KNOWLEDGE, ATTITUDE, AND PRACTICES OF FINAL-YEAR DIAGNOSTIC RADIOGRAPHY STUDENTS ON SETTING EXPOSURE FACTORS, AT THE UNIVERSITY OF TECHNOLOGY, IN THE ETHEKWINI DISTRICT.

A dissertation submitted in fulfilment of the requirements for the Degree of Master of Health Sciences in Radiography in the Faculty of Health Sciences, Durban University of Technology

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DECLARATION OF ORIGINALITY

I do hereby declare that this dissertation is my own original work and has not been submitted for a degree at any other university. All the sources used in the work have been acknowledged and referenced in accordance with the Durban University of Technology requirements.

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Ms Yashodha Rajendra Date……20 FEB 2024……..

Approved for final submission

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Dr T E Khoza Date……20 Feb 2024…….

Supervisor

DEDICATION

I dedicate this dissertation to my parents, Mr and Mrs Rampershad, who are my inspiration and who have supported me and encouraged me in my life pursuits.

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ABSTRACT

Background: This study focused on the ability of diagnostic radiography students to set accurate imaging exposure factors and their knowledge, attitude and practice of the factors that influence these imaging parameters. The setting of imaging exposure factors refer to exposure technique while exposure factors refer to the kilovoltage and milliamperes that are required to produce a radiographic image. The importance of understanding the relationship between these factors permits radiographers to maintain optimal image quality whilst keeping the radiation dose to the patient as low as reasonably achievable (ALARA).

Aim of the study: The aim of the study was to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of setting exposure factors.

Methodology: The type of study conducted was a quantitative cross-sectional survey of final-year diagnostic radiography students at the University of technology in Kwa-Zulu Natal regarding the application of factors that affect radiation dose and image quality. The sampling technique selected for this study was probability-stratified sampling. Total sampling was used due to the small number of final-year students.

Results: Various statistical tests such as Descriptive statistics, the Analysis Of Variance Model, Binomial test, Pearson's correlation coefficient, One-sample t-test, Cronbach alpha and Independent samples t-test were adopted to analyse the data yielded by the collection tool. There were no significant differences in demographics. The mean value for knowledge was 67.71%. Attitude and practice were moderately correlated with $p=0.004$ and $r=-0.474$. This correlation was measured using Person’s correlation coefficient test. The study demonstrated that despite having adequate knowledge of imaging exposures and a positive attitude, students did not always practice accurately.

Conclusion: This study investigated final-year diagnostic radiography students' competence in their final year and focused on their readiness for community service in terms of their knowledge, attitude and practice of imaging exposure factors. The overall benefit of this study highlighted the final-year diagnostic radiography students' ability to set correct exposure factors thus identifying any weaknesses that will prevent them from practicing radiography correctly. Additional support from training institutions and universities, in the areas of weakness would provide students with the necessary tools to practise radiography during their community service without radiating their patients unnecessarily.

Keywords: final year diagnostic radiography students, competence, exposure factors, radiation dose, image quality.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AED	Automatic exposure device
ALARA	As low as reasonably achievable
ANOVA	Analysis Of Variance Model
DAP	Dose area product
DRL	Dose reference level
DUT	Durban University of Technology
EDA	Exploratory Descriptive Analysis
EI	Exposure Index
FFD	Focal film distance
HPCSA	Health Professions Council of South Africa
IAEA	International Atomic Energy Agency
KAP	Knowledge Attitude and Practice
kV	Kilo-voltage
KZN	Kwa-Zulu Natal
mA	Milliampere
mAs	Milliampere per second
SPSS	Statistical package for the Social Sciences
SAHPRA	South African Health Products Regulatory Association
SID	Source to Image Distance

WHO	World Health Organization
WIL	Work Integrated Learning

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND OF THE STUDY

This study focused on the ability of final-year diagnostic radiography students to select imaging exposure factors accurately. As a radiographer who supervised students, the researcher noted that diagnostic radiography students were not applying the theory of exposure selection when serving their clinical time at radiographic facilities hence the researcher sought to investigate this observation.

Diagnostic radiography students who completed their final year will carry out community service thereafter. Majority of them work unsupervised in clinics and hospitals and are responsible for protecting patients from unnecessary exposure to radiation. The present curriculum teaches students about factors that affect kilovoltage (kV) and milliamperes (mAs) selection. According to Schiska (2021: 230), the correct selection of mAs and kV, whilst considering factors such as part thickness and distance were necessary to minimize dose to patients and to ensure diagnostic images. However, with the change in technology from analogue to digital equipment, the question arises: are final-year students competent when setting exposure factors?

South Africa is a third-world country and most hospitals still use equipment that requires manual exposure settings. This poses a problem if students are serving their clinical block in institutions where the radiographic equipment has automatic exposure devices (AEDs). Thus students may not use manual selection of imaging exposure factors during training in some hospital facilities. The use of AEDs may hinder students' ability to correctly select manual exposure factors. Students are required to understand the relationship between kV and mAs and the factors that affect them as this will ensure correct exposures, which are necessary for diagnostic image quality and radiation dose optimization. This prevents patients from being unnecessarily irradiated.

This study aimed to determine the knowledge, attitude and practices of final-year diagnostic radiography students in terms of selecting exposure factors.

1.2 PROBLEM STATEMENT

Ionizing radiation is considered a hazardous substance and is regulated by the government to protect the public from its effects if utilized incorrectly (South Africa, Department of Health 1973:1). High doses of ionizing radiation can lead to cancer. This was evident in a study by Schiska (2021: 230) who cited an increase in the number of orthopedic surgeons who were diagnosed with cancer as compared to those who did not work with radiation. It is for this reason that the Radiography and Clinical Technology Board of the Health Professions Council of South Africa (2020: 3) needs to be justified when using radiation to x-ray patients for diagnostic purposes. This study was motivated by the observation of diagnostic radiography students struggling to understand the factors that affect imaging exposures. During clinical assessments, students appeared to struggle with the application of knowledge on how the factors of tissue thickness, grids, focus size, source-to-image distance and various other factors, affected image quality and radiation dose to the patient. There appeared to be a gap in students' abilities to set manual exposures. This was possibly due to the increased use of automatic exposure devices as analogue equipment was being replaced by digital equipment and or the possibility of observing the attitude and practices of their mentoring radiographers. According to Douglas (2021: 40), analogue systems have been replaced by digital systems worldwide thus it is the responsibility of radiographers to ensure that they have the necessary knowledge and skills to operate digital equipment including the correct selection of exposure factors required for these systems. A study by Sebelego *et al*. (2019: 7) confirmed that radiographers were not adhering to correct radiographic practice by demonstrating poor positioning, exclusion of collimation and incorrect imaging factors hence the need to investigate this phenomenon.

The Radiography and Clinical Technology Board of the Health Professions Council of South Africa (2020: 5) stated that radiographers were required to understand ionizing radiation regulations to protect themselves and others. Under the Code of Practice for users of medical x-ray equipment, the Department of Health stated that “Radiation doses from medical exposures and those received by the public and occupationally exposed persons must be kept as low as reasonably achievable (ALARA)” (South Africa, Department of Health 2016: 2).

Imaging exposures are related to radiation dose and image quality. Radiography students require adequate knowledge and understanding of the relationship between radiation dose and exposure factors, and the relationship between exposure factors and image quality otherwise they may have difficulty setting the correct exposures required for the part being x-rayed. Schiska (2021: 230). The following factors influence image quality and radiation dose: kilovoltage, milliamperes, source to image receptor distance, thickness of tissue and use of grids (Radiology Key 2016: 3) thus the need for diagnostic radiography students to comprehend the application of correct exposure factors Schiska (2021: 230).

Siebert and Morin (2011:577) alluded to an increase in dose due to the digital manipulation of images. This raised concern regarding the knowledge of radiographers in accurately setting exposure factors. According to Siebert and Morin (2011:579), digital systems have some advantages of reducing patient dose due to post-manipulation of the images. However, it does not imply that the initial dose given to the patient is within acceptable ranges. Gibson and Davidson (2012: 460) in Australia highlighted an increase of dose to patients due to digital radiography. This trend to over-expose is known as “dose creep”. These authors suggested that the transformation from analogue to digital systems may be a contributing factor to radiographers using higher exposure factors, thus proper training in this area may be required.

Hence the need for this study to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of selecting correct imaging

exposure factors. The study investigated the students' ability to practice radiography in accordance Department of Health with the standard set out by HPCSA (2020: 5) and SAHPRA (2022: 15), which states that radiographers must have appropriate knowledge and skills when radiating patients.

1.3 AIM OF THE STUDY

The aim of the study was to determine the knowledge, attitude and practices of final-year diagnostic radiography students in terms of setting exposure factors.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study were to:

- Determine the knowledge of final-year diagnostic radiography students when selecting exposure factors.
- Determine the attitude of final-year diagnostic radiography students when x-raying patients.
- Determine the practice of final-year diagnostic radiography students when using manual exposure parameters

Research question:

What is the knowledge, attitude and practice of final-year diagnostic radiography students in setting imaging exposure factors?

1.5 SIGNIFICANCE OF THE STUDY

The significance of such a study was to identify gaps, if any in final-year diagnostic radiography students' training and provide invaluable information to universities and

clinical training institutions in terms of whether these students were competent or not with regards to exposure selection. If final-year diagnostic radiography students demonstrated sound knowledge, attitude and practice when setting exposure factors, this would indicate that the university and training institutions were providing the necessary theoretical and practical education to the students to ensure that these students were well-equipped to correctly manipulate exposure factors to suit their patients, thus keeping unnecessary radiation to a minimum level. However, if the study demonstrated that final-year diagnostic radiography students did not possess adequate theoretical and practical knowledge in this area, the university and clinical training facilities may need to adapt their methods of teaching in order to offer students an environment that may be conducive to their training needs.

1.6 STRUCTURE OF THE DISSERTATION

- Chapter 1: Introduction - The background, motivation, rationale and main aim of the study regarding final-year diagnostic students is discussed.
- Chapter 2: Literature review - A comprehensive review of literature on the responsibilities of diagnostic radiography students, including their knowledge and skills, will be critically analyzed and linked to the aim and objectives of the study.
- Chapter 3: Methodology - A quantitative and descriptive research design was used in this study. Questionnaires were formatted as the method of data collection and will be described.
- Chapter 4: Results – Presentation and analysis of data using appropriate methods such as graphs.
- Chapter 5: Discussion – Discussion and validation of results against relevant literature.

- Chapter 6: Conclusions and recommendations - findings were summarized and final concluding comments were made together with recommendations arising from the findings.

1.7 SUMMARY OF THE CHAPTER

This chapter has presented the background to this study and the problem statement. The aim and objectives have been stated and were followed by the significance of the study. The structure of the study allowed for the reader to follow the layout of the study. The literature that supported and validated the study is discussed in the next chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

A literature review may be defined as an evaluation or analysis of a collection of data regarding a specific topic. It should be an informative, unbiased summary of information that may include opposing and similar views (Winchester and Salji. 2016: 308). Literature reviews consist of conceptual and theoretical frameworks which guide the researcher's topic (Maggio *et al*. 2016: 297). Literature reviews support researchers' theories. In this study, the researcher investigated the perception of final-year diagnostic radiography students with their knowledge, attitude and practice in terms of imaging exposure factors. The study was guided by a theoretical framework using the KAP (knowledge, attitude, practice) model. KAP models are used to collect information on the knowledge, attitude and practice of broad or precise topics of a specific group of people (Lee *et al*. 2021: 3).

The information was gathered with the use of a structured self-developed questionnaire to identify gaps in the knowledge, attitude and practices when setting imaging exposures by final-year diagnostic radiography students. This chapter intended to discuss literature that was relevant to the knowledge, attitude and practice of final-year diagnostic radiography students in terms of exposure factors.

2.2 LITERATURE REVIEW STRATEGY.

Various studies on diagnostic radiography students have been conducted. Some have focused on theoretical knowledge in the form of values and ethics (Lundval *et al.* 2021: 440). Other studies have focused on theoretical knowledge and the application of it by students. However, in these studies, the findings indicated that 'the students had difficulties in demonstrating their knowledge in practice, which together with professionals, could not be explained' (Lundval *et al.* 2021: 442). A

study by Hyde (2015:245) depicted that clinical placement and different supervisors negatively impacted students' ability to learn. The cited research gave insight into some of the problems and difficulties faced by radiographic students within the clinical environment that may contribute to students not being able to acquire the necessary knowledge and skills but there was limited information on final-year diagnostic radiography students' knowledge of exposure factors. With the use of keywords such as student radiographers, exposure factors, radiation optimization and image quality, the researcher was able to acquire adequate information from scholarly articles and books and utilised it for this chapter.

Keywords for the literature search: Student radiographers, exposure factors, radiation optimization and image quality.

2.3 OVERVIEW OF THE STUDY

The optimization of radiation protection in radiography is a global subject and various campaigns such as Image Gently in the United States of America and Eurosafe in Europe have been established to educate radiation personnel on how to reduce dose to patients (Munroe and Peer 2021: 23). In 2015, Afrosafe was launched in Africa to reduce patient radiation dose. In 2018, the Afrosafe South African Chapter was established and sanctioned by the Department of Health: Radiation Control Board (Munroe and Peer 2021: 23). The basis of these campaigns was to inform radiographers on how to optimize radiation protection. If radiographers were able to practice optimal protection by ensuring correct exposure factors, then the knowledge, attitude and practice of radiographers will be transferred to the students who study under their supervision.

At present, students complete a 4-year degree in Diagnostic Radiography and on completion are required to serve one year of community service in government health facilities in South Africa (Health Professions Council of South Africa 1998:32). Newly

qualified diagnostic radiographers carry out their community service in public health facilities nationally. Some work unsupervised and these newly qualified diagnostic radiographers must be competent in producing diagnostic images with minimum dose to their patients and themselves. One of the primary duties of diagnostic radiography students and diagnostic radiographers is to produce diagnostic images while keeping the radiation dose to patients and themselves, as low as reasonably possible (ALARA principle) by ensuring the correct selection of imaging exposure factors (South African Health Products Regulatory Authority 2022: 16). Whilst students were given every opportunity to develop as proficient radiographers, it was not always possible to monitor their development. Therefore, the objectives of this study were to determine final-year diagnostic radiography students' knowledge, attitude and practice when setting imaging exposure factors. This would provide insight into the readiness of final-year diagnostic students in terms of imaging exposure selection.

2.4 GLOBAL VIEW OF RADIOGRAPHIC PRACTICE IN TERMS OF RADIATION OPTIMIZATION AND IMAGE QUALITY

The rapid technological advancement from analogue to digital radiography worldwide has caused various studies to highlight its negative impact on radiographers' and student radiographers' practice (Mussmann *et al*. 2021: 1228; Lundvall *et al*. 2021: 445; Alsleem and Davidson 2012:50; Berkhout *et al*. 2014: 126 and Rastegar 2019: 40). A discussion paper by Mussmann *et al*. in Denmark (2021: 1228) investigated the relationship between the technological advances in plain film radiography from analogue to digital and the influence thereof on the selection of imaging exposure factors. The author believed that digital radiography prevented radiographers from analyzing the factors that affected the selection of kV and mAs thus creating the phenomena of dose creep (Mussmann *et al*. 2021: 1229). According to Mussman *et al*. (2021: 1229), radiographers were losing their skills in terms of exposure technique. The paper demonstrated a need for further training of radiographers in plain film x-rays due to the digitalization of x-rays.

This observation was confirmed by Berkhout *et al*. (2014: 126), whose study demonstrated an increase in patient dose in dental radiography with the conversion of analogue dental equipment to digital systems. By taking a series of radiographs, with increasing exposure times on dry bone specimens and using five different intraoral radiography systems, the researchers were able to determine that digital systems required less exposure than film for diagnostically acceptable radiographs. However, digital imaging also had a wider latitude, thus allowing for over-exposure or under-exposure. This indicated that if users did not understand the difference in systems or relationships between exposure factors, or if they found digital radiography to be more convenient, there would be a likelihood of increased patient dose. The findings from Mussmann *et al*. in Denmark (2021: 1228) and Berkhout *et al*. (2014: 126) aligned with the observation made by the researcher that diagnostic radiography students may not be able to apply their knowledge on imaging exposure factors thus causing them to practice incorrectly hence one of the objectives of the study was to determine if final year diagnostic radiography students were practising the correct selection of imaging exposure factors.

The convenience of digital radiography ignited an interest in Rastegar from Iran (2019: 33) who used reject analysis as an indicator to assess the rate of image rejection at two direct digital radiography departments to find the reasons for rejection. The radiography students and radiographers were observed to see how they dealt with image rejection. In this study, it was found that the two highest underlying causes of repeats were incorrect exposure factors and poor positioning, and the reason for incorrect exposure factors may have been due to a lack of knowledge or radiographers' reliance on automatic exposure devices (Rastegar 2019: 40). The studies cited have suggested that the conversion from analogue to digital radiography may be a contributing factor to radiographers increasing patient dose without realizing it hence the need to investigate this phenomenon.

2.5 AFRICAN RADIOGRAPHIC PRACTICE IN TERMS OF RADIATION OPTIMIZATION AND IMAGE QUALITY

The launch of Afrosafe in Africa indicated that Africa was committed to dose optimization (Munroe and Peer 2021: 23). However, Benza *et al*. in Namibia (2018:35) conducted a study by using reject film analysis as a method of quality assurance to identify the reasons for radiographic errors. The recent replacement of analogue imaging systems with computerized radiography prompted the authors to investigate the causes of image rejection. The authors determined that positioning and exposure factors were the highest cause of rejected images. With the use of a quantitative, descriptive, non-experimental research design, the researchers were able to conclude that most of the rejected images were from poor positioning (63%) and incorrect exposure factors (24.9%). The researchers recommended that radiographers should attend refresher courses on anatomy and precise exposure charts should be available (Benza *et al*. 2018: 35). Although this study was limited to one facility and could not differentiate between student errors and qualified radiographer errors, it seemed that in Africa, radiographers and student radiographers appear to practice radiography similarly to international studies. This study intended to determine whether the final-year students from the University of Technology portrayed similar traits to international studies in terms of setting imaging exposure factors.

This phenomenon is reiterated by Ofori *et al*. (2016: 150), who stated that studies in Ghana have demonstrated that the incorrect selection of imaging exposure factors was the highest cause of poor image quality in radiographs. Hence, it was important to understand the relationship between exposure factors and image quality. Ofori *et al*. (2016: 150) and Benza *et al*. 2018: 35) have shown evidence of radiographers selecting incorrect imaging factors however Gyan *et al*. (2021: 426) demonstrated how the reduction of patient radiation dose by 29.3 % may be achieved. With the use of a phantom, Gyan *et al*. (2021: 426) were able to find the optimal exposure factors for lumber spines while keeping the radiation dose to a minimum. Gyan stated that each radiographic facility should find its own optimal imaging exposure factors for specific

body parts (Gyan *et al*. 2021: 426). Optimal exposure parameters ensured minimum radiation dose to patients whilst maintaining diagnostic image quality.

Whilst studies (Benza *et al*. 2018: 35; Berkhout *et al*. 2014: 126; Rastegar 2019: 40 and Ofori *et al*. 2016: 150) have revealed that diagnostic radiographers, internationally and continentally, may not be practicing imaging techniques optimally, Gyan *et al*. (2021: 426) used a phantom to create optimal exposure factors for lumbar spines thus demonstrating that each institution may adopt similar practices to develop optimal exposure techniques. This exercise would assist students and radiographers in selecting the correct or optimal exposure factors for specific body parts. Furthermore, permitting students to be a part of the process of creating optimal exposure techniques, would further assist students in understanding the factors that affect image quality and radiation dose thus preparing final-year diagnostic radiography students for community service.

2.6 RADIOGRAPHIC PRACTICE IN TERMS OF RADIATION OPTIMIZATION AND IMAGE QUALITY IN SOUTH AFRICA

South African radiographers have not escaped the trend of international and African radiographic practices, which was reflected in a study by Lewis *et al*. (2022: 389), where 27% of patients in Gauteng received a higher radiation dose than necessary for a diagnostic image. The study highlighted the lack of optimal radiation protection nationally and internationally due to poor radiographic practice. The authors stated that radiographers needed to consider the condition of the patient, the size and the patient's history to set optimal exposure factors. The researcher's view may be correlated with Sebelego *et al*. (2019: 1) who investigated the reasons for repeat x-rays in an academic hospital in Bloemfontein by using a checklist assembled from literature to evaluate 578 routine shoulder images. The study demonstrated that shoulder x-rays were repeated due mainly to poor radiographic techniques such as positioning of the patient, thus increasing patient dose. The author recommended that in-service training on radiographic techniques was required to prevent unnecessary repeat x-rays. There is a

possibility that a lack of consideration for imaging factors may be related to the use of digital radiography, as noted by Nyathi (2010: 6).

Nyathi in South Africa (2010: 6) concluded that digital radiography removed the essential radiographic technique of exposure settings, which was the centre of film-screen radiography. Thus, there was a need to ensure that students were provided with the relevant knowledge in understanding exposure settings. With the introduction of digital imaging, there appeared to be a decline in the knowledge of exposure factors among radiographers. However, Campbell *et al*. (2019: 39) found that radiographers in South Africa showed indifference toward exposure setting and dose optimization when using digital equipment as opposed to a lack of knowledge. This raised the question of whether radiographers and student radiographers understood the relationship between correct exposure factors, image quality and optimization of radiation dose or was radiographers and students demonstrated poor attitudes when using digital equipment.

According to the Health Professions Council of South Africa (2014: 2), the radiographer must always ensure that patients are irradiated the least amount of times by selecting the correct radiographic exposure factors and correctly positioning the patient. Sherer *et al*. (2014: 280) inferred that x-rays that were repeated due to carelessness and negligence by the radiographer should be eliminated. Incorrect exposure factors, positioning, and immobilization are considered careless acts (Sherer *et al*. 2014: 280). This interpretation is highlighted by Hofmann *et al*. (2015: 1) who found that whilst film-screen radiography yielded a higher repeat rate for exposure factors, digital radiography yielded higher repeat rates for positioning. Exposure factors and positioning are core functions of radiographers and student radiographers, and when poorly practiced, increase the dose to patients and decrease image quality. As custodians of the radiography profession, radiographers must ensure that diagnostic radiography students are trained in all aspects of radiography including imaging factors.

2.7 FACTORS THAT INFLUENCE THE SELECTION OF IMAGING EXPOSURES

With proper training and education, students would be equipped with the necessary knowledge and skills to x-ray patients with minimum dose to the patient and themselves (International Society of Radiographers and Radiographical Technologists 2006: 20). Students learned the theory of factors that influence image quality and patient dose at universities. However, they were required to apply this knowledge when x-raying patients as this information has an impact on the quality of the image. The following factors influence image quality and radiation dose: kilovoltage (kV), milliamperes (mA), source-to-image distance, the thickness of tissue, and the use of grids (Radiology Key 2016: 3).

2.7.1 KILOVOLTAGE: Controls radiographic contrast. It also controls x-ray penetration (Radiology Key 2016: 2). The higher the kV, the lesser the absorption of x-rays to the tissue. For example, an abdomen x-ray done at 100cm FFD using 60kV and 50mAs would give an under-penetrated x-ray image as compared to an abdomen x-ray done at 100cmFFD using 80kV and 50mAs which may give a darker image. The reason for this is that, at 50kV, most of the x-rays were absorbed by the tissue of the patient whereas at 80kV, most of the x-ray beam would have gone through the tissue to penetrate the image receptor (Seeram 2019: 6).

2.7.2 MILLIAMPERES: Maintains radiographic density. mA is regarded as the quantity of the x-ray beam. Too little mA would give a mottled grainy image and too much would give a black image (Bontrager and Lampignano 2014: 45). For example, an abdominal x-ray done at 100cm FFD using 70kV and 50mA and .05s will not have enough electron emission to reach the receptor plate, even though the kV is sufficient whereas an abdominal x-ray done at 100cm FFD using 70kV and 200mA and 0.5s would give a very black image due to too much electron emission.

2.7.3 SOURCE TO IMAGE DISTANCE (SID): The correlation between the SID and the strength of the beam was explained using the inverse square law, which

described “the intensity of the x-ray beam as being inversely proportional to the square of the distance” (Radiology Key 2016: 2).This simply means that the further away the source is from the image receptor, the greater the exposure required to give a diagnostic image.

2.7.4 TISSUE THICKNESS: Bigger body parts require higher exposure factors to allow adequate tissue penetration for a diagnostic image. Radiographers have no control over the size of patients but by knowing the average exposures expected for anatomical areas and patients of different sizes, they may prevent repeat x-rays. Technique charts examinations of different body parts that display approximate factors for various examinations and patient thicknesses may be helpful to students who do not know exposure factors (Herrmann *et al.* 2012: 85).

2.7.5 THE USE OF GRID: Grids decrease scatter radiation but increase radiation dose to patients as a higher exposure is required when using grids (Radiology Key 2016: 3).

From the above literature on factors that affect exposure selection, it was noted that image quality depended on exposure selection. If the exposure selection was incorrect, the image would not be diagnostic and the x-ray would need to be repeated. This would signify that the patient was irradiated more than necessary. Hence student radiographers and radiographers must know the factors that affect image quality and how to manipulate these factors when x-raying patients.

2.8 EXPOSURE TECHNIQUE DECISION MAKING

Students who are unable to understand the relationship of factors risk repeating the x-ray, thus increasing the radiation dose to their patient. Hence, Hayre and Cox (2020: 87) provided two simple flowcharts for exposure technique decision-making to assist

radiographers with determining if a repeat x-ray was necessary when selecting exposures for analogue and digital imaging. Permission to use these images was granted via an email from one of the authors (Appendix A).

Figure 2.1 refers to the process of deciding if a radiograph requires repeating for analogue imaging. The authors advised that if bony trabecular patterns were visible, then repeating the image was not necessary. However, if one cannot see the bony pattern, radiographers need to determine if the image was under-exposed (white) or over-exposed (black). If under-exposed, one must increase the exposure technique. However, one must also make note of the patient's size. If the image was over-exposed, the radiographer must decrease the exposure factors and again make a note of the patient's size.

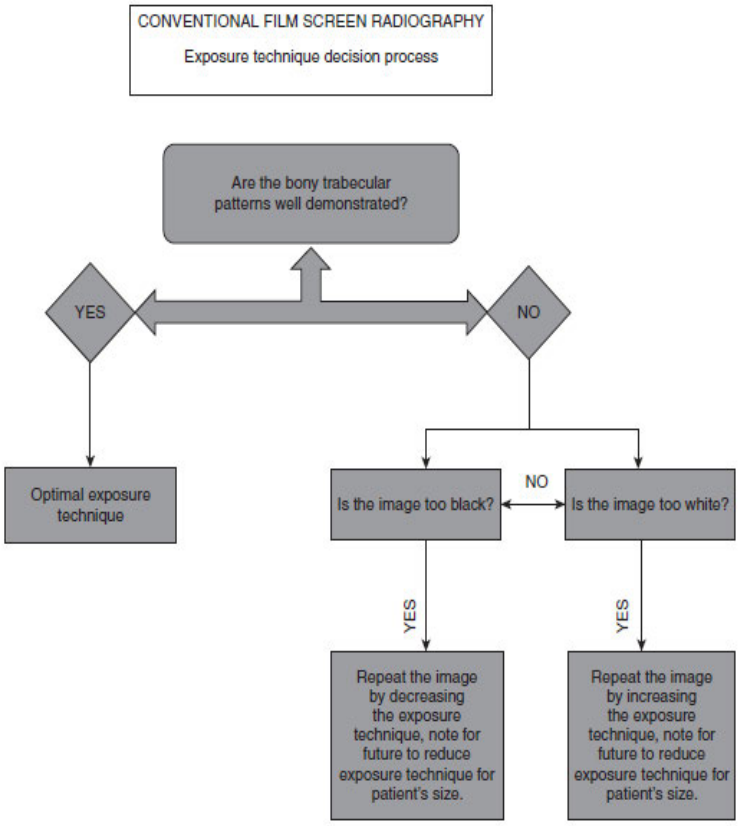

Figure 2.1: Conventional Film/Screen Radiography Exposure Technique Decision-Making Process.

In Figure 2.2, the authors, Hayre and Cox (2020: 87) discussed the decision-making process for repeating images in digital systems. Radiographers may use the exposure index (EI) reading as a guide to determine if a repeat x-ray was required. EI was set by manufacturers to assist radiographers in determining if their images were optimally exposed. If the EI was within the recommended range, the radiographer may adjust the brightness and contrast for an ideal image display and may not repeat the x-ray. Should the EI be out of range, one must look for quantum mottle, which may be seen as a grainy image caused by under-exposure or saturation caused by over-exposure. Over-exposure must be corrected by reducing the exposure factors considerably, whilst quantum mottle images require further investigation. The radiographer may check if the correct program was selected or if the patient was centered correctly, or if the correct image receptor was chosen. All of these may contribute to poor image quality and radiographers must be cognizant of them. By recognizing the factors that contribute to image quality and radiation dose, radiographers would be able to share this knowledge and practice with student radiographers thus allowing them to become proficient radiographers upon qualification.

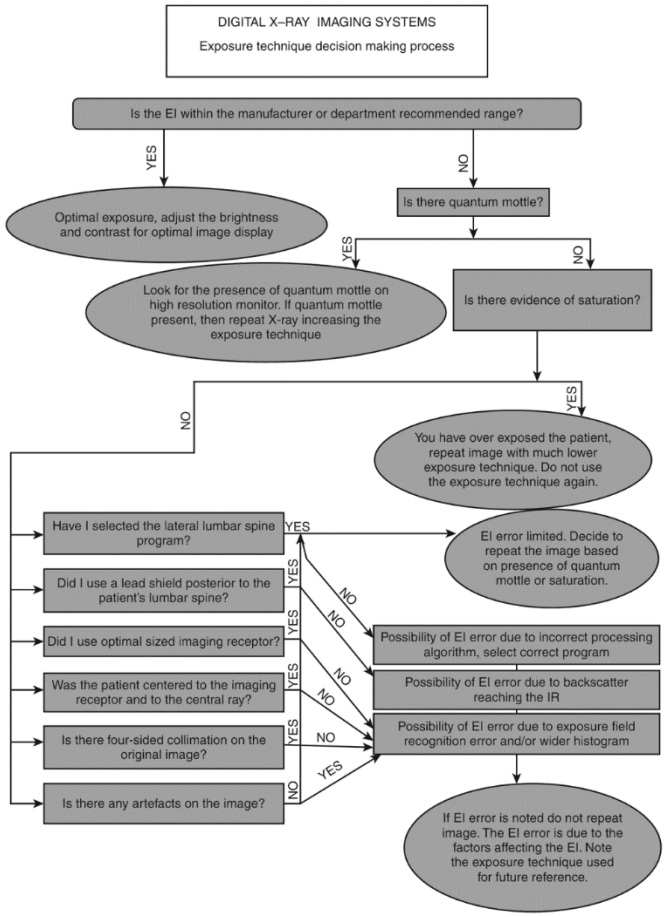

Figure 2.2: Digital X-Ray Equipment Exposure Technique Decision Making Process

2.9 DOSE REFERENCE LEVEL AND DOSE AREA PRODUCT

In addition to the above diagrams, to further assist radiographers and student radiographers in determining whether they were over-radiating their patients, international institutions such as the International Commission for Radiation Protection (ICRP), International Atomic Energy Agency (IAEA) and the national body South African Health Products Regulatory Authority (SAPHRA) have provided

radiation protection guidelines. Some of the guidelines included dose reference levels (DRL) for patients undergoing examinations and keeping a record of dose area product (DAP) meter readings for fluoroscopy procedures (SAHPRA 2022: 15) and ICRP 2013: 4). DRL is a value that guides the radiographer to recognize if they are over-radiating their patients by using higher exposure factors than required (IAEA 2018: 108). DAP meters are used to calculate the amount of radiation that a patient was exposed to when undergoing an imaging procedure. High readings could be an indication that the patient was being radiated for a long duration during a fluoroscopic procedure, or higher exposure factors were used (IAEA 2018: 106). These guidelines were formulated to create radiation protection awareness amongst radiation workers. By inculcating the practice of checking DRLs daily, radiographers and students may improve their skills in selecting the correct imaging exposures. The onus lies on radiographers to ensure that students note DRLs in the clinical institutions thus creating good radiographic practice.

According to AIEA (2018: 109), DRLs were formulated at a national level in countries and patient size and age are some of the factors that must be considered when developing DRLs. A study by Kawooya *et al*. (2022: 5) discussed the implementation of DRLs in various countries as a method to optimize radiation protection. DRLs have been established in Nigeria for CT abdomen scans; in Kenya for paediatric plain radiographs; and in South Africa for paediatric CTs and common CT examinations. To optimize radiation protection, radiographers are required to have knowledge of patient doses and DRLs (Nassef and Massoud 2014: 195). Nassef and Massoud (2014: 198) investigated DRLs in Saudi Arabia and compared them to international standards. The study found that their levels were in keeping with the levels of the United Kingdom and Australia, as shown by the following values in Table 2.1.

Average dose area product in this study and the corresponding reference levels for Australia and the UK.

Table 2.1: DAP per radiograph (Gy.cm2)

Examination	This study	Australian reference levels2013	UK- 2005
Chest PA	**0.24 (0.12-0.42)**	**0.12**	**0.12**
Chest Lateral	**0.65 (0.18-1.48)**	**No value given**	**0.3**
Lumbar spine AP	**2.44 (2.14-2.93)**	**1.6**	**1.6**
Pelvis AP	**1.33 (0.82-1.88)**	**3.0**	**3.0**

Wambani *et al.* (2015: 25) assessed patient dose using an indirect method and concluded that the DRLs in Kenya were below international standards. However, if one compares the readings to Nassef and Massoud's (2014: 198) study, the values appear higher than Saudi Arabia: 0.13 mGy for postero-anterior chest radiograph; 2.78 mGy for AP lumbar spine; 2.60 for AP pelvis. Each country ought to develop their DRLs and may compare them with international standards (AIEA 2018: 12). SAPHRA provided guidelines to South African medical x-ray equipment license-holders in terms of DRLs in their facilities. It is stated that license-holders should be mindful of the approximate patient radiation doses. Moreover, DRLs should be introduced for applications in diagnostic x-ray examinations as performed in their facilities (SAPHRA 2022: 14). Currently in South Africa, each institution may formulate its own DRLs. The purpose of DRLs was to assist radiographers in practicing radiation optimization by selecting the correct exposure factors based on the patient's size, age and weight (AIEA 2018: 10).

International organizations such as Image Gently, Eurosafe and Afrosafe have provided relevant information to radiation personnel on how to optimize radiation dose to patients (Munroe and Peer 2021: 23) however creating behavioral change in students and radiographers, requires an understanding of information. This understanding is knowledge and together with attitude and practice, becomes an essential part of behavioral change. One of the methods of measuring the

components of behavioral change is using a behavioral change model such as the KAP (knowledge, attitude and practice) theoretical model (Xuewei *et al.* 2022: 42).

2.10 RESEARCH THEORY

A KAP model is described as a collection of information on knowledge, attitude and practice of broad or precise topics of a specific group of people (Lee *et al*. 2021: 3). According to Xuewei *et al.* (2022: 42), the KAP model was created as a survey tool to evaluate the relationships between knowledge and practice or attitude and practice or knowledge and attitude. The KAP model used a structured questionnaire that was prepared for a specific group of people and the questionnaire was used to investigate and evaluate the knowledge, attitude and practice of a particular subject. In this study, the subject was the setting of imaging exposure factors by final-year radiography students with emphasis on their knowledge, attitude and practice.

To conduct research or measure the components of behavior (knowledge, attitude and practice), the correct theoretical framework is required (Xuewei *et al.* 2022: 42). This framework guided or supported the theory of the study. The framework may encompass the problem statement, research questions and the appropriate research literature review. Research and methodology are guided by this framework to provide an explanation of the data collected and report the findings of the study (Khaldi. 2017: 16). Using the KAP model as a guide for the theoretical framework of the study, the researcher attempted to measure the knowledge, attitude, and practice of final-year radiographic students about the setting of imaging exposure factors. The information was gathered with the use of a structured questionnaire and was used to identify gaps in knowledge, beliefs and behavioral patterns (Andrade *et al*. 2020: 479). This study used a self-developed questionnaire that targeted students' knowledge, attitude and practice of imaging exposure factors and is discussed in Chapter 3 under the data collection tool.

2.10.1 KNOWLEDGE

According to the Cambridge Dictionary (Cambridge 2022: 1 and Xuewei *et al.* (2022: 42), knowledge is defined as an understanding of a subject or information that was acquired from observation or study. In this study, knowledge referred to the acquisition of information by students through studying radiography. Learning can be described as individual and collective processes whereby the individual depends on the person's motivation and personal circumstances and collectively depends on the culture and organizational factors of the workplace (McLean *et al*. 2018: 114). This study focused on diagnostic radiography students' knowledge of exposure factors as well as their attitudes and practices.

If students can not apply their knowledge of exposure factors and the factors that affect the correct selection, there is a great risk of unnecessary radiation doses to patients. Australia's Alsleem and Davidson (2012: 50) discussed the importance of recognizing the parameters that affect radiation dose and their influence on the quality of an image. The authors stated that the knowledge of exposure factors such as milliamperes, time and kilovoltage were important in controlling the radiation dose to the patient.

However, students' knowledge may be hampered by negative clinical environments as described by Lundvall *et al*. (2021: 445) from Sweden whose study provided insight into factors such as different clinical placement and different supervisor practices that created anxiety among students, thus sometimes having a negative impact on their learning. In Kwa-Zulu Natal, diagnostic radiography students are placed in private and government facilities. The students are faced with cultural differences and language barriers. This may lead to poor performance and increased anxiety amongst students who struggle with adapting to cultural diversity and different languages. This study may highlight gaps in clinical training on the selection of imaging exposure factors between government and private institutions, if any. The researcher intended to investigate final-year diagnostic radiography students'

knowledge of factors affecting exposure factors and the selection of imaging factors with the use of a questionnaire where one of the sections was knowledge.

2.10.2 ATTITUDE

A simple definition of 'attitude' can be a way of thinking or feeling that affects a person's behavior (Oxford 2022: 1) whereas Xuewei *et al.* (2022: 42) defined it as "positive and negative" assessments of an entity. Student attitude plays an integral part in their learning, as seen in a study in Zambia where the radiographers shared their feelings regarding their experiences as clinical supervisors. One of the themes that arose from a study by Bwanga and Shichore (2020: 24) in Zambia demonstrated that the positive attitude of students made the clinical supervisors want to teach the students, hence giving students valuable skills to practice radiography optimally. The findings of the study inferred that students, who showed enthusiasm and a willingness to learn, were able to develop good radiographic techniques. Whilst Van der Merwe *et al.* (2017: 109) observed that student radiographers and qualified radiographers in the Free State did not adhere to the ALARA principle at all times, even though they knew of it. The authors suggested that the nonchalant attitude demonstrated by radiographers may be due to radiographers demonstrating complacency with the use of digital imaging equipment (Van der Merwe *et al.* 2017: 109). Hence, the researchers investigated the need for standardization of training for radiation safety (Van der Merwe *et al*. 2017: 109). Van der Merwe *et al*. (2017: 109) used a quantitative design with a Delphi survey and believed that the findings from the study could provide guidelines for a standardized training course in radiation safety for students, thus providing a platform to create awareness of radiation optimization and change the attitude of students from not abiding by the ALARA principle to adopting it as part of their daily practice (Van der Merwe *et al*. 2017: 109). The studies conducted by Bwanga and Shichore (2020: 24) and Van der Merwe *et al*. (2017: 109) presented different conclusions. Bwanga and Shichore (2020: 24) believed that students' positive attitude was the key to them learning effectively whilst

Van der Merwe *et al*. (2017: 109) recognized that with standardized training, students would become proficient at radiographic technique and radiation safety. Hence via specific questions in the questionnaire, the researcher attempted to investigate the attitude of final–year diagnostic radiography students while setting imaging exposure factors in order to determine if students had good attitude or poor attitude.

2.10.3 PRACTICE

Practice may be considered as the act of doing something or the application of an idea (Cambridge 2022: 1) whilst Xuewei *et al.* (2022: 42) referred to practice as being consistent actions. Poor radiographic practice such as poor communication, incorrect exposure factors, poor positioning and lack of radiation protection may lead to un-diagnostic images. Therefore, proper practice in students would ensure diagnostic images and optimal radiation protection in patients, as seen in a study in South Africa by Nghikuluula *et al.* (2021: 2). The study concluded that the successful outcome of a radiographic procedure depended on good practice from radiographic students, one of the practices being good communication between students and patients (Nghikuluula *et al.* 2021: 2). Studies by Lewis *et al.* (2022: 389) and Sebelego *et al*. (2019:1) discussed the standard of radiographic practice amongst radiographers in South Africa. Both authors demonstrated that poor radiographic practice resulted in an increase in unnecessary radiation dose to patients. The results from the studies demonstrated that some radiographers had poor radiographic practice (Lewis *et al.* 2022: 389) and Sebelego *et al*. 2019:1). The studies provided invaluable information on students and radiographers' practice of exposure technique hence the need to investigate the practice of final-year diagnostic radiography students in terms of accurately setting exposure factors.

2.11 RESEARCH GAP

Ionizing radiation is considered a hazardous substance and is regulated by the government to protect the public from its effects if utilized incorrectly (South Africa, Department of Health 1973: 1). High doses of ionizing radiation can lead to cancer or foetal deformities, hence there needs to be justification when using radiation to x-ray patients for diagnostic purposes.

There appeared to be a gap in students' abilities to set manual exposures on analogue x-ray units, as well as digital units that do not have automatic exposure devices. This was possibly due to the increased use of automatic exposure devices as analogue equipment is being replaced by digital. Students appeared to struggle with understanding the relationship between mAs and kV selection when setting manual exposures. The Radiography and Clinical Technology Board of the Health Professions Council of South Africa (2020: 3) stated that radiographers need to understand the ionizing radiation regulations in order to protect themselves and others. Under the Code of Practice for users of medical x-ray equipment, the Department of Health (2010) stated that "Radiation doses from medical exposures and those received by the public and occupationally exposed persons must be kept as low as reasonable achievable (ALARA)" (2016). Students who do not understand the relationship between radiation dose and exposure factors, and the relationship between exposure factors and image quality may have difficulty setting the correct exposures required for the part being x-rayed. The following factors influence image quality and radiation dose: kilovoltage, milliamperes, source to image distance, thickness of tissue and use of grids (Radiology Key 2016: 3). Student radiographers must be able to comprehend the application of correct exposure factors and apply them when imaging patients.

Siebert and Morin (2011: 577) posit that there was an increase in dose due to the digital manipulation of images. This raised concern regarding the knowledge of radiographers in accurately setting exposure factors. According to Siebert and Morin (2011:579), digital systems have some advantages of reducing patient dose due to

post-manipulation of the images, but it did not imply that the initial dose given to the patient was within acceptable ranges. Gibson and Davidson (2012: 460) in Australia highlighted an increase of dose to patients due to digital radiography. This trend to over-expose is known as “dose creep”. These authors suggested that the transformation from analogue to digital systems may be a contributing factor to radiographers using higher exposure factors, thus proper training in this area may be required. If radiographers were continuously using higher exposure factors than necessary, students might be practicing similarly.

This study intended to determine the ability of final-year diagnostic radiography students, to set correct exposure factors, by investigating the students’ knowledge, attitude and practice in the selection of imaging exposure factors in accordance to the standard set out by the HPCSA (2020: 5) and SAHPRA (2022: 14) that stated, radiographers must have appropriate knowledge and skills when radiating patients. The overall benefit of this study highlighted the students’ ability to correctly set imaging exposure factors, thus limiting unnecessary repeat x-rays and keeping radiation dose to a minimum. These students would be able to practice optimal radiographic exposure techniques during their community service without radiating their patients unnecessarily.

2.12 SUMMARY

Optimal radiation protection is a fundamental practice of radiographers. One of the methods used to ensure optimal radiation protection is to keep exposure factors as low as reasonably possible. With ever-changing technology in radiology, radiographers and student radiographers must keep abreast with these changes as this allows them to adapt and to remain proficient in their profession. The continuous professional development of radiographers will ensure that they pass updated knowledge to student radiographers, thus equipping students with the necessary tools to correctly select exposure factors and produce diagnostic images whilst maintaining optimal radiation protection to their patients. This chapter reviewed and

discussed various academic literature on the abilities of diagnostic radiography students. The following chapter describes the research design and the methodology adopted for this study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Scholars in research communities conduct studies by following specific steps such as deciding on the research design, paradigm, data tools, data collection and sampling (Chilisa and Kawulich.2021: 6). Research methodology allows the researcher to select the correct technique of collecting and processing data. This chapter discussed the different research paradigms, designs, data collection tools and the process followed by the researcher to collect and analyse the data for this study. The study focused on the knowledge, attitude and practice of student radiographers in terms of image exposure factors to determine whether students were competent in setting imaging exposure factors. Their competence would ensure optimal image quality with minimal radiation dose to their patient.

3.2 RESEARCH PARADIGM

Research paradigms are described as a style or manner of conducting research that has been corroborated by the research community (Davies and Fisher 2018: 22). There are different types of paradigms, such as positivism, post-positivism, interpretivism, critical and pragmatism (Davies and Fisher 2018:22). Positivist or scientific paradigms are based on a single reality and should be carried out objectively by applying quantitative research designs such as cross-sectional, descriptive or cohort studies (Davies and Fisher 2018: 22). Whilst post-positivist paradigms have single realities, it cannot be certain that there is only one reality and it cannot be completely objective (Chilisa and Kawulich.2021:6). Unlike the scientific approach, Interpretivism is centred on subjectivity and not objectivity. It focuses on experience and is guided by qualitative research designs (Shah and Al-Bargi 2013: 256). Similarly, critical paradigms use qualitative designs. This paradigm investigates social inequalities and injustices (Shah and Al-Bargi 2013: 259). Pragmatism recognizes both single and several realities and utilises mixed methods designs. In addition, it uses both qualitative and quantitative methods (Morgan, 2020: 65). For this study, a

quantitative cross-sectional design was used, guided by the positivism approach. This design was most suited for the study because the researcher attempted to measure the knowledge, attitude and practice of diagnostic radiographic students in terms of imaging exposure factors with the use of a questionnaire. The positivism design uses surveys and questionnaires to quantify and measure the research objectives of the study, thus maintaining the objectivity and impartiality of the study. This study adopted a self-developed questionnaire with questions formulated to quantify and measure the knowledge, attitude and practice of diagnostic radiography students.

All research paradigms are usually guided by four considerations, namely:

- *Ontology*: This term refers to the reality of a study. Positivism is based on a single reality (Davies and Fisher 2018: 22). The ontology of this study was whether the correct selection of imaging exposure factors by students was being adhered to limit radiation dose to their patients and themselves.
- *Epistemology*: refers to how the researcher knew this reality. This may be subjective or objective (Kivunja and Kuyini .2017: 27). The observation made by the researcher that students may not know how to select the correct exposures was supported by various peer-reviewed articles that raised a concern about dose creep in the radiographic field (Davidson 2020: 59 and Gibson 2012: 458). This was the epistemology in this study.
- *Axiology*: Axiology refers to the ethical considerations in a study (Varkey 2021:19). The basic principles of ethics are non-maleficence and beneficence (Varkey 2021:19). This simply means to not harm. Several features in ethics must be taken into consideration namely: anonymity; informed consent and data protection (Fleming and Zegwaard 2018: 210). When conducting research, the researcher may not infringe on the rights of the participants of the study and must consider the needs of vulnerable groups.
- *Methodology*: refers to the method or approach used by the researcher to collect evidence related to the study (Chilisa and Kawulich.2021: 6). To determine the validity of this observation, a quantitative method, using a

cross-sectional survey of final-year students was conducted by the researcher and this became the methodology.

3.3 RESEARCH DESIGN

Research can be broadly divided into quantitative, qualitative and mixed methods studies (Khaldi 2017: 16). Qualitative methods are primarily guided by the interpretive and critical research paradigms. This method provides the philosophical and theoretical framework of the research (Fisher and Bloomfield 2019: 25). Grounded theory, narrative and ethnography are examples of qualitative methodology. Mixed methods are a combination of quantitative and qualitative methods where exploratory, descriptive and explanatory designs may be used (Khaldi 2017: 16). Quantitative methods of data collection intend to calculate and measure a specific phenomenon with the use of a survey and statistical processing of information (O'Leary 2017: 117). Quantitative methods may be further divided into the following categories:

- Descriptive research methods describe the present state of the variables of interest. It is also referred to as a collection of data with carefully calculated measurements of every variable (Christensen *et al.* 2014: 46).
- Experimental methods of research may be called true experiments and they examine the relationships between independent variables and dependent variables. It analyses the cause-effect relationship between the independent and dependent variable (Christensen *et al.* 2014: 49). However, the independent variable is manipulated unlike quasi-experiment where the method is similar to the experimental but there is no manipulation of the independent variable (Christensen *et al.* 2014: 49).
- Correlational research methods investigate and analyse the relationship between variables and it identifies patterns or trends in the study. The variables are observed in their natural setting and are not manipulated (Christensen *et al.* 2014: 61). Survey methods are performed using the unchanged list of questions that are given to the participants of the study.

- Surveys may be divided into cross-sectional and longitudinal research types. Cross-sectional studies are performed at a single specific time when all the data is collected from all the participants whereas longitudinal studies are performed at more than one time frame. Data is collected at two or more time frames (Christensen *et al.* 2014: 66).

A quantitative research method was used in this study because the objective of a quantitative research method was to find a sample size that is representative of the population and then test and measure the variables from the study. The findings from quantitative studies would be able to make extrapolations about the larger population (Fisher and Bloomfield 2019: 24). This study was guided by a quantitative cross-sectional survey of final-year diagnostic radiography students at DUT regarding the application of factors that affect radiation dose and image quality. A cross-sectional design was chosen due to its ability to determine the practices and knowledge in participants at a specific time (Kesmodel 2018: 390). Cross-sectional studies may be divided into descriptive which may be defined as describing the common features of a population or analytical research which refers to investigation of relationships between variables (Zangirolami-Raimundo 2018: 256). The cross-sectional design type was suitable for the current study as it was a simple cost-effective method of collecting data on the knowledge, attitude and practice of final-year diagnostic radiography students using closed-ended questions in the form of a questionnaire. Such a design allowed for an accurate assessment of student's knowledge, attitude and practice when setting exposure factors. The accuracy of the study stemmed from the chosen design as it was able to quantify and measure the findings with the use of statistical tests that calculated the participants' responses. The various statistical tests are discussed in chapter 4.

3.4 SETTING

Research setting refers to the area where the research took place (Given 2008: 552). The researcher conducted this study at the Durban University of Technology (DUT). This university has approximately 33,000 students, amongst which are approximately

40 final-year Diagnostic Radiography students. DUT has six faculties, namely Applied Sciences, Management Sciences, Accounting and Informatics, Engineering and the Built Environment, Arts and Design, and Health Sciences. The Department of Radiography is part of the Faculty of Health Sciences. There is an on-site radiographic clinic and the school offers virtual learning (Durban University of Technology 2020).

3.5 SAMPLING PROCESS

Sampling is defined as a process to select a fraction of bodies from a population group for research purposes (Bhardwaj 2019: 19). There are two types of sampling techniques, namely random/probability and non-random/non-probability (Taherdoost 2016:20). Non-probability sampling refers to a sampling technique where participants do not have an equal opportunity of being selected for a study (Taherdoost 2016:20). Types of non-probability sampling include purposive, convenience and snowball (Fisher and Bloomfield 2019: 25). Whereas, probability sampling refers to a technique whereby each participant has an equal opportunity of being selected from the total population (Iliyasu and Etikan 2021: 26). This type of sampling is preferred when conducting quantitative studies and examples of probability sampling are simple, stratified or cluster (Fisher and Bloomfield 2019: 25). Stratified sampling is ideal when the researcher wants to create relationships between different groups in the population. This study used probability stratified sampling. In this study, amongst the relationships that were tested, were those between students placed in private hospitals and those in public hospitals. The comparison between government and private diagnostic radiography students may assist universities and training institutions with identifying gaps if any, in students' practical training. A significant difference in results may require the universities to investigate the reason for the discrepancies.

Only final-year diagnostic radiography students of the university were incorporated into the study, and they were grouped according to whether they were private or government students. There were 37 final-year students who were considered for this

study. In consultation with a statistician, who used alpha = 0.05 (95% confidence) and a margin error of 0.05, the minimum sample required from a population of 37 was 34. The researcher was able to meet this requirement with a sample size of 35 participants from a total of 37 final-year students. The population size in this study was small, hence almost the total population size was required to conduct the research, giving the researcher accurate information that was used in this study (O'Leary, Z. 2017: 384). According to Kennedy (2020: 21) sample size can be as little as thirty or as large as three hundred. He further stated that very small sample sizes may give too little information while very large sample sizes may give more information than what is required by the study (Kennedy 2020: 21). In addition, Kennedy (2020: 21) argued that reliability may be established if there were strong inter-correlations between scale items.

The population may also be divided into smaller groups according to their common characteristics e.g. age and gender (Fisher and Bloomfield 2019: 25). In this study, relationships or correlations between age, gender and institution were investigated against the knowledge, attitude and practice of final-year diagnostic students. Significant differences between the various groups, such as female participants performing significantly better than their male counterparts or government participants performing significantly better than private participants, if any, may require further investigation as to the reasons for the differences.

Inclusion and exclusion criteria

Inclusion criteria

- Final year diagnostic radiography students.
- Students must be registered with the HPCSA as student radiographers

Exclusion criteria

- Diagnostic radiography students from other institutions
- 1st, 2nd and 3rd year diagnostic radiography students.

3.6 DATA COLLECTION PROCESS

A permission letter (Appendix B and C) was sent to the post-graduate office and the gatekeeper requesting that the research be undertaken at DUT. Permission was granted by the postgraduate office, to conduct the study (Appendix D). Conducting the research at DUT was opportune as the students were attending lectures during their block and the researcher was able to acquire a total sample of the population of final-year diagnostic radiography students. The researcher made prior arrangements with the Department of Radiography to hand out the questionnaires (Appendix E). The questionnaire was hand-delivered at the end of a contact class session with students. Every student was provided with information letters (Appendix F) and consent forms (Appendix G) before the study. They were informed that participation was voluntary and confidential. Each student was given a questionnaire (Appendix E) to complete. The researcher was given time by the university to discuss the study with the students before the questionnaires were completed. Any queries and additional information were answered before the commencement of the study. Students were made to be at ease and relaxed to limit anxiety amongst them. On completion of the questionnaire, the researcher collected them from the participants and stored them in a sealed envelope to transport them for analysis.

3.7 DATA COLLECTION TOOL:

There are different methods of collecting data. The common ones include interviews, case studies, focus group discussions, observations, surveys and questionnaires, as well as video and photography (O'Leary, Z. 2014: 422). This technique is intended to collect and record information consistently. It makes use of a questionnaire with relevant questions that can be administered in various ways, such as an online survey or distributed in person (O'Leary, Z. 2014: 422). There must be a standard questionnaire and the results should be created using a set of analysis methods (O'Leary, Z. 2017: 426). Christensen *et al*. (2014: 324) provided a detailed guide on constructing a survey questionnaire. The authors advised researchers to follow the subsequent principles when developing a questionnaire

- When creating a questionnaire, start with ensuring a proper framework based on the literature review and the items or questions must be related to the research objectives (Christensen *et al*. 2014: 324).
- The items must be suitable for the target population (Christensen *et al.* 2014: 343).
- For quantitative studies, closed-ended questions without ambiguity are most suitable (O'Leary, Z. 2014: 422).
- Items must be simple to understand and short (Christensen *et al.* 2014: 343). The researcher avoided leading or double-negative questions, and the format of the questionnaire was easy to use.
- Decide if questions need to be closed-ended or open-ended (Christensen *et al.* 2014: 343).
- Deliberate the types of closed-ended response categories that are available (Christensen *et al.* 2014: 343)
- To measure complicated constructs and ideas, multiple questions or items are required (Christensen *et al.* 2014: 343).
- Questionnaires and surveys must be easy to use (Christensen *et al.* 2014: 343).
- Pilot testing may be performed until the questionnaire is completed correctly (Christensen *et al.* 2014: 343). In this study, the questionnaire was perfected by changing questions as per feedback from the statistician. It was then given to the 3rd year radiography students to assess if they understood the questions before the administration of the main study.
- Chirk-Jenn (2006: 33) stated that a questionnaire was considered well-made if it was valid, reliable, interesting and concise. The questions must be relevant to the research and should follow a logical sequence.

The questionnaire (Appendix E) for this study was self-developed and created by using guidelines from the above literature (Christensen *et al.* 2014: 324; Chirk-Jenn 2006: 33 and O'Leary, Z. 2014: 422). The theoretical framework that guided the development of the questions for each section was the KAP model. The questions were created from the objectives of the study.

The questionnaire consisted of four parts:

- Section 1 was demographics and this part provided information regarding the institution, age, gender at birth and ethnicity of the participant. Demographics refer to socio-economic and physical information about a population group (Connelly 2013: 269). Hammer (2020: 261) stated that the exclusion of demographics risked the assumption of ‘absolutism” which means that the topic of interest may be the same regardless of demographics (age, race, gender or culture etc.). By including demographics, researchers practice “universalism” which means that the topic of interest may vary depending on the demographics of the population (Hammer 2020: 261). Researchers may not assume differences between groups of a study population without including demographics.
- Section 2 was knowledge where various questions on the factors of imaging exposures were tested using yes-no responses. The questions were developed from the DUT, Department of Radiography, WIL assessment manual of 2020 (DUT School of Radiography 2020: 23) to measure and analyse the knowledge of final-year diagnostic students. This section was related to the first objective of the study, to determine the knowledge of final-year diagnostic students in terms of imaging exposures. Nyathi (2020: 6) concluded that there was a deterioration in the knowledge of imaging factors among radiographers due to the increased use of digital imaging. This inference was supported by Lewis *et al*. (2022: 389) who demonstrated in their study that 27% of the patients in Gauteng received radiation doses above the required level to produce diagnostic images. Thus the section on knowledge was created to test the knowledge of participants with regards to imaging exposure factors.
- Section 3 was on attitude and the questions were formed from the second objective of the study, to determine the attitude of the study participants. The items in this section were used to measure participants’ attitudes while setting imaging exposure factors. Campbell *et al*. (2019: 39) inferred that South African radiographers showed indifference when setting exposure factors on digital imaging equipment while Sherer *et al*. (2014: 280) concluded that repeat x-rays were due to carelessness and negligence of radiographers and the

authors viewed acts of poor positioning and incorrect selection of exposure factors as carelessness Sherer *et al*. (2014: 280). Hence, the researcher sought to investigate the attitude of the participants in relation to imaging exposure factors.

- Section 4 was based on practice where the researcher set specific questions that were aligned to the third objective of the study, to determine the practice of students when selecting imaging exposure factors. The questions or items measured students' practice of exposure technique. Studies by Rastegar (2019; 33) and Benza *et al*. (2018: 36) used reject analysis as a method to identify the causes of repeat imaging. Both authors found that incorrect exposure factors were one of the reasons for repeating x-rays. Thus the need to measure the practice of participants in terms of exposure factor selection was measured

Apart from the questionnaire matching the objectives of the study, it was also required to be reliable. According to Taber (2018: 1273), Cronbach's alpha is an appropriate tool that may be used to measure the reliability or internal consistency of concepts or constructs in surveys or questionnaires and it refers to how closely associated, a set of items are as a group (Taber 2018: 1273). One of the tests used in the study to measure reliability was Cronbach's alpha. The value for Cronbrach's alpha was .749. The results will be discussed in chapter 5. The questions in each section were asked in various ways to measure the fundamental concepts of the study. The concepts being measured and analysed were knowledge, attitude and practice of final year diagnostic radiography students in terms of imaging factors.

The questionnaire utilised the Likert scale for measuring responses in section 3 and 4. The questions were short and easy to understand and were suitable to the respondents. Apart from ensuring that the questions of the study were linked to the objectives of the study and were reliable, the researcher was required to perform a pilot study before the main study.

3.8 PILOT STUDY

Before the main study, a pilot study was performed. The purpose of a pilot group was to ensure that the participants understood the questions before the main study and to safeguard the reliability and validity of the study (Shanyinde *et al.* 2011:1). Another advantage of doing a pilot study was that it assisted with assessing the accuracy of the data collection tool (Shanyinde *et al*. 2011:1).

Owing to the small number of final-year diagnostic radiography students, the pilot study was carried out utilising three third-year diagnostic radiography students. The students were randomly selected from the third-year diagnostic radiographic group at the University of Technology. The students from the pilot study were provided with a letter of information and an explanation of what they were required to do by the researcher. Informed consent was obtained before the students answered the questionnaire. The pilot study was completed on the 1st of October 2022. The questionnaire was distributed to three third year diagnostic radiography students who subsequently completed it within 10 minutes from the time they commenced. The comments provided by the students verified that they found the questions easy to understand. The questions, where they selected unsure as a response, were because they were unsure of the answer and not because they did not understand the question. Based on the student's feedback, the researcher was satisfied with the final collection tool and a report on the findings of the pilot study was submitted to IREC for final approval of the study

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3.9 DATA ANALYSIS

Data analysis is the process of collecting raw data and transforming it into valuable information that can be used in decision-making (Kudyba 2014: 230). There are various data analysis techniques such as data mining and business intelligence. Data mining centres around statistical modelling (Kudyba 2014: 232), and statistical application can be divided into descriptive statistic exploratory data analysis known as exploratory data analysis (EDA) and confirmatory data analysis. For this study, the

EDA technique was used. EDA may be explained as a method or technique that is used to describe and review features of a specific set of data. It also assists with finding relationships between the variables of the data set (Christensen *et al.* 2014: 395).

On completion of the questionnaires, the results were tabulated and graphically demonstrated. With the use of probability stratified sampling, data was collected and analysed using the latest version (26) of SPSS (Statistical Package for the Social Sciences). Statistics can be described as the collection, analysis, understanding and demonstration of data (Trajkovski 2016:5). Parametric statistics and non-parametric statistics are examples of statistical methods. Parametric statistics refer to the normal distribution of the data and examples of parametric statistical tests are T, z, and f tests; while Chi-square tests and Spearman's rank correlation coefficient are examples of non-parametric statistics or distribution-free tests (Trajkovski 2016: 12). A t-test can be used to identify any differences between government and private students and demonstrate their knowledge in the application of exposure factors. The data was then graphically demonstrated using graphs. The results from the data were analysed by a statistician and the researcher.

The statistical tests used in this study to examine the data are listed below. An explanation of these tests may be found in Chapter 4.

- Descriptive statistics refer to mean, mode and standard deviations in statistics (Vetter 2017: 1797). The data such as frequencies are denoted in tables or graphs.
- Analysis of the Variance Model (ANOVA) compares two or more groups of cases in one variable for several independent samples (Pallant 2016:275). In this study, a comparison of institution and gender groups was made against students' knowledge.
- The binomial test examines the two possible responses from the participants in a study (Glen 2020: 1). Yes/ No questions were created in the section of knowledge.

- Pearson's correlation coefficient measures the linear association between two groups (Pandey 2015:18). Correlations were made between knowledge, attitude and practice.
- One sample t-test is a test that investigates if the mean score is different from a scalar value (Ross *et al*. 2017: 9). This test was used to examine the average scores for agreement and disagreement with the neutral score being 3.
- Independent samples t-test compares two independent groups of cases (Pallant 2016: 265). In this study, an analysis of the differences in gender and institution was made.
- Cronbrach's alpha is a measure of internal consistency, and it refers to how closely connected a set of items are as a group. (Taber 2018:1273).

3.10 RELIABILITY

Reliability refers to the accuracy of the research tool and its consistency (Heale and Twycross 2015: 66). If the tool consistently gives the same results, it is said to be reliable (Heale and Twycross 2015: 66). Lakshmi and Mohideen (2013: 2755) defined reliability as the degree to which measures are free from errors. Test-retest, inter-rater and internal consistency are different forms of reliability (Christensen *et al.* 2014: 134). The reliability of the study was ensured with the use of a pilot study where three third-year diagnostic radiography students were asked to complete the questionnaire before the study was performed on the final-year group. Moreover, the use of a questionnaire on its own provides consistency in the manner in which questions are asked, meaning that students would have read the same questions asked in the same way. Cronbach's alpha test may also be used to check the reliability of the questionnaire. It is a measure of reliability or internal consistency for data collection tools such as questionnaires (Taber 2018: 1273). This test may be used when multiple items are measuring the same idea or concept (Taber 2018: 1273). In this study, several items were used to measure the knowledge, attitude and practice of final-year diagnostic radiography students. With the use of Cronbach's alpha, items were grouped, to give an acceptable variable to measure attitude (.749).

3.11 VALIDITY

Validity refers to how accurately a concept can be measured and the accuracy of building conclusions from the data (Heale and Twycross 2015: 66). According to Lakshmi and Mohideen (2013: 2756), a measure is valid if it measures what it is supposed to measure correctly. According to Christensen *et al.* (2014: 159), there are several types of validity such as face, content, construct, internal, external and statistical conclusion validity. Face validity suggests the test that is measuring a construct must have questions that are related to that construct or theory (Heale and Twycross 2015: 66) e.g. the researcher was testing the knowledge, attitude and practice of final-year diagnostic radiography students in terms of imaging exposures. The questions asked by the researcher must be related to the subject under investigation. Content validity refers to a test that measures all parts of a theory or construct (Lakshmi and Mohideen 2013: 2756) e.g. the researcher was investigating imaging exposure factors. If five elements affect imaging exposure factors then all five components must be tested. Internal validity implies the results received from an experiment are due to a manipulation of independent variables (Christensen *et al.* 2014: 179). Face validity was achieved in this study by ensuring that the questionnaire complied with questions that were relevant to the knowledge, attitude and practice of participants in the study in terms of setting exposure factors. Internal consistency was attained with the use of Cronbach's alpha where the value was .749. External validity could not be verified as the study did not include students of other provinces or institutions. The validity of the study was only plausible for the students at DUT. The questionnaire covered the areas that demonstrated the knowledge of exposure factors and the application of factors affecting image quality, thus adding to the validity of the study as it comprised the relevant aspects of exposure factors.

3.12 ETHICAL CONSIDERATIONS

Ethical considerations are a fundamental aspect of any research and pertain to the protection of subjects in a research programme. Non-maleficence, beneficence, autonomy and justice are the four principles associated with ethics (Christensen *et al.*

2014: 100). Non-maleficence and beneficence mean to do no harm and to assist or help (Christensen *et al.* 2014: 100) whilst justice refers to the suitable or correct and impartial treatment of people whereas autonomy represents an individual's power to make their own decisions or choices if they are competent to do so (Varkey 2021: 19).

There are several ethical elements, namely anonymity, informed consent, confidentiality and data protection, that must be adhered to when conducting research (Fleming and Zegwaard 2018: 210). Anonymity denotes the privacy or secrecy of a participant's details. These details cannot be exposed during the data collection, analysis of data or the recording of the results (Arifin 2018: 30). Their anonymity must be guaranteed and the data collected from the study is confidential and must be stored safely and be protected (Arifin 2018: 30).

Informed consent refers to a participant granting permission to partake in the study after being informed of the risks and benefits (Arfin 2018: 30). For informed consent to be valid, the participant must be of sound mind and receive full disclosure regarding the study hence allowing the participant to decide to participate in the study voluntarily (Varkey 2021: 19). Each participant is required to understand that the study is voluntary and must be informed of the risks and benefits of the study in their preferred language. They may then give their informed consent (Cacciatolo 2015: 58).

Confidentiality signifies the sharing of participants' details with their permission however in studies, participants' details are kept private and are not shared with persons other than the researcher undertaking the study (Varkey 2021: 20). In this study, participants' personal details such as their names were found on the informed consent form but were not seen on data collection tools. Data protection means safeguarding the information from participants and keeping it in a suitable way such as using a safe where access is restricted (Fleming and Zegwaard 2018: 210). The data collected in this study was sealed in an envelope after receiving them from the participants. The documents were scanned by the researcher and saved onto a universal serial bus (USB device) and the hardcopies have been stored in a secure place that has been locked.

Consideration needs to be given to vulnerable groups such as students and mentally challenged participants (Arifin 2018: 30). This study was conducted with the participation of final-year diagnostic radiography students however all students were above 18 years.

For this study, ethical approval was obtained from the DUT Ethics Committee. The participants' identities were kept anonymous, meaning that no person would have known their identity. The questionnaire was formulated without including any personal details that would be able to identify any student. Throughout the research process, from the data collection tool, to the analysis of data and the reporting of data, the participants' identities were anonymous and no participant was mentioned by names. Participation was voluntary. Each participant was given an information letter (Appendix E) that explained the reason for the study and how it was carried out. A letter of consent (Appendix F) was given to each subject asking them to participate in the study, with a brief explanation of how the study remained confidential. Participant names appeared on the informant consent form however this form was not part of the data collection tool and was kept separately. The information provided was confidential and not shared with any person. All data collected was stored safely and an electronic copy was password protected. This information would be stored for five years and discarded appropriately by deletion of the electronic copy and shredding of the hardcopy.

3.13 SUMMARY OF THE CHAPTER

The process of research may be confusing and tedious for first-time researchers. However, by following the guidelines from the research community, the researcher was able to collect and analyse data in a scientific manner. Research design, paradigm, data collection tools, sampling and data analysis are fundamental parts of a study and by adhering to these processes, the researcher was able to provide a detailed, concise accurate study. The next chapter presented the findings of the study.

CHAPTER 4: PRESENTATION OF FINDINGS

4.1 INTRODUCTION

This chapter focused on the statistical presentation of the data collected. Statistics can be described as a study of data collected, and can be explained in two ways using nominal or ratio level methods (Witte and Witte 2017: 3). Statistics is based on two types of variables, qualitative and quantitative. The data was examined using two methods, namely descriptive and inferential. Descriptive techniques concentrate on central tendency, variability and the distribution of sample data (Stewart 2018: 1). It makes use of the mean, median, mode, range and standard deviation. Inferential techniques refer to the assumptions made and whether the data analysed are in line with those assumptions (Vetter 2017: 1797).

Data was collected from thirty-five final year students at a university of technology in KwaZulu-Natal. On completion of the data collection, the data gathered was examined using appropriate statistical tests to extract the information required to fulfil the objectives of the study. The information collected was presented in the form of text, graphs and tables. The chapter was structured with the explanation of the statistical tests used, followed by the data collection tool and lastly, an analysis of the data collected for each of the sections in the questionnaire.

4.2 STATISTICAL TESTS

Various statistical tests may be applied to examine the collected data. A set of statistical techniques were adopted to extract information and provide accurate findings for this study. These tests were prepared to determine if the final-year diagnostic radiography students had adequate knowledge, attitude and practice in selecting the correct imaging exposure factors.

4.2.1 Descriptive statistics include the mean, mode and standard deviations, where required. It also concentrates on the central tendency or dispersion of the data (Vetter 2017: 1797). Descriptive statistics consist of univariate or bivariate data (Vetter 2017: 1797). In this study, univariate data refer to data dependant on a single factor such as

testing for knowledge whereas bivariate data tries to link two variables by finding an association or correlation between them such as the age and the knowledge of students. An example of this would be: Did the age of students affect their level of knowledge? The information collected from the data was presented in the form of tables and graphs for the different sections of the questionnaire thus making it convenient to note the distribution of frequencies.

4.2.2 The Analysis Of Variance Model (ANOVA) is a test used for several independent samples and it compares more than two groups of cases simultaneously to establish if there are relationships between the groups (Pallant 2016: 275). In this study, a comparison of ethnicity, gender, institution and age groups were made against students' knowledge; attitude and practice to determine if either of these groups had a significant impact on students' knowledge, attitude and practice. An ANOVA result with an F ration close to 1 would indicate a null hypothesis, meaning that there was no significant difference between the groups (Christensen *et al.* 2014: 445).

4.2.3 The Binomial test examines whether a significant proportion of respondents select one of a possible two responses and this can be extended when data with more than two response options is split into two distinct groups (Glen 2020: 1). This test was helpful in determining the differences in the section of knowledge. The section on knowledge comprised of yes /no/unsure responses where each question produced a P-value. The P-value between 0.00 and 0.05 in SPSS would be considered significant.

4.2.4 Pearson's correlation coefficient is a measure of linear association between two groups. It shows the direction and strength of the relationship between variables and is calculated in a number between -1 and 1 (Pandey 2015:18). Strong correlations would have values between 0.5 and 1 whereas weak correlations have values less than 0.29 (Pandey 2015: 18). In this study, correlations were made between knowledge, attitude and practice. The values from this test would indicate if there were correlations or relationships between knowledge, attitude and practice of the participants.

4.2.5 The One-sample t-test determines whether a mean score is significantly different from a scalar value (Ross *et al.* 2017: 9). One-sample t-test may be used to determine if the population average or mean gives a different value to what the assumed value may be (Ross *et al.* 2017: 9). This type of test was selected to determine if the average agreement/disagreement scores differ significantly from the neutral or central score. In this study, the central score was 3 for the sections on attitude and practice. Values close to 3 would indicate little significance whereas significant disagreement would be seen by values < 3 and significant agreement may be seen by values >3

4.2.6 The Independent samples t-test compares two independent groups of cases. The test is used to determine if there is a significant difference in the mean scores of the two different groups (Pallant 2016: 265). The test was used in this study to analyse differences in gender and institution and age. Each independent factor such as the age, institution and gender was analysed against knowledge, attitude and practice separately. Results demonstrating a p-value < 0.05 would be considered significant.

4.2.7 Cronbrach's alpha is considered to be a measure of internal consistency, and it refers to how closely connected a set of items are as a group. It is understood to be a measure of reliability or internal consistency (Taber 2018: 1273). This test may be used when multiple items are measuring the same idea or construct. In this study Cronbach alpha was used to measure attitude and practice. The participants were questioned in different ways, however when the questions were combined it gave the overall measure of attitude and practice. Cronbach Alpha is measured in 0 or 1 however it could also give negative numbers. Negative numbers may demonstrate that something is incorrect with the data whilst 0.7 and above is considered good results. (Taber 2018: 1273). The value of Cronbrach's alpha for this study was .749.

4.3 THE DATA COLLECTION TOOL

The data collection tool was in the form of a questionnaire. The questionnaire was self-developed and was verified using a pilot study. It consisted of four parts, the first being demographics. The remainder of the questionnaire focused of questions related to the

knowledge, attitude and practice of final-year diagnostic radiography students (Appendix E).

4.4 DEMOGRAPHICS

Demographics refer to socio-economic and physical information about a population group (Connelly 2013: 269). This includes age, ethnicity, sex, income, etc. (Connelly 2013: 269). Researchers cannot surmise that there are differences or no differences between groups of participants if demographics are not included in the study (Hammer 2020: 261). This segment analysed the variables of race, age, gender at birth and institution.

4.4.1 Institution:

The majority of the students who conducted their clinical training in government institutions were 71.4% (n=25), whereas 28.6 % (n=10) were placed in private radiology practices. This is depicted in Figure 4.1.

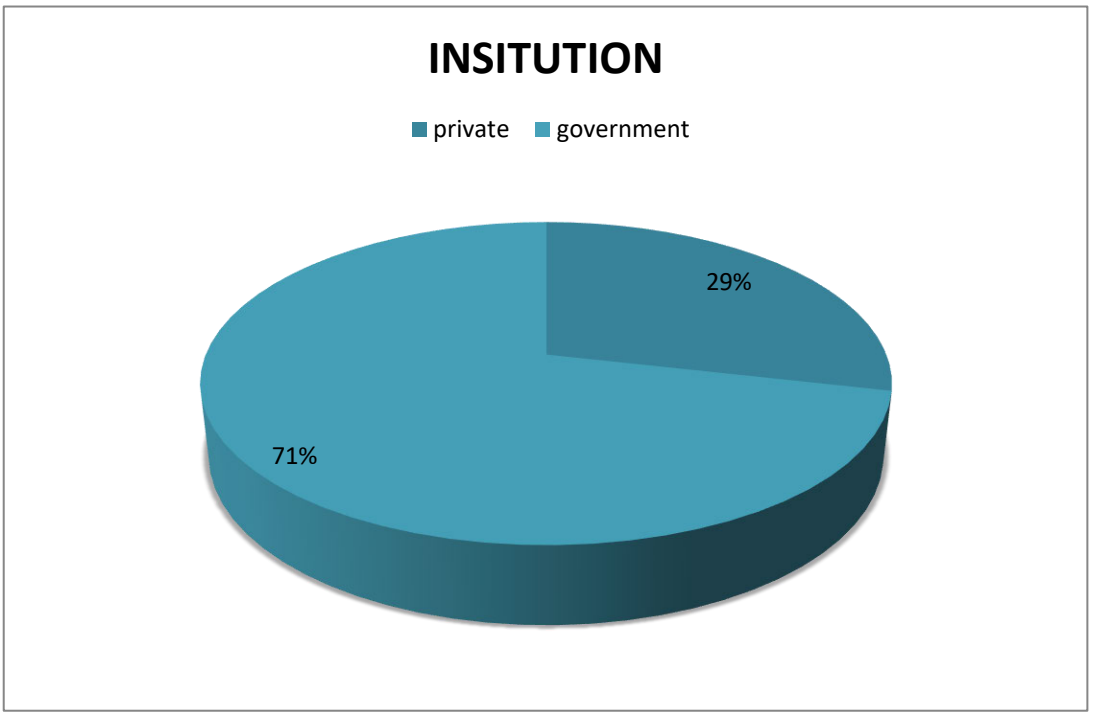

Figure 4.1: The representation of institution (n=35)

4.4.2 Ethnicity:

The data on ethnicity demonstrated that 65.7% (n=23) of the participants were black, 2.9% (n=1) were coloureds, 28.6% (n=10) were Indian and 2.9% (n=1) were white. This is demonstrated in Figure 4.2.

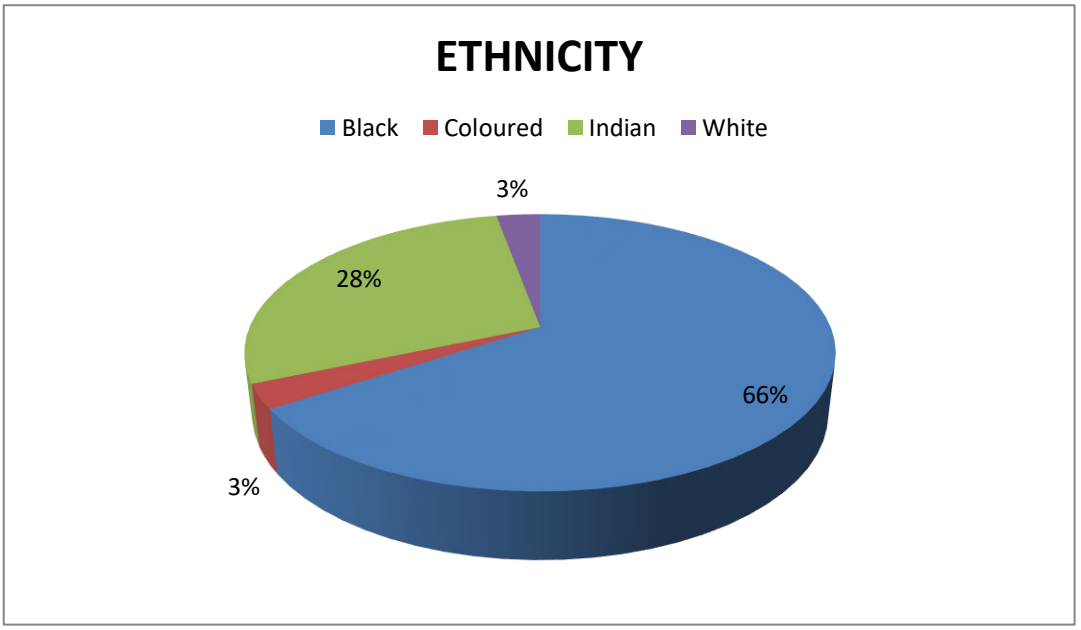

Figure 4.2: The representation of ethnicity (n=35)

4.4.3 Age:

Of these participants, 74.3% (n=26) were within the 22-25 year age group. A small percentage of 5.7% (n=2) was 26 years and over, and 20% (n=7) was students in the 18-21 categories. This may be seen in Figure 4.3.

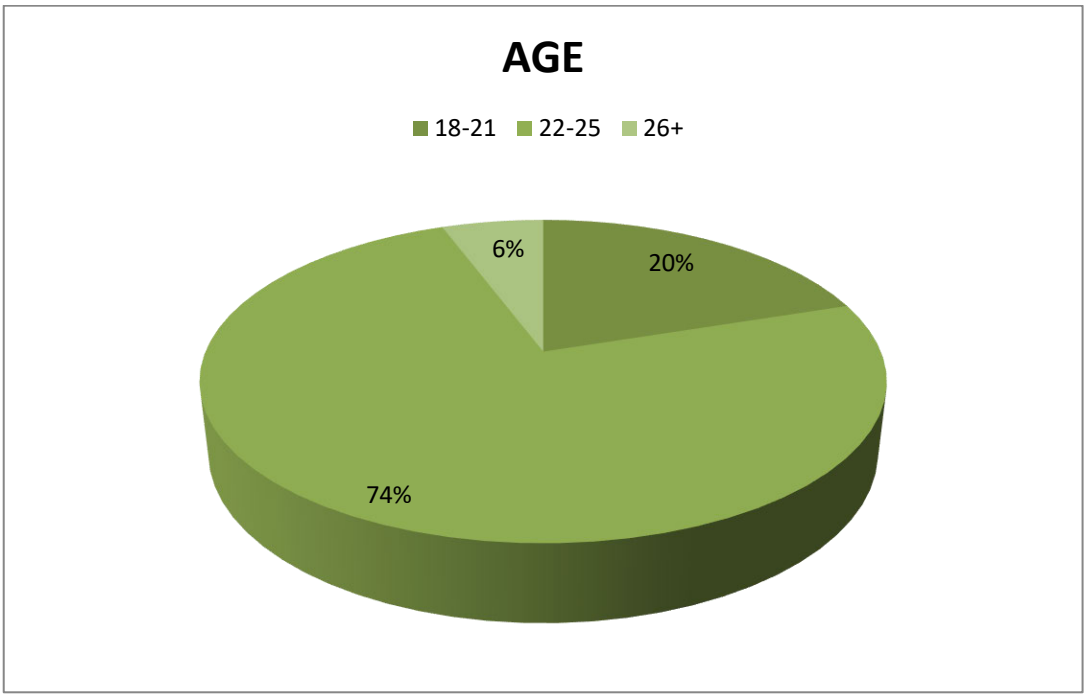

Figure 4.3: The representation of age (n=35)

4.4.4 Gender at birth:

A vast 85.7% (n=30) of the sample were female and 14.3% (n=5) were male. This is demonstrated in Figure 4.4.

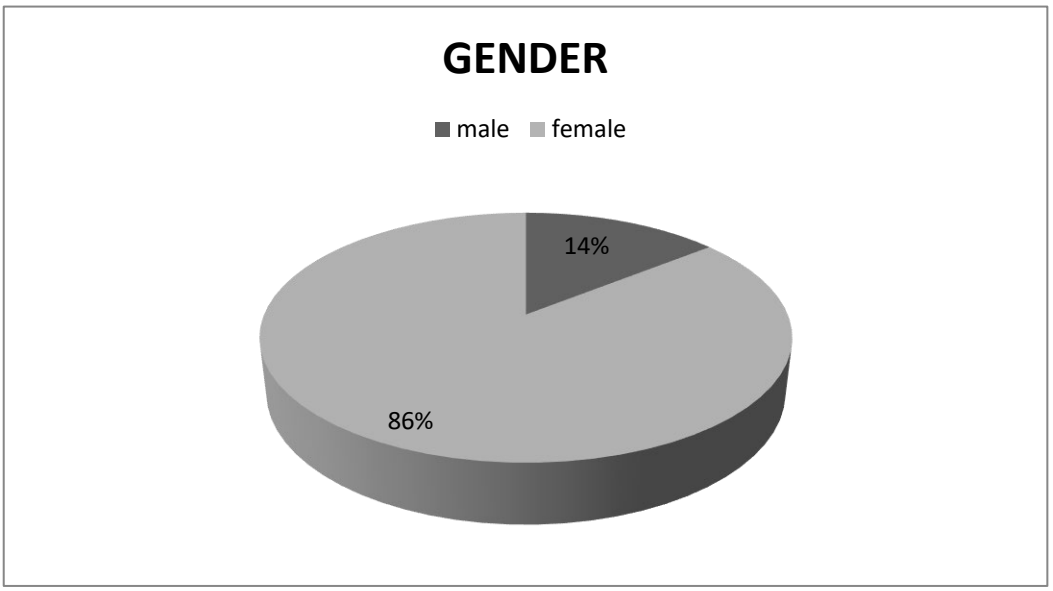

Figure 4.4: The representation of gender (n=35)

4.5 ANALYSIS ON KNOWLEDGE

This section was created using correct and incorrect responses and was analysed using binomial testing. Binomial tests are generally used when an investigation has two possible outcomes, such as true and false or yes and no. With binomial tests, the researcher must also have an idea of what the probability of success is (Glen 2020: 1). In other words, the test was done in order to see if there was a difference between the results yielded and what was expected (Glen 2020: 1).

Students were given a series of questions relating to factors affecting exposure setting and exposure factors. The questions were constructed to incorporate the various factors that affect image exposure settings. Each question tested a different factor in order to examine the various aspects of students' knowledge.

The data collected was demonstrated using a table (Figure 4.1), followed by an explanation and a graphic illustration using a bar graph (Figure 4.5). The table consisted of twelve questions (items), frequency (number of correct and incorrect responses, the total number of participants (n) and the p-value. The p-value is defined as a measurement to confirm a theory against the data collected (Beers 2022: 1). It measures the probability of attaining the perceived results. The lower the p-value is, the greater the statistical significance. A p-value of 0.05 or lower is generally considered statistically significant (Beers 2022: 1). This simply means that with 95% confidence, the specific result is applicable to the whole population and not just the sample. A high p-value signifies that the result is only applicable to the sample and not the whole population (Beers 2022: 1). In SPSS, a p-value given as .000 is very small and reported as p<.001; a p value of e.g. .017 is reported as p=.017.

Table 4.1: Knowledge of factors affecting imaging exposure selection.

Item	Frequency (%)		n	p-value
	Correct	Incorrect		
1.The use of grids increases exposure factors and increases image quality by reducing scatter	35 (100)	0 (0)	35	<.001*
2.Thicker body parts require higher mAs for penetration	13 (37)	22 (63)	35	.175
3.Large focal spot size allows for more electrons to pass through in a shorter time	25 (71)	10 (29)	35	.017*
4.Small focal spot size is needed for smaller body parts such as hands and feet	33 (94)	2 (6)	35	<.001*
5.Source to image distance is directly proportional to mAs	10 (29)	25 (71)	35	.017*
6.200 film screen combinations are considered faster than 400 film screen combinations	1 (3)	34 (97)	35	<.001*
7.kV and mAs selection for a knee in bucky is similar to a pelvis in bucky	28 (80)	7 (20)	35	.001*
8.Pregnant women should never be x-rayed	30 (86)	5 (14)	35	<.001*
9.Greater collimation requires less kV AND mAs	6 (17)	29 (83)	35	<.001*
10.Small focal spot size is used for details such as trabecular patterns	34 (97)	1 (3)	35	<.001*
11.Babies should be x-rayed using the shortest possible time	34 (97)	1 (3)	35	<.001*
12.ALARA principle means that a lot of radiation is acceptable	35 (100)	0 (0)	35	<.001*

***Indicates significance at the 95% level

Question 1 referred to 'the use of grids increases exposure factors and increases image quality by reducing scatter'. This question was answered correctly by all the participants

hence yielding a result of 100%, thus demonstrating that the value of p <.001 was statistically significant.

Question 2 had split responses where 13 participants correctly answered and 22 had incorrectly answered the question on ‘thicker body parts require higher mAs for penetration’. This gave a percentage of 37% correct answers and 63% incorrect responses. The value of p =.175 which is higher than.05 thus indicating the P-value is statistically insignificant.

Question 3 discussed ‘large focal spot size’ and again there were split responses, whereby 25 students correctly answered while 10 were incorrect, giving a percentage of 71 % correct and 29% incorrect. This gave a statistically significant p- value (.017).

Question 4: Small focal spot size is needed for smaller body parts such as hands and feet’ presented a statistically significant p-value of <.001, where 94% of the participants answered correctly and 6% were incorrect.

Question 5 relating to ‘source to image distance’ was divided', whereby 10 students answered correctly and 25 were incorrect, giving a percentage of 29% and 71%. A statistically significant p-value of .017 was noted.

Question 6 was based on ‘200 film screen combinations are considered faster than 400 film screen combinations’ resulted in 34 incorrectly answered responses and 1 correct. This resulted in 97% incorrect and 3% correct. The p-value was <.001.

Question 7 was on ‘kV and mAs selection for a knee in bucky is similar to a pelvis in bucky’. Whilst the majority answered correctly, 7 responses were incorrect, thus giving a percentage of 80% correct and 20% incorrect. There was a statistically significant p-value of .001.

Question 8 focused on ‘Pregnant women should never be x-rayed’. The result was 5 incorrect and 30 correct responses. 86% provided correct responses and the p-value was <.001.

Question 9 referred to ‘greater collimation requires less kV and mAs’. Most of the participants answered incorrectly (29), thus showing that students were not able to

understand this concept. A vast 83 % were incorrect and 17% were correct. The p-value was <.001, thus demonstrating a statistically significant p-value.

Question 10 mentioned ‘Small focal spot size is used for details such as trabecular patterns’, where 34 students answered correctly and 1 was incorrect. This yielded a 97% correct response and 3% incorrect. The value of p was <.001.

Question 11 regarding ‘Babies should be x-rayed using the shortest possible time’ resulted in 34 correct answers and 1 incorrect response. This produced 97% correct answers and 3% incorrect; hence illustrating that students acknowledged how to x-ray babies and those babies needed the shortest time for imaging. The p-value of <.001 was statistically significant.

Question 12 was directed to ‘ALARA principle means that a lot of radiation is acceptable’ where all participants answered correctly, giving a 100% response. The p-value was <.001. This indicated that students discerned the principle of ALARA. The graph below is a graphic summary of the section on knowledge (Figure 4.5).

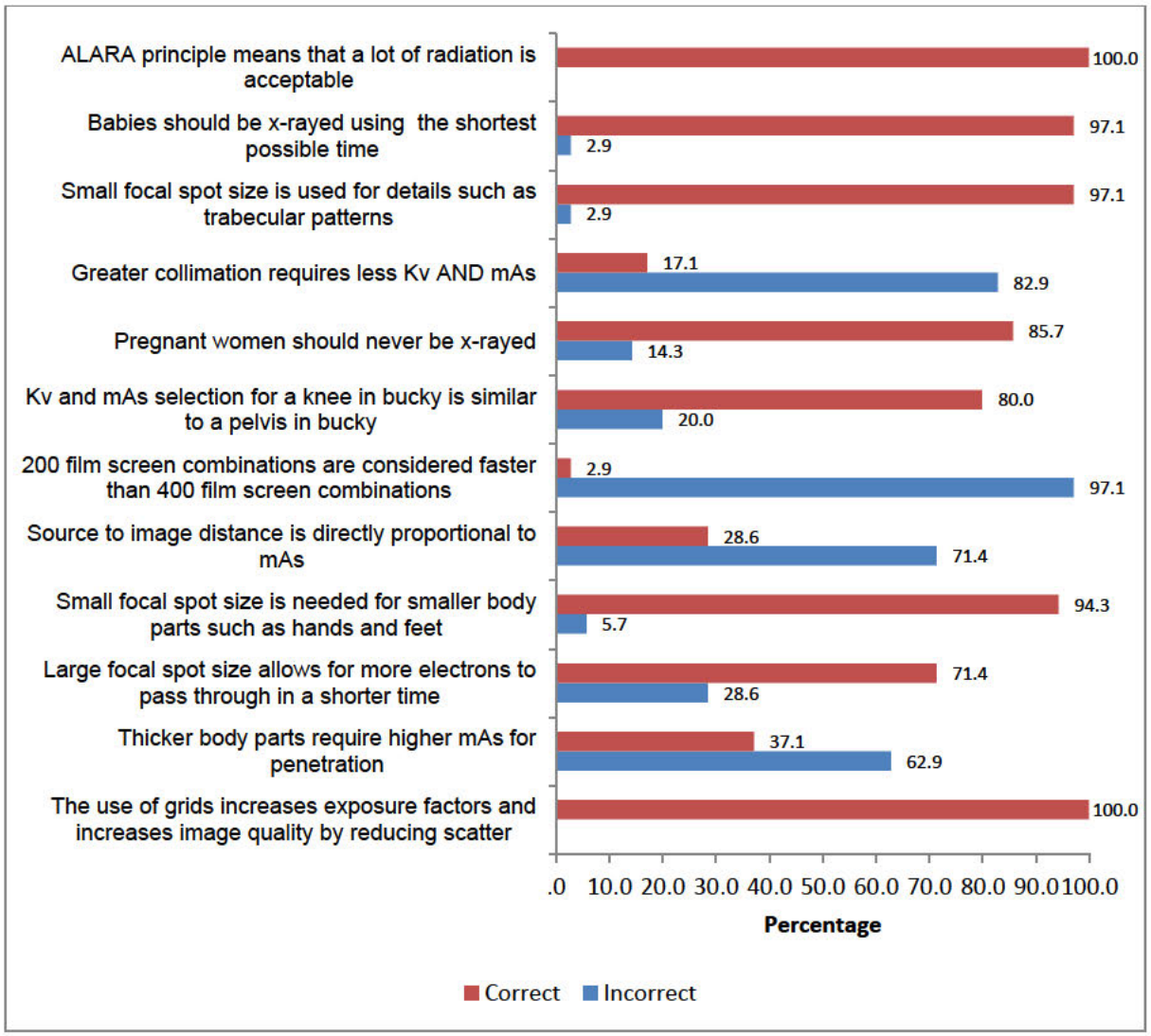

Figure 4.5: The representation of knowledge (n=35)

The graph (Figure 4.5) demonstrated that with the application of binomial testing, correct results were achieved by a significant proportion for the following items:

- The use of grids increases exposure factors and increases image quality by reducing scatter (100%)
- Large focal spot size allows for more electrons to pass through in a shorter time (71%)
- Small focal spot size is needed for smaller body parts such as hands and feet (94%)
- kV and mAs selection for a knee in bucky is similar to a pelvis in bucky (80%)
- Pregnant women should never be x-rayed (86%)
- Small focal spot size is used for details such as trabecular patterns (97%)
- Babies should be x-rayed using the shortest possible time (97%)
- ALARA principle means that a lot of radiation is acceptable (100%).

The graph (Figure 4.5) also demonstrated that incorrect results were achieved by a significant proportion for the following items:

- 200 film screen combinations are considered faster than 400 film screen combinations (97%)
- Source to image distance (71%)
- Greater collimation requires less kV and mAs (83 %)

One question demonstrated results with no significant proportion.

- Thicker body parts require higher mAs for penetration (63%)

From the summary, it was noted that three questions posed a challenge to the participants where the majority of the students answered incorrectly and eight questions were correctly answered by most of the participants.

4.6 ANALYSIS ON ATTITUDE

The test for student attitude was produced using a Likert scale and the analysis was done utilizing a one-sample t-test. This method of analysis is commonly used when determining if the average agreement or disagreement score differs significantly from the central/neutral score of '3'.

If the difference was significant, then it would be interpreted as a significant agreement if the mean score >3 and significant disagreement if the mean score <3. In the case of this study, significant disagreement will imply that the students have a good attitude because almost all the questions were negatively phrased. The section on attitude was summarized in a table and followed by an explanation and graphic demonstration.

Table 4.2: The representation of attitude (n=35) * indicates significant at the 95% level

Item	Responses as Frequency (%)					n	Mean (SD)	t	df	p-value
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree					
1.It doesn't matter if I don't change the exposure for AP and lateral wrist because it doesn't make a difference to the image quality	13 (37.1)	13 (37.1)	4 (11.4)	5 (14.3)	-	35	2.03 (1.043)	-5.511	34	<.001*
2.It is not important to collimate because electronic cropping is now available	25 (71.4)	10 (28.6)				35	1.29 (0.458)	-22.127	34	<.001*
3.The DAP meter reading is not important	11 (31.4)	14 (40)	8 (22.9)			33	1.91 (0.765)	-8.192	32	<.001*
4. When using automatic exposure devices, there is no need to look at the kV and mAs because analogue equipment is outdated and I do not need to know how it works.	22 (62.9)	13 (37.1)				35	1.37 (0.490)	-19.653	34	<.001*
5.I feel that the values on the exposure chart are too low; hence I prefer to use higher kV and mAs	4 (11.4)	14 (40)	11 (31.4)	4 (11.4)	1 (2.9)	34	2.53 (0.961)	-2.856	33	.007*
6.It is acceptable if I don't know what the ALARA principle means	31 (88.6)	4 (11.4)				35	1.11 (0.323)	-34.560	34	<.001*
7.I think that it's acceptable to take x-rays at any distance as long as the exposure factors are changed according to the distance	20 (57.1)	12 (34.3)	1 (2.9)	1 (2.9)	1 (2.9)	35	1.60 (0.914)	-9.062	34	<.001*
8.Proper immobilization of babies is not necessary because I can repeat the x-ray if the baby moves	29 (82.9)	5 (14.3)				34	1.15 (0.359)	-30.055	33	<.001*
9.I do not need to understand the factors that affect image quality because digital equipment has electronic image manipulation	26 (74.3)	9 (25.7)				35	1.26 (0.443)	-23.252	34	<.001*
10.AED is convenient because I don't have to select my own exposure factors	3 (8.6)	11 (31.4)	11 (31.4)	8 (22.9)	2 (5.7)	35	2.86 (1.061)	-0.796	34	.431
11.If I use my gut feel and not the theoretical settings it will not be detrimental to the patient	19 (54.3)	9 (25.7)	7 (20)			35	1.66 (0.802)	-9.902	34	<.001*

Question 1 was developed to determine whether students understood that exposure factors may vary when x-raying different views. The mean (2.03) was in keeping with students having a positive attitude. Moreover, 11.4% were neutral, 14.3% agreed and 74.3% disagreed. This indicated that a majority of the students disagreed. The p-value was <.001.

Question 2 was formed to assess if students recognized that electronic collimation was not acceptable and it yielded a mean of 1.29. All (100%) of the participants disagreed, indicating a good attitude, thus noting a statistically significant p-value of <.001.

Question 3 was created to investigate if students knew the importance of DAP meter reading and showed a mean of 1.91. A vast 75.8% of the students disagreed, illustrating a good attitude whilst 22.9% remained neutral. The value of p was <.001.

Question 4 was formulated to identify if students comprehended the significance of knowing exposures when using automatic devices. This gave a mean value of 1.37. All (100%) of the participants disagreed, signifying a good attitude. The p-value was statistically significant, with the value of <.001.

Question 5 was constructed to detect whether students were abiding by the exposure chart values. The mean value was 2.53. Approximately 51.9% disagreed with the statement, whilst 31.4% remained neutral and 14.1% agreed. The 51.9% of the participants answered adequately. The p-value noted was .007.

Question 6 was based on the principle of ALARA in order to identify whether students practiced it accordingly. It provided a mean value of 1.11. All participants disagreed with the statement, thereby indicating a good attitude. The p-value was <.001.

Question 7 was formulated to ascertain whether students thought that using any distance was right as long as the exposure factors are acceptable. This statement gave a mean of 1.60. A significant 91.4% of the participants demonstrated a good attitude. There was a statistically significant p-value of <.001.

Question 8 was directed at ‘Proper immobilization of babies’, where the mean one or many values? 1.15. All 100% of those who answered disagreed, thus showing a good attitude. A statistically significant p-value of <.001 was recorded.

Question 9 made a comparison between understanding exposure factors and using electronic manipulation to test if students felt that it was necessary to know exposure factors regardless

of digital equipment. The mean value produced was 1.26. All (100%) disagreed thus demonstrating a good attitude. The p-value was <.001.

Question 10: ‘AED is convenient’ was used to gauge how students felt about the use of AED and had a mean value of 2.86. Moreover, 40% of the participants disagreed while 31.4% was neutral and 28.6% agreed. These results signified that students may not understand the advantages of AED. The p-value of .431 was calculated and considered statistically insignificant.

Question 11 on gut feel and not the theoretical settings was constructed to measure how students perceived the use of their instincts as compared to theoretical knowledge. The mean value was 1.66. Most (80%) were in disagreement and 20% stayed neutral. This was statistically significant, with the p-value of <.001.

Significant disagreement was shown in all these items, apart from question 5 and question 10. This displayed a good attitude in nine of the questions that were relevant to their training. However, the areas where some students were neutral need to be examined further to determine if they may require further training. These results can be easily viewed on Figure 4.6, which illustrated that questions 5 and 10 values were closer to 3, thus implying that students may be unsure of these radiographic concepts.

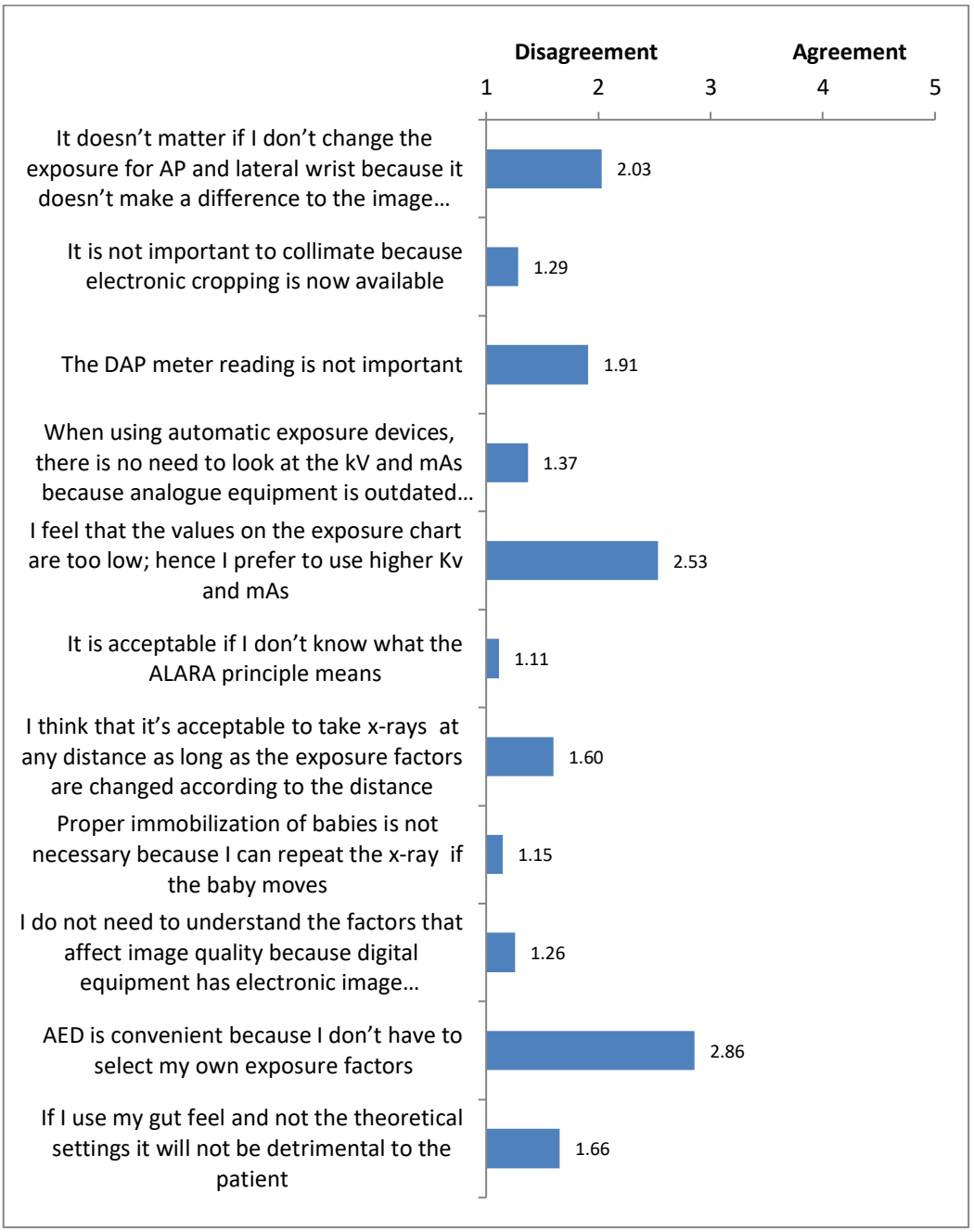

Figure 4.6: The representation of attitude (n=35)

4.7 ANALYSIS ON PRACTICE

Students' practice of imaging exposure factors was tested using a Likert scale and the analysis was done by using the one-sample t-test as with the section on attitude. This segment of practice is summarized in the table below (Figure 4.3) and is followed by a text explanation and graphic demonstration.

Table 4.3: The representation of practice (n=35)

Item	Responses as Frequency (%)					n	Mean (SD)	t	df	p-value
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree					
1. When using a grid, I change the exposure factors to compensate for the use of the grid.	1 (2.9)		1 (2.9)	13 (37.1)	20 (57.1)	35	4.46 (0.817)	10.554	34	<.001*
2. I use the same exposure for PA chest and lateral chest	9 (25.7)	22 (62.9)	1 (2.9)	3 (8.6)		35	1.94 (0.802)	-7.795	34	<.001*
3.When a greater collimation is required I increase the kV and mAs	6 (17.1)	13 (37.1)	9 (25.7)	7 (20)		35	2.49 (1.011)	-3.010	34	.005
4. When using automatic exposure setting, I look at the kV and mAs after I have exposed	9 (25.7)	3 (8.6)	4 (11.4)	16 (45.7)	2 (5.7)	34	2.97 (1.381)	-.124	33	.902
5. After I have exposed, I make a mental note of the DAP value.	3 (8.6)	8 (22.9)	13 (37.1)	7 (20)	2 (5.7)	33	2.9 (1.042)	-.501	32	.620
6. I do not always adhere to 100cm SID distance when imaging patients on the table	13 (37.1)	8 (22.9)	5 (14.3)	9 (25.7)		35	2.29 (1.226)	-3.446	34	.002
7. I keep the collimation beams open because I am afraid I may cut off anatomy	10 (28.6)	11 (31.4)	9 (25.7)	3 (8.6)	2 (5.7)	35	2.31 (1.157)	-3.505	34	.001
8. I always take note of the focal spot size when x-raying a patient.	1 (2.9)	8 (22.9)	7 (20)	11 (31.4)	7 (20)	34	3.44 (1.160)	2.218	33	.034
9. I rarely select my own exposure factors because AED is convenient to use	3 (8.6)	17 (48.6)	9 (25.7)	5 (14.3)	1 (2.9)	35	2.54 (0.950)	-2.847	34	.007
10. I use low kV and long time for all my patients.	16 (45.7)	18 (51.4)	1 (2.9)			35	1.57 (0.558)	-15.157	34	<.001*

Question 1: ‘When using a grid, I change the exposure factors to compensate for the use of the grid’ is considered good practice and having a score of 4.46 demonstrates good practice amongst students. The majority of 94.2% agreed with this statement. This indicated that most of the students knew that they need to adjust their exposure factors accordingly when using grids. A statistically significant p-value of <.001 was recorded.

Question 2: I use the same exposure for PA chest and lateral chest’ indicates bad practice. With a mean value of 1.94, this indicated that a majority of the students do change the exposure factors accordingly. A significant 88.6% disagreed, hence indicating that they do change exposure factors accordingly. The value of p was <.001 and was considered statistically significant.

Question 3: ‘When a greater collimation is required, I increase the kV and mAs is bad practice and students achieved a mean value of 2.49, thus demonstrating that 54.2% understood that it is bad practice. However, 25.7% remained neutral and 20% agreed with the statement. The value of p = 0.005.

Question 4: ‘When using automatic exposure setting, I look at the kV and mAs after I have exposed’. This indicated good practice; however it yielded a mean value of 2.97. A further 35.3% disagreed, indicating that they did not look at kV and mAs, whilst 11% remained neutral. It was noted that the p-value was .902, thus implying that it was statistically insignificant.

Question 5: ‘After I have exposed, I make a mental note of the DAP value.’ Noting DAP reading is good practice. However, the mean values was 2.91, thus demonstrating that a significant number of students have disagreed (33.3%) and 39.4% remained neutral. This result indicated poor practice from a notable percentage of students however the p-value was .620.

Question 6: ‘I do not always adhere to 100cm SID distance when imaging patients on the table’ is bad practice and had a mean value of 2.29, demonstrating that 60% disagreed. It is noted that a combined value of 40% of the students remained neutral or agreed with the statement. The p-value calculated was .002.

Question 7: ‘I keep the collimation beams open because I am afraid I may cut off anatomy’ is bad practice. The mean value given is 2.31. Whilst 60% of the students

disagreed, 25.7% remained neutral and 14.3% agreed, thus demonstrating that a substantial percentage of students were adhering to the correct practice of collimation. The p-value was .001.

Question 8: ‘I always take note of the focal spot size when x-raying a patient’ is considered good practice. Although 53% agreed, 20.6% remained neutral and 26.5% disagreed. A statistically significant p-value of .034 was noted however sizeable percentage of students does not look at focal spot size.

Question 9: ‘I rarely select my own exposure factors because AED is convenient to use’ is acceptable practice and gave a mean value of 2.54. Most (57.1%) disagreed, 17.2% agreed and 25.7% were neutral. The results for this question showed that less than half of the students may not understand the advantages of AED. The p-value was .007.

Question 10: ‘I use low kV and long time for all my patients’ is bad practice, and produced a mean value of 1.57, with 97.1% of the students disagreeing with the statement. It was noted that the p-value was<.001.

These results were also depicted in Figure 4.7, where it was noted that the majority of the questions had values greater than 2 but less than 3, thus indicating that not all students were practising radiographic techniques correctly. With the exception of questions 1 and 10 where the values were furthest from 3, the remainder of the questions were close to 3.

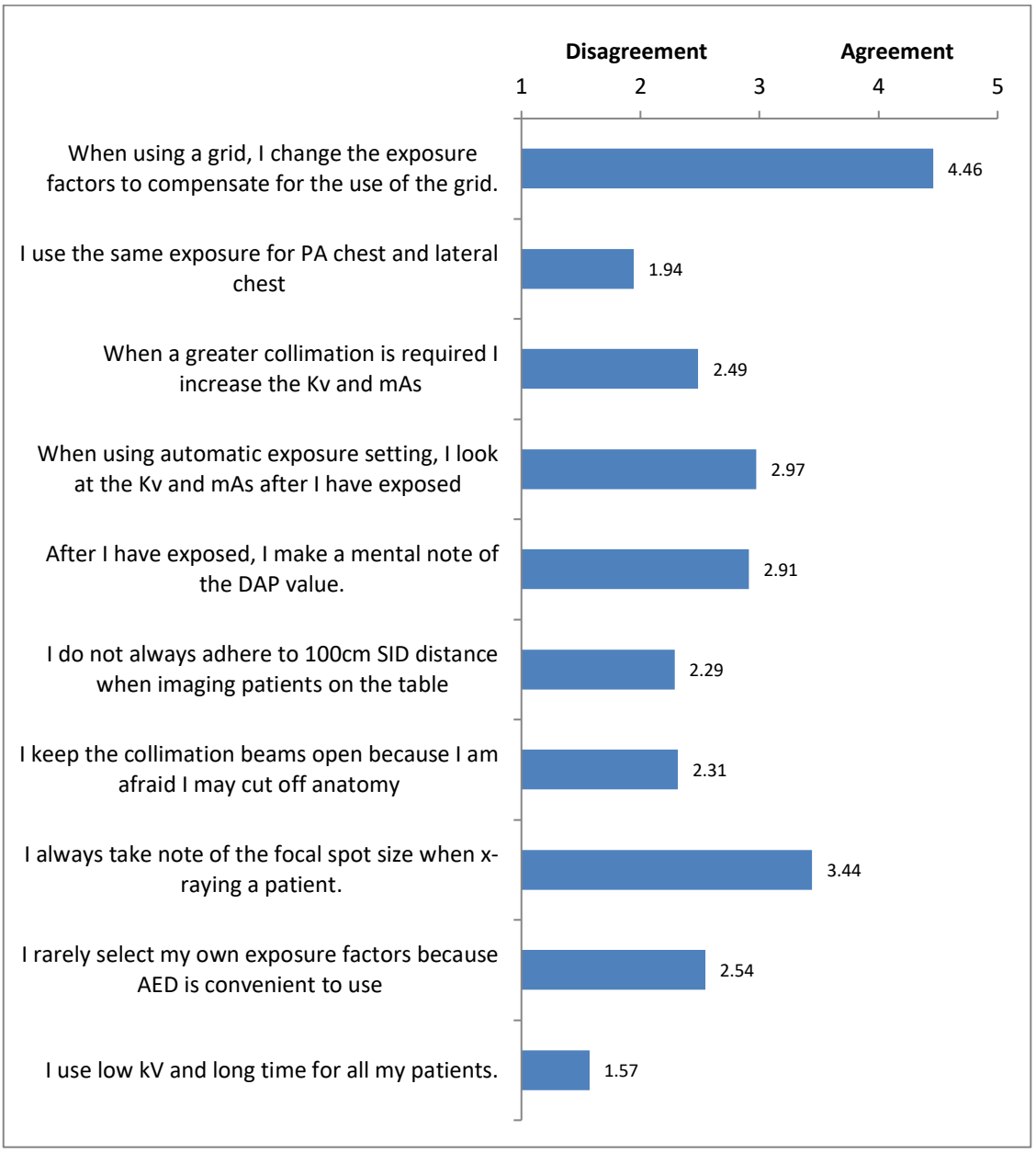

Figure 4.7: The representation of practice (n=35)

4.8 COMPARISON OF RESULTS AGAINST DEMOGRAPHICS

The researcher attempted to demonstrate if there were significant differences in these constructs in relation to institution, gender, age and race with the use of independent samples t-tests and ANOVA. Analysis in this area proved challenging due to the data set being small. However, using the Conbrach's alpha measure (measure of reliability), the researcher was able to get a grouping that was reliable. The items that were grouped together to give an acceptable composite variable to measure attitude were items 4, 9 and 11. The remaining seven items were combined by calculating the average of their

scores to form the variable for attitude (ATT). When attempting to obtain groupings for practice, acceptable reliability could be achieved only from items 1, 2, 6, 7 and 10. The results have indicated that there were no significant differences in these areas of comparison.

4.8.1 Institution

Test = independent samples t-test

Using the independent samples t-test, a comparison was made between institutions for knowledge, attitude and practice.

The mean values for knowledge were 71.80 and 66.08 for private and government respectively, and the standard deviation was 5.594 and 11.463. The mean for attitude was 1.3429 and 1.5943. The standard deviation for attitude was 0.34470 and 0.43386 for private and government respectively. The mean values for practice were 3.9600 and 4.1120 for private and government respectively, and the standard deviation was 0.58727 and 0.62471. No significant differences were noted for any variable across institutions.

Table 4.4. Representation of Institution

	Institution	N	Mean	Std. Deviation
Knowledge %	private	10	71.80	5.594
	government	25	66.08	11.463
ATT	private	10	1.3429	.34470
	government	25	1.5943	.43386
PRAC	private	10	3.9600	.58727
	government	25	4.1120	.62471

4.8.2 Gender at Birth

A comparison was made between males and females for knowledge, attitude and practice using independent samples t-test. There were minimal differences in the mean values between males and females for the different areas tested, as seen in Table 4.5.

Test = independent samples t-test

Table 4.5: Representation of Gender

	Gender	N	Mean	Std. Deviation
Knowledge %	male	5	73.40	3.578
	female	30	66.77	10.874
ATT	male	5	1.6857	.57499
	female	30	1.4952	.39656
PRAC	male	5	3.8400	.45607
	female	30	4.1067	.62969

No significant differences were noted for any variable across gender.

4.8.3 Race

ANOVA was utilized to demonstrate differences in ethnicity. The mean values in Table 4.6 illustrate that the difference in the mean values are small, indicating no significant differences noted for any variable across race.

Test – ANOVA

Table 4.6: Representation of Ethnicity

		N	Mean	Std. Deviation
Knowledge %	Black	23	68.17	11.324
	Coloured	1	67.00	.
	Indian	10	66.00	9.189
	White	1	75.00	.
	Total	35	67.71	10.388
ATT	Black	23	1.4658	.44182
	Coloured	1	2.0000	.
	Indian	10	1.6286	.37616
	White	1	1.2857	.
	Total	35	1.5224	.42143
PRAC	Black	23	4.2174	.61766
	Coloured	1	4.0000	.
	Indian	10	3.7400	.54201
	White	1	4.0000	.

		N	Mean	Std. Deviation
Knowledge %	Black	23	68.17	11.324
	Coloured	1	67.00	.
	Indian	10	66.00	9.189
	White	1	75.00	.
	Total	35	67.71	10.388
ATT	Black	23	1.4658	.44182
	Coloured	1	2.0000	.
	Indian	10	1.6286	.37616
	White	1	1.2857	.
	Total	35	1.5224	.42143
PRAC	Black	23	4.2174	.61766
	Coloured	1	4.0000	.
	Indian	10	3.7400	.54201
	White	1	4.0000	.
	Total	35	4.0686	.60961

4.8.4 AGE

A comparison was made amongst the different age groups for knowledge, attitude and practice using ANOVA. Table 4.7 demonstrates insignificant differences in the mean values for the variables.

Test – ANOVA

Table 4.7: Representation of Age

		N	Mean	Std. Deviation
Knowledge %	18-21	7	65.71	11.116
	22-25	26	68.31	10.751
	26+	2	67.00	.000
	Total	35	67.71	10.388
ATT	18-21	7	1.3265	.25707
	22-25	26	1.5934	.45120
	26+	2	1.2857	.20203
	Total	35	1.5224	.42143
PRAC	18-21	7	4.1714	.64734
	22-25	26	4.1154	.56899
	26+	2	3.1000	.14142
	Total	35	4.0686	.60961

No significant differences were noted for any variable across age.

4.9 CORRELATIONS

Correlation analysis is used to illustrate relationships between two quantitative variables. The relationship or association may be linear, which simply means that one variable

increases or decreases a fixed amount for a unit increase or decrease in the other (Sedgwick 2012: 345). The most common correlation coefficient is the Pearson correlation, which measures a linear relationship or linear association between two variables. The Pearson correlation coefficient may be calculated for any data set that has a finite covariance matrix (Sedgwick 2012: 345).

The researcher used the Pearson correlation method in order to identify any relationship between knowledge, attitude and practice in this study. Attitude and practice are moderately correlated, r=-.474, p=.004. 'Good' attitude is associated with 'good' practice. Table 4.8 exhibits this relationship.

Table 4.8: Representation of Correlation for Knowledge , Attitude and Practice

		Knowledge %	ATT	PRAC
Knowledge %	Pearson Correlation	1	-.068	.200
	Sig. (2-tailed)		.700	.249
	N	35	35	35
ATT	Pearson Correlation	-.068	1	-.474**
	Sig. (2-tailed)	.700		.004
	N	35	35	35
PRAC	Pearson Correlation	.200	-.474**	1
	Sig. (2-tailed)	.249	.004	
	N	35	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

4.10 SUMMARY

This chapter demonstrated a detailed analysis of the knowledge, attitude and practice of final-year diagnostic radiography students at a KwaZulu-Natal university. The section on knowledge was analysed using the binomial test, whilst attitude and practice were compared with the use of t-tests. Knowledge, attitude and practice were also compared to the demographic variables using ANOVA and Pearson's correlation. The significance of these results has been discussed in the next chapter.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 INTRODUCTION

The significance of the findings is discussed in this chapter. The chapter has been structured to provide a summary of the response rate, followed by a discussion of the results for the various sections of the questionnaire that have been developed from the objectives of the study. The objectives of this study were to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of setting imaging exposures. The chapter examined the results of the demographics, knowledge, attitude and practice of diagnostic radiography students from a KZN university and its significance.

5.2 RESPONSE RATE

KZN has one university that offers diagnostic radiography as a career. The total number of 4th-year diagnostic students in the university was 37 in 2022. However, the researcher was able to collect data from 35 students, giving a response rate of 94.6 %. This high response rate may be attributed to the researcher being present after a contact session with a lecturer; hence most of the students were in attendance.

5.3 DEMOGRAPHICS

It is noted that the sample size was small. However, comparisons could be made between the different demographic groups.

5.3.1 INSTITUTION

Whilst the majority of the students attended clinical training at government facilities (71.4%) and 28.6 % attended private facilities, there was no significant difference in their knowledge, practice and attitude when compared to students who trained in private facilities. Various studies by Hyde (2015: 242), Mifsud *et al.* (2015: 17) and Girn (2022:

493) have highlighted the importance of clinical placement in radiography. Clinical placement or work-integrated learning (WIL) provides invaluable junctures for students to work and learn in real-time situations with real patients and staff members. However, there is a paucity of information on comparisons between government institutions and private facilities. From the results of this study, there was no significant difference between government placed students and private students.

5.3.2 GENDER AT BIRTH

The percentage of females was 85.7% as compared to males who made up 14.3% of the group. This high proportion of females is in keeping with the gender profile of South African radiographers. A study by Gam (2015: 64) acknowledged that the radiographic profession has a higher number of females as compared to males (88.4%), and a study by Erasmus (2018: 46) highlighted this similar phenomenon of female domination with a ratio of 9:1.

5.3.3 ETHNICITY

Whilst 65.7% of the participants were black, 2.9% were coloureds, 28.6% were Indian and 2.9% were white, the results did not demonstrate any significant differences amongst the different ethnic groups.

5.3.4 AGE

The majority (74.3%) of the participants were in the 22-25 year age group. This result was aligned to the average age of students who were enrolled for a four-year degree at the university. This was in keeping with Seabi *et al.* (2014:71) who conducted a study at the University of Witwatersand where the average age of students was 22.4 years old.

Students in these age categories are termed millennials or the Y generation (Smith 2006: 1 and Eckleberry-Hunt and Tucciarone 2011: 458). Whilst this group of students are “technology savvy”, they face the challenge of generational gaps and differences. Mentors, lecturers, educators, etc., have trouble understanding this generation of millennials and vice-versa. Eckleberry-Hunt and Tucciarone (2011: 460) stated that this generation did not conform to the traditional methods of studying or being taught. They often needed to be told what to do and lacked the ability to solve problems. Hence it was

essential to find creative methods to teach them such as the use of virtual learning, online classes and giving them direct instructions. Kong *et al.* (2015: 29) stated that “Simulation-based learning may increase students’ radiographic knowledge and improve students’ confidence in some elements of clinical skills and decision-making”. Whilst students in this study performed well in the areas of knowledge and attitude, the section on practice produced results (Figure 4.7) that were indicative of the millennial traits where students were unable to apply their theoretical knowledge for two items.

5.3.5 THE RELATIONSHIPS BETWEEN DEMOGRAPHIC FACTORS

- INSTITUTIONS: There was no significant difference between government-trained and private-trained students. Due to the scarcity of studies between government and private students, it may be speculated that qualified radiographers in both institutions are similar in their methods of training due to the fact that most of them have completed their degrees or diplomas at the same university in KZN, and also completed their clinical placements in the same hospitals in KZN.
- GENDER: The small percentage of male students did not have any significant difference in their knowledge, attitude and practice as compared to their female counterparts. This demonstrated that male and female students were similar in their level of knowledge, attitude and practice.
- AGE: The difference in age groups did not demonstrate any significant variance to students’ knowledge, attitude and practice.
- ETHNICITY: The study revealed that there was no significant difference in ethnicity.

5.4 DISCUSSION IN LINE WITH THE RESEARCH OBJECTIVES.

5.4.1 OBJECTIVE 1: TO DETERMINE THE KNOWLEDGE OF FINAL-YEAR DAIGNOSTIC STUDENTS WHEN SELECTING EXPOSURE FACTORS

The section on knowledge was created using twelve questions that related to the different factors affecting the imaging exposure setting. The test used in analysing this section was binomial testing. The results demonstrated that of the twelve questions, eight questions were answered correctly by a significant proportion. This indicated that the majority of

final-year diagnostic radiography students have good knowledge of exposure selection. However, three questions achieved incorrect responses by a significant proportion. This implied that the sections based on these questions may require additional investigating and coaching, if necessary, in order for students to have a better understanding of these segments. According to Schiska (2021: 28), it was necessary for students to understand the relationship between the imaging factors that they select and the effect thereof on image quality and patient dose. The correct selection of imaging exposure factors results in optimal image quality and minimal radiation dose to the patient. These sentiments were shared by van der Merwe *et al.* (2017: 123) who believed that the knowledge of radiation safety from radiographers was concerning, hence a standardized method of teaching radiation safety was required. However, the participants in this study achieved admiral results in the section of knowledge with the exception to three questions. These results contradicted van der Merwe's (2017: 123) view and that of the researcher who felt that students were struggling with accurately setting imaging exposure factors.

Students performed relatively well in this section (knowledge). Questions on grids, focal spot size, similar body parts, babies and the ALARA principle were answered correctly by more than 70% of the students. Despite the fact that students have answered these questions adequately, Schiska (2021: 29) emphasized that with the evolution of grids, there is a need to understand how electronic grids could reduce radiation dose if used properly. The author further stated that the latest recommendations suggested imaging paediatric cases where the tissues were less than 13 cm thick without a grid as this would reduce radiation dose substantially. Students would need to constantly update their knowledge in order to maintain dose optimization for their patients.

The results from the question on ALARA correspond with the guidelines set by the Health Professions Council of South Africa where radiation workers must understand the ALARA principle and practise it accordingly (Health Professional Council of South Africa 2014: 2). Van der Merwe *et al.* (2017: 109) concurred that radiographers and student radiographers had adequate knowledge of the ALARA principle but did not practice it accordingly.

Questions on body part thickness, SID, film/screen combination and collimation were answered incorrectly, thus signifying a lack of knowledge in these areas. Students were unable to discern that thicker body parts required more penetrative power. Kilo-voltage is desirable for penetrative power rather than milliamperes (Seeram 2019: 6). A significant

percentage(63%) of the participants did not understand this concept, thus raising concern that they may select incorrect exposure factors, which will ultimately increase the unnecessary radiation dose to patients (Herrmann *et al.* 2012: 85). Whilst the results for knowledge were good overall, the result for this concept was poor hence demonstrating that there were some areas in students' training that may require additional attention.

Schiska, (2021: 29) discussed how proper collimation reduced unnecessary exposure outside the field of view by 100 times. This guideline became significant for students to consider when keeping collimators open due to being afraid of cutting off anatomy, by collimating too close to the region of interest. Whilst students knew to collimate, 82.9% of the participants in this study did not know that collimation is one of the factors that affects kV and mAs selection.

Students were similarly not familiar with the inverse square law when changing distance. They appeared to have little knowledge that mAs must be increased when increasing SID using the inverse square law principle (Radiology Key 2016: 5). The binomial test results demonstrate that 71% of the participants answered the question on SID incorrectly, thus confirming that students may require additional support in this section.

The results from the binomial testing for film/screen combinations indicated that 97% of the participants were incorrect. The poor performance of students for film/screen combinations may be attributed to the change from film/screen radiography to digital radiography. Analogue radiography has been replaced by digital radiography and the use of film has become obsolete, hence students may not have knowledge of the different types of film/screen combinations (Mussmann *et al.* 2021: 1228). Hofmann *et al*. (2015: 1) noted that film/screen radiography yielded a higher percentage of repeat radiographs due to incorrect exposure factors as compared to digital radiography. With the replacement of analogue systems by digital systems, knowledge of film/screen combinations may not be required in the future. This information would be good to know as part of the history of radiography but not necessarily, need to know.

Apart from the change of film/screen to digital radiography that may attribute to students' poor performance in certain areas of knowledge, various reasons may be considered. According to Hayre and Cox (2020: 220), there is a shift from a traditional teacher-centred approach to learning to student-centred learning. Students were encouraged to embrace

self-regulated learning which encompasses reflection and self-assessment. This method of teaching was developed to assist students in becoming responsible for their knowledge and learning (Hayre and Cox 2020: 220). Given this change in teaching, combined with a generation of millennials who struggled with traditional teaching and were unable to complete tasks without assistance (Eckleberry-Hunt and Tucciarone 2011: 460), it could be that some students have not been able to adapt to self-regulation learning, hence resulting in the poor performance by students for some areas in the knowledge section. Students may have not understood these areas when they were being taught and did not seek further guidance from the university or clinical training centres.

From the results given, it may be concluded that most students have a sound knowledge of the factors that affect exposure selection. However, it must be noted that whilst eight of the twelve questions had significantly correct response rates, three questions had significantly incorrect responses. The binomial test presented a mean percentage for the questions correctly answered of 67.71%. This implies that 32.29% of the questions were incorrectly answered. Whilst 32.29% may not be significant, it is still noteworthy.

5.4.2 OBJECTIVE 2: TO DETERMINE THE ATTITUDE OF FINAL-YEAR STUDENTS WHEN X-RAYING PATIENTS

The segment on attitude was formed using eleven questions related to the feelings of participants when imaging patients. Nine of the questions were answered accurately by most of the students, thus indicating a good attitude. The positive attitude displayed by students was contrary to the study performed by Campbell *et al.* (2019: 39), which highlighted the indifference that radiographers showed when selecting exposure factors on digital x-ray units. A similar finding was depicted by Van der Merwe *et al.* (2017: 109) who documented that radiographers and student radiographers knew the ALARA principle but did not adhere to it, thus showing poor attitude.

Two questions based on the use of exposure charts (question 5) and the convenience of AEDs (question 10) produced results that indicated uncertainty amongst students. The uncertainty on the use of exposure charts and the use of AEDs may have been inculcated by observing qualified radiographers who select their own exposure factors. However, qualified radiographers may not always know the correct exposure factors, as demonstrated by Benza *et al.* (2018: 36) who concluded that 24.9% of rejected images

were due to incorrect exposure factors and recommended that precise exposure charts be available for qualified radiographers and students. This recommendation aligned with the regulations of the South African Radiation Control Board (Department Of Health Directorate: Radiation Control. 2012: 7). The results from this study demonstrated that whilst 53% of the participants answered correctly, 47% of the students either agreed or remained neutral when asked if they preferred their own exposures. This attitude goes against the guidelines of the South African Radiation Control Board, which clearly state that exposure technique charts are required in all general radiography rooms (Department Of Health Directorate: Radiation Control 2012: 7).

Rastegar's (2019: 40) findings are similar to the findings of this section on attitude. He found that incorrect exposure factors may be due to the lack of knowledge owing to the use of AEDs. There are similar studies that demonstrate a significant percentage of radiographers who do not use correct exposure factors, resulting in increased radiation dose to patients due to repeat imaging (Benza *et al.* 2018: 37; Ofori *et al.* 2016: 150 and Lewis *et al.* 2022: 389). Whilst is it noted that most of the students displayed a good attitude during the assessment of this section, the one sample t-test results exhibited a significant degree of misunderstanding for questions 5 and 10.

With regard to the convenience of AED, the one sample t-test results depicted that 40% of the students disagreed and 31.4% remained neutral. This result may be primarily due to students misunderstanding the question or they may have felt that it is a bad habit to use AED. There is paucity in research to substantiate this theory.

5.4.3 OBJECTIVE 3: TO DETERMINE THE PRACTICE OF FINAL-YEAR STUDENTS WHEN USING MANUAL EXPOSURE PARAMETERS

Studies by Hyde (2015: 242), Mifsud *et al.* (2015: 17) and Girn (2022: 493) established common themes which indicated that whilst students found WIL an integral part of learning, they also found it daunting when working with sick patients, qualified staff and rotating through various areas in a department. The studies demonstrated that WIL gave students the necessary skills to assist them when x-raying live patients (Hyde 2015: 242; Mifsud *et al.* 2015: 17 and Girn 2022: 493). However, whilst students may have the necessary skills and knowledge, their practice was not in keeping with their knowledge in this study.

The area of practice was developed using ten questions that pertained to how students applied their theoretical knowledge when x-raying patients. Two of the questions demonstrated that students practised correctly when using grids and selected the appropriate kV for different body parts. Three questions further demonstrated that a significant number of students practised changing their exposure factors accordingly when x-raying a chest from PA to lateral views, used the correct distance when x-raying their patients and collimated properly. Alsleem and Davidson (2012: 50) reiterated the necessity of recognizing the parameters that affect radiation dose and their influence on the quality of an image. This view is reflected in the areas of the questionnaire where the students understood the relationship between the selection on exposure factors and the factors that affect it. However, the areas where the students performed poorly suggest that students may require added training.

With the use of one sample t-testing, the following areas raised concern: a student's practice of using AEC if it is available, changing exposure factors to suit the collimation size and noting focal spot size. The results reflected a student's dilemma when confronted with these aspects of imaging exposure selection. Whilst the percentage of students who remained neutral fell under the 50% mark, it was noted that the percentage of students who were neutral ranged from 20 to 37.1%.

The uncertainty in the students' practice is evident in the results given and one of the reasons for the students' uncertainty may stem from their radiographic supervisors during WIL who themselves may not be adequately trained to assist students, as seen in a study by du Plessis and Bezuidenhout (2019: 104). Based on the outcome of their study regarding WIL for radiography students, du Plessis and Bezuidenhout (2019: 104) concluded that there is an urgent need for the training of WIL supervisors in order to provide a quality standard of practical education to students. The authors also recommended that lecturers from universities adhere to visiting students more frequently during their time at WIL instead of few times in a year. This allows for proper assessments of students' abilities and skills while completing WIL. It was identified that a structured course for WIL supervisors will be beneficial to the students in terms of teaching them soft skill and radiographic skills (du Plessis and Bezuidenhout 2019: 104).

The questionnaire had questions that were used to determine DAP meter and kV and mAs readings after exposure. DAP meters' functionality is to determine the amount of

radiation that a patient was exposed to when undergoing an imaging procedure (IAEA 2018: 106). The results from these questions were indicative of students not complying with this practice. By noting the readings, students will be able to ascertain if they have over-exposed or under-exposed the patient to radiation. Siebert and Morin (2011: 577) and Gibson and Davidson (2012: 460) have reasoned that whilst digital radiography may decrease patient radiation dose due to image manipulation thus avoiding repeat x-rays, this does not imply that the original dose was within normal limits. Radiographers have consistently increased radiation dose to patients which resulted in the phenomena of 'dose creep' (Gibson and Davidson 2012: 460). Dose creep refers to the unintentional practice of increasing kV and mAs when imaging a patient (Gibson and Davidson 2012: 460). The wider latitude of digital radiography makes image manipulation easy and radiographers do not need to repeat x-rays that are over-exposed (Douglas 2021: 40). One of the ways to prevent dose creep, was to note the DAP meter reading or the exposure index value and the exposure factors used on patients, whether automatic exposure settings or manual settings. By making note of these readings, student radiographers and radiographers were able identify the over-exposure and under-exposure of a patient (Douglas 2021: 40).

5.5 DISCUSSION IN LINE WITH THEORETICAL FRAMEWORK (KAP)

The theoretical framework used in this study was guided by the KAP model. According to Lee *et al.* (2021: 3), KAP surveys are generally used to identify gaps in knowledge and behavioural patterns in socio-demographic groups. It is a quantitative method of collecting data with the use of a standardized questionnaire (Andrade *et al.* 2020: 479). Students were tested in the areas of knowledge, attitude and practice. With the use of carefully designed questions, the researcher attempted to assess students' level of knowledge, attitude and practice.

On completion of the statistical analysis and with the aid of binomial testing, it was established that students had a mean percentage of 67.71% in knowledge. In other words, the average percentage that the total number of participants received was approximately 67% in the section of knowledge. This was significant as it revealed that

more than half of the group performed well in the area of knowledge. However, it also indicated that 22.29% of their knowledge required additional attention.

The area on attitude was analysed using the one-sample t-test, which presented that students demonstrated positive attitudes. However, the section on exposure charts and AEDs displayed students' uncertainty on the use of exposure charts and AEDs, thus highlighting the need for further investigation.

Students' practice displayed good behaviour using the one-sample t-test. Whist students passed this section; there were areas of concern where 20 to 37.1%students were unsure of manipulating imaging factors when changing collimation size or noting the focal spot size.

The sections on attitude and practice were indicative of positive attitude and adequate practice when selecting radiographic exposure factors. However, it was noted that attitude and practice was moderately correlated, as indicated by Pearson's correlation where p=.004 and r= -0.474. This implies that despite having a positive attitude, students were not always practicing their radiographic technique correctly, as determined by the results of one-sample t-tests. Their practice is in line with international and national research that was discussed in the literature chapter.

5.6 SUMMARY

The results from this study provide sufficient evidence that demonstrate good and poor performances by students. Whilst the overall results depicted an adequate percentage of knowledge, attitude and practice for students, there are areas that require further investigation and training. Theoretical knowledge on the inverse square law, film/screen combination and collimation resulted in poor performance by students. Students also showed poor attitudes when using exposure technique charts and AEDs. Not making note of the DAP meter reading or not looking at the kV and mAs after exposing on an AED are areas that need to be corrected by the supervisors who are watching students when they x-ray their patients. The following chapter will focus on the recommendations and limitations of this study.

6.0 CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The aim of the study was to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of setting imaging exposure factors, at the University of Technology in the eThekweni district. The outcomes resulting from the study conducted have led to conclusions and recommendations that have been discussed in this chapter. The conclusions or inferences made were derived from the research data and have endeavoured to answer to objectives of this study. The recommendations outlined were for the benefit of radiographers who supervise students and universities that may use this study to improve training methods to radiographic students. The researcher also acknowledges and discusses the limitations of this study in the chapter.

6.2 CONCLUSIONS AND INFERENCES DERIVED FROM THE DATA ANALYSIS

The objectives of the study were to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of the selection of imaging exposure factors. The current study presented data that inferred final-year diagnostic radiography students possessed adequate knowledge, attitude and practice in terms of setting imaging exposure factors without supervision. However, it also highlighted sections that required further training or teaching.

In the area of knowledge, participants may require further understanding on the relationship between collimation and exposure factors, SID and part thickness. By reinforcing the knowledge in these sections, participants would be able to set correct exposure factors constantly, hence eliminating unnecessary repeat x-rays for their patients. Apart from a small percentage of incorrect answers in knowledge, participants demonstrated characteristics that were contradictory to the study completed by Benza *et al.* (2018: 35) who revealed that 24.9% of the rejected images were due to incorrect imaging exposure factors while 2.2% was due to lack of collimation.

The section on attitude revealed that participants mostly had good attitude. However, the participants need to be mindful of AEDs and exposure technique charts. AEDs assist radiographers by automatically selecting kV and mAs when performing an examination, but accurate exposure charts are necessary in order to confirm what would be the minimum exposure required for a diagnostic image. According to Lewis *et al*. (2022: 38) and Benza *et al*. (2018: 350), accurate exposure charts displayed in radiology departments have reduced the repeat rate of images thus preventing unnecessary radiation doses to patients. Whilst participants had a good attitude, the two items that they performed poorly were AEDs and the use of exposure charts. Further education may be required for these items.

Practice was the last part of the questionnaire. The participants passed this section, but 20-37% of the participants displayed uncertainty when asked about collimation size and focal spot size. This raised concern because despite having good knowledge, students appeared unsure about their practice in the areas mentioned. Participants did not take note of DAP meter readings or the focal spot size or the exposure factors that were displayed after using automated exposure devices. In keeping with the phenomena of not observing DAP meter readings; Lewis *et al*. (2022: 38) reiterated the importance of noting exposure indices (EI) in their study. It was noted that 27% of the EI indicated over-exposure of images while 23% of the EIs revealed under-exposure of images. A visual note of these values would be able to convey to participants if they had under-exposed or over-exposed their patient. Whilst the overall performance by participants was adequate, room for improvement was noted.

The researcher acknowledged that the participants performed well in the study and this was contrary to the observation made by the researcher who believed that final-year diagnostic radiography students appeared to be struggling with the selection of imaging exposure factors. The objectives of the study were fulfilled and the researcher was satisfied with the outcome of the study.

6.3 LIMITATIONS

The study was limited to final-year diagnostic radiography students of one year in a university that was based in one province in South Africa. It was probable that the results could have varied if the study was conducted on a national level or if it was carried out over a few years for final-year diagnostic radiography students instead of pertaining to just a single group of students. It is recommended that future studies include all universities that have diagnostic

radiography as a course and perhaps conduct the study over a few years. This will permit researchers to evaluate if the knowledge, attitude and practice of all final -ear students are similar.

6.4 RECOMMENDATIONS

Whilst participants achieved scores that demonstrated their capabilities when setting imaging exposure factors, improvements to their knowledge, attitude and practice may be made by ensuring that role-players participate in diagnostic radiography students' professional development as radiographers.

6.4.1 RECOMMENDATIONS FOR STUDENT RADIOGRAPHERS

As a generation of millennials who forge ahead into the workplace, diagnostic radiography students need to take note of the differences between their generation and the older generation of qualified radiographers who were born between 1965-1979 and are called the 'x generation (Berkup 2014: 221). The older generation of radiographers or x- generation expects a degree of initiative and willingness to learn from a student. If students behave complacently in the workplace, radiographers may view this as sign of disinterest from the diagnostic radiography student and may not take the time to teach these students. In order to get the maximum benefit from WIL rotations, diagnostic radiography students have to develop a willingness to learn and to apply their theoretical knowledge. The selection of imaging exposure factors is not a simple process. One must take into consideration numerous factors before the correct selection of imaging exposure factors can be made. Diagnostic radiography students must be aware of this process and are required to follow it always. A consistent willingness to learn will allow radiographers to support and teach students more readily during their WIL placement, thus providing students with the training that is required in order to develop them into professional radiographers.

6.4.2 RECOMMENDATIONS FOR RADIOGRAPHERS

The generational gap between students and qualified radiographers is significant, but there are techniques to decrease the gap. Firstly, radiographers must understand the differences

between generations. Millennial students were nurtured and protected by their parents (Eckleberry-Hunt and Tucciarone 2011: 460). Their ability to problem-solve and to take initiative has been reduced due to their parents performing most of the tasks assigned to their children (Kong *et al.* 2015: 29). This phenomenon makes it difficult for the millennial student to learn using traditional methods. Qualified radiographers need to understand this and find innovative ways to teach these students. By understanding the millennial student, radiographers will be able to teach the students using appropriate methods suitable for these students, hence enhancing the knowledge of students and creating a more conducive learning environment for the students. This change in teaching style may permit students to improve their radiographic technique in a clinical environment.

Whilst literature advised that there is a need to understand the Y-generation, there is scarcity of information on what should the previous generations do in order to understand this generation of students, apart from changing traditional teaching methods to using technology and being more patient and more engaging toward students. Short-courses or seminars on the evolution of students have been developed by companies to assist people in the workplace with understanding the millennial generation. An example of such courses is the Dale Carnegie course that was developed to create a culture that engages and retains millennial employees in the workplace. These courses may be online or in-person. Various companies such as Dale Carnagie provide workshops and literature to assist the X-generation in understanding and working with the Y-generation. Radiographers will gain valuable insight into the behaviour patterns of students and in doing so will give radiographers the necessary tools that are required to assist the students.

6.4.3 RECOMMENDATIONS FOR UNIVERSITIES

Universities are the bridging instrument between students and qualified radiographers. Lecturers have gained intuition and understanding of students due to their constant interaction with students. Universities have the unique advantage of being the medium between students and radiographers; hence universities could incorporate a session on understanding the millennial student for radiographic institutions. Universities have the resources to hold seminars, talks or workshops in order to assist radiographers with understanding students and providing them with the necessary tools to teach students

appropriately. Therefore, it is recommended that universities collaborate with clinical institutions and host workshops or seminars for Y-generation radiographers.

Part of a lecturer's scope of practice is to assess students during their WIL rotation. Lecturers could use this opportunity to educate the radiographers on how to successfully teach students without becoming frustrated.

6.5 CONCLUSION

The aim of the study was to determine the knowledge, attitude and practice of final-year diagnostic radiography students in terms of setting exposure factors in the University of Technology in the eThekwini district. With the aid of a self-developed questionnaire, the study was conducted and the results were analyzed. From the study's data, various conclusions were acknowledged. The first conclusion was that whilst participants performed well in the study, there were some areas that needed further training, namely: taking note of DAP meter readings or focal spot size; the relationship between collimation and exposure factors; the convenience of AEDs and the inverse square law. The second conclusion was that students had adequate knowledge of radiographic techniques and they practiced it correctly most times. The third conclusion was that the generational gap between qualified radiographers and students needs to be reduced, which may be achieved by educating radiographers to understand millennial students. The results from this study are only valid for the final-year diagnostic radiography students of DUT.

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8.0 APPENDICES

APPENDIX A: PERMISSION TO USE IMAGES

RE: PERMISSION TO USE IMAGES IN MY DISSERTATION

Hayre, Chris <C.M.Hayre@exeter.ac.uk>
Mon 2024/01/01 23:20

To: Yashodha Rajendra <yashodha@live.co.za>; Cox, William A S <w.cox@imperial.ac.uk>
Cc: Thandokuhle Emmanual Khoza <ThandokuhleK@dut.ac.za>

Yes this is fine and good luck with everything...
Best
Chris

Dr. Christopher Hayre
PhD, MBA, PgC (Ed.), BSc (Hons), FHEA
Senior Lecturer in Medical Imaging (Diagnostic Radiography)
Programme Director: Medical Imaging (Diagnostic Radiography)
Department of Health and Care Professions
Room 1.32, South Cloisters
Mobile: +44 (0) 7706020050
University of Exeter, Devon, United Kingdom

Recent publication(s)

Al-Hayek, Y., Spuur, K., Davidson, R., **Hayre, C.M.,** Currie, G., and Zheng, X. (2024) Patient Off-Centering in Relation to CT Numbers and Radiation Dose: A Survey Study on Current Practice and Knowledge. Radiography. 30 (1), pp.100-106 https://doi.org/10.1016/j.radi.2023.10.009

Hayre, C.M., Muller, D., Scherer, M., Hackett, P.M.W., and Gordley-Smith, A (eds.) (2024) Emerging Technologies in Healthcare: Interpersonal and Client Based Perspectives. CRC Press. ISBN: 9781032224985

I work a flexible working pattern so may send emails out of 'normal' working hours. Please be assured that I do not expect a response outside of your own working hours.

From: Yashodha Rajendra <yashodha@live.co.za>
Sent: Thursday, December 28, 2023 6:55 PM

APPENDIX B: PERMISSION LETTER TO POST GRADUATE OFFICE

27 October 2022

Durban University of Technology
Faculty of Heath Science
Department of Radiography

Request for Permission to Conduct Research

Dear Head of Department.
Dr TE Khoza

My name is Yashodha Rajendra, an independent practice radiographer who is registered for a master's degree in radiography at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves Knowledge, attitude, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini.

I am hereby seeking your consent to conduct research of fourth year diagnostic radiography students and to personally distribute the questionnaire to these students on campus after a lecture.

I have provided you with a copy of my proposal which includes copies of the data collection tools and consent and/ or assent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 0827393256 or e-mail me at yashodha@live.co.za. Thank you for your time and consideration in this matter.

Yours sincerely,

Yashodha Rajendra
Diagnostic Radiographer

APPENDIX C: GATEKEEPER PERMISSION LETTER

21 March 2022

Durban University of Technology
The Gatekeeper

Request for Permission to Conduct Research

Dear Gatekeeper.

My name is Yashodha Rajendra, an independent practice radiographer who is registered for a master's degree in radiography at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves Knowledge, attitude, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini.

I am hereby seeking your consent to conduct research of final year diagnostic radiography students and to personally distribute the questionnaire to these students on campus after a lecture.

I have provided you with a copy of my proposal which includes copies of the data collection tools and consent and/ or assent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 0827393256 or e-mail me at yashodha@live.co.za. Thank you for your time and consideration in this matter.

Yours sincerely,

Yashodha Rajendra
Diagnostic Radiographer

APPENDIX D: PERMISSION LETTER FROM POST GRADUATE OFFICE

Directorate for Research and Postgraduate Support
Durban University of Technology
Open House
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732948

10 October 2022

Ms Yashodha Rajendra
c/o Department of Radiography
Faculty of Health Sciences
Durban University of Technology

Dear Ms Rajendra

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted **Gatekeeper Permission** for you to conduct your research "Knowledge, attitudes, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a University of Technology, in eThekwini" at the Durban University of Technology. **Kindly note that this letter must be issued to the IREC for approval before you commence data collection**.

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

We would be grateful if a summary of your key research findings would be submitted to the IRIC on completion of your studies.

Kind regards.
Yours sincerely

MS V GOVENDER
ACTING-DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECTORATE

APPENDIX E: QUESTIONNAIRE

FACTORS THAT AFFECT EXPOSURE SELECTION (kV and mAs)

For each question, select the ONE option that best applies to you

Section A: Demographics

1 Type of WIL institution

Private	Government

2 Race

Black	Coloured	Indian	White	Other: specify

3 Age in years

18-21	22-25	>25

4 Gender assigned at birth

Male	Female

Section B: Knowledge

Respond YES, NO or UNSURE to each of the following items:

KNOWLEDGE	Yes	No	Unsure
1 The use of grids increases exposure factors and increases image quality by reducing scatter			
2 Thicker body parts require higher mAs for penetration			
3 Large focal spot size allows for more electrons to pass through in a shorter time			
4 Small focal spot size is needed for smaller body parts such as hands and feet			
5 Source to image distance is directly proportional to mAs			
6 200 film screen combinations are considered faster than 400 film screen combinations			
7 kV and mAs selection for a knee in bucky is similar to a pelvis in bucky			
8 Pregnant women should never be x-rayed			
9 Greater collimation requires less kV AND mAs			
10 Small focal spot size is used for details such as trabecular patterns			
11 Babies should be x-rayed using the shortest possible time			
12 ALARA principle means that a lot of radiation is acceptable			

Section C: Attitude

Indicate your level of agreement to the following statements:

ATTITUDE	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1 It doesn't matter if I don't change the exposure for AP and lateral wrist because it doesn't make a difference to the image quality					
2 It is not important to collimate because electronic cropping is now available					
3 The DAP meter reading is not important					
4 When using automatic exposure devices, there is no need to look at the kV and mAs because analogue equipment is outdated and I do not need to know how it works.					
5 I feel that the values on the exposure chart are too low; hence I prefer to use higher kV and mAs					
6 It is acceptable if I don't know what the ALARA principle means					
7 I think that it's acceptable to take x-rays at any distance as long as the exposure factors are changed according to the distance					
8 Proper immobilization of babies is not necessary because I can repeat the x-ray if the baby moves					
9 I do not need to understand the factors that affect image quality because digital equipment has electronic image manipulation					
10 AED is convenient because I don't have to select my own exposure factors					
11 If I use my gut feel and not the theoretical settings it will not be detrimental to the patient					

Section D: Practices

Indicate your level of agreement to the following statements:

PRACTICES	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1 When using a grid, I change the exposure factors to compensate for the use of the grid.					
2. I use the same exposure for PA chest and lateral chest					
3.When a greater collimation is required I increase the kV and mAs					
4. When using automatic exposure setting, I look at the kV and mAs after I have exposed					
5. After I have exposed, I make a mental note of the DAP value.					
6 I do not always adhere to 100cm SID distance when imaging patients on the table					
7 I keep the collimation beams open because I am afraid I may cut off anatomy					
8 I always take note of the focal spot size when x-raying a patient.					
9 I rarely select my own exposure factors because AED is convenient to use					
10 I use low kV and long time for all my patients.					

APPENDIX F: LETTER OF INFORMATION

LETTER OF INFORMATION

Title of the Research Study : Knowledge, attitudes, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini

Principal Investigator/s/researcher: (Name/s, qualifications): Ms Yashodha Rajendra-
BTech Radiography(Diagnostic)

Co-Investigator/s/supervisor/s: (Name/s, qualifications): Dr T E Khoza
PHD Radiography (Diagnostic)

Brief Introduction and Aim of the Study:

Good day dear student
I hope you have been well during the pandemic.

I am Yashodha Rajendra, an independent radiographer doing research for my masters in diagnostic radiography.

I would like to invite you to participate in a research study that I am currently doing regarding final year diagnostic radiography students who study in DUT.

What is Research (Research is a systematic search or enquiry for generalized new knowledge)

The research intends to explore the knowledge, attitude and practice of final year radiography students in terms of imaging exposure factors in order to reduce unnecessary radiation dose to the patients and themselves.
The selection of correct factors is important in the prevention of unnecessary radiation to patients and radiographers hence the aim of the study is to illustrate that students are equipped with the necessary skills to reduce radiation dose to patients while producing good quality diagnostic images.
Kindly feel free to ask any question regarding this study should you not understand the information provided. You may discuss this study with family and friends and you are under no obligation to commit to participating at this stage. You are free to take a copy of the information letter to read at your convenience.

Outline of the Procedures: A permission letter will be sent to the postgraduate office requesting that the research be undertaken at DUT. The study will take place at DUT. Every student will be provided with consent forms and information letters prior to the study. You will be informed that the study is voluntary and confidential. The questionnaire will be distributed to 4th year students at DUT by me after a lecture. I will request permission from the department of radiography to handout the questionnaires to all of you. The study is open to all 4th year diagnostic radiography students who have successfully completed their prior modules. The research simply consists of a questionnaire that needs to be completed by you. The expected duration for completing the questionnaire is approximately 15 minutes. On completion, you may hand it over to me. I will collect all the questionnaires for analysis. Your participation will then be completed and you will be free to leave as soon as you have returned the questionnaire to me.

Taking into consideration the university's policy regarding Covid 19 at the time of collecting data, the researcher may have to change the collection method but that will occur if the university's Covid 19 policy prevents the collection of data at the campus.

Responsibilities of the participant:
To participate in the study by completing the questionnaire as candidly as possible.

Risks or Discomforts to the Participant: There are no health risks or discomfort that you will experience during the survey. Any fears and feelings of discomfort will be addressed by the researcher in order to make this experience simple and easy for you.

Explain to the participant the reasons he/she may be withdraw from the Study:
As a participant, you are free to withdraw from the study at any point without prejudice from the researcher however your contribution is vital to the success of this study.
Should the research be terminated due to unforeseen circumstances, or should the researcher decide to withdraw you from the study, a notification will be forwarded to you explaining the reasons for termination of the study or your exclusion..

Benefits:
Your contribution will provide important data on the knowledge, attitude and practice of students that can be used in the restructuring of the present curriculum if the research indicates a gap in training. The data can be used the assist lecturers in identifying problem areas in the training of diagnostic students e.g. if a high percentage of students do not know how to select the correct exposures for a pelvic x-ray, the lecturer may use this information to assist students in understanding how to select the correct exposure factors

Remuneration:
Please note that your participation is voluntary and you will not be remunerated for partaking in this study however your contribution will be valuable to the researcher.

Costs of the Study:
As a participant, you will not incur any costs by being part of this study. The necessary tools e.g. Pens and questionnaires will be provided by the researcher.

Confidentiality: Your participation will be confidential and your answers will not be revealed to any other parties. Your personal details will not appear on the questionnaire hence allowing for anonymity. Other parties will not have access to these questionnaires except for the researcher, supervisor and the statistician.

Results: Results may be published in journals or kept in the library at DUT

Research-related Injury: Not applicable. You will only be asked to fill in a questionnaire.

Storage of all electronic and hard copies including tape recordings
The data will be stored for duration of the study and thereafter disposed of via shredding after 5 years. Hardcopies such as paper printed questionnaire will be kept in a locked cabinet for 5 years. The questionnaires may be scanned and kept as a soft copy on a computer as a backup, should the questionnaires be destroyed. Soft copies will be deleted after 5 years.

Persons to contact in the Event of Any Problems or Queries:(Supervisor and details)
Please contact the researcher: Yashodha Rajendra 0313098465
My supervisor: Dr Khoza 0313732450
Institutional Research Ethics Administrator on 031 373 2375.

Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

APPENDIX G: INFORMED CONSENT

INFORMED CONSENT

Title of the Research Study : Knowledge, attitudes, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini

Principal Investigator/s/researcher: (Name/s, qualifications): Ms Yashodha Rajendra- BTech Radiography(Diagnostic)

Co-Investigator/s/supervisor/s: (Name/s, qualifications): Dr T E Khoza PHD Radiography (Diagnostic)

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Yashodha Rajendra, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, _____ (name of researcher) herewith confirm that the above participant has been fully

informed about the nature, conduct and risks of the above study.

Full Name of Researcher	**Date**	**Signature**
Full Name of Witness (If applicable)	**Date**	**Signature**
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

APPENDIX G: ETHICAL CLEARANCE

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwin Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

26 October 2022

Ms Y Rajendra
106 Glendale Drive
Glendale Gardens
Malvern
4093

Dear Ms Rajendra

Knowledge, attitudes, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini
Ethical Clearance number IREC 227/22

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC

APPENDIX H: LETTER OF PERMISSION TO THE RESEARCH DIRECTOR

21 March 2022

Durban University of Technology
The Research Director

Request for Permission to Conduct Research

Dear Research Director.

My name is Yashodha Rajendra, an independent practice radiographer who is registered for a master's degree in radiography at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves Knowledge, attitudes, and practice of final-year diagnostic radiography students on reducing patient radiation dose, at a university of Technology, in eThekwini.

I am hereby seeking your consent to conduct research of final year diagnostic radiography students and to personally distribute the questionnaire to these students on campus after a lecture.

I have provided you with a copy of my proposal which includes copies of the data collection tools and consent and/ or assent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 0827393256 or e-mail me at yashodha@live.co.za. Thank you for your time and consideration in this matter.

Yours sincerely,

Yashodha Rajendra
Diagnostic Radiographer

APPENDIX J: CERTIFICATE OF TRAINING

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Yashodha Rajendra

a complété avec succès - has successfully completed

Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Clinical Trials Centre
The University of Hong Kong

Release Date: 2022/03/14

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

APPROVED BY
SIWF FMH
ISFM

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Foederatio Pharmaceutica Helvetiae
FPH
Programmes de formation postgraduée et continue

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[REV : 20220217]