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ORIGINAL RESEARCH

# An Assessment of Senior Dental Students Knowledge and Attitude toward Radiation Protection for Pediatric Patients in Islamic Azad University of Isfahan

**Ali Khodabandeh[1], Negin Khosravi[2]*, Hajar Shekarchizadeh[3]**

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## Abstract

**Background: During the educational period of the university, students are trained to perform radiographic examinations and the principles of radiation protection for both children and adults. Considering that the knowledge of dental students and dentists about the principles of radiation protection can prevent the occurrence of many possible radiation risks on children, the present study was conducted to investigate the knowledge and attitude towards radiation protection for children of final year dental students at Isfahan Azad University.**

**Materials and Methods: This descriptive-analytical cross-sectional study was performed on 67 students (including all 30 students in the 11th semester and 37 students in the 12th semester). Of the participants, 55.2% were female and, 44.8% were male, 23 to 37 years. Data collection was conducted using a questionnaire divided into three sections: Demographic Information (age, gender, and if the student was a transfer or visiting student), Knowledge Assessment (12 questions), and Attitude Assessment (6 questions). After the students answered the questions in the questionnaire, the data were analyzed using Mann-Whitney statistical tests and Spearman's correlation coefficient.**

**Results: Knowledge level had no significant relationship with age (p=0.272) and academic semester (p=0.491). However, the level of knowledge in men was significantly higher than in women (p=0.033). Attitude level had no significant relationship with age (p=0.634), gender (p=0.125), or academic semester (p=0.532).**

**Conclusion: The knowledge of the students about radiation protection for children was average, but their attitude was good. This shows the need for further investigation and academic training regarding the improvement of their level of knowledge. Also, age and academic semester did not affect students' knowledge and attitude. Gender does not affect students' attitudes, but male students had higher knowledge about radiation protection in children.**

**Keywords: Knowledge; Attitude; Radiation Protection; Dental Students**

## Introduction

Dental radiographs are important tools in diagnosing oral diseases. These radiographs help dentists choose appropriate treatments based on patients' dental conditions. The biological effects of X-rays used in radiography can be categorized into deterministic and stochastic effects. In deterministic effects, the severity of clinical symptoms is dose-dependent, meaning that if the radiation dose is sufficiently high to reach a certain threshold, it can occur in all individuals exposed (1). In contrast, stochastic effects do not have a threshold, and clinical effects can occur at any level of X-ray used; examples include radiation-induced cancers and hereditary effects (2, 3). In dental radiography, since the radiation dose is low and does not reach the threshold necessary to produce

**Corresponding author: Negin Khosravi**

Department of oral and maxillofacial radiology, Faculty of Dentistry, Isfahan (khorasgan) Branch, Islamic Azad University, Isfahan, Iran
Email: negin_dnt@yahoo.com

[1] Faculty of dentistry, Isfahan (khorasgan) Branch, Islamic Azad University, Isfahan, Iran
[2] Department of oral and maxillofacial radiology, Faculty of Dentistry, Isfahan (khorasgan) Branch, Islamic Azad University, Isfahan, Iran
[3] Department of community dentistry, Faculty of Dentistry, Isfahan (khorasgan) Branch, Islamic Azad university, Isfahan, Iran



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deterministic effects, there are no deterministic effects observed. However, stochastic effects, particularly radiation-induced cancers, can occur at this low dose level (4). Concerns arise from observations such as the frequent performance of dental radiographs (especially in children, who are more sensitive to radiation), the use of old X-ray machines with higher exposure levels, the development of cone beam computed tomography, and the poor knowledge of dentists and other staff performing dental radiography regarding radiation (5).

Children are at significant risk of ionizing radiation effects following X-ray examinations (6). The increased risk of harm effect in children is due to their growing tissues, which have high cellular sensitivity and highwater content, leading to more severe damage. Additionally, because of their smaller body size, larger areas of their bodies are exposed to ionizing radiation during radiography, which can predispose them to inheritable genetic effects in the future (7).

Despite the low doses of X-rays used in dental radiology, it is often assumed that the associated risks are also low. However, due to children's heightened sensitivity to radiation and the increasing number of pediatric patients receiving the same low doses of X-rays, the potential effects of radiation, particularly radiation-induced cancers, have become a significant health concern for children (8). Studies indicate that the risk of X-ray-induced cancers at similar doses in children is greater than in adults; therefore, dental radiography in children should only be performed when necessary, and if the radiation risks to the child outweigh the benefits, radiography should be avoided as much as possible (9).

Newer technologies, such as digital radiography, have reduced the radiation received by patients. Additionally, the use of lead aprons, thyroid collars, high-speed films, and proper positioning of the X-ray tube during radiography should be particularly emphasized for children to reduce radiation exposure risks (10).

In the study by Tazeh Kand and Eftekhari (11), dentists' knowledge was found to be at an average level across various fields of study. Thus, designing and implementing more targeted refresher courses to maintain and enhance dentists' knowledge according to guidelines provided by authorities remains necessary. Badrian et al. (12) evaluated the knowledge of dentists about the biological effects of ionizing radiation in Isfahan as weak, angling positioning insufficient education during their studies ,and the lack of continuing education courses.

Considering that dental students will soon enter the healthcare community, their level of knowledge and attitude regarding radiation protection, especially for children as a more sensitive population to X-rays, is of high importance. However, based on most studies conducted, the knowledge and performance of dentists, dental students, and other health staff in this area are weak (5,12-15). Since dental students' and dentists' knowledge of radiation protection principles can reduce many potential radiation risks to children, the present study aimed to investigate the knowledge and attitudes regarding radiation protection for children among final-year dental students at Islamic Azad University of Isfahan.

**Materials and Methods**

In this descriptive-analytical cross-sectional study, 67 students participated, including all 30 students in the 11th semester and 37 students in the 12th semester who had completed the theoretical courses in radiology 1 and 2 and pediatric dentistry 1 and 2. Of the participants, 55.2% were female and 44.8% were male, with ages ranging from 23 to 37 years. Exclusion criteria were visiting and transferred students who were excluded from the study.

Ethical approval for performing the survey was obtained from the Scientific Research Committee (IR.IAU.KHUISF.REC.1402-174) of Khorasgan University, College of Dentistry.

Data collection was conducted using a questionnaire divided into three sections: first section was about demographic Information regarding age, gender, and whether the student was a transferred or visiting student), second section was knowledge assessment which contained 12 questions related to knowledge of radiation protection for children. Each question had one correct answer, assigned a score of one point, while incorrect answers received a score of zero. The total knowledge score ranged from 0 to 12. Each student's score was expressed as a percentage of the total possible score. Scores were classified as follows: 0-50% indicated weak knowledge, 50-75% indicated moderate knowledge, and 75-100% indicated good knowledge. Third section was about attitude assessment. This section included 6 attitude questions regarding radiation protection for children. Responses were measured on a five-point Likert scale, resulting in a score range of 6 - 30. Scores of 6-14 were classified as poor attitude, 14-22 as moderate attitude, and 22-30 as good attitude.



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To determine the validity and reliability of the questionnaire, 10 specialists in oral and maxillofacial radiology and faculty members were asked to classify each question according to a three-part Likert scale: "essential," "helpful but not essential," and "not necessary." Content validity was assessed using three criteria: "simplicity and fluency," "relevance and specificity," and "clarity and transparency," with a four-point Likert scale applied to each question.

Based on Cronbach's alpha coefficient, the reliability for knowledge was 0.852, and for attitude, it was 0.70. After confirming the normal distribution of data in each category with the Shapiro-Wilk test, data analysis was performed using the Mann-Whitney U test, Spearman correlation coefficient, independent t-test, and SPSS version 27, with a significance level set at 5%.

## Results

Regarding knowledge of radiation protection for children, 12 questions were posed. The highest percentage of correct responses from students was related to the question, "Which part of body requires the most protection during a child's radiograph?" where 95.5% answered correctly. The lowest correct response was for the question, "In which type of radiograph, using the thyroid collar is essential and does not interfere with imaging the area of interest?" with only 3.0% of students answering correctly (Table 1).

**Table 1.** Distribution of the frequency of correct and incorrect answers of final semester dental students to questions about radiation protection for children.

| Question | Wrong answer | Correct answer |
|---|---|---|
| | Number (%) | Number (%) |
| Do you know ALARA principles? | 14 (20.9) | 53 (79.1) |
| Which item is one of the principles of ALARA? | 24 (35.8) | 43 () |
| If there is no wall or lead protective barrier in place, at what distance should the operator be at least from the head of the radiation tube? | 42(62.7) | 25 (37.3) |
| If there is no wall or lead protective barrier in place, at what angle should the operator be positioned with respect to the central x-ray beam? | 20(29.9) | 47 (70.1) |
| Which factors affect the selected exposure time in the control panel for radiography of the child? | 12 (17.9) | 55 (82.1) |
| In which radiography does the child receive more x-ray exposure? | 21 (31.3) | 46 (68.7) |
| Which part of body requires the most protection during a child's radiograph? | 3.0 (4.5) | 64 (95.5) |
| What type of image receptor is best to use in reducing children's exposure? | 31 (46.3) | 36 (53.7) |
| In which type of radiograph, using the thyroid collar is essential and does not interfere with imaging the area of interest? | 65 (97.0) | 2 (3.0) |
| Which type of the x-ray tube Cone is suitable for reducing exposure during imaging a child? | 27 (40.3) | 40 (59.7) |
| Which item is correct regarding prescribing radiographs for children? | 8 (11.9) | 59 (88.1) |
| What is the most ideal protective wall to protect personnel from X-rays during dental radiography of a child? | 11 (16.4) | 56 (83.6) |

According to the Mann-Whitney U test results, there was no significant difference in knowledge scores regarding radiation protection for children between 11th and 12th-semester students (p=0.491). Male students scored significantly higher than female students (p=0.033). Spearman correlation results showed no significant relationship between student age and knowledge scores regarding radiation protection for children (p=0.272, r=0.136) (Table 2).

**Table 2.** Comparison of final semester students' knowledge score regarding radiation protection for children based on individual characteristics (Mann-Whitney test for sex and semester & spearman correction for age)

| Variable | Group | Number | Mean ± SD | P value |
|---|---|---|---|---|
| academic semester | 11th semester | 30 | 67.22 ±13.12 | 0.491 |
| | $12^{th}$ semester | 37 | 63.96 ±17.35 | |
| Gender | Female | 37 | 62.61 ±14.78 | 0.033 |
| | Men | 30 | 68.89 ±16.07 | |
| Age | Less than 25 years | 40 | 62.92 ±15.44 | 0.272 |
| | 30-25 | 21 | 71.83 ±13.56 | |
| | Above 30 years | 6 | 59.72 ±18.57 | |



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For assessing attitudes toward radiation protection for children, 6 questions were posed. The highest percentage of correct responses was for the question, "Is the use of a thyroid collar essential for protecting a child during radiography?" The lowest percentage of correct responses was for the questions, "Is there a possibility of harmful effects with any single exposure to X-ray radiation?" and "Can X-rays used in radiography be harmful to a growing child?" (Table 3).

**Table 3.** Frequency distribution of final semester dental students' responses to attitude questions towards radiation protection for children

| Question | very opposite | Opposite | No idea | Agree | Very agree |
|---|---|---|---|---|---|
| | Number (%) | Number (%) | Number (%) | Number (%) | Number (%) |
| Can X-rays used in radiography be harmful to a growing child? | 1(1.5) | 13 (19.4) | 12 (17.9) | 30(44.8) | 11 (16.4) |
| Children are more at risk of damage from X-rays than adults | 0 (0.0) | 6 (9.0) | 8(11.9) | 32(47.8) | 21(31.3) |
| Is there a possibility of harmful effects with any single exposure to radiation | 4 (6.0) | 9 (13.4) | 13(19.4) | 27(40.3) | 14 (20.9) |
| Is the use of a thyroid collar essential for protecting a child during radiography? | 0 (0.0) | 1 (1.5) | 1(1.5) | 24(35.8) | 41 (61.2) |
| Children are more likely to develop tumors induced by X-rays than adults. | 0 (0.0) | 3 (4.5) | 14(20.9) | 40(59.7) | 10 (14.9) |
| When taking radiographs of a child, the X-ray exposure should be reduced compared to adults. | 1 (1.5) | 4 (6.0) | 3(4.5) | 37(55.2) | 22 (32.8) |

Based on the independent t-test results, there was no significant difference in attitude scores regarding radiation protection for children between 11th and 12th-semester students (p=0.532) and between male and female students (p=0.125). The significance test of the Spearman correlation showed no significant relationship between student age and attitude scores regarding radiation protection for children (p=0.634, r=0.059) (Table 4).

**Table 4.** Comparison of final semester students' attitude scores towards radiation protection for children based on individual characteristics

| Variable | Group | Number | Mean ± SD | P value |
|---|---|---|---|---|
| academic semester | 11th semester | 30 | 23.40±3.10 | 0.532 |
| | 12th semester | 37 | 23.89±3.25 | |
| Gender | Female | 37 | 23.14±3.32 | 0.125 |
| | Men | 30 | 24.33±2.89 | |
| Age | Less than 25 years | 40 | 23.73±3.40 | 0.634 |
| | 30-25 | 21 | 23.24±2.91 | |
| | Above 30 years | 6 | 24.83±2.48 | |

## Discussion

According to the results of this study, the students surveyed in the 11th and 12th semesters exhibited a moderate level of knowledge, with male students showing higher knowledge regarding radiation protection for children than female students. Most students demonstrated a high level of attitude.

In the study by Zakirulla et al. (5), students' knowledge and attitudes were assessed weak, contrasting the findings of the present study. This discrepancy might be attributed to differences in the educational levels of universities and personality differences among students in the two studies. In the study by Preete et al. (16), despite high knowledge among pediatric



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specialists in Bengaluru, India, their performance regarding radiation safety and the need for a safe method against radiation was low. One reason for the differences between study results may be due to varying health and treatment considerations in the two studies. However, in the study by Dirik and Şanlıdağ (17), despite the lack of formal education, knowledge regarding medical radiation was found to be at an acceptable level, which aligns with the results of the present study.

Abo El Aish et al. (18) stated in their study that training courses significantly impact knowledge of radiation protection measures. Older participants demonstrated better radiation protection performance. Higher work experience and education levels improved performance. The only factor affecting performance levels was knowledge; for each unit increase in knowledge, performance increased by 2.2%.

In the study by Khani et al. (19), which examined the knowledge, attitudes, and performance of staff in radiology centers regarding radiation protection, it was shown that gender did not affect knowledge and performance, but male staff had higher levels of attitude toward radiation protection.

In the maxillofacial region, the thyroid gland is the most radiation-sensitive organ, especially for children. In the present study, 95.5% of participants believed that the thyroid is the most important part of the body for protection during a child's radiographic procedure, aligning with the results of other studies (5, 20).

According to the findings of this study, the use of a thyroid collar to protect children during dental radiography is essential, which is consistent with the study by Mutyabule and Whaites (21), but inconsistent with the findings of Yurt et al. (22) and Zakirulla et al. (5), where the difference may be due to higher training and learning at this center.

In this study, two questions related to ALARA (As Low as Reasonably Achievable) were posed. The ALARA principle is adopted to reduce radiation dose. ALARA justifies radiological tests with the minimum radiation dose necessary to obtain a radiograph of adequate diagnostic quality. Consequently, radiography should be performed under conditions of minimal radiation dose while achieving acceptable diagnostic information (23). Therefore, radiography equipment operators must be thoroughly familiar with safety principles and regulations to protect themselves, colleagues, and patients. In this study, 79.1% of participants were aware of ALARA and its principles, and 64.2% knew that justification, dose limitation, and optimization are principles of ALARA. However, in the study by Dirik and Şanlıdağ (17), only 23 respondents were aware of ALARA principles, indicating better training and higher learning in the current study population. In the study by Mehdi et al., less than 50% of participating specialists were aware of radiation protection principles, and overall knowledge of radiation protection (ALARA) among pediatricians working in selected hospitals and clinics was low (17).

In this study, 79.1% of participants agreed that children are at higher risk from X-rays. Similarly, in the study by Zakirulla et al. (5), 83% agreed with this study, which aligns with the current study's results. However, in the study by Dirik and Şanlıdağ (17), only 20.3% were aware of this issue, indicating a need for further education in this area.

According to the results of the current study, 61% of participants were aware of the harmful effects of radiation on children. In the study by Zakirulla et al. (5), 53% of individuals recognized the risks of radiation for children. Although the radiation dose used in dental radiography is low, reducing even this amount can effectively protect children's health.

Considering the findings of the recent study, participants' knowledge regarding the minimum distance that should be maintained from the tube head was 37%, and regarding the appropriate angle from the tube head, it was 70.1%. In the study by Zakirulla et al. (5), 25% of individuals were aware of these principles. Additionally, in the study by Shahab et al. (24), the knowledge level was 36%, indicating a need for more education and information in this area, especially regarding the distance from the tube head.

In this study, 88.1% of participants agreed that clinical examinations should be performed before prescribing radiographs. In the study by Zakirulla et al. (5), the response rate to this question was 64%. Higher percentage of knowledge in our study indicates better training and learning at this educational center.

Regarding protective measures for children during radiography against radiation, three questions were posed, including exposure time, type of image receptor used, and suitable X-ray cone, with correct response rates of 82.1%, 53.7%, and 59.7%, respectively. In the study by Zakirulla et al. (5), less than half of the participants (44%) answered these questions correctly, which may be due to more extensive training and knowledge at this educational center.



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In the study of knowledge, attitudes, and performance of dental students regarding radiation protection for pediatric patients by Rahman et al. (25), it was shown that students, with increasing years of study, were able to obtain appropriate radiographs without unnecessary repetition. Final-year dental students demonstrated significantly greater judgment and knowledge in using radiography for children compared to third-year students. However, in practice, both third year and final-year students, regardless of their academic year, did not follow radiation protection measures despite their knowledge.

Based on the results of the present study, the level of knowledge and attitudes among dental students was at a desirable level, which may be attributed to proper and systematic education by instructors and the correct implementation of training during the clinical phase and patient examinations. Thus, it can be stated that education is crucial for improving the level of knowledge and performance of students. It is evident that proper training for students and conducting educational courses for dentists can effectively enhance their knowledge , attitudes, and consequently their performance. One possible reason why the level of knowledge and attitudes of students in this study was higher than in other reviewed studies could be that the population studied was still in their educational phase and had not distanced themselves from their studies like practicing dentists.

Furthermore, considering that age and academic term were not significant factors in causing differences in the level of knowledge and attitudes among students, it can be concluded that all students have acquired radiation protection skills for children at a similar level.

## Conclusion

The knowledge of students regarding radiation protection was at a moderate level, but their attitudes were good, indicating a need for further examination and training to improve their knowledge. Additionally, age and academic term did not have an impact on the knowledge and attitudes of the students.

**Conflict of Interests:** The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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