RADIOPROTECTION METHODS IN DENTAL RADIOLOGY – AN INTEGRATIVE REVIEW

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***Abstract*—** Dental radiology is an indispensable tool for diagnosis and clinical follow-up, but the use of ionizing radiation poses health risks for both patients and professionals. This study aimed to analyze the radioprotection methods employed in dental practice through an integrative literature review. The research was conducted in PubMed and LILACS databases, considering articles published between 2016 and 2020. The descriptors "Dental radiology," "Radiological protection," and "Dentistry" were used. After applying inclusion and exclusion criteria, 15 articles were selected for analysis. The results showed that, despite awareness of the importance of radioprotection, there are still deficiencies in adopting essential measures such as the proper use of personal protective equipment, correct radiation hazard signage, and systematic application of the ALARA principle. It was also observed that factors such as professional experience, type of institution, and level of training directly influence dentists' knowledge, attitudes, and practices regarding radiation safety. It is concluded that there is an urgent need to strengthen inspection processes, implement more effective public policies, and reinforce continuing education programs to align dental practice with the recommendations of the International Commission on Radiological Protection. Strengthening these measures is essential to reduce unnecessary risks and ensure greater safety for both patients and professionals.
***Keywords*—** ALARA, Dental radiology, Dentistry, Radiological protection.

1 INTRODUCTION

Dental radiographic examinations are the most widely used and indispensable tool for aiding in the diagnosis, planning, execution, and monitoring of clinical cases (MOURA et al., 2014). Over the past few

decades, due to technological advancements and the greater availability of equipment for performing radiological examinations, there has been a progressive increase in the demand for these examinations in dentistry, in addition to addressing the difficulties presented when the clinical examination is inconclusive (CASTRO et al., 2017).

Due to the increase in the number of these procedures in dentistry, concern about the radiological protection measures adopted by dentists has led several researchers to study the subject. The biological effects caused by contact between ionizing radiation and individuals result from the interaction between radiation and human tissue, which can be greater or lesser depending on the radiosensitivity of the cells (RODRIGUES et al., 2019).

Such gaps compromise safety in dental services and can result in unnecessary exposures, posing a public health problem. In this context, an integrative review is warranted to synthesize the available knowledge on radiation protection methods in dental radiology, identifying advances, limitations, and the need for updates. This study is relevant because it provides support for safer clinical practice, fosters continuing education programs, and guides public policies aimed at strengthening the culture of radiation safety in dentistry.

On June 1, 1998, Ordinance No. 453 of the Brazilian Health Surveillance Secretariat was established, seeking to protect patients and professionals during exposure to ionizing radiation, in addition to defining guidelines for medical and dental radiological protection. This ordinance was revoked on December 20, 2019, by the Collegiate Board Resolution – RDC No. 330.

The time frame between 2016 and 2020 was chosen because it corresponds to a period marked by significant technological advances in dental radiology, the wider implementation of digital imaging systems, and regulatory updates such as RDC No. 330/2019 in Brazil, which reinforced the need for stricter radiological protection practices. This temporal scope ensures the inclusion of recent and relevant evidence on the subject (SINGH et al., 2021; LOPES et al., 2022).

Considering the importance of radioprotection by professionals, this work aims to review the selected studies in an integrative manner regarding compliance with radioprotection standards in dental radiology.

2 METHODOLOGY

This is an integrative literature review. An integrative review is a research method that enables the search, critical evaluation, and synthesis of available evidence related to the topic under investigation. The final result is the current state of knowledge on the topic under investigation, the implementation of effective interventions in healthcare, cost reduction, and the identification of gaps that guide future research (MENDES et al, 2008).

The databases searched were PubMed and LILACS (Latin American and Caribbean Literature in Health Sciences), and the descriptors used for the search were: Dental Radiology, Radiation Protection, and Dentistry, and their English equivalents: Dental Radiology, Radiological Protection, and Dentistry, contained in the Virtual Health Library (VHL) descriptors.

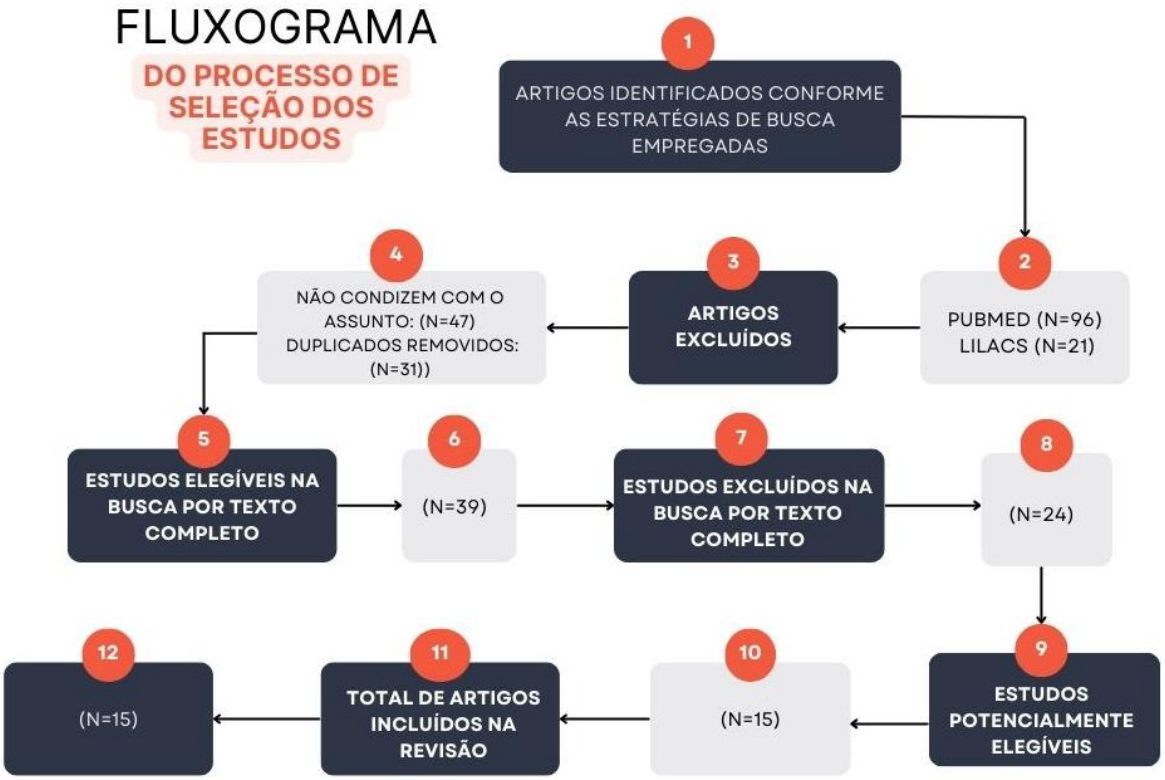
The inclusion criteria were articles available in full, published between 2016 and 2020. The exclusion criteria were articles that did not meet the study objectives, as well as monographs, theses, dissertations, case studies, and literature reviews.

The initial search identified a total of 117 titles found in electronic searches through the following databases: PubMed (n=96) and LILACS (n=21). After reading the titles and abstracts, 78 studies were removed due to duplication or not being relevant to the proposed topic, and 39 were selected as imminently relevant to this study.

Subsequently, the remaining 39 studies were obtained in full and analyzed for eligibility, considering the studies that actually addressed radiation protection methods in dental radiology. After full-text review, 24

studies were excluded and 15 were included, as summarized in the selection flowchart (Figure 01). The research results (n = 15) are presented in table form.

Figure 1. Flowchart of the study selection process.



Source: Data from the present study, (2025).

3 RESULTS AND DISCUSSIONS

The summary of the sixteen selected scientific articles was presented in a table containing information such as the article title, author names, year of publication, country of origin, objective, and conclusion. Based on these variables, the following results were highlighted, as shown in Table 1.

TABLE I
CHARACTERIZATION OF THE CONTENT OF THE ARTICLES RESEARCHED.

	Title/Author/Origin	Objective	Conclusion
1.	Radiological protection: knowledge and methods of dentists. ALVES *et al.*, 2016 (Brasil)	To assess the knowledge of dentists in the city of Patos-PB regarding biosafety in dental radiology and the protection methods used.	It was observed that most professionals are aware of the aspects of radioprotection; however, some dentists are still unaware of them and do not practice biosafety in radiology, putting their own health and that of their patients at risk.
2.	Oral radiology safety standards adopted by general dentists working in the national capital region.	To investigate the knowledge and behavior of general dentists working in the National Capital Region regarding radiation	The results showed that general dentists' knowledge, behavior, and practices regarding radiation safety are

CHAUDHRY et al., 2016 (India)	safety during oral radiographic procedures.	unsatisfactory. To ensure compliance with basic and necessary radiation safety and protection guidelines, state boards must implement strict rules with penalties, and introduce new and interesting educational methods for this field.
3. Radiation protection - a matter of knowledge and technique in dental offices. CONSTANTINIUC et al., 2016 (Romania)	To investigate the extent to which dentists who provide dental radiology services know and apply technical work and patient protection standards.	It was concluded that neither dentists' knowledge nor their behavior regarding oral radiology safety standards is satisfactory. By highlighting the current level of theoretical knowledge and attitudes toward radiation protection in oral medicine, the study suggests that more attention should be paid to this aspect to reduce patient exposure to ionizing radiation.
4. Assessment of radiation protection conditions in intraoral radiology. MIGUEL et al., 2016 (Brazil)	Analyze radiation protection conditions in dental offices in the city of Curitiba, Paraná.	Lack of knowledge about radiological protection, poor equipment operating conditions and visual image processing are the main reasons for unnecessary patient exposure to ionizing radiation.
5. Radiation protection awareness and practices in oral health facilities in Cameroon. AGBOR; AZODO, 2016 (Cameroon)	To determine radiation protection awareness and practices in oral health units in Cameroon.	The data from this study revealed that many aspects of radiation protection in dental radiology are suboptimal; therefore, specific education and training in radiation protection is considered necessary among oral health professionals in Cameroon. It is recommended that the Cameroon National Radiation Protection Agency establish radiation protection guidelines for the provision of dental health care.
6. Radiation protection equipment used in dental healthcare establishments. OLIVEIRA et al., 2016 (Brazil)	To evaluate the procedures of dentists regarding radioprotection aspects in the city of Patos, PB, according to Brazilian health legislation.	Some aspects of radiation protection are in disagreement with Brazilian health legislation in dental offices in Patos, demonstrating that there are dentists who are unaware of

			or do not comply with some current radiation protection standards, which could minimize the inherent risks of radiation exposure.
7.	Radiation protection audit in a university dental clinic in Baixada Fluminense. ALMEIDA et al., 2017 (Brazil)	To detect possible non-conformities in a university dental clinic located in Baixada Fluminense, so that the radiological protection of patients, companions and occupationally exposed individuals is adequate.	Based on the information obtained, we can conclude that the dental clinic has adequate radiation protection facilities. However, it must adapt to ensure that all radiation protection requirements listed in current legislation are available at all times. This is essential to maintain compliance with health regulations.
8.	Korean dentists' perceptions and attitudes towards radiation safety and protection. AN et al., 2017 (South Korea)	To investigate dentists' perceptions and attitudes towards radiation safety in dental practices in Korea.	Dentists with less than 10 years of experience were less aware of radiation protection procedures. Therefore, considering dentists' experience and the X-ray equipment installed, ongoing and effective education regarding radiation safety and protection is recommended for both dentists and patients.
9.	Assessment of knowledge, attitude and practice in radiological protection in dental radiography professionals. KHANI et al., 2017 (Iran)	To assess the knowledge, attitude and practice (KAP) in radiological protection among dental radiography professionals.	The study showed that the level of KAP in radiation protection is associated with length of professional practice, clinic size, and geographic region. Furthermore, the lack of correlation between clinic type and KAP highlights the fact that in dental clinics, the absence of a radiation protection officer or a radiology specialist for training purposes results in a similar result regarding radiation protection status in educational and non-educational clinics.
10.	Dentists' Compliance with Dental Radiology Safety Standards. SINGH et al., 2018 (India)	To assess knowledge about radiological protection, the physician's attitude towards radiological protection, radiological protection methods used and the type of	Based on the results of the study, we conclude that dentists should be warned about the adverse effects of radiation exposure and, since general dentist compliance is low,

	radiographic equipment used in dental practice.	Continuing Education in Dentistry programs should be conducted to educate dentists who already use X-ray machines and keep them updated with the latest technologies.
11. Knowledge, attitude and perception (KAP) towards radiation hazards and protection among dental professionals in Riyadh, Kingdom of Saudi Arabia. BASHEER et al., 2019 (Saudi Arabia)	To assess the knowledge, attitude and perception among dental students and dentists regarding dental radiation and to assess the difference in knowledge between dentists, dental staff and dental students.	From the results obtained in this study, it was noted that the level of CAP in relation to radiological protection was higher among dental students compared to dentists, and the lowest CAP value was found in the dental team.
12. Knowledge, attitude and practice of dentists regarding radiation risks and safety - a cross-sectional study. FAREEN; SUBRAMANIAM, 2019 (India)	To assess dentists' knowledge, attitudes, and practices regarding radiation hazards and safety.	It was observed that dentists' knowledge, attitudes, and practices regarding radiation protection and safety are greater, but less frequently applied in their practice. This requires the implementation of appropriate measures to ensure maximum safety.
13. The need to develop guidelines for radiation protection in dental institutions. HWANG, 2019 (South Korea)	To determine the state of radiation safety in dental care institutions and contribute to the development of guidelines for radiation protection in dental clinics in order to improve the working environment and reduce the radiation risk for professionals.	The level of radiation protection practiced in dental health centers was far below the level of knowledge, demonstrating the high demand for radiation protection guidelines. Therefore, institutional arrangements require the development and use of various types of radiation protection guidelines to mitigate radiation risks and improve the working environment.
14. Knowledge, attitude and practice (KAP) of radiation protection by undergraduate dental students and postgraduate endodontic students, general practitioners and endodontists. ALMOHAIMEDE et al., 2020 (Saudi Arabia)	To assess the knowledge, attitude, and perception of radiation hazard and preventive measures among undergraduate dental students, general practitioners, postgraduate endodontic students, and endodontists in Saudi Arabia.	Within the limitations of the study, it can be concluded that knowledge of radiation hazards and ionizing radiation prevention measures among undergraduate dental students, postgraduate endodontists, and endodontists in Saudi Arabia was quite reasonable, especially in academia. However, radiation protection

			measures need to be further emphasized among general practitioners, postgraduate endodontists, and endodontists, especially in government hospitals and the private sector.
15.	Assessment of compliance with radiation protection principles in dental radiography centers (Western Iran): cross-sectional study. TOHIDNIA et al., 2020 (Iran)	To assess compliance with radiological protection principles in dental radiography centers and the risks.	According to the results of this study, radiation protection measures are generally not organized, implemented, or monitored, and fall far short of standards and recommendations. These conditions may be due to negligence and a lack of awareness among dental radiologists and dentists about the potential dangers of X-rays used in dentistry, a lack of adequate oversight of these centers' protection by health authorities, and a lack of continuing education in radiation protection.

Source: Own authorship, (2021)

Regarding personal protection and the application of the ALARA (as low as reasonably achievable) principle, the study by Alves et al. (2016) (article 1), conducted in Brazil to assess dentists' knowledge of radiation protection methods, demonstrated that most professionals were concerned with both personal and patient protection and the correct use of techniques for each radiograph, thus avoiding potential repetitions and, consequently, unnecessary exposures. However, some professionals reported not adopting such practices, leaving much to be desired in the application of simple radiation protection measures.

The use of PPE, combined with the application of correct techniques, aims to reduce the radiation dose that the patient will receive, as well as avoid unnecessary exposure to radiosensitive organs, such as the gonads and thyroid. Oliveira et al. (2016) (article 6) draw attention to the lack of ionizing radiation signage in X-ray rooms in 94.2% of offices. Such signage is crucial to prevent people from remaining in the examination area unnecessarily, in addition to warning of the dangers such exposure can cause. It is also concerning that only 20% of the lead aprons were stored correctly.

It is known that aprons should not be folded or placed on the floor, as this can damage the PPE and render it ineffective for radiation protection purposes. Finally, the study finds the apparent negligence of some professionals regarding radiation protection aspects observed in the results concerning, in accordance with the legislation, due to the risks posed to patients. It is emphasized that neglecting such measures results in unnecessary exposures, which can cause harm to patients and professionals.

A study conducted in India (CHAUDHRY et al., 2016 - article 2) showed that the knowledge and practices adopted by general dentists are insufficient to maintain radiation protection barriers and adherence to the ALARA principle, a safety concept in radiological procedures that aims to minimize exposure to patients and professionals by employing the lowest possible radiation dose for the procedure. The authors suggest that after graduation, professionals should keep their knowledge aligned with new evidence, and this can be achieved through continuing dental education programs.

Article 15 (TOHIDNIA et al., 2020) showed that only 4% (3) of dental centers used digital imaging systems. Some private centers did not use lead aprons. Furthermore, automatic film processing was not used in the centers, and there was no control program for radiographic devices. They concluded that the level of protection is inadequate and should be improved through the application of international recommendations and regulations on radiation protection measures, in addition to the use of modern radiology equipment in dental centers. It is worth noting that the use of digital radiology reduces radiation exposure for patients and professionals, in addition to eliminating errors associated with manual film processing (ALCARAZ et al., 2009).

Also analyzing the KAP of dental radiology professionals, article 9 (KHANI et al., 2017), from Iran, also showed significant differences between KAP and length of professional experience. Article 10 (SINGH et al., 2018) assessed the relationship between dentists' knowledge of radiation protection and their attitudes and methods used. Of the 1,000 dentists who responded to the questionnaire, only 29.9% demonstrated adequate knowledge of safety standards in dental radiology, and only 19.8% demonstrated adequate knowledge of their practice.

The result is worrying and demonstrates the need for professionals to adhere to continuing education programs, in order to align knowledge, attitude and professional practice, in addition to updating them on new technologies.

4 CONCLUSION

According to the articles analyzed, it can be concluded that dental professionals, regardless of their country of origin, do not fully comply with radiation protection standards in their daily clinical practice, putting the health of both patients and their staff at risk.

The importance of continuing education is emphasized to keep them up-to-date on radiation protection protocols, due to legislative updates and technological innovations that are constantly emerging in radiology equipment.

The need for each country to align with the standards of the International Commission on Radiological Protection (ICRP) is also essential. This is in addition to increased oversight of dental radiology practice locations to avoid unnecessary exposures and risks.

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