inappropriate [23, 24]. The search was not conducted on examinations, letters to the editor, books sections, abstracts from professional meetings and lectures, or book chapters. Research on dental imaging diagnostic procedures (CBCT, panoramic radiology, and periapical in radiography) that did not assess at least one technique were excluded [24]. Studies that failed to replicate the amount of radiation in the uterus region or declined to include pregnant women in the sample were also eliminated [24].

Results

After searching the databases of Scopus, PubMed, and Web of Science, 3,913 articles were discovered. The investigators removed 3,892 papers after going through the job descriptions and abstractions, leaving 21 for full-text review. Following full-text evaluation, 18 more publications were eliminated for a variety of reason [24, 25]: 6 of them dealt with literature

reviews, 5 with rules and regulations, and 1 with a letter to the editor, and 6 with topics unrelated to dental imaging studies. The reference lists revealed four more articles, which were added [25]. Five publications in total were selected for this systematic review following a qualitative and quantitative analysis [25, 26]. Fig. 1 shows a flowchart that illustrates the study selection procedure in accordance with PRISMA 2010 standards [26]. In terms of experimental design, three of the studies examined retrospectively analysed pregnant women who had dental X-rays taken, looking at outcomes like low birth weight, stillbirth, and new-born health [26]. The radioactive dose absorbs at the uterus or the thyroid gland, which may have an effect on the foetus, were measured using female phantoms in the four remaining trials. Regarding the confounding factors and sensitivity measurement, it was determined that there was a substantial risk of bias in the research [27, 28]. Phantom research revealed minimal bias risk for every factor assessed, with the exception of examiners' blinded during result evaluation Table 1.

Table 1: Using a modified form of the risk of bias assessment tool for non-randomized studies, the five studies' risk of bias was evaluated (RoBANS) [29].

Domain	Hujoel <i>et al.</i> , 1994 [31]	Buch <i>et al.</i> , 2009 [32]	Okano <i>et al.</i> , 2009 [33]	Kelaranta <i>et al.</i> , 2016 [34]	Rottke <i>et al.</i> , 2013 [35]
The process of choosing participants.	+	+	-	-	+
Confounding factors.	-	+	-	-	-
Being exposed measurement.	+	-	+	+	+
Blinding outcome evaluations.	?	?	?	?	?
Insufficient results information.	-	-	-	+	-
Reporting of certain outcomes alone.	-	+	-	-	+

Table 2 provides information on a number of different aspects of the chosen studies, such as the imaging equipment and variables used, the global standards applied, the year of the publication, the country, the study type, the sample type, the kind of dental investigation that was conducted,^[29] the radiation dose that the pregnant women received, the energy from radiation dose that the uterus and foetus (with and

without lead apron shielding) received, and so on. All of the publications pointed out that dental scanning should only be done on expectant mothers when it is clinically warranted^[30]. Nevertheless, none of the publications specified the kind of collimation used or the quantity of dental exams required to reach the maximum acceptable radiation exposure.

Table 2: Information about the five publications that were chosen for this evaluation, such as the writers, the year of its release, country of publication, the study type, the sample category, the type of dental examination that was done, the radiation dosage, the use of lead apron shielding, the dental imaging technology that was used, the exposure variables, and the use of globally accepted regulations^[29, 30]

Author, Year	Ref.	Country	Type of study	Type of Sample	Dental exams	Dental devices	Exposure variables	Fetal radiation doses	Guideline
Hujoel <i>et al.</i> , 1994	[31]	US	Retrospective cross-sectional	Critical Document from NNS-NFMS	Not specified	Not specified	Not specified	Not specified	N/A
Buch <i>et al.</i> , 2009	[32]	US	Population-based case-control	Documents from WDS Dental Insurance and certificates of birth	Full-month periapical batwing	Not specified	Not specified	>0.6mDy* 0.3-0.8 mGy*	N/A
Okano <i>et al.</i> , 2009	[33]	Japan	cross-sectional	RANDO female phantom	Full-month periapical	Panorama instruments from Gendex digital, a Siemens Heliodont business	70kv, mA. 0.16-0.6s 64kvVp, 7mA,0.25-0.69 Not specified	0.96 µSv 2.98 µSv	N/A
Kelaranta <i>et al.</i> , 2016	[34]	Germany	cross-sectional	RANDO Woman phantom	Panoramic	3D Accuitomo CB MeruRay	85KV, 5, mA 121 kv.14mA	2.98 µSv, 0.38 µSv 3.69 µSv 0.96µSv	ICRP
Rottke <i>et al.</i> , 2013	[35]	Southern Africa	cross-sectional	RANDO Full-body Phantom	CBCT	SCANORA 3D Pro Max 3D	69KV, 14mA, 18s 79KV, 8mA, 15s	36.96 µSv, 239.87µSv	EADMER

This systemic review's writers performed the comparison analysis. General dentists can use Table 3 to assist them with choosing when to ask patients who are pregnant for imaging studies. Table 3^[35] shows the typical compelling dose values for each imaging assessment. For intraoral radiographs (entire

mouth), the going with measurement for D-speed film was 388 µSv^[35, 36], for F-speed/PSP film it was 171 µSv, and for CCD sensor imaging it was 85 µSv. The dose that is powerful for additional oral all-encompassing radiology shifted somewhere in the range of 9 and 24µSv^[35, 36].

Table 3: Comparing the annual dosage and effective dose that pregnant women got during various dental exams^[36]

Dental exam		Effective dose (µSv)	Maximum number of such tests per year for expectant mothers while staying below the 1-mSv dosage cap	Are pregnant women able to endure this modality?
Intraoral (1 exam)	D speeds film	25.9	39	Yes
	CCD sensor	19.9	81	Yes
	F Speed film	69.0	196	Yes
Extra oral	Panoramic	9-28	41-118	Yes
CBCT	Small FOV	18-293	2-39	Yes
	Medium FOV	49-219	1-219	Yes
	Large FOV	69-189*	0.-21	Consideration

As far as possible for pregnant ladies lies somewhere in the range of 14.7 and 0.93 CBCT tests; enormous FOV CBCT tests are the most prohibitive with regards to the possibility breaking the limit, as per the accessible data^[36, 37]. This indicates that the sole imaging technique to show an index below zero was large-FOV CBCT, indicating that one imaging scan may be able to provide pregnant women with a yearly radiation dosage that is higher than what is considered safe.

Discussion

The goal of the current study was to evaluate pregnant women's attitudes and knowledge regarding the risks associated with dental radiation. During dental therapy, radiographs are essential for determining a final diagnosis^[37]. The unique and complicated time of pregnancy includes a number of physiological changes that aid in the development

and maturation of a new life^[37, 38]. The human mouth is a reflection of the body, reflecting and influencing overall health. Pregnant women need to have regular and prompt dental care because their oral health has a significant impact on their unborn child's health^[37, 38]. Pregnancy and dental care provide a serious ethical conundrum, particularly when it comes to X-rays^[38]. When performing a radiological evaluation in an emergency, it is important to proceed carefully.

Professionals in dentistry who have worked in the industry for longer have a greater understanding of the ALARA concept. The ALARA principle calls for limiting exposure time, utilising an efficient shielding technique, and maintaining a secure distance from the sources of radiation^[38, 39]. More so than dentists with 1-2 years of expertise, professional dentists are aware of the use of E-speed film. Since e-speed film shortens the exposure a period of time they also understand

the ALARA concept. Additionally, lead aprons for patients are typically utilised by practitioners with over ten years of expertise^[39, 40]. Unlike newer doctors who were unaware that patients should wear lead aprons, all practitioners were aware of the safe distance. When it came to answering questions about their knowledge, professionals with little previous experience gave the most inaccurate replies^[40, 41]. This study highlighted the ignorance and inadequacy of freshly graduated dentists, and it was suggested that radiography education be expanded upon in university curriculum. In a similar vein, more experienced dentists employ the right methods to limit their exposure to ionising radiation^[41]. As a result, it was suggested that first-year study be raised and that regular programmes on radiographic protection procedures be established.

The study evaluated the extent to which dentists are able to acquire and apply radiation safety and risk information in their work. Ninety-four percent of practitioners wanted to increase their level of expertise. Stated differently, the majority expressed interest in learning more about radiation protection techniques because they lack a solid experience in this area. Of the 94%, 23% of practitioners with over ten years of experience do not feel that they can further their expertise, and the majority feel the same way^[42]. This emphasises how seasoned professionals may have a tendency to overlook ongoing education initiatives. This further demonstrates the accuracy of the studies that suggested the educational initiatives.

In dental clinics, CBCT, intraoral, and radiography with panoramic images are the most commonly conducted imaging tests^[42, 43]. All of these make use of ionising radiation, which causes the body to produce free radicals^[43]. Ionising radiation can cause consequences that appear instantly or over a longer period of time, depending on the dosage taken and the body's reaction. However, a number of researchers argue that patients are not at all at danger of radiation damage from imaging tests that use modest radiation doses, including intraoral radiography^[44, 45].

Therefore, in order to minimise negative effects on the developing child, regulations indicating the maximum safe dosage levels and the related limitations on the frequency of dental treatments for imaging for pregnant women must be put in place^[46]. The amount of radiation that pregnant women are exposed to during full-mouth periapical examination using traditional film radiographs and digital radiography. They characterised this dose as low, stating that it is^[45, 46] comparable to about three hours of ambient radiation when taking into account the radiation that enters the uterus directly. Researchers discovered no discernible variation in uterine radiation dose between lead-shielded and non-shielded subjects. However, they underlined that the duty of the dental surgeon is to protect the foetus from radiation exposure, not to mitigate the statistically significant risks associated with even low-level radiation from electrical sources, such as those seen in intraoral and panoramic radiography.

Regulations defining the kinds of X-ray machines that are available on each continent and the proper radiation dosages for certain dental diagnostics, such as intraoral and panoramic radiography and CBCT, are dependable for dental professionals across the globe. These guidelines support the As Low as Diagnostically Acceptable (ALADA) principle, which promotes the use of the lowest radiation dose feasible while still getting an image resolution sufficient for an appropriate assessment, and they cover the regulatory requirements for all dental specialties^[46, 47].

Just five publications contextualised their findings about the hazards of dental imaging in expectant mothers using any kind of guidance. The authors emphasised the necessity of taking extra steps to shield professionals and patients from ionising radiation, pointing out that European and worldwide guidelines for radiation safety in dental radiography can vary from one another. Their research also aimed to establish an acceptable radiation dose for dentistry imaging techniques (CBCT, panoramic, and intraoral) with as well as without lead aprons used to protect the uterus. The results showed that the levels of radiation involved were much below the upper limits advised for expectant mothers.

The recommended dosage of radiation^[46] for intraoral and panoramic images should not be given to pregnant patients undergoing these exams in the same way that it would for CBCT. These recommendations provide the combined area and protocols to be used in accordance with the particular indication for the tomographic investigation, which may differ depending on the continent. There have been reports of reported foetal doses ranging from 0.009 to 6.9 μGy without a protective covering and from 0.005 to 2.1 μGy with a protection^[46]. Both of these dose limits are regarded as safe because, particularly when in comparison to radiological examinations of the abdominopelvic area, they are below the threshold linked to any danger of being exposed to radiation to the foetus.

An employee who has revealed pregnancy remains subject to a yearly dose limit of 1 mSv (1 mGy), which is just over one percent (0.7%) of the radiation exposure that would result from a single dental exam in the absence of lead protection^[46, 47]. Moreover, it has been demonstrated that wearing lead-based gloves can lower the foetal dosage by 39% to 97%, which leads the authors to propose that it might not be required to ask about pregnancy in dental radiology. Foetal doses from non-lead shielded intraoral, panoramic, and cephalometric exams make from 0.1% to 10% of the highest foetal doses recorded in CBCT^[47].

However, none of the studies that were reviewed addressed the connection between the dose limit and the quantity of approved dental check-ups. Precaution throughout dental imaging treatments should not be disregarded, as they can protect patients from ionising radiation levels in general^[48, 49]. These Precautions for expectant mothers should include more than only the fundamental radioprotection techniques^[47, 48]. Using more sensitive image receptors and utilising a rectangular collimator for intraoral X-ray technology are two examples of these safety measures^[50].

Conclusion

Dental professionals must to be sufficiently knowledgeable about radiation protective procedures in the mouth. This review study's primary objectives were to evaluate dental professionals' understanding and awareness of protection against radiation, identify any possible relationships between different dental practitioner categories' awareness and knowledge and their socioeconomic background, and then evaluate the degree to which dental professionals abide by the pertinent regulations. The main conclusion of this study was that pregnant women need to be properly educated about dental radiation and that dental X-rays are safe, so they can have dental care without feeling afraid. Pregnant women should get education through neighbourhood-based teaching approaches.

The systematic review's findings support the notion that, in circumstances where there is a valid clinical rationale, dental

imaging exams for expectant mothers shouldn't be restricted because the minor potential risk is outweighed by the health advantages. Moreover, there was no evidence discovered to support the need for a thyroid shield or lead apron. The dental radiography community has not yet addressed the projected number of dental imaging exams appropriate for expecting mothers, despite the fact that multiple studies have established safety limits for radiation exposure. In the end, there is no reason to postpone or forgo radiographic scans when pregnant because dental radiography poses no hazards to the foetus, such as growth retardation or mortality, and there is little evidence connecting it to low birth weight at delivery. Finally, it is imperative to adhere to the ALADAIP radioprotection standards and the examination's guiding principle. These are especially important for pregnant women undergoing ionising radiation operations.

Conflict of Interest

Not available

Financial Support

Not available

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