

Knowledge, Attitude, and Perception of Dental Undergraduates and Interns Regarding Radiographic Protection in Shivamogga City: A Questionnaire-based Cross-sectional Study

Beebi Ayesha¹, Vivek HP², Chethan Jagadish³, Preethi Nagdev⁴, Aishwarya Rai⁵, Parimala R⁶

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ABSTRACT

Background: Dental radiography is indispensable in diagnosis and treatment planning, but ionizing radiation carries inherent biological risks. Ensuring that dental students are well-informed about radiation protection protocols is essential for patient and operator safety. Assessing their knowledge, attitude, and perception enables identification of gaps and implementation of focused training measures.

Aim and objectives: To assess the knowledge, attitude, and perception (KAP) of dental undergraduates and interns regarding radiation protection in Shivamogga city.

Materials and methods: A cross-sectional questionnaire-based survey was conducted among 529 dental students (third year, final year, and interns) from two dental colleges in Shivamogga, Karnataka. A structured questionnaire with 15 closed-ended questions was distributed via Google Forms. Data were analyzed using descriptive statistics and Pearson's chi-square test, with $p \leq 0.05$ considered significant.

Results: Of the 529 participants, 36.3% were third-year students, 30.1% final-year students, and 33.6% interns, with females comprising 70.9%. Awareness of radiation hazards was high (94.5%), as was recognition of radiographs' importance in dentistry (92.8%) and preference for protective aprons (87.7%). However, only 34.8% believed X-rays are safe for children, and misconceptions persisted regarding CT scan safety (64.8%). Interns showed the highest knowledge and compliance, followed by third- and final-year students. Chi-square analysis revealed significant associations between demographic factors and responses, particularly in awareness of operator distance, protective protocols, and radiographic contraindications during pregnancy.

Conclusion: Dental students in Shivamogga demonstrated encouraging awareness of radiation hazards and safety protocols, with interns showing greater compliance. Nonetheless, gaps remain in pediatric safety awareness, patient handling, and consistent protective device usage. Integration of structured training, reinforcement of ALARA principles, and mandatory radiation safety workshops are recommended to strengthen knowledge and ensure translation into safe clinical practice.

Keywords: Dental students, Hazards, Internship, Radiation protection, Radiation protocol.

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INTRODUCTION

Dental radiography is an essential diagnostic tool in modern dentistry, aiding in the detection of caries, periodontal diseases, periapical pathologies, and maxillofacial lesions.¹ With the increasing use of advanced imaging modalities such as computed tomography (CT) and cone-beam computed tomography (CBCT), exposure to ionizing radiation in dental practice has significantly increased.²

Although dental X-ray doses are relatively low, ionizing radiation has cumulative biological effects and may induce stochastic risks such as cancer and genetic mutations.³ Therefore, strict adherence to radiation protection principles is crucial. The ALARA (As Low As Reasonably Achievable) principle emphasizes minimizing radiation exposure while maintaining diagnostic quality.⁴ International bodies such as the International Commission on Radiological Protection and national authorities such as the Atomic Energy Regulatory Board provide guidelines on justification, optimization, and dose limitation to ensure safety in dental radiography.⁵

Despite these recommendations, several studies have reported inadequate knowledge and inconsistent practices regarding radiation protection among dental students and practitioners in India.⁶⁻⁸ Recent studies further highlight this concern, showing that although awareness of radiation hazards is moderate to

¹⁻⁶Department of Public Health Dentistry, Subbaiah Institute of Dental Sciences, Shivamogga, Karnataka, India

Corresponding Author: Beebi Ayesha, Department of Public Health Dentistry, Subbaiah Institute of Dental Sciences, Shivamogga, Karnataka, India, Phone: +91 9620314559, e-mail: beebiayasha7@gmail.com

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good, there is a significant gap between knowledge and actual implementation of safety practices, particularly adherence to ALARA and use of protective measures.⁹ Additionally, recent surveys have emphasized variability in radiation safety awareness among dental professionals and the need for continuous education and curriculum reinforcement.¹⁰ This gap is particularly concerning among clinical-year students and interns, who are frequently exposed to diagnostic radiation during their training. The study hypothesizes that clinical-year dental students and interns possess insufficient

knowledge, attitude, and practices (KAP) regarding radiation safety and protection, making them more vulnerable to radiation hazards.

Aim

To assess the knowledge, attitudes, and perceptions (KAP) of dental students regarding the radiation protection protocols in Shivamogga city.

Objectives

To assess the knowledge, attitude, and perception regarding radiographic protection among dental students in Shivamogga district through a questionnaire.

MATERIALS AND METHODS

Study Design

The current study was a cross-sectional survey conducted from June 2025 to July 2025.

Samples Size

- Sampling technique: Convenience sampling
- The study sample comprised a total of 529 dental students.

Data Collection Procedure

The questionnaire was developed based on previously published studies and standardized guidelines on radiation safety. Content validity was established by a panel of subject experts in Public Health Dentistry, who evaluated the relevance, clarity, and comprehensiveness of each item. Necessary modifications were made based on their feedback. A pilot study was conducted among a small group of dental students (not included in the final sample) to assess feasibility, clarity, and time required for completion. Based on pilot results, minor adjustments were incorporated. The reliability of the questionnaire was assessed using internal consistency measures (Cronbach's alpha), which demonstrated acceptable reliability ($\alpha = 0.78$). The final questionnaire was distributed using Google Forms via personal email and mobile phones. Prior approval was obtained from the Head of the Institution. Participation was voluntary, and anonymity and confidentiality of responses were assured.

The classification of questionnaire items into knowledge, attitude, and perception domains was based on established KAP survey methodology frameworks widely used in public health research. Each domain reflects a distinct construct:

- Knowledge items assess factual understanding of radiation protection principles (e.g., hazards, operator distance, monitoring badges) based on standard guidelines such as ALARA.
- Attitude items evaluate participants' behavioral intentions toward radiation safety (e.g., use of protective aprons, adherence to protocols).
- Perception items capture subjective beliefs and risk appraisal (e.g., safety of X-rays in children, CT scan safety).

This classification was validated by public health dentistry experts and supported by prior KAP studies, ensuring clarity and meaningful interpretation of gaps between knowledge and practice.

Ethical Considerations

Ethical clearance for the study was obtained from the Institutional Ethics Committee (EC/NEW/INST/2023/3485) on 13/05/2025. Permission was also obtained from the Head of the Institution prior to data collection. Participation was voluntary, and informed

consent was obtained from all participants. Confidentiality and anonymity of responses were strictly maintained.

Inclusion Criteria

- Dental students in 3rd BDS, 4th BDS, and internship.
- Participants willing to provide informed consent.

Exclusion Criteria

- Students from 1st to 2nd BDS.
- Incomplete or improperly filled questionnaires.
- Participants unwilling to participate.

Sampling Method and Administrative Procedure

Before distributing the questionnaire, permission from the Institution was acquired, and the participants were informed of the study's importance. This study employs a practical approach. Each dental undergraduate student and intern from the two dental institutions stated above received a link to a questionnaire, which they were given enough time to complete, and the findings were then gathered from them. Two portions of a structured questionnaire were given to the participants. General information including name, age, gender, year of study, and college were included in the first section. The second component was a questionnaire that asked 15 questions about dental undergraduates and interns' KAP about radiographic protection.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 27.0. Descriptive statistics were computed. Associations between categorical variables were assessed using Pearson's chi-square test. A p -value ≤ 0.05 was considered statistically significant.

For statistically significant associations, effect size was calculated using Cramer's V to determine the strength of association.

Response Rate and Data Handling

A total of 529 responses were received, and all complete responses were included in the final analysis. Questionnaires with missing or incomplete data were excluded to maintain data accuracy and validity (Figs 1 to 4).

RESULTS

A total of 529 dental undergraduate students and interns from two dental institutions in Shivamogga participated in the study. Of these, 36.3% were third-year students, 30.1% were final-year students, and 33.6% were interns, while 70.9% of the participants were females. Overall, the participants demonstrated good awareness regarding radiation hazards and radiation protection protocols; however,

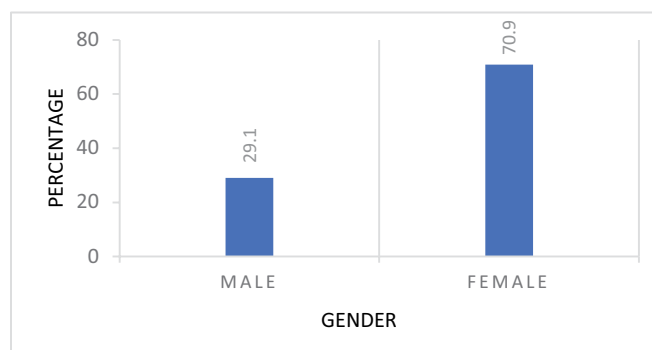


Fig. 1: Distribution of study participants by gender

important gaps were identified in the implementation of safe radiation practices and in specific aspects of radiation safety knowledge.

Table 1 shows that most participants had good knowledge of radiation hazards (94.5%), operator distance (84.9%), pregnancy contraindications (85.8%), and high-speed films (70.5%), though awareness of monitoring badges (73.5%) and hazard symbols (67.9%) was lower, with 29.9% holding misconceptions about X-ray reflection. Attitudes were generally positive, with high adherence to protective measures; however, 70.5% reported asking patients to hold films, indicating unsafe practice. In perception, most recognized

the importance (92.8%) and harmful effects (86.8%) of X-rays, but only 38.8% considered them safe for children, and 64.8% perceived CT scans as safe. Overall, despite good awareness, gaps persist in pediatric safety, CT scan understanding, and safe clinical practices.

Chi-square analysis revealed statistically significant associations across gender, institution, academic year, and at different ages. Detailed results are presented in tabular form (Tables 2 to 5).

Chi-square with Cramer's V

Chi-square analysis revealed several statistically significant associations between demographic variables and questionnaire responses, and Cramer's V was used to assess their magnitude. In gender-based comparisons, significant associations were observed for importance of X-rays (Q3), use of protective aprons (Q4), awareness of operator distance (Q5), future adherence to protocols (Q10), and pregnancy contraindications (Q14), though all showed weak effect sizes. Institutional comparisons showed significant associations for pediatric safety (Q6), CT scan safety (Q8), monitoring badges (Q9), and harmful effects of X-rays (Q15), with Q15

DENTAL INSTITUTION

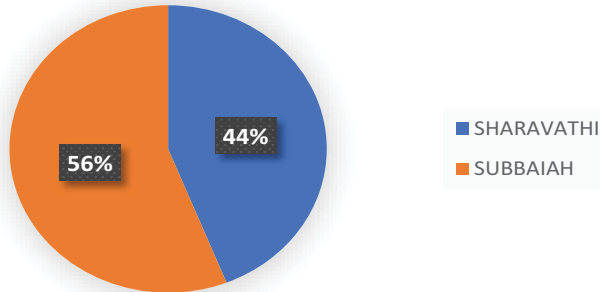


Fig. 2: Distribution of study participants by dental institution

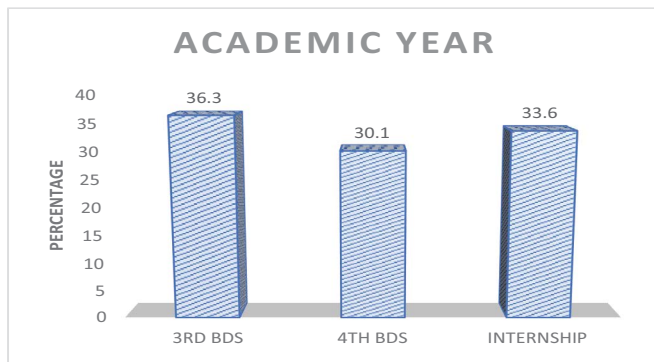


Fig. 3: Distribution of study participants by academic year

Table 1: Distribution of responses to questionnaire

Question	Yes (%)	No (%)
Q1	94.5	5.5
Q2	70.1	29.9
Q3	92.8	7.2
Q4	87.7	12.3
Q5	84.9	15.1
Q6	34.8	65.2
Q7	85.1	14.9
Q8	64.8	35.2
Q9	73.5	26.5
Q10	87.9	12.1
Q11	70.5	29.5
Q12	67.9	32.1
Q13	70.5	29.5
Q14	85.8	14.2
Q15	86.8	13.2

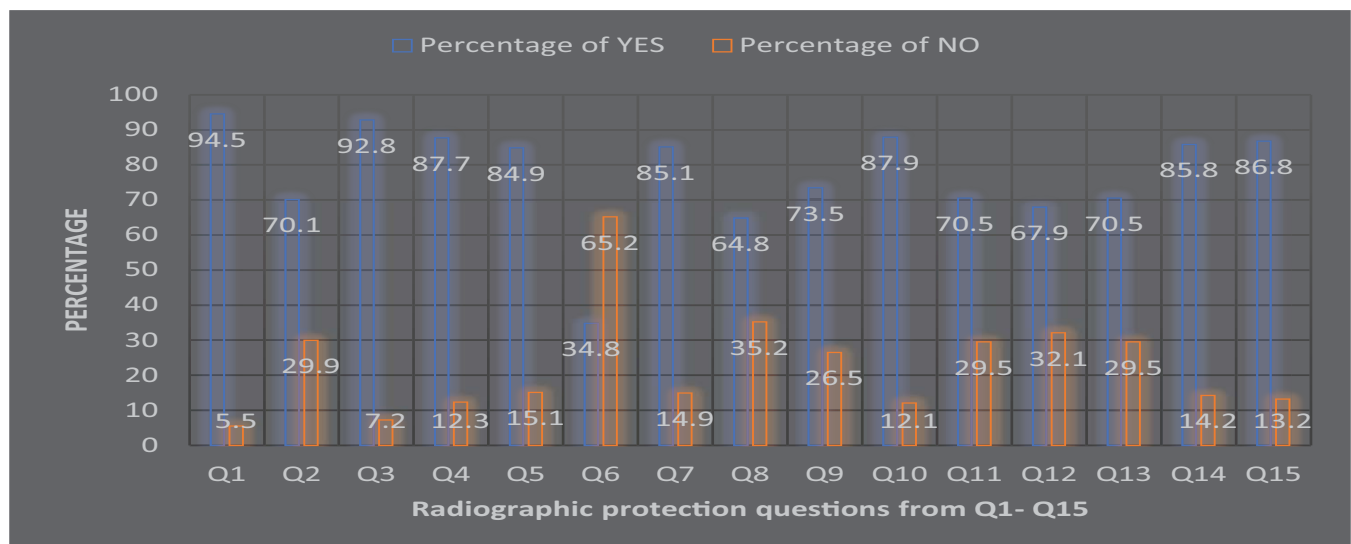


Fig. 4: Distribution of responses to the radiographic protection questionnaire (Q1-Q15)

Table 2: Comparison of questionnaire responses between male and female participants

Question	Response	Male n (%)	Female n (%)	Total	Chi-square value	p-value
Q1: Are you aware of radiation hazards?	Yes	144 (28.8)	356 (71.2)	500 (94.5)	0.429	0.531 (NS)
	No	10 (34.5)	19 (65.5)	29 (5.5)		
Q2: Do you think X-rays reflect from walls of the room?	Yes	112 (30.2)	259 (69.8)	371 (70.1)	1.043	0.594 (NS)
	No	42 (26.6)	116 (73.4)	158 (29.9)		
Q3: Do you think X-rays play an important role in dentistry?	Yes	136 (27.7)	355 (72.3)	491 (92.8)	6.613	0.015*
	No	18 (47.4)	20 (52.6)	38 (7.2)		
Q4: Do you prefer to wear any protective aprons during exposure?	Yes	128 (27.6)	336 (72.4)	464 (87.7)	4.257	0.042*
	No	26 (40.0)	39 (60.0)	65 (12.3)		
Q5: Are you aware of the ideal distance an operator should stand while dental radiographic exposure?	Yes	119 (26.5)	330 (73.5)	449 (84.9)	9.787	0.003**
	No	35 (43.8)	45 (56.3)	80 (15.1)		
Q6: Do you think X-rays are safe for children?	Yes	58 (31.5)	126 (68.5)	184 (34.8)	0.794	0.422 (NS)
	No	96 (27.8)	249 (72.2)	345 (65.2)		
Q7: Do you follow radiation protection protocols?	Yes	127 (28.2)	323 (71.8)	450 (85.1)	1.155	0.285 (NS)
	No	27 (34.2)	52 (65.8)	79 (14.9)		
Q8: Do you think CT scans are safe?	Yes	107 (31.2)	236 (68.8)	343 (64.8)	2.053	0.162 (NS)
	No	47 (25.3)	139 (74.7)	186 (35.2)		
Q9: Are you aware of personal monitoring badges?	Yes	109 (28.0)	280 (72.0)	389 (73.5)	0.848	0.386 (NS)
	No	45 (32.1)	95 (67.9)	140 (26.5)		
Q10: Do you follow radiation protection protocols at the time of your future private clinical practice?	Yes	124 (26.7)	341 (73.3)	465 (87.9)	11.133	0.002**
	No	30 (46.9)	34 (53.1)	64 (12.1)		
Q11: Do you think high-speed films reduce exposure?	Yes	108 (29.0)	265 (71.0)	373 (70.5)	0.015	0.917 (NS)
	No	46 (29.5)	110 (70.5)	156 (29.5)		
Q12: Are you aware of the radiation hazard symbol?	Yes	107 (29.8)	252 (70.2)	359 (67.9)	0.260	0.682 (NS)
	No	47 (27.6)	123 (72.4)	170 (32.1)		
Q13: Do you ask the patient to hold the films?	Yes	112 (30.0)	261 (70.0)	373 (70.5)	0.513	0.529 (NS)
	No	42 (26.9)	114 (73.1)	156 (29.5)		
Q14: Do you think radiographs are strictly contraindicated for pregnant women?	Yes	120 (26.4)	334 (73.6)	454 (85.8)	11.143	0.001**
	No	34 (45.3)	41 (54.7)	75 (14.2)		
Q15: Do you think X-rays are harmful?	Yes	131 (28.6)	327 (71.4)	458 (86.7)	0.532	0.482 (NS)
	No	23 (32.9)	47 (67.1)	70 (13.3)		

NS, Nonsignificant; **Highly significant; *Significant

showing moderate association. Across academic years, significant associations were seen for X-ray reflection (Q2), monitoring badges (Q9), and asking patients to hold films (Q13), all demonstrating moderate associations, indicating the influence of academic progression. Overall, although associations were statistically

significant ($p < 0.05$), most had weak practical significance. Despite this, a major concern remains that 70.5% of participants reported asking patients to hold films, indicating unsafe clinical practice despite awareness. were highly prevalent (70.5%), indicating a discrepancy between knowledge and implementation (Table 6).

Table 3: Comparison of questionnaire responses between the Subbaiah and Sharavathi participants

Question	Response	Subbaiah n (%)	Sharavathi n (%)	Total	Chi-square value	p-value
Q1: Are you aware of radiation hazards?	Yes	284 (56.8)	216 (43.2)	500 (94.5)	0.287	0.701 (NS)
	No	15 (51.7)	14 (48.3)	29 (5.5)		
Q2: Do you think X-rays reflect from the walls of the room?	Yes	206 (55.5)	165 (44.5)	371 (70.1)	1.92	0.383 (NS)
	No	93 (58.8)	65 (41.2)	158 (29.9)		
Q3: Do you think X-rays play an important role in dentistry?	Yes	275 (56.0)	216 (44.0)	491 (92.8)	0.734	0.497 (NS)
	No	24 (63.2)	14 (36.8)	38 (7.2)		
Q4: Do you prefer to wear any protective aprons during exposure?	Yes	261 (56.3)	203 (43.8)	464 (87.7)	0.113	0.790 (NS)
	No	38 (58.5)	27 (41.5)	65 (12.3)		
Q5: Are you aware of the ideal distance an operator should stand while dental radiographic exposure?	Yes	254 (56.6)	195 (43.4)	449 (84.9)	0.003	1.000 (NS)
	No	45 (56.3)	35 (43.8)	80 (15.1)		
Q6: Do you think X-rays are safe for children?	Yes	87 (47.3)	97 (52.7)	184 (34.8)	9.8	0.002**
	No	212 (61.4)	133 (38.6)	345 (65.2)		
Q7: Do you follow radiation protection protocols?	Yes	248 (55.1)	202 (44.9)	450 (85.1)	2.44	0.140 (NS)
	No	51 (64.6)	28 (35.4)	79 (14.9)		
Q8: Do you think CT scans are safe?	Yes	182 (53.1)	161 (46.9)	343 (64.8)	4.754	0.035*
	No	117 (62.9)	69 (37.1)	186 (35.2)		
Q9: Are you aware of personal monitoring badges?	Yes	206 (53.0)	183 (47.0)	389 (73.5)	7.604	0.007**
	No	93 (66.4)	47 (33.6)	140 (26.5)		
Q10: Do you follow radiation protection protocols at the time of your future private clinical practice?	Yes	265 (57.0)	200 (43.0)	465 (87.9)	0.342	0.592 (NS)
	No	34 (53.1)	30 (46.9)	64 (12.1)		
Q11: Do you think high-speed films reduce exposure?	Yes	201 (53.9)	172 (46.1)	373 (70.5)	3.572	0.048*
	No	98 (62.8)	58 (37.2)	156 (29.5)		
Q12: Are you aware of the radiation hazard symbol?	Yes	190 (52.9)	169 (47.1)	359 (67.9)	5.881	0.019*
	No	109 (64.1)	61 (35.9)	170 (32.1)		
Q13: Do you ask the patient to hold the films?	Yes	200 (53.6)	173 (46.4)	373 (70.5)	4.336	0.043*
	No	99 (63.5)	57 (36.5)	156 (29.5)		
Q14: Do you think radiographs are strictly contraindicated for pregnant women?	Yes	251 (55.3)	203 (44.7)	454 (85.8)	1.989	0.169 (NS)
	No	48 (64.0)	27 (36.0)	75 (14.2)		
Q15: Do you think X-rays are harmful?	Yes	243 (53.1)	215 (46.9)	458 (86.7)	17.947	0.000**
	No	56 (80.0)	14 (20.0)	70 (13.3)		

NS, Nonsignificant; **Highly significant; *Significant

DISCUSSION

Ionizing radiation in dental imaging, though low in dose, carries potential risks such as stochastic effects and cumulative DNA damage, especially in children who are more radiosensitive. This underpins the ALARA principle, which emphasizes minimizing exposure while maintaining diagnostic quality. According to the International Commission on Radiological Protection and Atomic Energy Regulatory Board, radiation safety is based on justification,

optimization, and dose limitation, along with protective measures like maintaining operator distance and using lead aprons. However, the finding that 70.5% of participants asked patients to hold films is clinically unacceptable and violates these guidelines, highlighting a gap between knowledge and practice.

Interns and undergraduate students, who are introduced to radiology during training, were assessed using a structured questionnaire, which showed good awareness of radiation

Table 4: Comparison of questionnaire responses between the different academic year participants

Question	Response	3rd BDS	4th BDS	Internship	Total	Chi-square value	p-value
Q1: Are you aware of radiation hazards?	Yes	176 (35.2)	154 (30.8)	170 (34.0)	500 (94.5)	5.024	0.049*
	No	16 (55.2)	5 (17.2)	8 (27.6)	29 (5.5)		
Q2: Do you think X-rays reflect from walls of the room?	Yes	114 (30.7)	112 (30.2)	145 (39.1)	371 (70.1)	22.657	0.000**
	No	78 (49.4)	47 (29.7)	33 (20.9)	158 (29.9)		
Q3: Do you think X-rays play an important role in dentistry?	Yes	181 (36.9)	149 (30.3)	161 (32.8)	491 (92.8)	2.296	0.317 (NS)
	No	11 (28.9)	10 (26.3)	17 (44.7)	38 (7.2)		
Q4: Do you prefer to wear any protective aprons during exposure?	Yes	169 (36.4)	139 (30.0)	156 (33.6)	464 (87.7)	0.030	0.985 (NS)
	No	23 (35.4)	20 (30.8)	22 (33.8)	65 (12.3)		
Q5: Are you aware of the ideal distance an operator should stand while dental radiographic exposure?	Yes	161 (35.9)	132 (29.4)	156 (34.7)	449 (84.9)	1.643	0.440 (NS)
	No	31 (38.8)	27 (33.8)	22 (27.5)	80 (15.1)		
Q6: Do you think X-rays are safe for children?	Yes	59 (32.1)	61 (33.2)	64 (34.8)	184 (34.8)	2.398	0.302 (NS)
	No	133 (38.6)	98 (28.4)	114 (33.0)	345 (65.2)		
Q7: Do you follow radiation protection protocols?	Yes	169 (37.6)	132 (29.3)	149 (33.1)	450 (85.1)	2.103	0.349 (NS)
	No	23 (29.1)	27 (34.2)	29 (36.7)	79 (14.9)		
Q8: Do you think CT scans are safe?	Yes	110 (32.1)	110 (32.1)	123 (35.9)	343 (64.8)	7.531	0.023*
	No	82 (44.1)	49 (26.3)	55 (29.6)	186 (35.2)		
Q9: Are you aware of personal monitoring badges?	Yes	120 (30.8)	113 (29.0)	156 (40.1)	389 (73.5)	30.709	0.000**
	No	72 (51.4)	46 (32.9)	22 (15.7)	140 (26.5)		
Q10: Do you follow radiation protection protocols at the time of your future private clinical practice?	Yes	168 (36.1)	142 (30.5)	155 (33.3)	465 (87.9)	0.438	0.803 (NS)
	No	24 (37.5)	17 (26.6)	23 (35.9)	64 (12.1)		
Q11: Do you think high-speed films reduce exposure?	Yes	119 (31.9)	115 (30.8)	139 (37.3)	373 (70.5)	11.981	0.003**
	No	73 (46.8)	44 (28.2)	39 (25.0)	156 (29.5)		
Q12: Are you aware of the radiation hazard symbol?	Yes	110 (30.6)	114 (31.8)	135 (37.6)	359 (67.9)	16.108	0.000**
	No	82 (48.2)	45 (26.5)	43 (25.3)	170 (32.1)		
Q13: Do you ask the patient to hold the films?	Yes	114 (30.6)	117 (31.4)	142 (38.1)	373 (70.5)	19.521	0.000**
	No	78 (50.0)	42 (26.9)	36 (23.1)	156 (29.5)		
Q14: Do you think radiographs are strictly contraindicated for pregnant women?	Yes	161 (35.5)	139 (30.6)	154 (33.9)	454 (85.8)	1.016	0.602 (NS)
	No	31 (41.3)	20 (26.7)	24 (32.0)	75 (14.2)		
Q15: Do you think X-rays are harmful?	Yes	160 (34.9)	137 (29.9)	161 (35.2)	458 (86.7)	3.641	0.162 (NS)
	No	31 (44.3)	22 (31.4)	17 (24.3)	70 (13.3)		

NS, Nonsignificant; **Highly significant; *Significant

hazards and safety measures, though gaps in practical implementation persist.

In the present study, significant gender differences were observed, with females showing greater awareness regarding the role of X-rays in dentistry, the use of protective aprons, knowledge of safe operator distance, intent to follow protection protocols in private practice, and contraindications during pregnancy. These results are partly in agreement with Bali et al.,⁷ who reported awareness but limited application of safety measures, and with Javali and Dantu,⁶ who

highlighted inconsistent compliance despite adequate knowledge. However, unlike Rabhat et al.,⁸ who found poor adherence to protocols among undergraduates, our study indicates a more positive attitude among females towards future compliance, suggesting improving trends in radiation safety awareness among dental students.

In the present institutional comparison, statistically significant differences were observed in perceptions related to pediatric safety ($p = 0.002$), CT scan safety ($p = 0.035$), awareness of monitoring badges ($p = 0.007$), high-speed films ($p = 0.048$), hazard symbols

Table 5: Comparison of questionnaire responses between the different age interval participants

Question	Response	19–21 years n (%)	22–24 years n (%)	25–27 years n (%)	Total	Chi-square value	p-value
Q1: Are you aware of radiation hazards?	Yes	97 (19.4)	356 (71.2)	47 (9.4)	500 (94.5)	5.797	0.049*
	No	11 (37.9)	16 (55.2)	2 (6.9)	29 (5.5)		
Q2: Do you think X-rays reflect from walls of the room?	Yes	71 (19.1)	258 (69.5)	42 (11.3)	371 (70.1)	7.184	0.031*
	No	37 (23.4)	114 (72.2)	7 (4.4)	158 (29.9)		
Q3: Do you think X-rays play an important role in dentistry?	Yes	100 (20.4)	351 (71.5)	40 (8.1)	491 (92.8)	10.521	0.005**
	No	8 (21.1)	21 (55.3)	9 (23.7)	38 (7.2)		
Q4: Do you prefer to wear any protective aprons during exposure?	Yes	95 (20.5)	328 (70.7)	41 (8.8)	464 (87.7)	0.821	0.663 (NS)
	No	13 (20.0)	44 (67.7)	8 (12.3)	65 (12.3)		
Q5: Are you aware of the ideal distance an operator should stand while dental radiographic exposure?	Yes	90 (20.0)	321 (71.5)	38 (8.5)	449 (84.9)	2.828	0.243 (NS)
	No	18 (22.5)	51 (63.7)	11 (13.8)	80 (15.1)		
Q6: Do you think X-rays are safe for children?	Yes	42 (22.8)	126 (68.5)	16 (8.7)	184 (34.8)	1.037	0.595 (NS)
	No	66 (19.1)	246 (71.3)	33 (9.6)	345 (65.2)		
Q7: Do you follow radiation protection protocols?	Yes	94 (20.9)	317 (70.4)	39 (8.7)	450 (85.1)	1.493	0.474 (NS)
	No	14 (17.7)	55 (69.6)	10 (12.7)	79 (14.9)		
Q8: Do you think CT scans are safe?	Yes	64 (18.7)	240 (70.0)	39 (11.4)	343 (64.8)	6.17	0.046*
	No	44 (23.7)	132 (71.0)	10 (5.4)	186 (35.2)		
Q9: Are you aware of personal monitoring badges?	Yes	70 (18.0)	280 (72.0)	39 (10.0)	389 (73.5)	5.718	0.048*
	No	38 (27.1)	92 (65.7)	10 (7.1)	140 (26.5)		
Q10: Do you follow radiation protection protocols at the time of your future private clinical practice?	Yes	95 (20.4)	331 (71.2)	39 (8.4)	465 (87.9)	3.588	0.166 (NS)
	No	13 (20.3)	41 (64.1)	10 (15.6)	64 (12.1)		
Q11: Do you think high-speed films reduce exposure?	Yes	72 (19.3)	269 (72.1)	32 (8.6)	373 (70.5)	1.986	0.370 (NS)
	No	36 (23.1)	103 (66.0)	17 (10.9)	156 (29.5)		
Q12: Are you aware of the radiation hazard symbol?	Yes	65 (18.1)	260 (72.4)	34 (9.5)	359 (67.9)	3.674	0.159 (NS)
	No	43 (25.3)	112 (65.9)	15 (8.8)	170 (32.1)		
Q13: Do you ask the patient to hold the films?	Yes	67 (18.0)	268 (71.8)	38 (10.2)	373 (70.5)	5.318	0.024*
	No	41 (26.3)	104 (66.7)	11 (7.1)	156 (29.5)		
Q14: Do you think radiographs are strictly contraindicated for pregnant women?	Yes	90 (19.8)	325 (71.6)	39 (8.6)	454 (85.8)	2.841	0.242 (NS)
	No	18 (24.0)	47 (62.7)	10 (13.3)	75 (14.2)		
Q15: Do you think X-rays are harmful?	Yes	87 (19.0)	331 (72.3)	40 (8.7)	458 (86.7)	5.477	0.045*
	No	20 (28.6)	41 (58.6)	9 (12.9)	70 (13.3)		

NS, Nonsignificant; **Highly significant; *Significant

Table 6: Chi-square with Cramer's V

Variable	Question	χ^2	p-value	Cramer's V	Interpretation
Gender	Q3	6.613	0.015*	0.112	Weak
	Q4	4.257	0.042*	0.090	Weak
	Q5	9.787	0.003**	0.136	Weak
	Q10	11.133	0.002**	0.145	Weak
	Q14	11.143	0.001**	0.145	Weak
Institution	Q6	9.800	0.002**	0.136	Weak
	Q8	4.754	0.035*	0.095	Weak
	Q9	7.604	0.007**	0.120	Weak
	Q15	17.947	<0.001**	0.184	Moderate
Academic year	Q2	22.657	<0.001**	0.207	Moderate
	Q9	30.709	<0.001**	0.241	Moderate
	Q13	19.521	<0.001**	0.192	Moderate

* $p < 0.05$, significant; ** $p < 0.01$, highly significant; Cramer's V: 0–0.1, weak; 0.1–0.3, moderate; >0.3, strong

($p = 0.019$), asking patients to hold films ($p = 0.043$), and the harmful effects of X-rays ($p < 0.001$). These findings are in accordance with Gowda et al.¹¹, who also reported variable awareness among undergraduates, particularly regarding protective devices and safe practices. Similar to Swapna et al.,¹² our study highlights gaps in practical adherence, as a proportion of students still considered X-rays safe for children or permitted patients to hold films. However, in contrast to Swapna et al., who found generally lower awareness about monitoring devices and radiation symbols, our participants demonstrated relatively better knowledge in these areas. Overall, the results suggest that while awareness levels are improving, particularly in line with recent studies, consistent translation of knowledge into safe practices remains a challenge.

The chi-square analysis across academic years revealed significant differences in awareness of radiation hazards (Q1), CT scan safety (Q8), personal monitoring badges (Q9), high-speed films (Q11), radiation hazard symbols (Q12), and the practice of asking patients to hold films (Q13) ($p < 0.05$). These findings are in accordance with Muthu et al.¹³, who also observed that interns demonstrated greater awareness and compliance compared to undergraduates, likely due to increased clinical exposure. Similarly, Behal¹⁴ reported progressive improvement in knowledge from third year to internship, supporting the trend in our data. In contrast, Basheer et al.¹⁵ found that even practicing dental professionals in Riyadh showed inconsistent adherence to radiation safety protocols, suggesting that academic training alone may not guarantee long-term compliance. Additionally, while our study found no significant year-wise difference in protective apron usage (Q4) and protocol adherence (Q7, Q10), Zope et al.¹⁶ reported poor compliance in protective measures among trainee dentists, contrasting with our results where students indicated awareness even if practice was inconsistent.

A key concern was that 70.5% of participants reported asking patients to hold films, which is clinically unacceptable and violates guidelines by the Atomic Energy Regulatory Board and International Commission on Radiological Protection. Patients should not be used as film holders due to unnecessary radiation exposure. This highlights a clear gap between knowledge and practice and emphasizes the need for stricter training and supervision.

Limitations

The present study has certain limitations. Being cross-sectional, it reflects participants' knowledge and attitudes at a single point in time without assessing longitudinal changes. The use of self-

administered questionnaires may introduce response and social desirability bias. The study was limited to two institutions, which may affect generalizability. Additionally, the use of binary (Yes/No) responses limited analytical depth, and composite knowledge or practice scores could not be derived. Although chi-square analysis with Cramer's V was used, multivariate analysis was not performed, restricting identification of independent predictors. Furthermore, the study relied on self-reported practices without direct clinical observation, making it difficult to assess actual adherence to radiation safety protocols.

CONCLUSION

The present study indicates that dental undergraduates and interns demonstrate basic awareness of radiation hazards and protection principles; however, this knowledge is not consistently translated into safe clinical practice. A notable and clinically concerning finding was that 70.5% of participants reported asking patients to hold films, reflecting a significant deviation from recommended radiation safety protocols. Although interns showed relatively better awareness compared to undergraduates, persistent gaps remain in areas such as pediatric radiation safety, CT scan risk perception, and adherence to protective measures. These findings suggest that current educational exposure, while adequate at a theoretical level, is insufficient to ensure safe clinical implementation. To address these gaps, it is recommended that dental curricula incorporate structured radiation safety training, including hands-on demonstrations, simulation-based learning, and periodic reinforcement of safety protocols. Additionally, strict clinical supervision, mandatory adherence to radiation protection guidelines, and regular audits of radiographic practices are essential to ensure compliance and patient safety. Overall, the study highlights the need to bridge the gap between knowledge and practice through targeted educational and institutional interventions rather than assuming adequate competency based on awareness alone.

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AUTHOR'S CONTRIBUTION

Beebi Ayesha: Conceptualization, study design, data collection, data analysis, interpretation of results, manuscript drafting.

Vivek HP: Study supervision, methodology, critical revision of the manuscript, interpretation of findings, and final approval.

Chethan Jagadish: Data interpretation, manuscript review, and final approval.

Preethi Nagdev: Methodological guidance, manuscript editing, and final approval.

Aishwarya Rai: Literature review, manuscript revision, and final approval.

Parimala R: Statistical guidance, manuscript review, and final approval.

All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

AI USE DECLARATION

The authors declare that artificial intelligence (AI)-assisted tools were used only to improve the language, grammar, and readability of the manuscript. No AI tool was used to generate, manipulate, or interpret the research data, perform statistical analyses, or draw scientific conclusions.

ORCID

Aishwarya Rai  <https://orcid.org/0000-0001-7775-9718>

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ANNEXURE 1

QUESTIONNAIRE

Name: _____

Age: _____

Gender: ☐ Male ☐ Female

College:

☐ Subbaiah Institute of Dental Sciences, Shivamogga.☐ Sharavathi Dental College and Hospital, Shivamogga.

Academic Year:

☐ 3rd Year ☐ 4th Year ☐ Intern

Knowledge-based Questions

Sl. No.	Questions	Yes	No
K1	Are you aware of radiation hazards?	☐	☐
K2	Do you think X-rays reflect from the walls of the room?	☐	☐
K3	Are you aware of the ideal distance an operator should stand during dental radiographic exposure?	☐	☐
K4	Are you aware of personal monitoring badges?	☐	☐
K5	Do you think high-speed films reduce radiation exposure?	☐	☐
K6	Are you aware of the radiation hazard symbol?	☐	☐
K7	Do you think radiographs are strictly contraindicated for pregnant women?	☐	☐

Attitude-based Questions

Sl. No.	Question	Yes	No
A1	Do you prefer to wear protective aprons during radiographic exposure?	☐	☐
A2	Do you follow radiation protection protocols?	☐	☐
A3	Do you intend to follow radiation protection protocols during your future private clinical practice?	☐	☐
A4	Do you ask the patient to hold the films during radiographic exposure?	☐	☐

Perception-based Question

Sl. No.	Question	Yes	No
P1	Do you think X-rays play an important role in dentistry?	☐	☐
P2	Do you think X-rays are safe for children?	☐	☐
P3	Do you think CT scans are safe?	☐	☐
P4	Do you think X-rays are harmful?	☐	☐