

Peer Reviewed **Article****KNOWLEDGE OF COMPUTED TOMOGRAPHY SCAN PARAMETERS AND DOSE INDICATORS AMONG RADIOGRAPHY STUDENTS IN NIGERIA****Idris Garba** *DRad, MPhil:Rad, MTech:Rad, BTech:Rad* | **Adebayo Mufutawu** *BRad*

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<https://doi.org/10.54450/saradio.2024.62.2.831>**Abstract**

Background: Computed tomography (CT) scan parameters significantly affect the radiation dose received by patients and the quality of resulting images. Knowledge of exposure parameters, and the trade-offs related to a patient's dose and image quality, are fundamental skills for radiographers and radiography students. Knowledge of these parameters among radiography students for dose optimisation was investigated.

Methodology: Radiography students (n = 101) were invited to complete a web-based or a self-administered questionnaire using a convenience sampling method. The returned questionnaires were analysed using Statistical Package for Social Sciences (SPSS) version (20). A significant difference in response was determined using Chi-square, and a p-value of 0.05 was considered the significance level at the 95% confidence interval.

Results: The response rate was 100% (n = 101). It is difficult to achieve a 100% response rate, but this was possible due to the small sample of participants, and frequent reminders through verbal, phone and other media means. Overall knowledge of the scan parameters was noted as moderate. A statistically significant (p = 0.035) number of participants 92 (91.1%) indicated being aware of the CT dose indicators. However, a significant (p = 0.040) number of them 90 (89.1%) could not name the dose indicators correctly. Also, a significant (p = 0.052) number 85 (84.2%) did not know the most informative dose indicator.

Conclusion: Knowledge of the CT scan parameters among radiography students was moderate. However, knowledge of dose indicators was limited. Recommendation is that there needs to be an improvement in training and a review of the existing curriculum, especially an aspect of the experience to make the theoretical knowledge 'come alive'.

Keywords: CT, image quality, skills laboratory

INTRODUCTION

Computed tomography (CT) is an imaging system that creates tomographic images of the internal structures of the human body.^[1,2] Advances in CT technology, including multi-detector CT and dual-energy CT, have substantially enhanced capability in terms of speed and image quality.^[3] Technological advancement has more than doubled the clinical utility of CT over the past three decades.^[4] The increased capability has led to a rise in the number of CT procedures performed, which in turn led to an increase in radiation dose, with CT now constituting nearly half of the overall radiation exposure from medical examinations.^[5]

The clinical benefits of CT cannot be overemphasised. Radiation exposure however remains a source of concern; the

concept of the "As low as reasonably achievable" (ALARA) approach should therefore be applied to ensure the benefits outweigh the risks for a planned CT procedure.^[6] For example, the average effective radiation doses in adult CT examinations vary from approximately 2 mSv for brain CTs to around 8–10 mSv for CTs of the chest, abdomen, or pelvis, and these equivalent doses could only be achieved with hundreds of X-ray projections in a plain X-ray procedure.^[7] This calls for the application of dose optimisation strategies in CT practice to achieve lower doses whilst maintaining diagnostic confidence.^[8]

Radiation dose and image quality are controlled by CT exposure parameters, such as kilovoltage peak (kVp), and milliampere seconds (mAs).^[9] Optimal image quality, and a reduced radiation dose, can be achieved by radiographers

selecting and understanding the appropriate scan parameters for an examination.^[10] For example, lowering kV or mAs decreases a patient's dose, however, there could be an increase in image noise. The use of automatic tube current modulation (ATCM) provides efficient dose reduction by modulating the tube current based on a patient's anatomy. Pitch is inversely proportional to the patient dose and image quality. Slice thickness is also inversely proportional to the image noise, without a change in kV and mAs. Further, patients with a metallic implant could require an increase in kV to counter photon starvation due to the presence of metal in the area of interest. The wider window settings reduce the image contrast and the visual perception of noise. Using a smooth reconstruction kernel reduces the visualisation of noise, while a sharp kernel increases the visualisation of noise.^[9] Knowledge of these exposure parameters as well as the trade-offs related to a patient's dose and image quality are fundamental skills for radiographers and radiography students.^[11,12] Radiographers' knowledge of CT scan parameters was reported to be higher than that of radiologists at a single study location.^[13] Kada^[3] reported knowledge of the scan parameters as satisfactory among Norwegian radiography students. This knowledge has not been studied among Nigerian radiography students. Therefore, this study investigated radiography students' knowledge of the CT scan parameters and dose indicators for dose optimisation.

METHODS

The study was cross-sectional and prospective in design and was conducted among radiography students of a tertiary institution located in Nigeria. Ethics approval was obtained from the ethics and research committee of the State Ministry of Health with reference number SHREC/2024/4715.

Radiography students in the 4th (n = 60) and 5th (n = 41) years were invited to fill out a web-based 84 (83.2%) or self-administered questionnaire 17 (16.8%). Radiography in Nigeria is a 5-year programme, and the CT course is taken in the 4th year after 3rd students have been transferred to the clinical site. The questionnaire had a preliminary page providing information on the study and ensuring the confidentiality of the individual participants. Only those who consented to participate were included. The entire population of radiography students at the institution was included in the study.

The questionnaire had two sections: demographics, and knowledge of the CT scan parameters and dose indicators sections. The demographic section had the following information: level, age, and gender. The other section had 22 closed and open-ended questions on knowledge of the CT scan parameters and dose indicators. The questions were content validated by an expert in the field of CT dosimetry. Participants marked their answers as "true", "false", "don't know" or provided answers to open-ended questions. One (1) mark was awarded for a correct response and zero (0) mark was awarded for an incorrect response or where no response was provided.

The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20. The demographic information was analysed using descriptive statistics including frequencies and percentages. The participants' knowledge scores on the scan parameters and dose indicators were assessed using the Chi-square test, and a p-value of less than 0.05 was considered statistically significant. The overall level of knowledge was defined based on scores of the participants' responses using binned statistics. The scores were classified into three equal groups: lower ($\leq 33.3\%$), middle ($>33.3-66.6$), and upper ($>66.6-100\%$). The lower category was ranked as poor, the middle as moderate, and the higher as satisfactory.

RESULTS

A total of 101 participants in the 4th and 5th years completed the questionnaire with a response rate of 100% (n = 101). This response rate was achieved because of the sample size and frequent reminders through verbal, phone and other media means. Of the 101, 84 (83.2%) completed the web-based questionnaire, whilst 17 (16.8%) filled the self-administered questionnaire. Gender demographics: 70 males (69.3%) and 31 females (30.7%). Figure 1 shows the number of male and female participants according to age groups. The majority of the participants were between the ages of 24-29 years.

Table 1 shows a summary of the participants' responses to questions related to the CT scan parameters. The majority of the questions (14) were those with "true" as the correct answer and had a response rate of more than 50% as highlighted in Table 1. However, three out of the remaining five questions with "false" as the answer had a response of less than 50% (Table 1). There were no significant differences ($p > 0.05$) between participants with "true" and "false" responses, except for questions 4 and 7 where the responses differ significantly ($p < 0.05$). The overall knowledge of CT scan parameters among radiography students was noted to be moderate as shown in Table 2.

Table 3 presents a summary of the participants' responses to questions related to CT dose indicators. A statistically significant ($p = 0.035$) number of participants 92 (91.1%) indicated being aware of the CT dose indicators. However, a significant ($p = 0.040$) number of them 90 (89.1%) could not name the dose indicators correctly. Also, a significant ($P = 0.052$) number of them 85 (84.2%) did not know the most informative dose indicator.

DISCUSSION

The study investigated the knowledge of the CT scan parameters among radiography students. The results showed that the level of knowledge among the participants was moderate (Table 2). This was similar to the level of knowledge reported in a study by Kada^[3] who reported a satisfactory level of knowledge among Norwegian student radiographers. Although the level of knowledge was the same, students in the

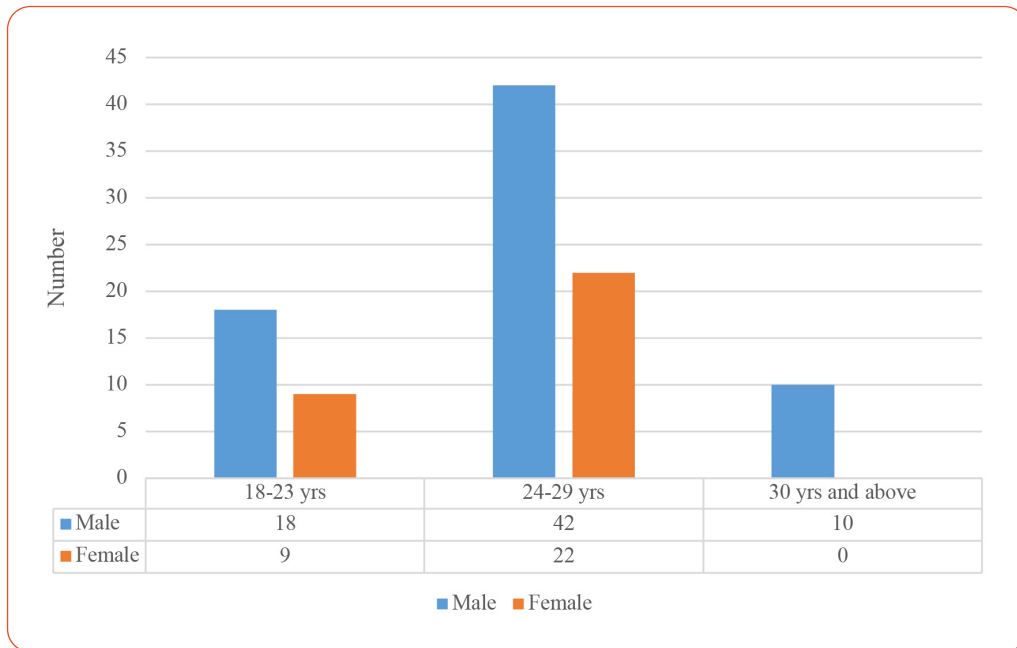


Figure 1. Number of participants according to age group.

Table 1. Summary of responses from the radiography students (number: 101) regarding their knowledge of CT scan parameters

SN	Questions	True	False	p-value
1	Reducing kVp would reduce the contrast resolution	71 (70.3%)	30 (29.7%)	0.073
2	Increasing kVp by 50% is equivalent to doubling the mAs	56 (55.4%)	45 (44.6%)	0.222
3	kVp should be increased with patients having metallic implants	70 (69.3%)	31 (30.7%)	0.810
4	Doubling the mAs doubles the dose	82 (81.2%)	19 (18.8%)	0.004
5	Reducing the mAs reduces the noise	49 (48.5%)	52 (51.5%)	0.201
6	mAs should be increased as the body part thickness increases	73 (72.3%)	28 (27.7%)	0.246
7	ATCM is affected by improper patient positioning	83 (82.2%)	18 (17.8%)	0.050
8	ATCM decreases patient dose on average	76 (75.2%)	25 (24.8%)	0.096
9	ATCM increases the dose for obese patients	53 (52.5%)	48 (47.8%)	0.752
10	Decreasing the pitch degrades image quality	44 (43.6%)	57 (56.4%)	0.829
11	Increasing the pitch decreases the dose	62 (61.4%)	39 (38.6%)	0.368
12	Increasing the slice thickness decreases the dose	63 (62.4%)	38 (37.6%)	0.552
13	Decreasing the slice thickness reduces 'partial volume' artefacts	61 (60.4%)	40 (39.6%)	0.447
14	Increasing the mAs decreases noise	56 (55.4%)	45 (44.6%)	0.098
15	Increasing kVp decreases noise	64 (63.4%)	37 (36.6%)	0.873
16	Increasing slice thickness increases noise	55 (54.5%)	46 (45.5%)	0.703
17	Increasing pitch increases noise	64 (63.4%)	37 (36.6%)	0.873
18	A smoothing reconstruction kernel increases the visualization of noise	36 (35.6%)	65 (64.4%)	0.982
19	Wider window settings, reduce the image contrast but also the visual perception of noise	61 (60.4%)	40 (39.6%)	0.903

Note: Questions with "TRUE" as the correct answer were highlighted
 ATCM: Automatic Tube Current Modulation

Table 2. Overall knowledge of CT parameters among radiography students (n=101)

Knowledge	Number of participants (n= 101)
Poor ($\leq 33\%$)	37 (36.6%)
Moderate ($> 33-66.6\%$)	40 (39.4%)
High ($> 66.6\%-100\%$)	24 (23.8%)

present study only got to know about the scan parameters through didactic classes and clinical placement in the hospital. Our institution did not have a CT scanner in the skills laboratory; literature however reports that a CT scanner helps to bridge the gap between knowledge and practice and make theoretical knowledge 'come alive'.^[3,14] The skills laboratory serves two main functions: as an environment where students learn and practice without concern about real patients, and where competence in skills and theoretical concepts can be learned through live demonstration.^[14] Although knowledge of CT parameters was not consistent between institutions with a CT on campus,^[3] it is still imperative to have a CT scanner in the demonstration laboratory as it will allow students to practice CT with different combinations of scan parameters which will solidify their theoretical knowledge and clinical practice required for CT dose optimisation.

More than two thirds of the participants (69.3%) correctly responded to the question whether kVp should be increased for patients with metallic implants (Table 1). Our findings are in keeping with those by Abuzaid et al.,^[15] and Rawashdeh et al.,^[16] where 66.7% and 69.1% of radiographers indicated the need for an increase in kV due to metal implants. This is encouraging as an increase in kV due to metal implants could reduce photon starvation and streaky artefacts that could potentially distort image quality.^[17,18]

Previous studies reported an understanding of the relationship between tube current (mA) and the dose.^[1-3,15,16] Our findings are in keeping with the literature; a significant ($p < 0.004$) number of the participants (81.2%) indicated knowing the impact of mA on the dose (Table 1). Understanding this concept is crucial, especially amongst students who eventually will graduate and begin to practice dose optimisation techniques as radiographers. Tube current remains

one of the key factors that affect patient dose and image quality and should be understood among imaging professionals.^[19,20]

In a study by Kada,^[3] it was reported that only 33% of the respondents answered correctly when asked about an increase in mAs with the increase in body part thickness. In our study 72.3% of the participants agreed that mAs should be increased with an increase in body thickness (Table 1). Understanding the relationship between mAs and body thickness is important as it guides in practising CT dose optimisation techniques. The thicker the area of examination the higher the mAs that is required to maintain acceptable image quality, and this is the basic principle behind the tube current modulation.^[21]

The use of automatic tube control modulation (ATCM) remains important in CT dose optimisation and should be emphasised among radiography students and radiographers.^[1,3,22] Studies have reported dose reduction with the use of ATCM.^[18,23,24] In the present study, 52.5% of the participants answered correctly that ATCM increases the dose to obese patients (Table 1). This concept is supposed to be well understood among students, however, the responses indicate the need for continuous advocates regarding the principle and use of ATCM. On the other hand, a significant ($p < 0.050$) number of participants (82.2%) accurately stated that incorrect patient positioning affects ATCM and that ATCM lowers patient dose on average, which was consistent with the findings of similar studies.^[15,16,25]

In the present study, 61.4% of the participants displayed adequate knowledge of the impact of pitch on radiation dose. The finding aligns with the results of studies conducted by Abuzaid et al.,^[15] Kada^[3] and Kazemi et al.^[2] who reported that more than half of their respective participants, namely, 50%, 53% and 65.5%, agreed that dose decreases as pitch increases. However, in the present study, less than half (43.6%) of the participants showed an understanding of the impact of pitch on image quality (Table 1). This needs to be looked into for the proper implementation of dose optimisation techniques. A study by Abdulaziz et al.^[6] reported an understanding of the impact of pitch on image quality among radiography students was considered commendable.

Almost two thirds (62.4%) of the participants knew about the relationship between dose and slice thickness. Further, 60.4% of the participants knew the relationship between

Table 3. Summary of responses from the radiography students (n=101) regarding their knowledge of dose indicators

SN	Questions	Yes	No	p-value
1	Are you aware of radiation dose indicators in CT?	92 (91.1%)	9 (8.9%)	0.035
SN	Questions	Correct	Incorrect	
2	If yes, could you mention them?	11 (10.9%)	90 (89.1%)	0.040
3	Which is the most informative dose indicator in CT that the patient would receive by the end of the examination?	16 (15.8%)	85 (84.2%)	0.052

slice thickness and partial volume artefacts (Table 1). The findings were similar to those reported in studies by Abu-zaid et al.^[15] and Kada.^[3] In addition, participants in the present study indicated that an increase in kVp decreases image noise (Table 1), however, this is in contrast with the findings of Foley et al.^[1] and Muhammad et al.^[12] On the other hand, the finding aligns with that of Kada,^[3] who reported that 50% of the students knew about the relationship between kV and image noise.

A significant ($p < 0.035$) number of participants (91.1%) indicated being aware of the CT dose indicators: volume computed tomography dose index (CTDIvol) and dose length product (DLP). However, a significant ($p = 0.040$) number of them 90 (89.1%) could not name the dose indicators correctly. Also, a significant ($p = 0.052$) number of them 85 (84.2%) did not know the most informative dose indicator (DLP). The findings align with those by Kada^[3] who reported a discouraging knowledge of dose indicators among radiography students. This is a source of concern as knowledge and well-trained students play a role in creating a positive radiation safety culture. Further knowledge of the CT dose indicators could help students understand when a high-dose protocol is selected based on the displayed CTDIvol and DLP such as brain CT for a stroke patient where the cervical spine is included, the procedure could have high DLP due to increase in scan length which requires optimisation.

RECOMMENDATIONS

Knowledge of the CT scan parameters and dose indicators among radiography students is essential as it prepares them to develop judgement and decision-making skills, especially in dose optimisation when they potentially graduate as radiographers. It is suggested that there should be a review of the CT course content to ensure aspects of dose indicators are covered and also delivered to students during lectures.

LIMITATIONS OF THE STUDY

The study's narrow scope, focusing on a single institution, limits the generalisability of the findings to the broader population of radiography students. Different educational settings and student demographics could yield different results. Radiography programmes across different institutions may vary in teaching methodologies, and resources available, impacting students' knowledge levels and responses to CT parameter questions.

CONCLUSION

The study showed moderate knowledge of the CT scan parameters among radiography students. However, knowledge of dose indicators was limited among all the students, which is a source of concern as this could affect the practice of dose optimisation. This calls for improvement in training and a review of the CT course content including an aspect of the practical experience to make the theoretical knowledge "come alive".

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COMPETING INTEREST

There is no competing interest in this study.

AUTHORS' CONTRIBUTIONS TO THE STUDY

IG (Bayero University Kano) was the main researcher and responsible for the conceptualisation of the idea and also provided critical comments and recommendations regarding the literature review. AM (Bayero University Kano) was responsible for writing the methodology, data curation; formal analysis; acquisition and writing the original draft.

INFORMED CONSENT

Not applicable

DISCLAIMER

The views and opinions expressed in the article are those of the authors and do not necessarily reflect the views of the publisher and editorial board.

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