***Original Research Article***

**Biosafety Knowledge and Compliance among Dentistry Students in Intraoral Radiography: A Cross-Sectional Study at a Private Institution in Brazil**

**ABSTRACT**

**Aims:** To assess the level of knowledge of Dentistry students at FIPMoc Afya University Center (UNIFIPMoc) regarding biosafety regulations in the execution of intraoral radiographs.

**Study design:** Cross-sectional and observational epidemiological study.

**Place and Duration of Study:** Health Care and Professional Practice Center (NASPP) at UNIFIPMoc, between February and August 2022.

**Methodology:** 104 students participated in the study, with students from the 5th to 9th semesters, with no restrictions regarding age, gender, ethnicity, or socioeconomic status. The study was approved by the Research Ethics Committee. Data were collected through a structured digital questionnaire containing 17 objective questions on the Google Forms platform, along with the Informed Consent Form (ICF). The analysis was descriptive and presented in tables with absolute numbers and percentages.

**Results:** The study's findings underscore both progress and gaps in biosafety training among dental students, highlighting areas for improvement in adherence to protocols. The high percentage of participants expressing concern about biosafety and the widespread use of physical barriers, such as plastic bags and masks (99.03%), indicate a strong awareness of infection control measures. However, inconsistencies in the use of disinfectants, particularly the 5.77% who did not use any, suggest a need for reinforcement in practical training. Notably, while over half (52.88%) of the students used plastic barriers to protect radiographic films, the lack of sterilization of positioners (85.57%) represents a critical gap that could compromise infection control. Similarly, the relatively low percentage of students washing their hands before and after procedures (41.35%) and the 50% who did not disinfect X-ray equipment highlight the necessity of reinforcing hygiene protocols in clinical training.

**Conclusion:** Although concern for biosafety and the use of physical barriers are observed, failures in infection control, sterilization, and hand hygiene indicate deficiencies in practical training. Simulated training, periodic evaluations, and strengthened faculty supervision are recommended.

*Keywords: Dentistry; Radiology; Biosafety; Exposure to Biological Agents; Containment of Biohazards; Practice Patterns, Dentist; University Medical Centers*

**1. INTRODUCTION**

Radiology has become an indispensable specialty in Dentistry, standing out for its integration with other disciplines and its importance in the diagnosis, planning, and monitoring of oral treatments (Álvares; Tavano, 2009); (Bolner; Silveira, 2011) UFRGS, Brazil, unpublished results. Extremely useful, dental radiology allows for accurate diagnoses and the definition of specific clinical approaches for healthcare professionals. Additionally, radiographic procedures serve as an essential complementary tool for identifying and managing the main pathologies of the oral cavity (Freitas; Rosa; Souza, 2000); (Barbosa; Abdo, 2012), Federal University of Minas Gerais (UFMG), Brazil, unpublished results.

Dental radiology, despite its importance, is one of the specialties in Dentistry that is often overlooked when it comes to the adoption of biosafety measures (Pasler; Visser; Oliveira, 2006; Lima *et al.*, 2024). Work activities in the field expose professionals to various occupational risks, with a particular emphasis on biological risk. In this context, the control of infectious diseases has become an increasing concern among healthcare professionals, considering that both patients and professionals can act as potential spreaders of pathogens (Bezerra *et al.*, 2014).

Despite the existence of standard precautions aimed at ensuring the safety of professionals and users, factors such as lack of knowledge, the application of sterilization methods, bacterial and viral resistance, as well as professionals' lack of attention in risk situations, have contributed to the increase in infection cases. Among these, viral infections stand out, including herpes simplex type 1 (HSV-1) and type 2 (HSV-2), varicella-zoster virus (VZV), human immunodeficiency virus (HIV), as well as the hepatitis B (HBV), C (HCV), and D (HDV) viruses. These infections are acquired during medical and dental procedures, affecting both professionals and patients (Bezerra *et al.*, 2014; Laheij *et al.*, 2012).

The COVID-19 pandemic, which began in 2019, highlighted the risks of cross-contamination in dental environments, primarily due to the spread of droplets, aerosols, and contact during treatments. In dental schools, where treatments occur simultaneously in shared spaces, the risk of transmission between oral health professionals and patients is even higher. With an incubation period of up to 14 days and the virus's ability to remain in saliva for up to 24 days, it is essential to treat all patients as potential carriers, regardless of whether they show symptoms. This scenario emphasized the importance of biosafety practices in all types of clinical environments – critical, semi-critical, and non-critical – and prompted structural changes in dental schools and clinics to implement new safety protocols (Araújo; Feitosa, 2021, Doctor Leão University Center Sampaio (UNILEÃO), Brazil, unpublished results; Athayde; Silva, 2021; Cabrera-Tasayco *et al.*, 2021; Lima *et al.*, 2024; Riatto *et al.*, 2020).

During the performance of radiographs in dental environments, the professional manipulates the film inside the patient's oral cavity, which often results in direct contact with tissues, saliva, secretions, and blood. These fluids can be transferred to the radiographic equipment, making it a potential vector for the spread of infectious diseases through cross-contamination (Barbosa; Abdo, 2012, UFMG, Brazil, unpublished results; Cordeiro; Retcheski, 2023, Uniguairacá University Center (CUU), Brazil, unpublished results; Fonseca; Aguiar, 2022), Federal University of Sergipe (UFS), Brazil unpublished results.

Dentists, oral health teams, and patients are constantly exposed to the risk of contamination, making it necessary to adopt appropriate measures to ensure the safety of everyone involved in the procedures (Fonseca; Aguiar, 2022), UFS, Brazil unpublished results. In the context of radiographic exams, it is essential to apply universal precautions, considering that all patients may transmit microorganisms (Barbosa; Abdo, 2012), UFMG, Brazil, unpublished results. The implementation of simple practices, such as taking medical histories, proper use of Personal Protective Equipment (PPE), hand hygiene, application of protective barriers, and cleaning and disinfection of equipment, is essential to minimize or eliminate cross-contamination (Fonseca; Aguiar, 2022), UFS, Brazil unpublished results.

The aim of this study was to assess the level of knowledge of Dentistry students at UNIFIPMoc, Montes Claros/MG campus, regarding the biosafety standards applied to the performance of intraoral radiographs.

**2. METHODOLOGY**

This is a cross-sectional and observational epidemiological study, with a convenience sample consisting of 104 students enrolled from the 5th to the 10th semester of the Dentistry program at UNIFIPMoc — Montes Claros Campus. The research included participants of different ages, genders, ethnicities, socioeconomic conditions, and without restrictions regarding course dependencies. The study was conducted in the city of Montes Claros, Minas Gerais, which has 414,240 inhabitants, according to the Brazilian Institute of Geography and Statistics (IBGE, 2022). In the city, there are 4 private institutions and 1 public institution offering the Dentistry program. Data collection took place at the UNIFIPMoc campus, which had 235 students enrolled from the 5th to the 10th semester during the research period. The study was submitted to the Research Ethics Committee and approved under the opinion No. 5.170.069, dated December 16, 2021. Data were collected between February and August 2022 through structured digital questionnaires with 17 objective questions (adapted from Diniz; Bento, 2009). These questionnaires addressed information about gender, students' academic semester, knowledge and access to the biosafety manual from the NASPP at UNIFIPMoc, as well as questions about the biosafety methods and procedures used in the clinical radiology practice by the students. The data collection instrument, consisting of a digital questionnaire, was developed on the Google Forms platform, along with the ICF. The access link was shared directly with all students via the WhatsApp messaging app. Upon clicking the link, participants were directed to the ICF and could only access the questionnaire after agreeing to the terms. In addition, a student involved in scientific initiation for this study visited the classrooms of all selected semesters to promote the research and made themselves available to clarify any doubts. The questions raised during the data collection period were answered directly through the contact platform.

Only fully completed questionnaires from enrolled and active students from the 5th to the 10th semester were included in the study. After data collection, the data were organized into Excel spreadsheets and analyzed using SPSS software (version 21.0, Chicago, USA). The analysis was descriptive and presented in tables with absolute numbers and percentages.

**3. RESULTS AND DISCUSSION**

In radiology practical classes, it is common to observe adequate attention to radiation exposure and biosafety. However, concern about cross-contamination prevention is often neglected by students, especially when radiographs are performed in clinics associated with other practical disciplines, different from radiology, where there is usually no direct supervision by instructors during the execution of radiographic procedures (Leite; Luck, 2018; Souza *et al.*, 2021).

The control of cross-contamination is an essential aspect of dental clinical practice, requiring strict adherence to biosafety standards to protect both students and patients from the transmission of infectious diseases (Sousa *et al.*, 2022). The institutionalization of clinical protocols for the use of X-ray machines and the handling of materials related to radiographic procedures is crucial to improving the biosafety of students and patients. Moreover, biosafety practices in radiology, encompassing both infection control and radiation protection, should be strictly mandatory for students during dental courses, ensuring training that prioritizes safety and the quality of care (Diniz; Bento, 2009).

The importance of adhering to sanitary regulations in undergraduate education is emphasized, guiding students on correct practices and risk prevention strategies. This learning is essential so that, in the future, professionals can promote, rehabilitate, and protect health in a comprehensive and appropriate manner, in accordance with the guidelines and regulations of the competent authorities (Queiroz *et al.*, 2019).

The study included the participation of 104 out of 235 students, corresponding to (44.25%) of the students from the 5th to the 10th semester. Of the total, 69 participants (66.3%) were female, with a predominance of students in the 5th and 9th semesters, both with 33 participants (31.7%) (Table 1). (100%) of the sample in this study expressed concerns about biosafety (Table 2), supporting the findings of (Brasileiro *et al.*, 2018). In their study, conducted with 88 students from the 3rd to the 5th year of the Dentistry program at the State University of Paraíba (UEPB), Campina Grande/PB campus, Brazil, (99.00%) of the participants also reported concerns about biosafety in the university's radiology clinic. These results are higher than those observed by (Diniz; Bento, 2009), also at UEPB, who, when investigating 109 students from the same course and period, found that only (90.00%) of the sample mentioned similar concerns.

On the other hand, studies conducted at other institutions showed lower percentages. (Mendes *et al.*, 2024; Tomo *et al.*, 2014) when analyzing Dentistry students at Universidade Brasil and Universidade Camilo Castelo Branco (UNICASTELO) in Fernandópolis/SP, found that (89.00%) and (62.25%) of the students, respectively, reported having knowledge about biosafety. It is worth noting that, in these studies, the samples included students from the early years, who may not have yet taken courses related to biosafety. Furthermore, the questions addressed were not limited to radiological procedures, which may explain the lower percentages compared to the findings of this study and those from UEPB.

**Table 1. Gender and period data of the 104 students from the 5th to the 10th semester of UNIFIPMoc in Montes Claros, 2022.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Total |
| Gender |  |  | 104 |
| Female | 69 | 66,3 |
| Male | 35 | 33,7 |
| Period |  |  |
| 5th Period | 33 | 31,7 |
| 6th Period | 13 | 12,5 |
| 7th Period | 3 | 2,9 |
| 8th Period | 11 | 10,6 |
| 9th Period | 33 | 31,7 |
| 10th Period | 11 | 10,6 |

*Source: Authors' own.*

Regarding knowledge about the NASPP's dental radiology biosafety manual, (61.50%) stated that they had never had access to the content (Table 2). This result is similar to that observed by (Leite; Luck, 2018), at the Federal University of Paraíba (UFPB) in João Pessoa/PB, Brazil, unpublished results, who, when analyzing 109 Dentistry students from the 5th to the 10th semester, found that (67.00%) were unaware of Ordinance No. 453/1998, which was used as a reference at the institution. On the other hand, the results differ from those found by (Tomo *et al.*, 2014) at UNICASTELO, where, in a sample of 374 students from all semesters of the Dentistry course, (90.17%) stated that they had never read the Dental Services Manual – Prevention and Risk Control, from the National Health Surveillance Agency (ANVISA), which was used as a reference at the institution and covers, among other topics, radiological protection.

Both in the study by (Leite; Luck, 2018), UFPB, Brazil, unpublished results and in that of (Tomo *et al.*, 2014), there is no clarification regarding the availability of these documents to students, whether in physical or digital format. This lack of access may have contributed to the low knowledge rates reported in the study by (Tomo *et al.*, 2014). Additionally, the inclusion of students who had not yet taken courses related to biosafety in the samples may have influenced the results.

**Table 2. Data on the knowledge and access to the NASPP dental radiology biosafety manual of the 104 students from the 5th to the 10th period of UNIFIPMoc in Montes Claros, 2022.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Total |
| Do you care about biosafety? |  |  | 104 |
| Yes | 104 | 100 |
| No | 0 | 0 |
| Do you know the NASPP dental radiology biosafety manual? |  |  |
| Yes | 58 | 55,8 |
| No | 46 | 44,2 |
| Have you had access to the NASPP dental radiology biosafety manual? |  |  |
| Yes | 40 | 38,5 |
| No | 64 | 61,5 |
| Do you think this research could contribute to the biosafety of NASPP? |  |  |
| Yes | 94 | 90,39 |
| No | 1 | 0,96 |
| Maybe | 9 | 8,65 |

*Source: Authors' own.*

The "Laboratory Biosafety Manual, 3rd edition" by the World Health Organization (WHO) provides essential guidelines to prevent cross-contamination in laboratory environments, which are also applicable to radiology laboratories. Key recommendations include conducting a risk assessment before each procedure, proper use of PPE such as gloves and masks, and frequent handwashing to reduce pathogen transmission. Additionally, regular disinfection of surfaces and equipment that come into contact with biological materials is crucial, as well as proper waste management, ensuring the safe disposal of contaminated materials. These practices help reduce risks and promote a safe environment for both professionals and patients.

At UNIFIPMoc, the biosafety manual for dental radiology, provides guidelines for procedures during radiological appointments in the institution’s Dentistry program. The study by (Leite; Luck, 2018), conducted at the UFPB, Brazil, unpublished results, revealed that, until that year, the radiological protection reference used by the institution was the Ordinance No. 453/1998 from the ANVISA, which establishes radiological protection guidelines for the use of X-ray diagnostics in Brazil.

Since then, this ordinance was repealed by the Collegiate Directorate Resolution (RDC) No. 330/2019, regulated by Normative Instructions (IN) 56/2019 and 57/2019, which define the sanitary requirements for quality and safety in extraoral and intraoral dental radiology systems. Later, RDC No. 330/2019 was replaced by RDC No. 440/2020 and, more recently, by RDC No. 611/2022, accompanied by INs 94/2022 and 95/2022, which currently regulate extraoral and intraoral dental radiology systems.

Healthcare professionals and their teams are constantly exposed to occupational risks, including the presence of infectious agents, which is a reality in all areas of the dentist’s practice, including dental radiology (Silva *et al.*, 2024). The study by (Sousa *et al.*, 2022), conducted at the dental school clinic of the Presidente Antônio Carlos University Center (UNIPAC) in Araguaína/TO, evaluated the effectiveness of cleaning and disinfection of clinical surfaces. The results indicated the presence of dirt and bacterial contamination even after professional cleaning, highlighting a significant risk of cross-contamination in clinical school environments.

The respondents were able to select multiple physical biosafety measures used in radiographic practice. The use of masks was reported by (99.03%) of the students in this study (Table 3), with results close to those of (Souza *et al.*, 2021) with (99.20%), (Sousa *et al.*, 2020) with (94.23%), and (Tomo *et al.*, 2014) with (71.35%). The use of lab coats was reported by (96.15%) of the students (Table 3), compared to (100%), (94.40%), and (64.06%) from (Sousa *et al.*, 2020; Souza *et al.*, 2021; Tomo *et al.*, 2014), respectively. The use of procedure gloves was indicated by (92.30%) of the students (Table 3), compared to the results of (Sousa *et al.*, 2020) with (80.77%) and (Tomo *et al.*, 2014) with (74.47%). Over-gloves were used by (87.50%) of the students (Table 3), compared to (61.10%) reported by (Souza *et al.*, 2021). Protective eyewear was adopted by (51.92%) of the respondents (Table 3), while (Sousa *et al.*, 2020; Souza *et al.*, 2021; Tomo *et al.*, 2014) found (25.00%), (92.90%), and (63.02%), respectively.

The research results showed that, in the intraoral radiographic techniques that use holders to assist in the correct positioning of the film, 55 students (52.88%) protect the radiographic films with plastic film barriers, 81 students (77.88%) wash the holders, and 77 (74.04%) disinfect them with 70% alcohol. However, 6 students (5.77%) do not disinfect the holders, and 89 (85.57%) do not sterilize these devices (Table 3).

**Table 3. Data on the biosafety measures used by the 104 students from the 5th to the 10th semester of UNIFIPMoc in Montes Claros, 2022.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Total |
| What biosafety measures do you use during radiographic procedures? |  |  | 104 |
| Plastic bag | 103 | 99,03 |
| Plastic wrap | 48 | 46,15 |
| Procedure gloves | 96 | 92,30 |
| Overgloves | 91 | 87,50 |
| Mask | 103 | 99,03 |
| Cloth lab coat | 100 | 96,15 |
| Disposable lab coat | 6 | 5,76 |
| Coveralls | 7 | 6,73 |
| Glasses | 54 | 51,92 |
| Face shield | 68 | 65,38 |

*Source: Authors' own.*

In the study by (Souza *et al.*, 2021), conducted with 126 Dentistry students from the Universidade Metropolitana de Santos (UMS), (100%) of the sample considered the use of PPE necessary. However, (4.00%) reported not using all PPE correctly, and (51.20%) stated they had forgotten to use some PPE. In contrast, in the study by (Tomo *et al.*, 2014), with 374 Dentistry students from UNICASTELO, (47.39%) of the participants declared they were unaware of the meaning of the acronym PPE. Not all PPEs used in Dentistry were considered by the participants, and regarding the reason for using PPE in clinical practice, (11.00%) of the students stated they used them because they were mandatory in the college clinics. This fact can be explained by the study by (Warmling *et al*., 2023), which analyzed 2,560 dentists, dental assistants, and dental hygienists in southern Brazil, showing that the correct use of PPE in the workplace seems to be related to stress and anxiety perceived by the professionals.

The differences between items assessed as PPE in the studies can be attributed to the radiological protection guidelines adopted by each institution. While (Souza *et al.*, 2021; Tomo *et al.*, 2014) investigated biosafety without differentiating clinics from distinct disciplines, (Sousa *et al.*, 2020) focused their evaluation on students during radiological practice in the endodontics clinic. This approach may have influenced the results, considering that the extended time required to perform endodontic procedures may lead students to take radiographs without adopting the appropriate measures to protect the patient and operator, due to the fear of not having enough time to complete the procedure.

Although procedures performed in dental radiology do not generate aerosols, there is potential for contamination of devices, equipment, and surfaces by saliva and blood, emphasizing the importance of strict biosafety measures. According to the study by (Silva *et al.*, 2024), which analyzed the presence of microorganisms on contact surfaces and radiological equipment before and after dental treatments in a teaching clinic at the Faculdade do Amazonas – IAES, in Manaus/AM, bacterial colonies were identified on all evaluated surfaces in the radiological environment. Therefore, it is essential that students and the professional team responsible for cleaning the environment receive education and training in biosafety for better control and prevention of cross-contamination (Sousa *et al.*, 2022).

In the study conducted by (Freitas *et al.*, 2012), which investigated the microbiological contamination of radiographic equipment at the School of Dentistry at the Federal University of Maranhão (UFMA), in São Luís, MA, a high incidence of contamination was revealed. The results indicated that the X-ray machines used in dental clinics represent a potential risk of cross-contamination, highlighting the importance of adopting biosafety practices during the acquisition and processing of radiographic images.

In this study, (68.26%) of participants reported using some disinfectant during the radiographic practice (Table 4). This result is lower than the one found by (Brasileiro *et al.*, 2018), where (77.00%) of participants adopted this practice, but higher than the one observed by (Diniz; Bento, 2009), where only (33.00%) used disinfectants, and (55.00%) did not know which substance to use for infection control.

The results of this research indicated that, in the intrabuccal radiographic techniques, (52.88%) of participants protect the radiographic films with plastic film barriers (Table 4), a percentage similar to that found by (Diniz; Bento, 2009), where (48.00%) used mechanical barriers, but lower than the (70.00%) reported by (Brasileiro *et al.*, 2018), who used this protection. The spraying of (70.00%) alcohol was used by (25.00%) of the sample as a biological protection (Table 4), a value higher than the (18.00%) observed by (Brasileiro *et al.*, 2018). Furthermore, (5.77%) used paper towels to dry the films (Table 4), a result close to (Diniz; Bento, 2009), who reported (8.00%) using the same method, and higher than the (1.00%) found by (Brasileiro *et al.*, 2018). Finally, (13.46%) of participants washed the films with running water as biological protection (Table 4), a result higher than the (7.00%) found by (Brasileiro *et al.*, 2018).

According to the guidelines of the Centers for Disease Control and Prevention (CDC) (2024), radiographic films and digital radiography sensors are classified as semicritical items and require protection with a physical barrier to minimize the risk of contamination. After use, these devices should undergo cleaning followed by heat sterilization or high-level disinfection. If they are not compatible with these methods, at a minimum, the use of an Food and Drug Administration (FDA)-approved barrier is recommended. Additionally, cleaning and disinfection with an intermediate-level hospital disinfectant, registered with the Environmental Protection Agency (EPA) and with tuberculocidal action, should be performed between appointments. Since the ability of these items to undergo sterilization or high-level disinfection may vary depending on the manufacturer, it is essential to follow the manufacturer's instructions to ensure proper reprocessing.

Regarding the positioners, (77.88%) of participants stated that they wash them after use, although only (14.42%) use soap and water in this process (Table 4). In the studies by (Diniz; Bento, 2009) and (Brasileiro *et al.*, 2018), (63.00%) and (58.00%) of participants, respectively, reported using some disinfectant solution for the asepsis of positioners after use. The most frequently used chemical solutions for disinfecting the positioners were 70% alcohol, cited by (74.04%) of students (Table 4), a percentage much higher than the (21.00%) reported by (Diniz; Bento, 2009). The use of soap and water was mentioned by (14.42%) of participants (Table 4), a result similar to the (13.00%) found by (Diniz; Bento, 2009) and higher than the (6.00%) observed in the study by (Brasileiro *et al.*, 2018). Glutaraldehyde at (2.00%) was indicated by only (0.96%) (Table 4), a value much lower than the (24.00%) reported by (Diniz; Bento, 2009). Furthermore, this study identified that (5.77%) do not use any disinfectant substance (Table 4).

In this study, (14.43%) of participants reported sterilizing the positioners (Table 4), a percentage lower than that observed in the study by (Diniz; Bento, 2009), where (20.00%) of students adopted this practice, and also lower than the (30.00%) reported by (Brasileiro *et al.*, 2018), who identified that (30.00%) of students used autoclaving as a sterilization method after using the positioners.

Regarding the X-ray equipment, only (25.96%) reported disinfecting some part of the machine (Table 5). This percentage is similar to the one found by (Brasileiro *et al.*, 2018), where (22.00%) of respondents stated that they disinfected parts of the equipment. Both results are higher than those found by (Diniz; Bento, 2009), who observed that only (16.00%) of students disinfected any surface of the X-ray machine.

**Table 4. Data on physical and chemical biosafety barriers used by 104 students from the 5th to the 10th semester at UNIFIPMoc in Montes Claros, 2022.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Total |
| Do you usually use any disinfectant substance in radiographic practice? |  |  | 104 |
| Yes | 71 | 68,26 |
| No | 30 | 28,84 |
| Did not answer | 3 | 2,90 |
| What type of biological protection do you usually use on intraoral films? |  |  |
| Physical barrier (plastic film) | 55 | 52,88 |
| Spraying 70% alcohol | 26 | 25,00 |
| Rinse with running water | 14 | 13,46 |
| Dry with paper towel | 6 | 5,77 |
| Did not answer | 3 | 2,89 |
| Do you wash the positioning devices? |  |  |
| Yes | 81 | 77,88 |
| No | 23 | 22,12 |
| What solution do you use for disinfection of the positioning devices? |  |  |
| 0.5% Sodium hypochlorite | 2 | 1,92 |
| 1.0% Sodium hypochlorite | 0 | 0 |
| 5.0% Sodium hypochlorite | 0 | 0 |
| 2.0% Glutaraldehyde | 1 | 0,96 |
| 70% Alcohol | 77 | 74,04 |
| Water and soap | 15 | 14,42 |
| I do not use disinfectant substances | 6 | 5,77 |
| Did not answer | 3 | 2,89 |
| Do you sterilize the positioning devices? |  |  |
| Yes | 15 | 14,43 |
| No | 89 | 85,57 |

*Source: Authors' own.*

Regarding the parts of the X-ray equipment most frequently disinfected, (17.31%) of the sample reported disinfecting the chair arm (Table 5), a percentage higher than the (6.00%) observed by (Brasileiro *et al.*, 2018) but lower than the (41.00%) recorded by (Diniz; Bento, 2009). (Silva *et al.*, 2024) highlighted a (53.65%) increase in the number of bacterial colonies on this surface after dental procedures. The locator cylinder was indicated by (16.35%) of participants (Table 5), a value higher than the (6.00%) found by (Brasileiro *et al.*, 2018) but below the (50.00%) reported by (Diniz; Bento, 2009). The trigger was disinfected by (7.69%) of participants (Table 5), a percentage above the (1.00%) recorded by (Brasileiro *et al.*, 2018) but lower than the (25.00%) observed by (Diniz; Bento, 2009). In the study by (Silva *et al.*, 2024), there was a (25.00%) reduction in the number of bacterial colonies on the trigger after dental procedures. Finally, the headpiece was disinfected by (6.73%) of participants (Table 5), a result similar to the (5.00%) identified by (Brasileiro *et al.*, 2018) but much lower than the (34.00%) found by (Diniz; Bento, 2009). (Silva *et al.*, 2024) reported an (11.65%) increase in the number of bacterial colonies on the headpiece after dental procedures.

According to the CDC guidelines (2024), cleaning followed by disinfection with a hospital-grade disinfectant registered with the EPA is recommended for non-critical items, such as X-ray equipment and the arms of the dental radiography chair. Additionally, the use of disposable barriers is advised to protect these surfaces.

Additionally, (62.50%) of the participants reported performing asepsis on the lead apron and thyroid protector (Table 5). These results are similar to those found by (Diniz; Bento, 2009), where (57.00%) performed asepsis on the lead apron and (47.00%) on the thyroid protector. However, both percentages are much higher than those recorded by (Brasileiro *et al.*, 2018), where only (3.00%) performed asepsis on the lead apron and (1.00%) on the thyroid protector. Silva et al. (2024) found a (25.35%) reduction in bacterial colonies on the lead apron after dental procedures.

**Table 5. Data on the disinfection of radiography equipment and lead aprons from the 104 students of the 5th to 10th semester at UNIFIPMoc in Montes Claros, 2022.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Total |
| Do you usually disinfect any part of the X-ray machine? |  |  | 104 |
| Yes | 27 | 25,96 |
| No | 52 | 50,00 |
| Sometimes | 25 | 24,04 |
| Which part do you disinfect? |  |  |
| Locator Cylinder | 17 | 16,35 |
| Headpiece | 7 | 6,73 |
| Chair Arm | 18 | 17,31 |
| Trigger | 8 | 7,69 |
| Auxiliary Table | 3 | 2,88 |
| None | 51 | 49,04 |
| Do you perform the asepsis of the lead apron and thyroid collar? |  |  |
| Yes | 65 | 62,50 |
| No | 39 | 37,50 |

*Source: Authors' own.*

The risk of cross-contamination on the analyzed surfaces, even with hygiene practices in place, reinforces the need for strict biosafety protocols. These protocols are essential to minimize the risk of infection associated with procedures involving contact with radiological equipment (Silva *et al.*, 2024).

Moreover, only (41.35%) of the sample reported washing their hands before and after the radiographic procedure (Figure 1), a percentage lower than that found by (Souza *et al.*, 2021), where (99.20%) of the participants stated that they considered handwashing essential before and after each clinical patient appointment.

**Fig. 1. hand washing and glove changing before and after the radiographic procedure of 104 students from the 5th to the 10th semester at UNIFIPMoc in Montes Claros, 2022.**

*Source: Authors' own.*

These findings highlight that pathogens can be transferred to the radiographic film processing stage in darkrooms, representing a significant source of cross-contamination between patients undergoing radiographs. (Freitas *et al.*, 2012) emphasize that the ideal procedure, even with the use of PPE, involves adopting measures that prevent contamination in the processing box. To this end, it is recommended to process films that have been previously decontaminated, using sanitized gloves or overgloves. Alternatively, processing can be performed without gloves, provided that other biosafety practices are strictly followed.

A safe alternative to reduce the chances of contamination during the processing stage in darkrooms is the adoption of digital radiography. This technology simplifies the processing and facilitates contamination control, although it does not eliminate it completely. In the study by (Oliveira *et al.*, 2023), the contamination of ten photostimulable phosphor (PSP) plates and their protective covers was evaluated after intraoral exams conducted in two private clinics in Goiânia/GO. A microbiological analysis after radiographic exams on 20 patients revealed similar contamination in the protective covers of the plates in both clinics, as well as on the photosensitive part of the receptors. The authors attributed the higher contamination of the plastic covers to handling with contaminated gloves during the insertion of the PSP into the image reading scanner. This demonstrates that, although digital radiography reduces the steps of the process, thus decreasing the likelihood of contamination, it does not eliminate the risk if biosafety protocols are not strictly followed.

Additionally, according to (Vette Lima *et al.*, 2024), digital radiographs offer environmental benefits by avoiding the use of chemicals and toxic substances in the scanning process. Thus, the transition from conventional to digital radiography is an essential strategy for a more sustainable and responsible dental practice.

This study stands out for collecting data from students who had already completed the radiology discipline, where biosafety requirements are more stringent. By analyzing the practices adopted by these students in other disciplines throughout the program, it was possible to assess the extent to which biosafety concepts were assimilated and applied in different contexts. The research included a diverse sample of students from the Dentistry program at UNIFIPMoc, and data collection was conducted in a structured manner using an instrument published in the literature. Additionally, the use of digital questionnaires ensured active student participation through a direct communication channel. The study also provides relevant contributions regarding biosafety practices in radiological procedures performed in teaching clinics, emphasizing the importance of awareness and the adoption of preventive measures to avoid cross-contamination.

This study presented some limitations, including the fact that not all participants answered every question on the questionnaire. Therefore, the results, presented as percentages (%), were calculated based on the total number of responses obtained for each question, rather than the total number of participants. Additionally, the self-reported nature of the data, a common feature in cross-sectional studies, may have introduced response bias, as participants may have provided inaccurate information or not accurately reflected their daily practices. Furthermore, the inability to generalize the results to other dental clinics is a limitation, considering that biosafety protocols and recommendations for handling equipment may vary significantly according to the internal regulations of each institution. For future studies, it is suggested to conduct microbiological analyses in the radiology clinic of the NASPP, with the goal of identifying the areas most susceptible to contamination and, consequently, implementing specific measures to combat it more effectively.

**4. CONCLUSION**

In conclusion, while the high level of concern for biosafety and the use of physical barriers suggest an important awareness of infection control, the inconsistencies observed in the application of disinfection protocols, equipment sterilization, and hand hygiene reveal gaps in practical training. To address these deficiencies, institutional policies should prioritize the standardization of biosafety protocols in the curriculum, ensuring that theoretical knowledge is effectively applied in clinical practice. The incorporation of mandatory continuous education and simulated biosafety training is essential to reinforce hygiene practices, proper disinfection techniques, and sterilization of radiographic accessories. Additionally, the implementation of periodic assessments and monitoring student adherence to infection control protocols can help identify persistent gaps and guide targeted interventions. These findings also highlight the need for faculty development programs that emphasize active supervision and mentorship, creating a learning environment where biosafety is consistently practiced.

**ETHICAL APPROVAL**

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

**Consent**

As per international standards or university standards, Participants’ written consent has been collected and preserved by the author(s).

Disclaimer (Artificial intelligence)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

During the preparation of this work, the author(s) used ChatGPT 3.5 to assist in the translation of the article. After using this tool/service, the author(s) reviewed and edited the content as necessary and take full responsibility for the content of the publication.

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