Assessment of Dental Students' Awareness of Radiation Dose Reduction Technique

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Abstract

Aim The aim of this study was to evaluate the knowledge, attitudes, and awareness levels of dental students regarding radiation dose reduction techniques and the ALARA (As Low As Reasonably Achievable) principle.

Material and method This descriptive cross-sectional survey study was conducted with the participation of 82 dental students. The questionnaire assessed participants' demographic characteristics, knowledge of radiation safety, attitudes, and self-perceived competence regarding practical applications. The data were analyzed using descriptive statistics and correlation analyses.

Results Only 32.9% of the participants reported being familiar with the ALARA principle. The overall level of theoretical knowledge and practical skills related to radiation dose reduction techniques was found to be low. While 93.9% of the students believed that adherence to the ALARA principle is mandatory, 100% agreed that compliance with radiation safety protocols enhances patient safety. Students enrolled in the English-language program reported significantly higher awareness and self-perceived competence compared to those in the Turkish-language program ($p < 0.05$). Correlation analyses revealed significant relationships between knowledge and attitudes (e.g., ALARA knowledge and perceived necessity: $r = 0.68$, $p < 0.01$).

Conclusion Although students exhibited positive attitudes toward radiation safety, their practical knowledge and application skills need to be further supported. It is recommended that theoretical education be reinforced with hands-on training and that more interactive sessions focused specifically on the clinical importance of the ALARA principle be integrated into the curriculum.

Keywords ALARA principle, Dental education, Dose reduction techniques, Radiation safety, Student awareness

Introduction

The use of ionizing radiation in medical practice offers significant advantages, particularly in diagnostic imaging and therapeutic procedures. However, considering its potential harmful effects on biological tissues, its application necessitates careful and informed use (1). In this context, the ALARA principle (As Low As Reasonably Achievable), an internationally recognized radiation protection guideline, serves as a fundamental approach aimed at minimizing radiation exposure. The ALARA principle mandates the implementation of all reasonable measures to reduce exposure to ionizing radiation for patients, healthcare workers, and the surrounding environment (2).

The ALARA concept is grounded in three core principles: minimizing exposure time, maximizing the distance from the radiation source, and utilizing appropriate protective shielding (3). These precautions are particularly critical in fields such as dentistry, where radiographic procedures are frequently performed. Although the radiation doses used in dental radiology are relatively low and pose minimal immediate risk to patients, the potential long-term effects of repeated exposures should not be underestimated (4).

In addition to technological infrastructure, the knowledge and awareness levels of healthcare professionals play a crucial role in radiation safety (5). Therefore, assessing dental students' knowledge, attitudes, and behaviors regarding the ALARA principle and radiation dose reduction techniques during their undergraduate education is essential in fostering professional responsibility and ensuring patient safety.

Nevertheless, numerous studies in the literature have indicated that students in the health sciences possess limited knowledge regarding the effects of ionizing radiation, protective measures, and the ALARA principle (6). Such deficiencies may lead to reduced adherence to safety protocols in clinical practice and result in unnecessary radiation exposure.

The aim of this study is to evaluate dental students' knowledge, attitudes, and self-perceived competence concerning the ALARA principle and radiation dose reduction techniques; to investigate potential differences based on variables such as language of instruction, gender, and educational experience; and to offer recommendations for improving educational strategies based on the findings.

Material and Methods

This descriptive cross-sectional survey study was conducted to evaluate the knowledge, attitudes, and awareness levels of dental students regarding radiation dose reduction techniques and the ALARA principle. A total of 82 students voluntarily participated in the study.

The study was approved by the Ethics Committee of the

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Biruni University (Ethics Committee No: 2024-BİAEK/12-35), and written informed consent was obtained from all participants. The research was conducted in accordance with the principles of the Declaration of Helsinki (7).

Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, percentage, and frequency) were used to summarize the data. Group comparisons were conducted using the Chi-square test for categorical variables and the independent samples t-test for comparisons between two groups.

In addition, Pearson correlation analysis was performed to examine the relationships between students' knowledge, attitudes, and self-perceived practical skills. A p-value of less than 0.05 was considered statistically significant in all analyses.

Results

The survey was completed by 82 students. Among the participants, 57.3% were male (n = 47) and 42.7% were female (n = 35) (Figure 1), with a mean age of 21.3 years (± 2.1). A total of 57.3% of the students were enrolled in the Turkish Dentistry Program, while 42.7% were studying in the English Dentistry Program (Figure 2). Overall, students' foundational knowledge of radiation safety and dose reduction principles was identified as an area with room for improvement. Only 32.9% of respondents (n = 27) stated that they were familiar with the ALARA (As Low As Reasonably Achievable) principle, highlighting a need to enhance awareness in this domain.

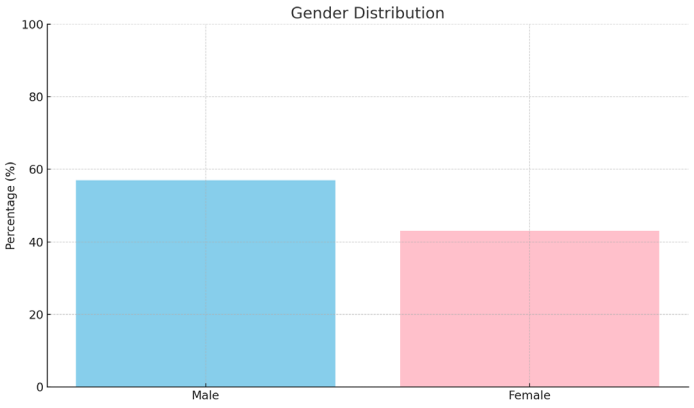

Figure 1: Gender distribution

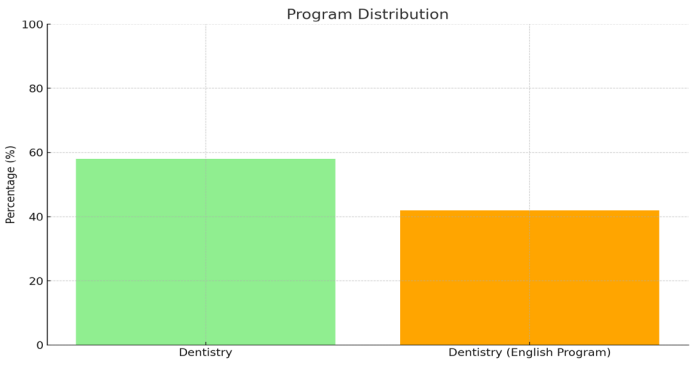

Figure 2: Program distribution

Responses to questions assessing knowledge and skills related to radiation dose reduction techniques indicated that both theoretical understanding and perceived competency remain underdeveloped. For instance, only 23.2% (n = 19) of the participants agreed with the statement "I know the basic principles of the ALARA concept," while 32.9% (n = 27) agreed with "I understand the biological effects of low-dose radiation techniques." Similarly, agreement with the statements "I know how to reduce radiation dose during radiological imaging" and "I can effectively implement low-dose techniques in my clinical practice" was reported by 28% (n = 23) and 25.6% (n = 21) of participants, respectively. These findings indicate a clear need for further development of both theoretical knowledge and practical competencies regarding radiation dose reduction techniques (Figure 3).

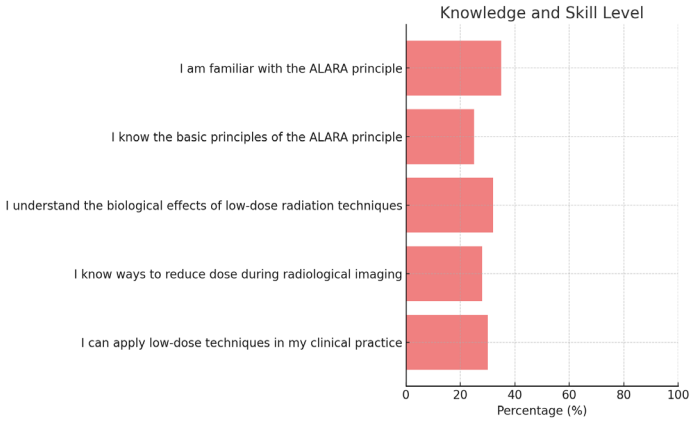

Figure 3: Knowledge and skill level

In contrast, students demonstrated more favorable attitudes toward radiation safety compared to their knowledge levels. The majority believed that adherence to the ALARA principle is mandatory (93.9%, n = 77), and all participants (100%, n = 82) agreed that compliance with radiation safety protocols enhances patient safety. These results suggest a high level of awareness regarding the importance of radiation safety. However, this positive attitude should be supported by stronger practical knowledge and skills. Notably, only 17.1% (n = 14) agreed with the statement "Implementing the ALARA principle makes clinical practice more difficult," indicating a generally positive perception of integrating ALARA into clinical routines. No statistically significant differences were found between male and female students in their responses to questions regarding knowledge, attitudes, or practical skills ($p > 0.05$). However, comparisons based on academic program revealed notable differences. Students in the English Dentistry Program reported higher levels of knowledge and perceived competence related to dose reduction techniques than those in the Turkish program. For example, 35% of students in the English program agreed with the statement "I know the basic principles of the ALARA concept," compared to only 11.1% of students in the Turkish program ($p < 0.05$). Similarly, a greater proportion of English program students agreed with the statement "I am competent in operating radiological equipment at low doses." No significant differences were found between age groups in terms of knowledge or skills.

Correlation analyses revealed statistically significant relationships between several survey items. A strong positive cor-

relation was observed between the statements "I know the basic principles of the ALARA concept" and "I believe it is mandatory to work in accordance with the ALARA principle" ($r = 0.68$, $p < 0.01$), suggesting that knowledge of foundational principles enhances belief in their necessity. Likewise, a strong positive correlation was found between "I am competent in operating radiological equipment at low doses" and "I can effectively implement low-dose techniques in my clinical practice" ($r = 0.75$, $p < 0.01$), indicating that students' perceived technical competence is closely related to their confidence in applying these skills clinically.

Educational experience also played a role in shaping awareness. Students who answered affirmatively to the question "Have you had the opportunity to practice radiographic imaging techniques during your education?" were more likely to respond positively to other items assessing knowledge and competence in radiation dose reduction techniques.

Discussion

This study evaluated the knowledge, attitudes, and self-efficacy levels of dental students regarding radiation dose reduction techniques and the ALARA principle. The findings revealed that, although students generally demonstrated positive attitudes toward radiation safety, this favorable outlook was not fully supported by adequate knowledge or practical competency. While 93.9% of participants considered adherence to the ALARA principle to be mandatory and 100% agreed that compliance with radiation safety protocols enhances patient safety, the low agreement rates with statements such as "I know the basic principles of the ALARA concept" and "I can effectively apply low-dose techniques in my clinical practice" indicate clear deficiencies in both theoretical understanding and practical skills. These findings are consistent with previous studies that have highlighted similar issues. For instance, Quinn et al. reported that most non-physician healthcare personnel lacked foundational knowledge of radiation safety and demonstrated limited proficiency in applying protective measures (8). Similarly, Daniels et al. (2015) noted that more than 60% of radiographic technicians in Nigeria were unfamiliar with the ALARA principle, and only 23% implemented it in their practice (6).

Studies focusing specifically on dental students have reported comparable results. Okumus and Yurdabakan found that although dental students in Turkey had heard of the ALARA principle, they were unable to apply it systematically in clinical practice (9). Most students demonstrated only a basic understanding of the biological effects of radiation and lacked familiarity with specific dose reduction techniques. This observation aligns with our finding of low self-efficacy regarding the operation of radiological equipment at low doses.

The significant correlations identified in this study further support these insights. A strong positive relationship was found between students' knowledge of ALARA principles and their belief in the necessity of applying them clinically ($r = 0.68$, $p < 0.01$). Likewise, perceived technical competency was strongly correlated with confidence in applying dose reduction techniques in clinical settings ($r = 0.75$, $p < 0.01$). These findings suggest that educational content not only influences theoretical knowledge but also directly shapes attitudes and behaviors. Avento et al. (2016) similarly reported a strong association between radiology technologists' knowledge and their adherence to safe practices (5).

Another noteworthy finding in our study was that students in the English Dentistry Program reported significantly higher levels of knowledge and awareness regarding radiation dose reduction techniques compared to those in the Turkish Program. This discrepancy may stem from various factors, such as curriculum content, language of instruction, pedagogical approaches, the currency of educational materials, and student demographics. Jha et al. highlighted that students in English-medium medical programs benefit from improved access to resources and enhanced terminological competence, which may positively influence knowledge acquisition (10). These results underscore the impact of instructional language and pedagogical strategies on learning outcomes.

Practical training experience emerged as another key factor influencing students' knowledge and skill levels. Participants who had opportunities to engage in hands-on radiographic imaging reported significantly higher self-efficacy and knowledge regarding dose reduction techniques. This finding is supported by Hankin et al., who demonstrated that simulation-based and clinical training models significantly enhance students' awareness of radiation safety (11). Rainford et al. also reported that simulation-based training positively affects radiology students' knowledge, adherence to safety protocols, and clinical decision-making skills (12). Taken together, these findings point to the need for a critical reassessment of how radiation safety is taught in dental education. Current theoretical courses appear insufficient in preparing students for clinical competency. It is essential to enrich curricula with interactive, scenario-based, simulation-supported, and practice-oriented learning strategies. A structured educational model incorporating in-depth content on radiation biology and protection, along with robust assessment methods, may address these educational gaps (13).

Furthermore, the results of this study highlight the importance of adopting an educational approach that promotes not only knowledge transfer but also behavioral change during the undergraduate period. Innovative assessment methods such as e-portfolios, Objective Structured Clinical Examination (OSCE) stations, and digital modules may serve as valuable tools for achieving this goal. Nevertheless, this study has certain limitations. It was conducted at a single institution with a limited sample size, which may restrict the generalizability of the findings. Additionally, the data were self-reported and may be subject to social desirability bias. Despite these limitations, the findings offer a valuable foundation for implementing educational improvements in radiation safety training for dental students.

Conclusion

Although the majority of students agreed on the importance of radiation safety and its positive impact on patient safety, this favorable attitude was not fully supported by adequate practical knowledge and application skills. Correlation analyses indicated that students' understanding of fundamental principles reinforced their belief in the necessity of adherence, and that opportunities for hands-on training significantly contributed to increased awareness. In light of these findings, it is recommended

that educators enhance radiation safety training by incorporating more interactive methods, enriching theoretical instruction with practical applications, and implementing strategies that emphasize the clinical relevance of the ALARA principle. Such an approach would contribute to the development of more competent and safety-conscious professionals in their post-graduate clinical practice.

Declarations

Ethics Committee Approval: *The study protocol was approved by the Biruni University Ethics Committee (No: 2024-BİAEK/12-35)*

Informed Consent: *Written informed consent was obtained from who participated in this study.*

Peer Review: *Externally peer-reviewed.*

Author Contributions: *Conception/Design of Study- M.Y.K.; Data Acquisition- M.Y.K.; Data Analysis/Interpretation- M.Y.K.; Drafting Manuscript- M.Y.K.; Critical Revision of Manuscript- M.Y.K.; Final Approval and Accountability- M.Y.K.; Material and Technical Support- M.Y.K.; Supervision- M.Y.K.*

Conflict of Interest: *Authors declared no conflict of interest.*

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