



**AN EXPLORATORY STUDY OF COMPLIANCE WITH PATIENT
RADIATION SAFETY STANDARDS AMONGST RADIOGRAPHERS IN
ESWATINI PUBLIC HOSPITALS**

Amelia Shungube (22290678)

Thesis submitted in fulfillment of the requirements for the degree of
Masters in Radiography in the Faculty of Health Sciences at the Durban
University of Technology

Supervisor : Dr T. E Khoza

Date : October 2023

Declaration

This is to certify that the work is entirely my own and not that of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Durban University of Technology or to any other institution for assessment or for any other purpose.

ABSTRACT

Background

The consequence of non-compliance with patient radiation safety standards is increased unnecessary radiation exposure with high chances of harmful biological effects. Somatic effects may take up to 40 years to manifest, which may cause radiographers to be careless with radiation protection compliance when used. Radiographers performing these procedures are trained to use the minimum amount of radiation necessary by observing the radiation safety standards. The study aimed to explore compliance with patient radiation safety standards by radiographers in Eswatini public hospitals in order to recommend appropriate compliance standards to the Eswatini Ministry of Health.

Methodology

The research questions were derived using a qualitative exploratory descriptive design, and constructivism paradigms. The data collection process consisted of in-depth one-on-one interviews. The sample was selected based on a purposive sampling approach. This study was conducted in the public hospitals in four regions of Eswatini. Study participants were radiographers employed in public hospitals with working experience of at least two years. Data saturation was achieved with 13 participants. After the data were collected, they were transcribed verbatim and analyzed using thematic analysis.

Findings

Three themes emerged from the data analysis, namely: a) Participants' attitudes towards compliance with radiation safety standards; b) radiographers' subjective norms; and c) perceived behavioral control factors. This study has revealed a gap in compliance with patients' radiation safety standards amongst radiographers employed in Eswatini public hospitals.

Conclusion

The study demonstrated awareness and knowledge of patient radiation safety standards amongst radiographers in Eswatini public hospitals. However, compliance with the standards remained a personal decision because radiographers are not obliged to

comply. Moreover, other factors contributing to non-compliance included defective lead protective devices; unavailability of all the lead protective designs; inappropriate design of the department building; and unauthorized staff making unjustified x-ray requests. The establishment of a self-regulatory body may assist in improving the situation through the introduction of radiation safety officers who will establish national Radiography policies and guidelines and ensure that radiographers follow them.

Keywords: Radiation, Radiation protection, Radiation safety standards Ionizing radiation, ALARA, Compliance

Dedication

This research is dedicated to my family: husband and my son Favor, my parents and my late best friend, Portia. Thank you for your support and encouragement!

Acknowledgements

To begin with, I would like to thank the Almighty God for giving me the strength, wisdom and perseverance necessary to complete this study.

In recognition of their contributions to the success of this study, I would like to express my sincere gratitude to the following individuals:

- Let me begin by thanking my supervisor, Dr T.E Khoza, for his outstanding guidance and support throughout this process. There are no words to adequately express my gratitude for your guidance, patience and support. It has been an honor and a privilege to work with him. He has been always available to provide hope, valuable feedback, support and encouragement. I would like to thank you for always being available to answer calls, text messages and to respond to an email on time.
- My appreciation goes to all government hospitals and health centers for granting me access to their institutions.
- It is with great gratitude that I thank the radiographers at these institutions for taking part in the study and for their willingness to assist me where they could. Without you, none of this would have been possible.
- My appreciation also goes to the Eswatini Health and Human Research Review board for granting me the permission to conduct the study in the country.

Table of Contents

	Page
Declaration	i
Abstract	ii
Dedication	iv
Acknowledgements	v
List of Appendices	ix
List of Tables	xii
CHAPTER 1: OVERVIEW OF THE STUDY	1
1.1 INTRODUCTION AND BACKGROUND TO THE STUDY	1
1.2 PROBLEM STATEMENT	2
1.3 AIM OF THE STUDY	3
1.4 REASERCH QUESTIONS	3
1.5 OBJECTIVES	3
1.6 SIGNIFICANCE OF THE STUDY	3
1.7 STRUCTURE OF THE DISSERTATION	4
1.8 SUMMARY OF THE CHAPTER	5
CHAPTER 2: LITERATURE REVIEW	6
2.1 INTRODUCTION	6
2.2 LITERATURE SEARCH	6
2.3 KEYWORDS USED	7
2.4 DEFINITION AND APPLICATION OF RADIATION	7
2.5 INTERNATIONAL CONTEXT	8
2.6 CONTEXT IN AFRICA	10
2.7 CONTEXT IN ESWATINI	12
2.8 THEORETICAL FRAMEWORK	14
2.9 RESEARCH GAP	16

2.10 SUMMARY OF THE CHAPTER	17
CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY	18
3.1 INTRODUCTION	18
3.2 RESEARCH PARADIGM	18
3.3 DESIGN OF THE STUDY	19
3.4 NATURAL SETTING	19
3.5 SAMPLING PROCESS	20
3.5.1 SAMPLING TECHNIQUE AND SAMPLE SIZE	20
3.5.1.1 SAMPLING OF HOSPITALS	21
3.5.1.2 SAMPLING OF RADIOGRAPHERS	21
3.5.1.3 INCLUSION AND EXCLUSION CRITERIA FOR RADIOGRAPHERS	21
3.5.1.3.1 INCLUSION CRITERIA	22
3.5.1.3.2 EXCLUSION CRITERIA	22
3.5.1.4 RECRUITMENT PROCESS	22
3.6 DATA COLLECTION PROCESS AND INSTRUMENTATION	23
3.7 DATA ANALYSIS	24
3.8 TRUSTWORTHINESS	25
3.8.1 CREDIBILITY	27
3.8.2 TRANSFERABILITY	25
3.8.3 RELIABILITY	25
3.8.4 CONFORMANCE	26
3.9 ETHICAL CONSIDERATION	26
3.10 SUMMARY OF THE CHAPTER	28
CHAPTER 4: PRESENTATION OF THE FINDINGS	29
4.1 INTRODUCTION	29
4.2 DEMOGRAPHICS OF THE PARTICIPANTS	29
4.2.1 GRAND TOUR QUESTION	30

4.2.2 PROBING QUESTION	30
4.3 CONCEPTUALISATION OF THE UNDERSTANDING AND VIEWS OF RADIOGRAPHERS IN AS FAR AS RADIATION PROTECTION COMPLIANCE IS CONCERNED IN ESWATINI	31
4.3.1. CATEGORY 1: PERSONAL ATTITUDE	34
4.3.1.1 THEME: ATTITUDE TO BEHAVIOR (COMPLIANCE WITH RADIATION SAFETY STANDARDS)	34
4.3.1.1.1 SUB-THEME: FAVOURABLE ATTITUDES	34
4.3.1.1.1.1 SUB-THEME: UNFAVOURABLE ATTITUDES	35
4.3.2 CATEGORY: RADIOGRAPHERS' SUBJECTIVE NORMs	36
4.3.2.1 THEME: RADIOGRAPHERS' ROUTINE BEHAVIOR	36
4.3.2.1.1 SUB-THEME: SOCIAL CULTURE/FACTORs	36
4.3.3 CATEGORY: RADIOGRAPHERS' PERCEIVED BEHAVIORAL CONTROL	37
4.3.3.1 THEME: CONTROL FACTORS	37
4.3.3.1.1 SUB-THEME: RESOURCE SHORTAGE	37
4.3.3.1.1.1 SUB-THEME: PATIENT-RELATED FACTORS	38
4.3.3.2.SUB-THEME: POOR INFRASTRUCTURE	39
4.3.3.3 SUB-THEME: UN-AUTHORIZED PERSONNEL REQUESTING X-RAY EXAMINATION	39
4.3.3.4 METHODS TO ENCOURAGE COMPLIANCE	40
4.4 SUMMARY OF THE CHAPTER	42
CHAPTER 5: DISCUSSIONS OF FINDINGS	44
5.1 INTRODUCTION	44
5.2 DEMOGRAPHICs OF PARTICIPANTS	44
5.3 PARTICIPANTS' ATTITUDES TOWARDS COMPLIANCE WITH RADIATION PROTECTION	45
5.3.1 FAVOURABLE ATTITUDES	46
5.3.1.1 UNFAVOURABLE ATTITUDES	47

5.4 RADIOGRAPHERS' SUBJECTIVE NORMS	48
5.5 RADIOGRAPHERS' PERCEIVED BEHAVIORAL CONTROL FACTORS	49
5.6 DISCUSSION ON THE RESEARCH QUESTIONS OF THE STUDY	53
5.6.1 WHAT IS THE LEVEL OF COMPLIANCE WITH THE IMPLEMENTATION OF PATIENT RADIATION SAFETY STANDARDS?	53
5.6.2 WHAT ARE THE CHALLENGES (IF ANY) FACED BY THE RADIOGRAPHERS IN THE IMPLEMENTATION OF PATIENT RADIATION SAFETY STANDARDS?	53
5.6.3 WHAT IS THE AVAILABLE RADIATION PROTECTION GEAR AND THEIR CONDITION?	54
5.7 SUMMARY OF THE CHAPTER	54
CHAPTER 6: CONCLUSION, LIMITATIONS AND RECOMMENDATIONS	55
6.1 INTRODUCTION	55
6.2 CONCLUSION	55
6.3 LIMITATIONS	56
6.4 RECOMMENDATIONS	57
6.5 FUTURE RESEARCH	58
REFERENCES	59
APPENDICES	67

List of Appendices

Appendix	Page number
Appendix 1: Interview guide	67
Appendix 2a: Letter of information (English version)	69
Appendix 2b: Letter of information (siSwati version)	70
Appendix 3a Consent letter (English version)	71
Appendix 3b: Consent letter (SiSwati version)	72
Appendix 4: Eswatini Health and Human Research review board study approval certificate	73
Appendix 5: University ethics clearance	74
Appendix 6: Matsanjani Health Center gate-keeper approval	75
Appendix 7a: Hlatikulu Government hospital gate keeper letter	76
Appendix 7b: Hlatikulu Government hospital Approval letter	77
Appendix 8 : Piggs Peak Government hospital gate-keeper letter	78
Appendix 8b: Piggs Peak Government hospital approval letter	79
Appendix 9a: Mankayane Government hospital gate-keeper letter	80
Appendix 9b: Mankayane Government hospital approval letter	81
Appendix 10a: Dvokolwako Health Center gate-keeper letter	82
Appendix 10b: Dvokolwako Health Center approval letter	83
Appendix 11: Lubombo Referral Hospital approval letter	84
Appendix 12: RFM Hospital approval	85
Appendix 13: Good Shepherd Hospital approval letter	86
Appendix 14a: Mbabane Government Hospital gate keeper letter	87
Appendix 14b: Mbabane Government Hospital approval letter	88
Appendix 15 a: EMkhuzweni Health Center approval letter	89

Turnitin report	90
Editor's Letter	106

List of Tables

Table 1.1 Design of the Dissertation 4

Table 3.1: Number of radiographers per hospital 20

Table 4.1: Demographic data of the participants 30

Table 4.2: Summary of the themes 33

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION TO THE STUDY AND BACKGROUND

Daily, hospitals and clinics use ionizing radiation for diagnostic imaging procedures. X-rays and gamma rays are the forms of ionizing radiation most frequently mentioned. Radiation-based procedures are necessary for accurate disease and injury diagnosis. The physicians and radiographers who perform these procedures are trained to use the least amount of radiation necessary (Health Physics Society, 2021. par. 3, line 3)

The International Atomic Energy Agency (IAEA) works to prevent patients from being exposed to superfluous and unintended radiation whilst ensuring that radiation doses are commensurate with medical purposes, as reported by Vienna (2018: par. 4, line 1). They intend to accomplish this by implementing radiation protection programs and activities designed to enhance radiation protection conformance. Unintended exposures and unsafe Radiology building design can lead to such exposures. In Eswatini's public institutions, all of the aforementioned programs were identified, with the exception of unsafe design in some hospitals. According to the researcher's knowledge, this phenomenon has not been studied in Eswatini. Lewis, Downing and Hayre (2022:1) conducted research in South Africa and concluded that even though participants' knowledge of radiation protection matched the mandated guidelines, limited internalization of the knowledge made compliance a matter of personal choice. Radiographers reflected on their casual demeanor and noted a similar demeanor amongst their counterparts. Patient and work-related impediments such as being rushed during the imaging of trauma and challenging patients, patient knowledge on radiation protection, resources, imaging referrals, inadequate training when transitioning from analog to digital radiography were identified as contributing to radiation protection compliance. In order to promote radiation protection compliance, strategies such as additional education, research and a mentality shift are utilized.

A study conducted in Trinidad by Partap ,Raghunanan, White and Seepal (2019:1) on the same topic concluded that the level of knowledge amongst radiographers across the country was minimal. Annual re-certification courses should be implemented such that individuals are kept apprised of current changes and reminded of commonly neglected safety practices (Partap *et al.* 2019:1). In addition, a global meta-analysis of all hospital contexts concluded that only one radiographer (12.9%) complied with radiation protection (Sarman and Hassan 2016:1). Similarly, a study conducted amongst radiographers in the Central region of Ghana found that radiation protection practices were generally well-known and that radiation protection compliance was satisfactory. However, this is insufficient, and there is still room for improvement to ensure that knowledge is applied to enhance appropriate safety measures, guarantee effective work, and reduce the negative effects of ionizing radiation (Fiagbedzi, Nyako ,Asare and Ndede 2022:1). The Theory of Planned Behavior (TPB) served as a foundation or support for this study. It predicts a person's intent to engage in a behavior at a particular time and location. Individual behavior is a function of behavior intentions, which are determined by three factors, namely an individual's attitude towards behavior, subjective norms, and perceived behavioral control (iSALT Team, 2014:2).

1.2 PROBLEM STATEMENT

This study aimed to investigate the underlying causes of Eswatini radiographers' non-compliance with radiation protection for patients. According to Abuzaid, Elshami, Shawki and Selama (2019:447) and Lewis *et al.* (2022:387), radiographers play a significant role in radiation protection and are essential for performing radiological examinations and radiation exposure. Therefore, they must ensure complete compliance with radiation protection and safety practices.

Non-compliance results in an increase in unnecessary radiation exposure with a high probability of detrimental effects that are difficult to assess because they occur in the descendants of patients exposed to radiation. Somatic effects may take up to 40 years to manifest, which may cause radiographers to be negligent with radiation protection compliance (Sarman and Hassan 2016:437). Using proper

techniques, equipment, shielding materials and beam collimation, as well as maintaining a safe distance from radiation sources, radiation protection is enforced to ensure that radiographers and patients are not exposed to unnecessary radiation (Bicol regional training 2020:1; Hubbe 2015:2).

1.3 AIM OF THE RESEARCH

The purpose of the study was to examine radiographers' compliance with patient radiation safety standards in public institutions in Eswatini, and to make recommendations to the Eswatini Ministry of Health regarding appropriate compliance standards.

1.4 RESEARCH INQUIRIES

- What is the level of compliance with patient radiation safety standards implementation?
- What difficulties do radiographers face in implementing patient radiation safety standards?

1.5 OBJECTIVES

- To determine the level of implementation compliance with patient radiation safety standards;
- To investigate the difficulties (if any) encountered by radiographers in implementing patient radiation safety standards; and
- To assess the availability and condition of radiation protection devices.

1.6 SIGNIFICANCE OF THE STUDY

The results of this study could be used to enhance radiation protection practices in public hospitals in Eswatini, potentially reducing patient radiation exposure. It could also influence the introduction or modification of policies pertaining to monitoring and evaluating compliance with protection guidelines in Eswatini.

In addition, this study seeks to determine whether diagnostic radiographers have adequate knowledge of the harmful effects of radiation exposure and the implementation of safety protocols. It also seeks to determine whether there are monitoring programs and responsible authorities that ensure that such protocols are adhered to, thereby ensuring radiation protection compliance.

The study also aims to pique the interest of radiographers and their superiors at the Department of Health regarding the significance of radiation's long-term side-effects. This study's findings will aid the Ministry of Health in evaluating its monitoring and compliance with radiation safety protocols.

1.7. DESIGN OF THE DISSERTATION

This dissertation comprises six (6) chapters, which are summarized in greater detail below.

Table 1.1: THE DISSERTATION STRUCTURE

First Chapter: Introduction	This chapter provides an overview of the study's context and a description of the research problem, purpose, objectives and significance.
Second Chapter: Literature Review	Current discourses on radiation awareness and the theoretical foundation of the research are discussed.
Third Chapter: Methodology	The paradigm, design, methodology, sampling procedure, data collection process, ethical considerations and data analysis methodologies are described in detail.
Fourth Chapter: Results	This chapter presents the study's findings by displaying the collected and analyzed data.
Fifth Chapter: Discussion	The fifth chapter discusses the collected data's results and trends as they pertain to the available literature.
Sixth Chapter: Conclusions, restrictions, and a recommendation	<p>A conclusion addressing the response to the aims and objectives of the research is presented.</p> <p>In addition, recommendations based on the study's findings and its limitations are elucidated.</p>

1.8 SUMMARY OF THE CHAPTER

In conclusion, a concise overview of radiation protection compliance and the researcher's motivation for conducting this study were provided. The problem statement and significance of this study were also described and connected to the study's aims and objectives.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

A literature review provides a summary of the sources consulted during research on a specific topic and demonstrates to the reader how the research works into the larger field of study (Ramdhani , Muhamad and Amin, 2014: 48). In addition, the literature review is an excellent method for synthesizing research findings and identifying future research areas, which is an essential stage in developing theoretical and conceptual frameworks (Snyder 2019: 333).

This chapter's objective is to review literature pertinent to the research topic and to discuss knowledge gaps and practices in the field of patient radiation safety standards compliance. It provides concise information on the literature sources as a starting point. The following heading shows sources of the reference search. It is followed by definitions of the study's keywords, as well as a header defining radiation and its applications. To accomplish the research objectives, this chapter conducts a comprehensive literature review on patient radiation safety compliance globally, in Africa, and in the context of Eswatini. This provides a comprehensive overview of the study.

The purpose of the study was to examine radiographers' conformance with patient radiation safety standards in Eswatini's public hospitals in order to recommend suitable compliance standards to the Eswatini Ministry of Health. The concepts of the Theory of Pre-meditated Behavior were presented as the theoretical framework. The chapter concludes with a discussion on the potential benefits of addressing the chapter's identified deficiencies.

2.2 REFERENCE SEARCH

There are few articles focusing on radiation protection compliance in Eswatini. To obtain a broader perspective, the search was expanded to include radiation protection compliance, which is more general and not country-specific. This section will critically and adequately review different studies conducted nationally and internationally. The Durban University of Technology (DUT) library provided

access to relevant textbooks and online journals, eBooks, Science Direct, conference papers, Google Scholar, pub med, DUT Google Scholar, dissertations, conference papers, and publications. A secondary search was conducted by browsing for articles cited by the primary search's authors.

In reviewing the relevant literature, the researcher ensured that they made a significant and reasonable contribution to understanding the topic. The information was then compiled and categorized according to its significance and relevance.

2.3 KEYWORDS APPLIED

- **Radiation:** This form of energy can be described as vibrations or particles as it travels from one location to another (Vienna 2023, para 1, line 1)
- **Radiation protection** is the minimization of the detrimental effects of ionizing radiation through the reduction of unnecessary radiation exposure (Frane 2023, para 1, line 1)
- **Radiation safety standards** are regulations enacted to protect against the hazards of ionizing radiation exposure (Care quality Commission 2023:3)
- **ALARA (As Low As Reasonable Achievable)** refers to making every effort to keep exposures to ionizing radiation as far below the dose limits as possible. (Abuzaid 2019:448)
- **Compliance:** the state or process of adhering to established guidelines or legislations (Iksanov,2021:2).

2.4 DEFINITION AND APPLICATIONS OF RADIATION

Medical applications of ionizing radiation are amongst the oldest uses of ionizing radiation. Ionizing radiation is the largest artificial radiation emitter (European Society of Radiology, 2019:25). The use of this form of radiation, which is crucial for diagnosing and treating a variety of diseases, is growing annually (European Society of Radiology, 2019:25). Since 41,3 million imaging tests were reported between March 2017 and April 2018 in England, the number of radiation procedures has increased. Tests conducted in February 2018 revealed that

approximately 1.73 million x-rays (plain radiography) were performed (Dixon, 2018:5).

Increased exposure to ionizing radiation in healthcare has been scientifically proven to cause damage to healthy tissues, such as skin burns and radiation sickness (deterministic effects) at high exposures. In addition, minimal exposures increase the risk of cancer and genetic damage (random/stochastic effects) (European Commission 2012,para 1,line 1) Moreover, errors in radiation exposures during diagnostic investigations are typically unrecognized or unreported, and are associated with a high morbidity rate (Dauda,Ozo and Towobola 2019:1).

2.5 INTERNATIONAL CONTEXT

The fundamental professional roles of radiographers are centered on providing imaging benefits to patients whilst always ensuring their safety. In Radiology, numerous patient safety issues must be considered. These encompass protection from direct harm arising from the techniques and technologies that radiographers use; ensuring the physical and psychological well-being of patients whilst under the radiographers' care; maintaining the highest possible quality of service provision; and protecting the staff to ensure that they can deliver a safe service (European Society of Radiology (ESR) & European Federation of Radiographer Societies EFRS 2019: 1)

The IAEA safety standards are applicable, throughout the entire life-cycle of all existing and new facilities and activities used for peaceful purposes, as well as to the protective measures taken to reduce existing radiation risks. Countries may use them as a guideline for their own national regulations regarding facilities and activities. According to the Fundamental Safety Principles, "the fundamental safety objective is to protect people and the environment from the harmful effects of ionizing radiation"(Vienna 2014:24). This objective must be attained without unduly restricting the operation of facilities or activities that pose radiation risks. Consequently, the system of protection and safety aims to assess, manage and

control exposure to radiation so that radiation risks, including risks of health effects and risks to the environment, are reduced to the extent that is reasonably achievable (Vienna 2014:24), which can be accomplished through radiographers' adherence to radiation protection as key players in radiation protection.

According to Northern Devon Healthcare (2017:12), radiographers are accountable for justifying and authorizing individual medical exposures based on the referrer's assessment information. In order to reduce radiation exposure hazards, medical radiation exposure must be justified, and ionizing radiation examinations must be optimized. Justification requires that the examination be medically necessary and beneficial. Optimization implies that the imaging should be performed using doses that are as low as reasonably achievable (ALARA) and consistent with the diagnostic task (Hyun 2016:1).

Similarly, Bicol Regional Training and Teaching Hospital (2015:1) confirms that radiation safety is enforced to ensure that patients and radiographers are not unnecessarily exposed to radiation through the use of appropriate techniques, equipment, and shielding materials. Salmanvandi *et al.* (2015:1) reported that some personal shields have defects (tears, holes and cracks) and that 13% of them were unacceptable in terms of equivalent lead thickness (ELT) and needed to be replaced because, if not, this could hinder efforts to comply with radiation protection safety standards for radiographers.

Contrary to the previously cited studies, the British Institute of Radiology Report (2020:1) concluded that patient shielding is generally not necessary in diagnostic and interventional Radiology. The primary reason is to protect the patient, as repeated contact shielding can frequently result in increased patient radiation dose. In addition, efforts expended on correct positioning and optimizing protocol parameters can result in greater dose reductions than lead application (British Institute of Radiology Report, 2020:2).

In addition, the International Atomic Energy Agency (IAEA) works to prevent patients from being exposed to unintended and superfluous radiation whilst ensuring that radiation doses are proportional to their medical purpose. This is

intended to be accomplished through the implementation of dedicated radiation protection initiatives and activities (Vienna, 2018, paragraph 4: line 1). Standards are only useful when applied appropriately (Vienna 2014:7). This further enlightens one that radiographers need to be well-informed about radiation protection in order to conform, and it revolves around them. Therefore, they are in a position to regulate or assure standard practice.

The International Commission on Radiological Protection (ICRP) consistently acknowledges the significance of education and training in reducing patient dosages whilst maintaining image quality. Different levels of training must be considered for entry-level users, retraining, and certification (Merwe, Kruger and Nel 2012:111). Currently, Eswatini radiographers do not have access to patient radiation protection workshops or training.

Moreover, a cross-sectional study conducted by Abuzaid, Elshami and Salama (2019:439) on radiographers working in government hospitals and health centers affiliated with the UAE's Ministry of Health revealed that forty percent of the radiographers' practices in implementing radiation protection were deemed to be relatively unsatisfactory. Therefore, proactive measures and corrective actions are required to enhance radiographers' knowledge of international standards and correct radiation protection procedures.

2.6 CONTEXT IN AFRICA

The use of ionizing radiation in diagnostic radiography could result in somatic and genetic injury. However, compliance with secure work and radiation protection practices could reduce these risks (Eze, Abonyi, Njoku, Irurhe and Olowu 2013:1). In addition, the use of radiation carries with it the obligation to maintain adequate knowledge and provide adequate patient radiation protection (Vilborn, Uys, Yakoob and Botha 2021:122). Consistently, Nyabanda (2015:5) indicates that the framework of Bonn's call for action includes, amongst other things, strengthening radiation protection education and training of health professionals; improving data collection on radiation exposures of patients; improving primary prevention of incidents and adverse events; and strengthening the radiation safety culture in

healthcare. Unfortunately, there is no infrastructure in place to promote radiation protection compliance in Eswatini, and radiographers are either registered or unregistered with the Dental Council.

According to the findings of a study conducted in Ghana by Fiagbedzi, Gorleku, Nyarko, Asare and Ndede (2022:1), adherence to radiation protection practices was generally adequate. In contrast, knowledge of radiation protection practices was generally high, but additional education was required. Implementing knowledge to enhance proper safety measures, assure practical work, and reduce the adverse effects of ionizing radiation could be enhanced. Furthermore, the Lagos Metropolis study by Eze *et al.* (2013:1) revealed that radiographers' knowledge of radiation safety was high, but their adherence to radiation protection practices was low. In all of the investigated institutions, the most modern radiation protection equipment required improvement. The majority of X-ray machines were outdated, and quality assurance evaluations performed on these machines required improvement (Eze *et al.* 2013; 1). This brings about a desire to find out more about the current situation in Eswatini as far as the above-mentioned is concerned because otherwise.

Moreover, this is consistent with the findings of Kamara, Okoye and Omubo-Pepple (2013:87), who demonstrated the need for increased monitoring of these Radiology facilities. Similarly, Lokhwani, Dalal, Jindal and Nagala (2019:742) emphasized that radiation safety personnel should conduct routine monitoring of radiation exposure protection. However, this service is unavailable in Eswatini.

According to Seyama (2022:46), this may be due to a leadership division/gap between higher-level management and clinical radiographers at the Ministry of Health level in Eswatini. Therefore, the Ministry may not be aware that radiographers in Eswatini require such a service. This might leave departments with obsolete and unusable lead-protecting devices, whereas Kellen, Hauwere Gossye, Peire, Pooter, and Bacher. (2022:2) suggest a reject analysis for malfunctioning lead-protecting devices. However, this must be accomplished in Eswatini.

2.7 THE ESWATINI CONTEXT

In South Africa, the Directorate for Radiation Control within the National Department of Health (DoH) is responsible for the overarching regulation of electronic devices. The Codes of Practice for Electronic Products (Hazardous Substance Act 15 of 1973) govern Radiation Control. The Hazardous Substances Act of 1973 is the most important piece of legislation providing the framework for controlling hazardous substances. It ensures that licenses are issued, inspectors are appointed, and bodies are inspected in accordance with Section 9. The Radiation Control's Code of Practice has clear guidelines for electronic goods (Modiba, 2014:16). It is lamentable that there are no national radiation safety standards for radiographers in Eswatini, hence they are unregulated. Therefore, their actions are determined by their particular preferences and the knowledge gained through tertiary education.

According to South African Radiation Control (2016:17), radiographers are responsible for justifying their practice and ensuring that no radiation protection measures are implemented unless the benefits outweigh the risks. Radiation Protection is emphasized in the Radiation Control Directorate's Code of Practice. The basic radiation protection principles are based on justification of the practice; optimization of protection by keeping occupationally exposed doses or that of patients as low as is reasonably achievable (ALARA principle); and limitation of individual dose and risk (Modiba, 2014:14). Nonetheless, Merwe *et al.* (2017:123) indicate that the ignorance of radiographers in South Africa regarding radiation safety requirements is a cause for concern, which might be a similar for concern in Eswatini.

Moreover, South African radiographers had a clear need for training regarding their attitudes toward radiation protection (Vilborn *et al.* 2021:122). According to Herbst (2012:9), more than 80 percent of over-exposures are typically the result of human error. Radiographers play a crucial role in radiation protection, thus they must take all precautions to prevent unwarranted radiation exposure (Lewis *et al.* 2022:47).

In addition, it is an integral part of the radiographer's education and ethical responsibility to understand radiation safety in order to prevent unnecessary radiation exposure (from both primary and secondary X-ray beams) to patients, co-workers, and oneself (Modiba, 2014: 15). This could be accomplished by requiring any caregiver holding a patient or cassette during exposure to wear a lead apron and, if applicable, lead latex gloves. No anatomical part of the caregiver must be in the principal beam, even if covered with lead (Radiation Control, 2016:17). Therefore, the responsibility of radiographers in radiation protection must also include the caretakers of the attending patients.

Consistently, Lewis *et al.* (2022:391) recommended additional education, research and a change in perspective as strategies to enforce radiation protection compliance, to further promote radiation protection conformance amongst South African radiographers. This emphasizes that it is the responsibility and role of radiographers to safeguard patients from radiation exposure, which remained a significant concern in Eswatini, and that radiographers adhere to this responsibility. In addition, Herbst (2012:6) demonstrated that it is disappointing that the current legal framework and enforcement of the act in South Africa are plagued by poor management, insufficient personnel levels, outdated data for radiation sources, and a lack of financial resources, amongst others. This is consistent with the findings of Dlamini (2019:6 and 7), who stated that Eswatini faced the challenge of having insufficient radiographers and being a low-income nation, resulting in a lack of funds to enhance radiation protection. Consequently, this factor, amongst others, contributed to non-compliance with radiation safety standards for patients amongst radiographers in this study.

To address this issue, it is stated that knowledge and education have a direct impact on the implementation of protection measures and require careful attention. Consequently, radiographers in South Africa participate in continuing professional development (CPD) activities that may reinforce the tertiary exposure to radiation protection principles (Merwe *et al.* 2017:111 and Vilborn *et al.* 2021:122). In

radiography, the current circumstance regarding existing guidelines is mastered and implemented. However, according to the knowledge of the researchers in Eswatini, there are no CPD events for radiographers. This was confirmed by the chief radiographer in Eswatini, Seyama (2022:33), who stated that she could not recall the council hosting any training for radiographers during the 18 years she worked as a radiographer in the country.

In contrast, the study by Lewis *et al.* (2022: 248) reveals that managers envisioned their ideal radiation protection environment and proposed means to achieve it. Collaboration between stakeholders, continuous education research, national standardized policies and radiography organizational structures were amongst the suggestions. Unfortunately, there are no national standardized radiation protection policies for patients in Eswatini. Moreover, a simple analysis of the situation reveals that there is a need for improved collaboration between radiographers and other stakeholders, possibly due to the absence of a radiographers' association or Radiography organizational structure. This is consistent with Seyama's (2022:33) assertion that there is a dearth of radiographers in Eswatini.

In order to avoid superfluous radiological examinations, Muhogora and Rehani's (2017:4) research demonstrated that diagnostic procedures must be adequately justified. Inconsistency, Munro *et al.* (2021) and Merwe (2017:111) indicated that health practitioners must know that every requested imaging examination must be justified to adhere to the principle 'as low as reasonably achievable (ALARA)'. Therefore, undergraduate curricula must incorporate nationally acknowledged guidelines on the risks and benefits of ionizing radiation medical imaging examinations. However, Eswatini lacked national radiation safety guidelines, and not all requested examinations were appropriate.

2.8 THEORETICAL FRAMEWORK

The Theory of Planned Behavior (TPB) provides support or a foundation for this study. It predicts a person's behavioral intention at a particular time and location.

Individual behavior is a function of three determinants: an individual's attitude towards behavior, subjective norms, and perceived behavioral control (iSALT Team, 2014:1).

It is believed that attitudes and subjective norms exert their influence on behavior through intentions. In addition, behavioral beliefs typically result in a favorable or unfavorable attitude towards the application of radiation safety standards; normative beliefs result in perceived subjective norms; and control beliefs result in or initiate perceived behavioral control. The greater the radiographer's favorable behavior, subjective norm and perceived control, the greater their intention to implement radiation protection (Arafat and Ibrahim, 2018, par. 1, line 14).

TPB assumes that intentions are the immediate precursor to behavior. The greater the intensity of an intention to perform a behavior, the greater its likelihood of occurring (Clough and Casey, 2011:2). In this investigation, the likelihood that personnel will comply with radiation protection is predicted by their intent to do so. In turn, the intention to comply is influenced by their attitudes towards radiation protection, their perceived capacity to control occupational radiation exposure levels, and how their co-workers and supervisors view radiation protection practices.

Depending on their beliefs regarding the results of radiation protection compliance, radiographers may have either positive or negative attitudes towards compliance. In cases where radiographers are adamant that radiation protection prevents harmful radiation effects such as cancer. Then, they will have a positive attitude at the individual level, which will increase their likelihood of complying with radiation protection in their daily work/practice (Hundah 2019:20 & Lewis 2022:48).

Moreover, increased radiation protection awareness amongst radiographers will encourage them to implement or comply daily because they will perceive that management and co-workers strongly condemn non-compliance with radiation

protection (Hundah 2019:21). It is believed that attitudes and subjective norms exert their influence on behavior through intentions. In addition, behavioral beliefs typically result in a positive or negative attitude towards compliance with radiation safety standards; normative beliefs result in perceived subjective norms; and control beliefs result in or initiate perceived behavioral control. Moreover, Hundah (2019:95) concluded that the participants had a positive attitude and moderate knowledge of radiation protection. Despite this, they did not adhere to the recommended radiation safety procedures. Despite participants' knowledge of radiation hazards, Awosan *et al.* (2016:10) and Maharjan *et al.* (2020:3) both found that radiation protection practices were inadequate.

In most cases, the greater the radiographer's favorable behavior, subjective norm and perceived control, the greater their intention to implement/comply with radiation protection (Arafat and Ibrahim, 2018:1). This demonstrates that the behavior or attitude of Eswatini's radiographers towards radiation safety measures is consistent with the Theory of Planned Behavior.

All medical exposures shall be subject to the principles of justification and optimization, according to the South African radiation employees' guideline (2016:14). X-ray examinations shall only be conducted when there are valid clinical indications, and the primary beam must be collimated continuously. No one may hold a patient, x-ray film cassette or other imaging apparatus during exposure unless it is impossible to obtain a diagnostically useful image. No part of the holder's body may be within the primary beam, even if covered by protective clothing. In addition, expectant women and minors (under 18) are prohibited from holding patients during exposure (South African Radiation Employees' Guideline 2016:14).

2.9 RESEARCH GAP

Even though radiation protection is taught in the tertiary curriculum for Radiography and there are international guidelines and policies for patient

radiation protection, there is still a need for further education. There is a need for a greater understanding of the challenges that radiographers in Eswatini face on a daily basis when it comes to complying with radiation protection practices. Minimal studies on patient radiation protection compliance and chronic exposure to low-dose radiation levels also contribute to radiographers' complacency regarding radiation safety protocols. This indicates a need for qualitative research as a starting point for addressing the complexities of patient radiation protection compliance issues. This study aims to investigate this disparity.

2.10 SUMMARY OF THE CHAPTER

The available literature on radiation protection in Radiography departments has been analyzed in depth. The current discourse that necessitated the need for this study has also been described. The following chapter describes how data were collected to meet the objectives of the study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Awal (2019: paragraph 2, line 1) defined research methodology as a systematic and theoretical analysis of the research methods applied to a field of study, which integrate the techniques and approaches of the instruments used to conduct a scientific research study. In this study, a qualitative research methodology was utilized because it is deemed appropriate when the researcher seeks to identify and theorize significant issues (Jamshed, 2014:1). It was used to investigate the obstacles that radiographers face in implementing patient radiation safety standards and to offer a recommendation. It enabled the researcher to contextualize how radiographers perceived their activities and environment, as well as their role in radiation protection compliance, and provided a picture of what was occurring (Hunter *et al.*2019: 3).

3.2 RESEARCH PARADGM

Patel (2015:1) describes a research paradigm is a set of shared beliefs and understandings amongst scientists regarding how problems should be understood and addressed. Davies and Fisher (2018:1) defined paradigms as distinct perspectives on the world, which frequently serve as the basis for research. They are a set of assumptions about what constitutes reality, how knowledge is created, and what is worthwhile to study (Davies and Fisher 2018:1). This theory was based on Constructivism. According to Adom, Yeboah and Ankrah (2016: 1), the constructivist philosophical theory is an effective tool that can generate numerous benefits when applied to research in a variety of academic fields. The constructivism paradigm is based on the analogy or premise that most of what people learn is formed or constructed through experience (Adom *et al.*2016:1). Constructivism was chosen because its ontology and epistemology are idealistic ('what is actual is an individual construction'), pluralistic and relativistic, and it is also founded on the interactional principle, thus interviews (Jordan, 2019:

paragraph 23, line 11). According to Ahmed (2008:1), ontology focuses on the type of world one is investigating; the essence of existence; and the structure of reality as a whole. Furthermore, it is stated that ontological assumptions answer the query of what can be known, or what is reality's nature? In light of the fact that there is currently a compliance gap in public institutions in eSwatini with regard to radiation protection, and that no incentive has been identified to encourage radiographers to comply, the researcher will determine the level of radiation protection compliance in eSwatini.

In addition, constructivism adopts epistemology, which is a means of understanding and explaining what one knows, as well as determining what types of knowledge are possible, and how to ensure that they are both adequate and legitimate. Thus, in this study, the researcher will conduct in-depth interviews with the radiographers in their departments in order to obtain their knowledge and ensure its legitimacy (Ahmed, 2008:3).

3.3 DESIGN OF THE STUDY

The study employed an exploratory descriptive design, which enabled the researcher to contextualize how radiographers perceived their activities and environment, as well as their role in radiation protection compliance, and to paint a picture of what is occurring (Hunter *et al.* 2019:3).

3.4 NATURAL ENVIRONMENT

A research venue is the location where research is conducted and data are collected (Roberts and Priests, 2010; 48). This research was conducted in public hospitals and health centres in Eswatini. Health facilities include Mbabane Government Hospital (MGH), Mankayane Hospital, Pigg's Peak Hospital, Hlatikulu Hospital, Lubombo Referral Hospital, and Good Shepherd Hospital. Included are Matsanjeni Health Centre, Nhlanguano Health Centre, Mkhuzweni Health Centre,

and Dvokolwako Health Centre. Given the study setting, the sample was drawn from the preceding list.

Table 3.1: The number of radiologists in each hospital

Hospital and Health Center Names	Number of radiographers
Government Hospital Mbabane	7
Pigg's Peak Public Hospital	3
Hlatikulu Public hospital	3
Hospital of Raleigh Fitkin Memorial	4
Mankayane Government Hospital	3
Lubombo Referral Government Hospital	2
Good Shepherd Hospital	7
Dvokolwako Health center	3
EMkhuzweni Health center	2
Nhlangano Health center	3
Matsanjeni Health center	2
Sithobela Health center	2

3.5 SAMPLING PROCESS

Sampling is a scientific technique used in systematic research to select units from a target population that are representative of the entire study population (Mulisa, 2020: 75).

3.5.1 Method(s) of sampling and sample size

Non-probabilistic, purposive sampling was used for sample selection. This technique is also known as the judgement sampling technique because participants are selected based on their qualities (Tongco, 2007:1). This choice is because the required information can be obtained from employed diagnostic radiographers with experience.

After obtaining permission from the hospital's Senior Medical Officer (SMO), the researcher contacted the radiographers who met the study's inclusion criteria. The sample size was 24 radiographers, but data saturation was attained after the 13th participant.

3.5.1.1 Hospital sampling

According to McMillan and Schumacher (2014: 350), site selection is crucial in research because it is the location where the researcher will recruit participants, conduct in-depth interviews, and capture extensive data. Using systematic sampling, hospitals from the four regions of Eswatini were selected. Hospitals and medical centers were chosen due to their Radiography services. Since the purpose of the study was to investigate radiographers' compliance with patient radiation safety standards in Eswatini's public health hospitals and health centers, this question was investigated. Purposeful sampling entails selecting the sample based on their participation in the phenomenon being investigated.

3.5.1.2 Sampling of Radiographers

The purpose of purposeful sampling is to select respondents who are most likely to provide relevant and useful data for the study (Kelly, 2010: 317). From the four

regions of Eswatini, appropriate participants for the study were selected through the use of purposeful sampling. The target audience consisted of radiographers with at least two years of experience working in public health hospitals in Eswatini. Radiographers were the study's main informants, hence they were purposefully sampled/selected.

3.5.1.3 Eligibility and exclusion criteria for Radiographers

3.5.1.3.1 Inclusion requirements

- Radiographers operating in public hospitals and health centers, and
- Radiographers with a minimum of one year's experience.

3.5.1.3.2 Exclusion requirements

- Radiographers who do not serve in public hospitals;
- Radiographers in public institutions who are qualified to participate but are unwilling to do so; and
- Radiography undergraduates and volunteers.

3.5.1.4 PROCESS OF RECRUITMENT

The recruitment procedure includes identifying potential research participants and providing them with information to determine their willingness to participate in a proposed study. In addition, the recruitment and retention of study participants are crucial to the overall success of the research study (Manohar, Narendar & MacMillan, Freya & Steiner-Lim, Genevieve & Arora, Amit 2018: 2).

With limited resources, purposeful sampling was used to select respondents most likely to provide relevant and useful information for the study (Campbell, 2020:653). From the four regions of Eswatini, appropriate participants for the study were selected through the use of purposeful sampling. The target audience consisted of radiographers with at least one year of experience working in public health hospitals in Eswatini. The radiographers were purposefully sampled/selected as the study's primary informants. In total, 24 radiographers

were invited to participate in the study, as described in the data collection procedure.

As rapport exists between the researcher and the participants, it is possible to state that word-of-mouth was the recruitment method. In addition, after obtaining permission from the gatekeeper, the researcher communicated directly with the radiographers to request their participation in the study. An informational letter was sent to the participants, who were then required to provide written consent (Appendix 3) (Manor *et al.* 2018:16).

3.6 PROCESS OF DATA COLLECTION AND INSTRUMENTATION

Face-to-face or one-on-one in-depth interviews with a minimum of two radiographers per hospital/health center were conducted. In some hospitals, both radiographers were interviewed to assure the validity of the data from that center due to a lack of personnel. This brought the total number of radiographers participating in the study to 24. The in-depth interviews with each hospital and health center were conducted according to a guide (Appendix 1).

The interview guide consisted of 15 queries, 5 of which were demographic in nature. This allowed for maximum data collection with minimal burden on the radiographers. The guide was designed to elicit information on demographics (gender, hospital name, age), working experience, availability of radiation protection gear and remarks on its condition, as well as a description of any obstacles encountered when using radiation protection. In addition, they shared the causes or perpetrators of non-compliance and possible solutions to improve the situation, as well as their opinions or comments on the radiation protection situation within the department.

The Radiographers were given a letter of information about the study (Appendix 2) and after agreeing to participate, they were given a letter of consent to sign (Appendix 3). The fourth appendix was a letter to senior medical officers requesting

permission to conduct research in the hospitals. The interviews were recorded (for all participants) with the radiographer's approval or permission, and the researcher took notes throughout the interview (Palinkas *et al.* 2015:3). The data was collected until data saturation, which means that a comprehensive understanding was attained until no new substantive information was acquired (Palinkas *et al.* 2015:3). The interview lasted approximately thirty minutes. Additionally, each interview was conducted in a private, silent room or space that was suitable for the participant. None of the interviews took place at their residences (Flemming and Regwaard 2018 :211).

3.7 DATA EVALUATION

In qualitative data analysis, preparing the data entails transcribing text from interviews into word-processing files for analysis (Creswell and Plano Clark 2018:314). All interview transcripts were transcribed, serialized and coded in accordance with the source. QSR NVivo, a computer program for qualitative data analysis, was used to manage data. Thematic data analysis was utilized, which is a robust yet adaptable method for analyzing qualitative data that can be applied within a variety of paradigmatic or epistemological orientations. This methodology is appropriate for this study because it permits the successful collection of radiographers' radiation protection compliance-related experiences, beliefs, and behavior (Kiger and Varpio, 2020:1). This research utilized Creswell's (2018:269) six-step data analysis procedure as follows:

- The initial phase was to transcribe and print the interview transcripts;
- The second phase consisted of reading or examining all the data. The researcher then read and comprehended the transcriptions after gaining a general understanding of the information and an opportunity to ruminate on its overall significance through the preceding steps;
- The third stage is coding all the data, which entails organizing the data by chunks (or text or image segments) and writing a category-representing word in the margins;

- The fourth phase that the researcher used involved the coding process to generate a description of the categories and themes for analysis. The researcher intended to categorize the classification of the data based on the theoretical framework of the study following the coding process;
- The fifth step was to refine the presentation of the description and themes in the qualitative narrative; and
- The final phase involved the interpretation of qualitative research findings.

3.8 TRUSTWORTHINESS

It is essential that the qualitative study be conducted systematically and methodologically in order to produce meaningful and useful results. To be considered credible, qualitative researchers must demonstrate that the data analysis was conducted in a precise, consistent and exhaustive manner by disclosing the methods of analysis in sufficient detail for the reader to determine whether the process is credible (Nowell et al., 2017: 1). Credibility, transferability, dependability and conformity were used to evaluate the study based on Shenton's (2004: 64) four criteria for establishing the reliability of qualitative research: credibility, transferability, dependability and conformity.

3.8.1 Credibility

This is the nature of qualitative research in terms of the veracity of research study findings (Statistical Consultation Blog, 2020: paragraph 2, line 1). Consequently, the credibility of this study was ensured by the use of appropriate, widely accepted research methodologies. Using a standard interview guide, the radiographers were interviewed in depth without bias. In addition, space triangulation was performed automatically due to the fact that the interviews were conducted in different hospitals with different radiographers. Triangulation refers to the use of multiple references to determine the truth.

3.8.2 Transferability

This is how qualitative researchers demonstrate the applicability of their findings to analogous situations, populations or phenomena. In order to demonstrate that the findings of this study can be applied to other contexts, circumstances and situations, the researcher ensured that all relevant information was described in detail from the study's context to its conclusion (Statistical Consultation Blog, 2020: paragraph 3, line 1).

3.8.3 Reliability

This indicates that the study could be repeated by other researchers with identical results so that if another person wants to replicate the study, they should have enough information from the report to do so and obtain the same findings. To ensure the reliability of this study, the researcher took steps so that the methodology and design were delineated and described in detail (Statistical Consultation Blog, 2020: paragraph 5).

3.8.4 Conformance

This represents the degree of neutrality in the study's findings. It requires the researcher to demonstrate how conclusions and interpretations were reached (Nowell *et al.* 2017:2). To maintain conformity, the researcher ensured that the findings were based on participant responses and not on any potential bias or personal motivations of the researcher (statistical consultation blog, 2020: paragraph 4, line 1). In addition, the audit trail technique was utilized, which outlines each step of data analysis that was intended to provide a justification for the decisions made.

3.9 ETHICAL CONSIDERATIONS

According to the Declaration of Helsinki, a researcher must consider both national and international ethical, legal and regulatory norms and standards for research involving human subjects (Kong and West, 2013:3). The fundamental ethical principle is to not injure research participants in any way. To ensure that these ethical standards were adhered to, letters of approval from the DUT Ethics Committee (IREC 308/22, Appendix 5) were requested. Additionally, permissions were requested from the Eswatini research ethics committee (Appendix 6, EHRRRB035/2023) and the senior medical administrators of each hospital and health center.

Before the interview, the researcher provided a letter with information about the study (Appendix 2) and a consent form (Appendix 3) to be signed. The potential participants were approached individually and given an information sheet to further clarify the study and they were given at least 24 hours to read and decide if they wished to participate. For feedback, the researcher called them after work hours for privacy. In addition, they were provided with an appropriate opportunity to ask questions and voice any concerns, which in this instance was when the researcher called to confirm their participation in the study, as described in the data collection process. It was also clarified that participation is voluntary, so employees could disengage from the study without repercussions to their employment (Arifin 2018: 31).

By not revealing the radiographers' names and identities during data collection, analysis and reporting/dissemination of the study's findings, anonymity and confidentiality were maintained. This was further ensured by conducting the interview individually or one-on-one in a private and quiet room. Moreover, the researcher was the only one able to match the identity of the participants and voice recordings (Arifin, 2018:30 and 31). The participants were informed that their information is confidential, that their names would be anonymized, and that the

information collected from them would be made confidential through the use of pseudonyms. The collected information would be known only by the researcher and would be used solely for the study before being discarded.

The audio was kept on a password-protected computer that only the researcher has access to, while the notebook containing the obtained data was stored in a secure locker. The data would then be disposed of after 5 years in a manner that would not be reversible with any chance of recovery once the researcher is sure and convinced that it will not be needed again after the analysis. The notebook pages would be shredded with an office shredder, taking extra care during the procedure and burning the pieces. Similarly, all audio from the audio tape would be deleted and removed from the recycle receptacle. If the audio-tape employs compact disc read-only memory (CDROMs), it will be stored in the same secure locker as a notebook and physically destroyed after five years.

Data transcription was conducted in a private room using earphones to prevent the possibility of other people hearing the recordings, and participants will be referred to by their pseudonyms in the verbatim quotations when the study's findings are presented (Arifin, 2018: 30).

3.10 SYNOPSIS OF THE CHAPTER

The procedure for collecting data has been described. In addition, the selection of the methodology, research instrument, and associated data collection measures has been described. The subsequent chapter details the results of this data acquisition effort.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 INTRODUCTION

This chapter presents the collated data's results. Using in-depth, one-on-one interviews, compliance with radiation safety standards by radiographers in Eswatini public hospitals was investigated in order to make recommendations to the Eswatini Ministry of Health regarding appropriate compliance. The purpose of this study was to investigate the level of compliance with the implementation of patient radiation safety standards, the challenges (if any) faced by radiographers in the implementation of patient radiation safety standards, and the availability and condition of radiation protection equipment. The interview guide was utilized to elicit abundant content from the radiographer participants. All audio recordings were recorded with the participant's permission. The interview took place primarily in a quiet room within the department or outside, away from commotion and destruction, per the radiographer's preference.

4.2 DEMOGRAPHIC INFORMATION ABOUT THE PARTICIPANTS

Participants were from public hospitals and health centers in all four regions of the nation. The regions are Lubombo, Manzini, Shiselweni, and Hhohho, and the participants were diagnostic radiographers employed at public hospitals and health institutions in Eswatini. Participants ranged in age from 20 to 60 years old and had between three and fifteen years of clinical experience. Most of them had between one and five years of experience. All four regions of the country were represented by hospitals and health institutions with radiography departments. Four participants were from the Hhohho region, three from the Manzini region, four from the Shiselweni region, and three from the Lubombo region. The ratio of males to females who participated was almost identical, with one male participant outnumbering females. There was no correlation between gender ratio, age

category, regional location, and work experience and knowledge score. This is consistent with Mahajan's (2020:1) research.

4.2.1 Grand tour question

1. What do you understand by radiation protection?

4.2.2 Probing question

i. What measures do you take personally to safeguard patients during your practice?

ii. Is there any policy that binds you to always comply?

Table 4.1 DEMOGRAPHIC INFORMATION REGARDING THE PARTICIPANTS

Participant	Gender	Age	Working experience in years	Region of hospital
1	F	20 to 29	2 to 5 years	Shiselweni
2	M	30 to 49	2 to 5 years	Shiselweni
3	M	20 to 29	2 to 5 years	Shiselweni
4	M	20 to 29	2 to 5 years	Shiselweni
5	F	30 to 49	2 to 5 years	Hhohho
6	M	30 to 49	15 and above	Hhohho
7	F	30 to 49	5 to 10 years	Manzini

8	M	30 to 49	2 to 5 years	Manzini
9	F	20 to 29	2 to 5 years	Lubombo
10	M	50 to 59	15 and above	Lubombo
11	F	30 to 49	5 to 10 years	Hhohho
12	M	30 to 49	5 to 10	Lubombo
13	F	30 to 49	5 to 10	Lubombo

The study had 3 research objectives as listed: to explore the level of compliance with the implementation of patient radiation safety standards; to explore the challenges (if any) faced by radiographers in the implementation of patient radiation safety standards; and to assess available radiation protection gear and their condition.

A purposive sampling method was employed to recruit the participants from public hospitals and health centers. Data saturation was attained at the 13th participant. Most of the participants had 2 to 5 years of experience.

4.3 CONCEPTUALISATION OF THE UNDERSTANDING AND VIEWS OF RADIOGRAPHERS INAS FAR AS RADIATION PROTECTION COMPLIANCE IN ESWATINI

The thematic analysis used on the transcripts stimulated important concepts that were identified in the interview data. The main categories in this study were generated from the Theory of Planned Behavior, which posits that individual behavior is driven by behavioral intentions where behavioral intentions are a

function of 3 determinants or comprises 3 main elements, namely individual attitude towards behavior, subjective norms, and perceived behavioral control (iSALT Team, 2014:1).

The first category that emerged is **Personal attitude** which gave the *attitude to compliance* theme, and resulted in two sub-themes: favorable attitude and unfavorable attitude. The second category, **subjective norm**, led to the formation of a *routine behavior* theme, from which two sub-themes, social factor, arose. The final category, perceived behavioral control, led to the construction of a perceived power theme and four subthemes, including a lack of resources. Patient-related factors, inadequate infrastructure, the incorrect personnel requesting x-rays, and strategies to promote compliance.

According to the interviews conducted, these themes (attitude towards compliance, routine behavior and perceived authority) helped to illuminate the participants' experience. These influenced the study's themes (Table 4.2). The researcher discussed the nine sub-themes that emerged from the three categories, namely favorable attitude and unfavorable attitude; social culture or factor, resources shortage; patient-related factors, poor infrastructure, the unauthorized staff making x-ray requests, and strategies to foster compliance, all of which emerged from the Theory of Planned Behavior determinants, the theory upon which this study is based.

In the following section, the researcher describes each category, theme and sub-theme. For the purpose of validating the developed themes and sub-themes, interview excerpts were used.

Table 4.2. Synopsis of Themes

DIFFERENT CATEGORIES	MAIN THEMES	SUB-RELATIVE THEMES
4.3.1 Individual Attitude	4.3.1.1 Attitude and Behavior of the Radiographer (Compliance with Radiation Safety Standards)	4.3.1.1.1 Favorable attitude 4.3.1.1.1.1 Unfavorable attitude
4.3.2 Subjective guidelines	4.3.2.1 Routine conduct of radiologists	4.3.2.1.1 Social factor/culture
4.3.3 Behavioral control perceived	4.3.3.1 Perceived Behavioral Control factors of Radiographers	4.3.3.1.1 Materials/Resources 4.3.3.1.1.1 patient-specific variables 4.3.3.2.2 Low-quality infrastructure 4.3.3.3 Unauthorized personnel making X-ray requests 4.3.3.3.4 Methods to promote compliance

4.3.1 CATEGORY1: PERSONAL ATTITUDE

The first factor in Ajzen's (1991) Theory of Planned/Premeditated Behavior is this category. This aids in predicting individuals' behaviors. therefore, if one wishes to predict individuals' future actions, one must examine their attitudes. This category comprises the totality of the participant's positive and negative knowledge, attitudes and preconceptions regarding radiation protection compliance.

4.3.1.1 THEME: ATTITUDE TO BEHAVIOR (Compliance with Radiation Safety Standards)

Regarding compliance with radiation protection safety standards, the participants' perspectives and experiences varied. Their responses revealed that some had positive attitudes and others had negative attitudes. These ideas comprised the sub-themes, which are positive and negative attitudes.

4.3.1.1.1 SUB-THEME: FAVOURABLE ATTITUDE

The first theme investigated and described the radiographers' experiences, knowledge, and application of radiation protection in practice. Most participants provided positive feedback.

Participants defined radiation protection as measures that must be implemented in order to safeguard patients, colleagues, oneself and the general public from dangerous radiation exposure. Radiation protection stipulates that an x-ray order or request must be justified and patient identification must be confirmed (Vom and Williams 2017: 212). If a caregiver is required to help immobilize the patient, they are provided with lead aprons to wear in the room. In addition to indicating that they pay more attention to collimation and averting repetitions, the participants mentioned the potential consequences of not using radiation protection. Participants expressed their comprehension using the following phrases:

"..I think radiation protection is basically about taking measures to protect the environment, the people around you, and yourself as a radiographer from radiation exposure, basically mostly I use lead aprons are used depending on the procedure requested, using the ALARA principle minimizing time, shield and using the required distance and also ensure caregivers are asked to go outside the room or given a lead apron to wear and be told to be away from the primary beam, failure may lead to stochastic and deterministic effects." #Participant 7

" ..I think radiation protection is about measures that have to be put in place taken to protect patients, colleagues, yourself, and the public from radiation exposure since radiation is dangerous, it can cause cancer and skin reddening to count a few so we are trying to minimize the exposure with all measures we can use like avoiding doing unnecessary exams to the patient, minimizing repeats through explaining the procedure and demonstrate to the patient, collimate to the area of interest, using correct (SID) source to image distance for that procedure, lead apron to avoid exposing unnecessary structures and high KVP technique where necessary..."#Participant 3

4.4.1.1.1.1 SUB-THEME: UNFAVORABLE ATTITUDES

The responses of the participants indicate that radiation protection is a personal matter and that the use of radiation protection depended on the radiographer who was caring for the patient. In addition, the participants admitted that they have a negative attitude and disregard for radiation protection because they believe that the biological damage to the body is minimal due to the small exposure, which is merely departmental culture, but they do their best to protect pregnant women and children. On some queries, such as the frequency with which they use radiation protection measures when attending patients, the radiographers shared the same opinions, indicating non-adherence and neglect. Participants expressed their comprehension using the following phrases:

"...for me, I feel like the radiation that we are getting is small.." we have that one apron there, and the other one is still in the box and I don't want to lie to you, sometimes I open the door when exposing while patients queue by the door, I open because it's very hot in this room, I always think about radiation protection and effects after attending to the patient my main concern is a good image that is why sometimes I pull the switch and expose while in the room for pediatrics but I know that radiation protection is something that I need to do, not like something needs to be done for me because on hot days I can open the air-conditioner and keep the door always closed when exposing.." #Participant 5

'..There are no radiation safety officers, national obligation, or policy for me to use radiation protection, whether I use radiation or not it's my issue or choice, I use radiation protection but it's not always because we are a busy institution most of the time we are rushing trying to push the queue we don't have time" #Participant 7

"..it's unlike that time when I was a student, now I use radiation protection as I want, no need to worry about anything or anyone like marks and supervisors, there is no one supervising me to check or any radiation safety officers that can randomly visit to see if I am using the radiation protection measures I work on my own so I use them the way I want".. #Participant 1

4.3.2 SUBJECTIVE NORMS OF THE RADIOGRAPHER

This category considers how one perceives the opinions of others regarding a particular behavior. It is not what other people believe that matters, but rather how one perceives their attitudes. This category's main theme is routine behavior, while its sub-theme is the social culture/social factor.

4.3.2.1 THEME: ROUTINE BEHAVIOR OF RADIOGRAPHERS

Regarding their routine application of radiation protection measures, the participants shared the same viewpoints and comments. Their responses demonstrated an in-depth understanding of the stages of life in which cells are highly sensitive to radiation exposure and may cause severe effects. They mentioned that they do everything they can to protect expectant women and children in all possible ways, which linked or associated their behavior with the influence of a social culture/factor that emerged as a sub-theme.

4.3.2.1 1 SUB-THEME/FACTOR: SOCIAL CULTURE

Participants showed increased conformance with radiation protection for children and pregnant women. This was influenced by the practices and ethos of their departmental colleagues. Participants expressed their comprehension using the following phrases:

"We don't always use radiation protection because we are a busy institution we don't have time even though this cannot be an excuse but for pregnant women who are involved in accidents we do use radiation protection, and for kids from 0 to 2 years we always protect and we mainly focus on lead shielding, for those pregnant women we ensure that we explain the risk of the examination and do it only if the risks outweigh the benefits like with pregnant women in first trimester we avoid by all means to examine unless it's a very critical patient, then we have got no other way." #Participant 9

4.3.3 CATEGORY: PERCEIVED BEHAVIORAL CONTROL BY THE RADIOGRAPHER

This category relates to the degree to which one believes that one has control over one's behavior. This depends on how one perceives internal factors, such as aptitude and determination, and external factors such as access to resources and support. This category's theme is perceived authority, and its sub-themes are lack of resources, patient-related factors, inadequate infrastructure, the wrong staff requesting x-rays, and strategies to promote compliance with radiation protection standards.

4.3.3.1 THEME: CONTROLLING FACTORS

This topic focuses on the factors that facilitate or hinder the performance of the behavior. The behavior of the radiologists is under their control. Resources, patient-related factors, poor infrastructure, the incorrect staff requesting x-rays, and strategies to promote compliance emerged as the predominant themes.

4.3.3.1.1 SUB-THEME: LACK OF RESOURCES

Participants further explained that they are discouraged from using lead aprons or do not use them. They feel ineffective because they have been in the position for a long time with no change. Therefore, if given the opportunity to ameliorate the situation, they would replace all existing aprons with new ones. In addition, they argued that because the lead-protecting devices have been in place for so long, replacements are necessary. It is challenging because they also assist expectant women. Participants expressed their comprehension using the following phrases:

'..I don't think they are effective, in terms of percentiles I would give them 30%..' given a chance to improve the situation I would buy new lead aprons, I feel like they should be changed at least after every 3 years – #Participant 9

In some instances where lead devices are available, one will find that they do not fulfill all roles, as lead devices are distinct and serve various purposes.

"...buy all the necessary equipment for shielding because we end up having to fold the apron for pregnant women which damages it because we don't have wrap-around, we only have lead aprons and they are not useful when doing exams like chest there is no way you can protect the patient with it otherwise it will get folded damaging it"... #Participant 3

"..we are not sure of the equipment situation as far as radiation protection is concerned.." provide radiation protection officers to come now and then and see the challenges we face and work on it, that include the equipment moreover, they can also do QA assessments for the rooms and the lead aprons if they are effective, we need radiation protection officers such people are needed so that you can improve or see if there are any discrepancies on the equipment and with us radiation workers.." #Participant 1

4.3.3.1.1.1 SUB-THEME PATIENT-RELATED FACTORS

Participants' perspectives on patient-related factors that prevent them from complying with radiation protection measures were identical. In addition to being hurried when treating trauma patients and dealing with difficult patients, some patients complain that the lead aprons are too heavy. Participants expressed their comprehension using the following phrases:

"..thyroid is one of the organs sensitive to radiation so we have to always protect it during examinations unfortunately with road traffic accident patients especially those unconscious we are not able to protect it because the first examination to do is the C-Spine and it cannot be covered with lead shield otherwise it will not show,

the same applies to pregnant women it becomes difficult to adhere to radiation protection measure in cases where femur or the hip is ordered."- #Participant 9

4.3.3.2 SUB-THEME: POOR INFRASTRUCTURE

As a result of the department's sub-par infrastructure, a number of participants have expressed a lack of motivation to conform with radiation protection measures. It is in the incorrect location and lacks radiation protection for patients waiting outside and in adjacent departments. Participants expressed their comprehension using the following phrases:

'..in our case, the only challenge we have is that we do not have a leaded door or any door at all so that means all those who don't know and pass by during exposure get exposed, can it be patients or any other staff, we are having a curtain as door"
#Participant 7

"..the room walls are not shielded, I once placed a cassette for 3 days in the other room department, and processed it later only to find it is exposed meaning patients and staff in the other room are being exposed unnecessarily and the patients on the queue are also receiving radiation exposure since the walls do not have lead, we are supposed to have a radiology department away from here because the infrastructure is not proper.." #Participant 6.

4.3.3.3 SUB-THEME: UNAUTHORIZED PERSONNEL REQUESTING X-RAY EXAM

Unauthorized personnel placing orders for x-rays was a concern raised by the participants. They strongly believe that only physicians should be able to order x-rays, as most of the time they receive unnecessary orders, such as for a patient with a scratch who is sent for an x-ray to rule out a fracture. Therefore, they believe it is essential to educate employees about the hazards of radiation and radiation

safety. Participants used the following expressions to characterize their experiences:

'...we find that we have to expose patients for unnecessary orders to rule out fracture while it's clear there is no need...' so other health care workers need to learn about radiation protection so we make sure we screen the request forms because there are those requests ordered by nurses and you will see that there is no need to do an x-ray so we need x-ray requests to be made by appropriate personnel which is a doctor..'"-#Participant 3

4.3.3.4 SUB-THEME: METHODS TO ENCOURAGE COMPLIANCE

This theme examines potential strategies or methods for enhancing radiographers' adherence and conformance with radiation protection regulations. The radiographers demonstrated interest and a willingness to develop, and they have high hopes that this study will be instrumental. As previously stated, participants cited several obstacles that prevent them from completely complying with radiation protection. Work-related, departmental and patient-related obstacles were identified. Nonetheless, the radiographers highlighted potential mitigation strategies for the problem. Radiation Safety Officer's could assess the situation and report their findings to the radiation authority board, which is also unavailable. Consequently, they believe that if this is established, they will have an appropriate international standard channel to follow and a board that can ensure and enforce radiation protection compliance in the departments. Participants suggested that structures be evaluated and constructed appropriately for radiation use. They indicated that the walls and doors do not contain lead and that the department is adjacent to another department with staff and patients, so the best solution is to construct a new building. Moreover, radiographers are in a favorable position and have sufficient knowledge to provide guidance when a new Radiology building is required. Participants described their expectations using the expressions listed below.

"...I hope this study yields good results on the issue of radiation protection in our departments because now we are talking about patients while we radiographers do not have dosimeters that's the most painful part, how about ourselves? We are not protected we don't know how much radiation accumulated in our body and it's a pity because we don't have what call a radiation board #Participant 3

On the issue of educating personnel and patients about radiation protection, the participants shared the same opinion. This could even make it difficult to order x-rays for patients without a proper assessment or consultation with the attending physician. When other employees are educated, they may also be cautious around the department, especially since some of the structures are not properly constructed.

"..educate our patients because if they were to be educated about radiation protection because most of them do not know anything about radiation protection whether you protect them from ionizing radiation or not they don't know, for them they come for whatever they are expecting whatever they are expecting and go out while " #Participants 7

"..we have been willing to do that service since I have been into this field, to teach the community of radiation safety finances are the problem, yeah, the financial part is the main problem had it been not that then I guess the country would have gotten to learn more about this like a year or 2 years ago, finances are holding us back, honestly speaking if we could push harder definitely we can get somewhere and teach people about this" #Participant 2

"..radiographers need professional seminars because if you have seminars and workshops that is where you develop the skills and the skill of protecting patients, it goes hand in hand with continuous professional development so that can also help in encouraging us to comply..' #Participant 2

Participants believe that the obstacles they face are a result of the lack of a Radiographers' Association in the country, as well as a radiation protection advisory/authority board. They also stated that they do not know where to direct this request in order for it to be understood as the majority of people are not yet familiar with Radiology. Therefore, having such a board will aid in the Radiology field's representation at the national level or the Ministry of Health. Participants expressed their comprehension using the following phrases:

"...I believe radiation protection policies can be implemented to enforce patient protection so that every radiographer is obligated and guided to always comply with radiation safety standards and clearly states the consequences that the radiographer may face if they don't comply because we protect some patients but not others because we tend to focus on pregnant women" #Participant 7

"...I believe we should have a board in the country of radiation workers who deal with anything that emits radiation, so that board can regulate how radiation is used in the country," #Participants 13

"Okay, I would say that it must begin with us as radiographers. Before pushing it and blaming it on someone else, we are the ones who must engage others and give them a sense of what we are talking about. We are also the ones who must create a proper structure for our partners and let them know what we are talking about when discussing a radiology department. Therefore, moving on to the next individual, we must also engage the government. The Ministry of Health must go out and learn about the different patterns and find a way to get feedback on what is happening in the hospital departments as long as it deals with health services, and it must open an office where we can submit our concerns or complaints" #Participant 2

4.4 SYNOPSIS OF THE CHAPTER

This chapter presented and analyzed the study's findings, which included demographic information about the radiographers who participated. In addition, strategies to increase compliance with radiation protection regulations amongst radiographers were outlined. The findings were presented in the form of themes derived from the codes generated from the interview transcripts. To facilitate comprehension, several themes were sub-divided into sub-themes and categories. The results of this study indicate that radiographers have a comprehensive understanding of radiation protection, the effects of radiation exposure, and how compliance can be ensured by discussing methods to improve the situation in their departments. The results presented in this chapter will be discussed in the context of extant literature on the Theory of Planned Behavior and patient radiation protection compliance by radiographers in the subsequent chapter.

CHAPTER: 5 DISCUSSIONS OF RESULTS

5.1. INTRODUCTION

This chapter discusses the results of the current study in light of the proposed theoretical framework, namely the Theory of Planned/Premeditated Behavior. This research examines radiographers' compliance with radiation safety standards in public hospitals in Eswatini. The Theory of Planned Behavior predicts the intention of an individual to engage in a behavior at a particular time and location. Individual behavior is a function of three determinants, namely an individual's attitude towards behavior; subjective norms; and perceived behavioral control, according to this theory (iSALT Team, 2014:1).

TPB was adopted because it implies that intentions are the immediate behavior that precedes or determines if the behavior will be done. The stronger the intention to perform a behavior, the greater the likelihood of the behavior happening (Clough and Casey, 2011: 2). In this investigation, the staff's intention to comply with radiation protection predicted their likelihood of doing so. In turn, the intention to comply is influenced by their attitudes towards radiation protection, their perceived capacity to control occupational radiation exposure levels, and how their co-workers and supervisors view radiation protection practices. The following is a discussion of the study's results in light of the Theory of Premeditated Behavior.

5.2 PARTICIPANTS' DEMOGRAPHIC PROFILE

Participants were from all four regions of the country, public hospitals, and health institutes, namely the Lubombo, Manzini, Shiselweni and Hhohho regions. The participants in the research were diagnostic radiographers employed by public hospitals and health centers in Eswatini. Participants' ages spanned from 20 to 60 years, and their clinical experience ranged from three to fifteen years and beyond. The majority had between one and five years of professional experience. Three

participants were from the region of Hhohho, two from the region of Manzini, four from the region of Shiselweni, and four from the region of Lubombo. The ratio of males to females who participated was nearly equal. Males (7) slightly outnumbered females (6).

5.3 ATTITUDE OF PARTICIPANTS TOWARDS COMPLIANCE WITH RADIATION PROTECTION

Attitude refers to the extent to which a person evaluates the behavior of interest favorably or negatively (La Morte, 2020: paragraph 3, line 1). It requires contemplation of the consequences of the behavior (La Morte, 2020: paragraph 3, line 1). This theory can be used to predict the behavior of individuals. Hence, one wishes to predict their future behavior, one must examine their attitudes. This study examined the attitudes of radiographers, including the participants' knowledge, attitudes and prejudices. This perspective included both positive and negative assessments of compliance with radiation safety standards (Motalebi *et al.*, 2023: 2). Regarding compliance with radiation protection safety standards, the participants' perspectives and experiences varied. Their responses revealed that some had positive attitudes and others had negative attitudes.

5.3.1 FAVORABLE ATTITUDES

The results of this study indicate that the majority of participants provided positive feedback regarding the radiographers' experiences, knowledge and implementation of radiation protection in practice.

Participants described their comprehension of radiation protection as measures they must implement to protect patients, colleagues, themselves and the public from radiation exposure since it is dangerous. Radiation protection mandates the justification of an x-ray request, ensuring that the patient's identity is confirmed (Hyun 2016:1). The examination chamber must contain only the patient. Sometimes a caregiver is required to assist with immobilization. In this case,

radiographers must use lead aprons to protect caregivers (Radiation Control, 2016:17). Participants also mentioned the potential biological and genetic effects of not using radiation protection. According to the results of the study, participants pay more attention to collimation and avoid repetitions.

Radiation protection was comprehended in accordance with the International Atomic Energy Agency (IAEA) and the South African Radiation Authority. All medical exposures shall be subject to the principles of justification and optimization, according to the South Africa Radiation Authority's code of conduct, and X-ray examinations shall not be performed without valid clinical indications (Radiation Control, 2016:11-17). Children may be more sensitive to radiation, necessitating a stronger justification for pediatric examinations. Obtaining prior x-ray images to reduce the need for duplicate filming was practiced.

The principal beam must always be collimated. Radiation examinations may only be requested by a physician or other health professional with the appropriate training and registration. Under guidelines for the protection of pediatric patients, it is stated that the extended life-expectancy of children increases the potential for the manifestation of radiation's possible harmful effects. In pediatric patients for a given procedure, each view shall be examined, where practical, before deciding whether to obtain a further view.

The occasional use of non-radiation personnel to assist, particularly in ward or theatre radiography, is acceptable but shall entail the full use of protective clothing, devices and techniques to minimize personnel radiation dose. It must be ensured that the same non-radiation personnel do not always participate. Women who are pregnant shall not be considered in this capacity. Holding of patients or x-ray film cassettes during exposure shall be done by persons accompanying the patient in preference to non-radiation personnel, and by non-radiation personnel in preference to radiation workers (Radiation Control, 2016: 11-17).

Non-radiation personnel should be designated based on a roster, i.e., it shall not be the same person who does the holding. No pregnant women or juvenile persons

(under the age of 18) shall do any holding. Any persons holding patients or film cassettes in position during an x-ray examination shall wear a lead rubber apron and, wherever practicable, lead rubber mittens. No part of the holder's body shall be in the primary beam, even if covered with protective garments. (Radiation Control, 2016: 17).

As stated previously, the South African code of practice for radiographers conforms to IAEA (Vienna 2023:5). "Medical exposures shall be justified by weighing the anticipated diagnostic or therapeutic benefits against the radiation detriment that they may cause, taking into account the benefits and risks of alternative techniques that do not involve medical exposure. Unfortunately, ESwatini lacks guidelines or a code of conduct, so radiographers rely solely on their tertiary education. According to the International Atomic Energy Agency (IAEA), radiation protection involves preventing patients from being exposed to unnecessary and unintended radiation whilst ensuring that radiation doses to patients are proportional to the medical purpose (Vienna, 2023: para 1: line 4).

The feedback received from participants is consistent with the study conducted in South Africa by Lewis *et al.* (2022:388), which indicated that the participants had appropriate radiation protection knowledge because they described their understanding of radiation protection as a skill of using correct patient positioning, precise collimation, and correct exposure factors to obtain high-quality images at the lowest possible exposure to the patient. Moreover, a study by Fiagbedzi *et al.* (2022:146) had similar results.

In addition, a systematic review of 41 studies was conducted between 2000 and 2019 in 22 countries on healthcare workers' knowledge, attitudes and practices towards radiation protection. It revealed that more than half of the participants had a positive attitude towards radiation protection, and that the other half had average knowledge and practice (Behzadmehr *et al.* 2020: 223). These results are consistent with this study's findings.

5.3.1.1 UNFAVORABLE ATTITUDES

This study demonstrated that radiation protection was a personal matter, and the use of radiation protection depended on the radiographer attending to the patient. The participants admitted they had a negative attitude and slight negligence towards radiation protection as they believed that the patient's radiation exposure was insufficient to cause biological or genetic effects.

This pattern of results was consistent with previous literature by Lewis *et al.* (2022:390) which indicated that radiographers believed that radiation protection was a waste of time and a nuisance, and also showed that radiographers admitted that when treating pediatric and geriatric patients, they always comply with radiation safety standards.

5.4 SUBJECTIVE NORM OF THE RADIOGRAPHERS

A subjective norm is the belief that an important person or group will approve or support a particular behavior (Ham *et al.* 2015:740). It considers how one views the ideas of other people about a specific behavior (La Morte 2022:1). It is not what others think, but one's perception of their attitudes, as it relates to a person's beliefs about whether peers and people of importance to the person believe he or she should engage in the behavior.

The results of this current study showed that there was no obligation or any policy/law that forces/pushes radiographers to use radiation safety standards in Eswatini. Hence, compliance with radiation protection was a personal choice, and their current routine behavior was poor because it was conditional. These findings were consistent with a study by Eze *et al.* (2013:1), which showed poor adherence to radiation protection practices amongst radiographers in the Lagos metropolis. The possible implication is that the patients are at risk of radiation effects. This was

because the routine behavior developed and became a departmental culture amongst the participants. This culture needs to promote compliance with patient radiation safety standards fully. This study's findings strongly imply that action was needed to discourage or stop this culture. A study by Motalebi, Kandi, Rostamzadeh, and Farshad (2020:5) suggests that using various training programs and facilitating safe behavior in the workplace can be the beginning of laying the groundwork and changing safe behavior in the workplace. The findings of Motalebi's study showed a significant improvement in subjective norms after the intervention in the supervisors' in the department. Furthermore, Motalebi *et al.* (2021:5) found that a person avoids and tries to perform certain behaviors to gain the support of influential people and co-workers in the organization. Therefore, gaining the support of influential people in the workplace is an effective intervention.

5.5 RADIOGRAPHERS' PERCEIVED BEHAVIORAL CONTROL FACTORS

Perceived behavioral control is an individual's perceived ease of achieving a particular behavior based on experience, which is primarily reflected in the individual's resources and capabilities to achieve the behavior (Xingwei Li *et al.* 2023:4). This definition is consistent with this study's findings because it revealed that there are multiple contributing factors for the current radiation protection practices.

This study revealed that the participants did not use lead aprons because they believed that they were no longer effective. The reason was that they had been there for a long time with no change. Kellen *et al.* (2022:2) suggested that there should be a reject analysis for defective lead-protecting devices. Additionally, the lead protective devices should be inspected twice a year to monitor defects (Lokhwani, 2021: 740).

Consistent with the findings of the present study, Salmanvandi *et al.* (2015:1) emphasized that quality control on radiation equipment must be performed

appropriately to ensure safety. The reason for this was that defective lead aprons are not new, they have existed in the past. In Iran, a study revealed that some personal shields had defects (tears, holes and cracks). Some of these shields were unacceptable in terms of equivalent lead thickness (ELT) and needed to be replaced.

Due to the nature of the different procedures, lead devices were only sometimes applicable in hospitals where they were available. This was because the radiographers had to fold them, despite the fact that they must not be folded to cover pregnancy or used as a wrap-around for any other procedure. If misused, they may develop cracks, which reduces their protection factor because radiation can pass through the cracks (University of Iowa.2018: para 3, line 1). Additionally, participants held similar opinions regarding patient-related factors that prevented them from complying with radiation protection measures. These factors included being rushed when attending to trauma patients; difficult patients, and some patients complaining that the lead aprons were too heavy. Since patients were unaware of the radiation effects, radiographers were tempted not to use the lead aprons.

Consistent with the findings of Lam, Larson, Eisenberg, Forman, and Lee. (2015:962), knowledge and perception of ionizing radiation medical imaging revealed that patients were generally unaware of radiation exposure. This finding is consistent with Tombo ,Krapels ,Boulding ,Majonga,Cummins and Holland. (2023:5), who demonstrated that basic infrastructure is lacking for delivering safe Radiology services. These were specifically observed regarding the building layout, which must be revised in the present study.

However, participants suggested improving compliance with patient radiation safety standards. Radiographers showed interest and willingness to improve and it is hoped that this study would play a significant role. Participants cited several barriers that prevent them from fully complying with radiation protection, despite their desire to do so. The findings of this study showed that participants had the

same sentiments about the need to educate staff on radiation protection. Education could show the unauthorized staff, who are primarily nurses, why they should not just make an X-ray request form. The reason was that they mainly send patients for X-rays even when there is no need, like when a patient may fall and have a bruise, to rule out a fracture. The X-ray request forms are clinical and legal documents completed by a referring clinician or his/her surrogate to communicate the required procedure and the reasons for the procedure (Jimah, 2021:1).

According to the Auckland District Health Board (2020:2), as far as x-ray requisition forms are concerned, an exception can be made only with nursing staff in accident and emergency departments who have completed a limb assessment training program, not just any nurse to avoid such mistakes. Amongst other competencies, this nurse must demonstrate knowledge of contra-indications for requesting x-rays and the risk of unnecessary radiation exposure. The practice of nurses requesting X-rays has been pioneered in accidents and emergencies and is now commonplace in many departments. The purpose of introducing a policy to support nurses and non-medical practitioners to request x-ray examinations is to ensure prompt diagnosis and treatment, and the delivery of patient-focused, high-quality care (Goodie 2016:3).

The findings of this study showed that patients had limited knowledge of radiation protection, which was consistent with the studies of Lam *et al.* (2015:962) and Deghani *et al.* (2014:116), who showed that despite growing concerns regarding medical radiation exposure, there was still limited and inferior awareness of radiation-induced cancer risks amongst patients. Therefore, given the low patient awareness about imaging dose, it was recommended to prepare and give all patients brochures that explain safety procedures and common concerns. Information posters must be displayed in the imaging department and throughout the hospital. Moreover, Hospital management should design programs that would emphasize patient education, like introductory talks every morning before work begins (Naderi *et al.*, 2021:2 and Kamara *et al.*, 2013:87). Therefore, organizing

public awareness programs on radiation safety can also be a turning point in improving patients' knowledge of the radiation-induced effects in Eswatini, based on the sentiments of the participants. This initiative could yield positive results provided that the requirements for radiation workers to comply with radiation safety standards effectively are also met.

The benefits of having a regulatory body include inspection and enforcement to ensure that facilities, equipment and work performance meet all requirements (Vienna, 2004:28). However, this study revealed that in Eswatini, there is a lack of this body. The participants had the same sentiments on the absence of a radiation regulatory body in the country being the main problem regarding compliance with radiation safety. Government is required to establish through legislation a national regulatory body to regulate the introduction and conduct of any practice involving sources of radiation (Vienna, 2004: 5). In order for this problem to be resolved, the Government must be fully engaged, just as Maina *et al.* (2020:1) indicated in their study that there was a need for concerted efforts between the Rwanda Utilities regulatory authority, the Ministry of Health (government), the University of Rwanda and hospital management to improve the radiation safety culture.

The participants believed that once the Government introduces the regulatory body, it would also be accessible for introducing radiation safety officers. The role of Radiation Safety Officers (RSO) is to prevent unnecessary exposure to ionizing and maintain necessary exposures as low as reasonably achievable (ALARA) (Morgan and Konerth, 2021:1). Furthermore, the responsibilities of RSOs are to report non-compliance with the plan or safety standards and provide what is needed to ensure compliance (Morgan and Konerthy, 2021:4). This clearly explains why compliance could not be at a high level in the country as RSOs are not available. The findings of this study further indicated that participants wished they had these RSOs to inspect their departments periodically. They ensure that radiographers have all that is essential for radiation protection, and that they can contact them in times of need. Times like when they need new lead-protecting

devices that may include wrap-around, lead aprons and thyroid shields, to name a few. The presence of Radiation Safety Officers helps keep the departments within the improved radiation safety standards through regular inspection of the departments. Furthermore, this is consistent with Kamara *et al.* (2013:87), who showed that there was also a need for more monitoring of these Radiology facilities. Similarly, Lokhwani *et al.* (2019:742) emphasized that regular surveillance of radiation exposure protection should be part of radiation safety officers. Unfortunately, it is not available in Eswatini.

This is consistent with Zekioglu and Palar (2021:1), who showed that the legislation in Turkey indicated that a Radiation Safety Committee must be established in hospitals. These committees have duties such as providing radiation safety, regular hospital training, and preparing a radiation safety handbook, all of which does not exist in Eswatini public hospitals.

5.6 DISCUSSION OF THE STUDY'S RESEARCH QUESTIONS

The purpose of the study was to examine radiographers' compliance with patient radiation safety standards in Eswatini public hospitals in order to recommend suitable compliance standards to the Eswatini Ministry of Health.

5.6.1 WHAT IS THE LEVEL OF COMPLIANCE WITH THE IMPLEMENTATION OF PATIENT RADIATION SAFETY STANDARDS?

The participants had the same expressions when responding to the question, "How often do you employ or use radiation safety standards during practice?". The findings of this study demonstrated that radiographers' knowledge of radiation protection aligned with legislated guidelines, but the conditional and limited use or application of the safety standards resulted in compliance being a personal choice. Radiation protection standards were personal choice/conditional because the focus was mainly on pediatric patients and pregnant women, which was

insufficient. This is consistent with a study by Uche Uze *et al.* (2013:1), which showed that adherence to radiation protection practices amongst radiographers in the Lagos metropolis during the period studied was poor.

5.6.2 WHAT ARE THE CHALLENGES, IF ANY, FACED BY RADIOGRAPHERS IN THE IMPLEMENTATION OF PATIENT RADIATION SAFETY STANDARDS?

The results of the study revealed that the participants faced obstacles that hindered their ability to comply with radiation safety standards. The question used to collect this information was, "What challenges or obstacles do you face that prevent you from employing radiation protection?" The study revealed that participants were demotivated from complying because of factors related to many patients, patients complaining that aprons are heavy, and a lack of resources, including the lead aprons, which are old and no longer effective.

Furthermore, the study findings revealed that radiographers need radiation safety officers. Another challenge raised was poor infrastructure relating to their department needing to be better equipped for radiation use. Moreover, there was a trending tendency for unauthorized staff to make unnecessary X-ray requests for patients. For example, a patient may fall and have a scratch, but that does not mean there is a need to send that patient for an X-ray to rule out a fracture.

5.6.3 WHAT RADIATION PROTECTION GEAR IS AVAILABLE AND DESCRIBE THEIR CONDITION?

The study findings showed that the lead apron was the most available radiation protection gear. It is also important to note that the participants indicated that they believed the lead aprons' condition was not good anymore, so they needed to be changed. These findings were consistent with Kellen *et al.* (2022:2). A similar study in Iran by Salmanvandi *et al.* (2015:1) showed that some personal shields have defects (tears, holes and cracks), and 13% of them were not acceptable in terms

of equivalent lead thickness (ELT) and needed to be replaced because, if not, this may drag down the efforts to comply with radiation protection safety standards for the radiographers. Hence, defective lead personal shields are something that have been there previously. Moreover, in the present study, very few participants indicated that they had thyroid shields, wrap-around, goggles, and gloves. The query to obtain this information was, "What radiation protection gear is available and describe their condition?"

5.7 SUMMARY OF THE CHAPTER

This chapter presented a discussion of the findings of the study. The demographic profile of the diagnostic radiographers interviewed was provided. The findings related to the compliance with patient radiation safety standards in Eswatini public hospitals and health centers. The next chapter will focus on the conclusion, limitations the researcher encountered, areas that still need to be researched, and recommendations guided by the study's findings.

CHAPTER 6: CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The study aimed to explore compliance with patient radiation safety standards amongst radiographers in Eswatini public hospitals and health centers. The researcher achieved this by using in-depth interview guides to collect data. The final chapter acknowledges the conclusion; limitations the researcher encountered; areas that still need to be researched; and recommendations guided by the study's findings.

6.2 CONCLUSION

It is clear from this study that radiographers have both unfavorable/negative and favorable/positive attitudes to radiation safety standards. They showed a positive attitude and a good knowledge of radiation protection and patient safety standards. However, despite this, compliance with radiation safety standards was focused more on pediatric patients and pregnant women. This subjectivity was the paramount negative attitude found in this study. This attitude further contributed to observing or considering subjective norms linked to their routine behavior. This was because the routine behavior that developed prevailed and became a departmental culture amongst the participants. This culture needs to promote compliance with patient radiation safety standards fully. This study's findings strongly imply that action was needed to discourage or stop this culture.

Furthermore, behavioral control in the findings showed that in as much as the participants wanted to comply, they were discouraged by their experiences, which is mainly reflected in the resources and capabilities that the individual has to achieve the behavior (Xingwei Li ,Dai and Shen 2023:4). In Eswatini, behavioral control was influenced by improper buildings, structure and location. The walls

were not lined with lead, and the department was located between busy departments like the laboratory. This was causing the patients and staff in the other rooms to be exposed. The lack of motivation, encouragement or enforcement from seniors also contributed to non-compliance. Motalebi *et al.* (2021:5) indicated that gaining the support of influential people in the workplace is an effective intervention to ensure compliance. Moreover, Perceived Behavioral Control showed that these factors and experiences reduce optimal compliance with radiation protection safety standards. The radiographers are not obliged to comply because no radiation regulatory body, policy or radiation safety officer is available in Eswatini, which resulted in compliance being a personal choice.

6.3 LIMITATIONS

Study limitations represent weaknesses within a research design that may influence the outcome and conclusions of the research. Researchers are obligated to the academic community to present complete and honest limitations of the proposed study (Ross and Zaidi, 2019:261). In addition, limitations are methodological problems, mistakes or unforeseen errors that arise during the study period. According to Bui (2014:202), limitations must be presented so that other researchers can learn from the researcher's mistakes and improve in future research. The limitations experienced in the study were:

- The researcher received no funding, hence this delayed the data collection process. This was because data collection involved face-to-face interviews while the settings were far from each other in location. However, the researcher completed the study and achieved its objectives, even though the data collection time could have also been improved.
- Qualitative research is restricted to a particular phenomenon in a certain population and within a specific context. Hence, generalizability is usually not an expected attribute (Leung, 2015: para.7, line 1). Therefore, the study's findings

cannot be generalized to private sector populations. This study was conducted only in the public sector. Therefore, the researcher cannot generalize the findings to the private sector. A qualitative approach was used in this study through one-on-one interviews as the primary data collection instrument. Even though these interviews were in-depth, a mixed-method approach would have been beneficial. Creswell and Plano Clark (2011: 12) assert that mixed methods can compensate for weaknesses associated with a study's quantitative or qualitative design. The mixed methods design allows the researcher to collect data with any tool, rather than being limited to only one of the tools associated with either quantitative or qualitative research methods (Creswell and Plano Clark 2011:12).

- The researcher personally knew the participants because some of them were supervisors during undergraduate practice and some of them were schoolmates. All became colleagues since the researcher is a clinical instructor who visits their workplace occasionally for students. This may have influenced participants to be biased with information.

6.4 RECOMMENDATIONS

Considering the outcome of this study, the researcher recommends the following:

The Government, through the Ministry of Health, must:

- Establish, through legislation, a national independent regulatory body to regulate the introduction and conduct of any practice involving radiation sources;
- Provide radiation safety officers to hospitals to ensure high radiation safety standards for patients; and they must inspect the lead protective devices;
- Assist in evaluating the Radiography department buildings. According to some radiographers, the building's walls must be constructed in accordance with radiation safety standards and must be lined with lead because radiation passes through the walls; and

- It is the patient's right to be protected, so it is important to educate the public on radiation safety.

The Radiography Head of Department must:

- As the department's primary influencers, they should assist in enforcing the staff's compliance with radiation safety and lead by example.

The Senior medical officer is required to:

- Conduct workshops that address the topics in which radiographers exhibited a negative attitude.

6.5 FUTURE STUDIES

- The findings cannot be generalized to the private sector because the study was conducted exclusively in the public sector. However, future research could include the private sector.
- Quantitative or mixed-method approaches may also be used to investigate this phenomenon further.
- Future research may also concentrate on assessing the implementation of this study's recommendations and its effectiveness in improving compliance with radiation safety standards by all the Government through the Ministry of Health, Radiographers, and Hospital.

References

- Abdelhamid Ahmed. 2008. Ontological, Epistemological, and Methodological Assumptions: Qualitative versus Quantitative <https://files.eric.ed.gov/fulltext/ED504903.pdf> (Accessed: 05 May 2023)
- Abuzaid M, Elshami W, Shawki M, Salama D. 2019. Assessment of compliance to radiation safety and protection at the radiology department. *Int J Radiat Res.*17 (3):447454 URL : <http://ijrr.com/article-1-2600-en.html> (Accessed 03 May 2022)
- Adom D, A Yeboah, A K Ankrah.2016. Constructivism Philosophical Paradigm: Implications for Research Teaching and Learning <https://www.eajournals.org/wpcontent/uploads/Constructivism-Philosophical-Paradigm-Implication-for-ResearchTeaching-and-Learning.pdf> (Accessed 05 May 2022)
- Adhikari, K. P, Boersma, H. F., Coates, R., Coulor, W., Gallego, E., Ben Omrane, L., Cruz Suarez, R., & Tsegmed, U. 2021. Radiation protection infrastructure-challenges in developing countries. *Journal of radiological protection: official journal of the Society for Radiological Protection*, 41(3), 10.1088/1361-6498/ac0c00. <https://doi.org/10.1088/1361-6498/ac0c00> (Accessed 30 August 2023)
- Ahmed A .2008 Ontological, Epistemological, and Methodological Assumptions: Qualitative versus Quantitative <https://files.eric.ed.gov/fulltext/ED504903.pdf> (Accessed 05 July 2022)
- Arifin, Siti Roshaidai.2018.Ethical Considerations in Qualitative Study. *INTERNATIONAL JOURNAL OF CARE SCHOLARS*. 1. 10.31436/ijcs.v1i2.82. https://www.researchgate.net/publication/328019725_Ethical_Considerations_in_Qualitative_Study (Accessed 05 May 202)

Awal A .2019. Basic Concept in Research Methodology and Method
<https://www.campuscareerclub.com/basic-concept-of-research-methodology/>
(Accessed 15 July 2022)

Bicol Regional Training Hospital .2015.Radiation and Safety
Procedures[https://brtth.doh.gov.ph/hospital-services/2-brtth-
events/uncategorised/117-radiationprotection-and-safety-procedures](https://brtth.doh.gov.ph/hospital-services/2-brtth-events/uncategorised/117-radiationprotection-and-safety-procedures) (01 April
2022)

Bitterman A.Frane N .2022.Radiation Safety and Protection
<https://www.ncbi.nlm.nih.gov/books/NBK557499/> (Accessed 12 May 2022)

British Institute Of Radiology Report.2020.Patient
Shielding Guidance [https://www.bir.org.uk/education-and-events/patient-
shielding-guidance.aspx](https://www.bir.org.uk/education-and-events/patient-shielding-guidance.aspx)_(07 June 2022)

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S.,
Bywaters, D., & Walker, K.2020. Purposive sampling: complex or simple?
Research case examples. *Journal of research in nursing: JRN*, 25(8), 652–661.
<https://doi.org/10.1177/1744987120927206> (Accessed 21 August 2022)

Caufield J .2019. How to Do Thematic Analysis| Step–by–Step Guide & Examples
<https://www.campuscareerclub.com>_(Accessed 26 July 2022)

Clough B. Jessica A, Eigeland, Imogen R, Madden, Rowland D.Leanne M & Casey
.2019. Development of the eTAP: A brief measure of attitudes and process in e-
interventions for mental health, internet interventions
<https://doi.org/10.1016/j.invent.2019.100256> (Accessed 12 June 2023)

Creswell, J. W., & Creswell, J. D. 2018. Research design: qualitative, quantitative,
and mixed methods approaches. Fifth edition. Los Angeles, SAGE.

Dauda AM, Ozoh JO, Towobola OA. Medical doctors' awareness of radiation exposure in diagnostic radiology investigations in a South African academic institution. SAfrJRad.2019.;23(1), a1707. <https://doi.org/10.4102/sajr.v23i1.1707> (Accessed 17 August 2023)

Davies, C., & Fisher, M.2018. Understanding research paradigms. Journal of the Australasian Rehabilitation Nurses Association, 21(3), 21–25. <https://search.informit.org/doi/10.3316/informit.160174725752074> (Accessed: 07 July 2023)

Dixon.2018.Diagnostic Imaging Dataset Annual Statistical Release <https://www.england.nhs.uk/statistics/wpcontent/uploads/sites/2/2018/11/AnnualStatistical-Release-2017-18-PDF-1.6MB-1.pdf> (Accessed : 29 April 2022)

Do KH.2016. General Principles of Radiation Protection in Fields of Diagnostic Medical Exposure. JKoreanMedSci. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4756345/> (Accessed: 10 June 2022)

European Society of Radiology .2019. (ESR, Patient safety in medical imaging: A joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS). Radiography, 25(2), pp.e26-e38. <https://www.sciencedirect.com/science/article/pii/S1078817419300094> (Accessed: 25 April 2022)

Fleming, J. and Zegwaard, K.E.2018.Methodologies, Methods and Ethical Considerations for Conducting Research in Work-Integrated Learning. International Journal of Work-Integrated Learning, 19(3), pp.205-213. (Accessed 19 August 2022)

Health Physics Society.2021.Radiation Exposure From Medical Exam and Procedures https://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf (Accessed: 27 April 2022)

Hundah S N .2019.Survey Of Radiation Protection Amongst Non- Radiology Staff Working In Fluoroscopy –Guided Operating Theatres At Public Health Institutions In The Ethekwini District Of Kwazulu Natal

Hunter, D, McCallum, J and Howes D .2019. Defining Exploratory –Descriptive Qualitative (EDQ) research and considering its application to healthcare. Journal of Nursing and Healthcare, 4 (1) <https://eprints.gla.ac.uk/180272/7/180272.pdf> (Accessed 5 June 2022)

ISALTteam.2014.Theory of Planned behavior https://cornerstone.lib.mnsu.edu/cgi/viewcontent.cgi?article=1000&context=isalt_resources (Accessed 25 June 2022)

Jamshed S. 2014.Qualitative research method-interviewing and observation. Journal of Basic and clinical pharmacy, 5(4), 87–88.<https://doi.org/10.4103/0976-0105.141942> (Accessed 18 July 2022)

Jordan, G. 2019. Positivist and constructivist paradigm <https://applingtesol.wordpress.com/2019/10/30/positivist-and-constructivist-paradigms/> (Accessed 10 July 2023)

Kellens, P., De Hauwere, A., Gossye, T., Peire, S., Tournicourt, I., Strubbe, L., De Pooter, J., & Bacher, K. 2022.Integrity of personal radiation protective equipment (PRPE): A 4-year longitudinal follow-up study. *Insights Into Imaging*, 13(1), 1-8. <https://doi.org/10.1186/s13244-022-01323-3> (Accessed 25 September 2023)

Kiger ME & Varpio L .2020. Thematic analysis of qualitative data https://www.plymouth.ac.uk/uploads/production/document/path/18/18247/Kiger_and_Varpio_2020_Thematic_analysis_of_qualitative_data_AMEE_Guide_No_131.pdf (Accessed 2 June 2022)

Kim JH. 2018. Three principles for radiation safety: time, distance, and shielding. KoreanJPain.31(3):145-146.doi:10.3344/kjp.2018.31.3.145
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6037814/> (Accessed 12 June 2022)

LaMorte W .2019. The Theory Of Planned Behavior
<https://sphweb.bumc.bu.edu/otlt/mphmodules/sb/behavioralchangetheories/BehavioralChangeTheories3.html> (Accessed 12 May 2022)

Lam DL, Larson DB, Eisenberg JD, Forman HP, Lee CI .2015.Communicating Potential Radiation-Induced Cancer Risks From Medical Imaging Directly to Patients. AJR Am J Roentgenol. 2015 Nov;205(5):962-70. doi: 10.2214/AJR.15.15057. Epub 2015 Aug 21. PMID: 26295534. (Accessed 20 August 2023)

Lewis S. Downing C. Hayre C.M .2022. South African Radiographers radiation protection practices, a qualitative study
https://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf (Accessed 15 May 2022)

Lewis S. Downing C. Hayre C.M .2021.Using the theory of planned behavior to determine radiation protection among South African diagnostic radiographers: a cross-sectional survey <https://onlinelibrary.wiley.com/doi/full/10.1002/jmrs.537> (Accessed 15 May 2022)

Lindley-Jones, M., & Finlayson, B. J. 2000.Triage nurse requested x rays--the results of a national survey. Journal of accident & emergency medicine, 17(2), 108–110. <https://doi.org/10.1136/emj.17.2.108> (Accessed 10 August 2022)

Morgan T and Konerth S .2022. The Role of radiation safety officer in patient safety. Contemporary Topics in Patient Safety-Volume.IntechOpen.DOI:10.5772/intechopen.97058
<https://www.intechopen.com/chapters/76011> (Accessed 28 August 2023)

Manohar, Narendar & MacMillan, Freya & Steiner-Lim, Genevieve & Arora, Amit. 2018. Recruitment of Research Participants. 10.1007/978-981-10-2779-6_75-1. <https://www.researchgate.net/publication/323554760> Recruitment of Research Participants (Accessed 18 June 2022)

Muhogora, W., & Rehani, M. M. 2017. Review of the current status of radiation protection in diagnostic radiology in Africa. *Journal of medical imaging (Bellingham, Wash.)*, 4(3), 031202. <https://doi.org/10.1117/1.JMI.4.3.031202> (Accessed 29 August 2023)

Mulisa F. 2022. Sampling techniques involving human subjects: Applications, pitfalls, and suggestions for further studies <https://dergipark.org.tr/en/download/article-file/2856569> (Accessed 12 May 2022)

Maina, P. M., Motto, J. A., & Hazell, L. J. 2020. Investigation of radiation protection and safety measures in Rwandan public hospitals: Readiness for the implementation of the new regulations. *Journal of medical imaging and radiation sciences*, 51(4), 629–638. <https://doi.org/10.1016/j.jmir.2020.07.056> (Accessed 20 September 2023)

McLeod, S. A .2019. Sampling methods. Simply Psychology. www.simplypsychology.org/sampling.html (Accessed 23 June 2022)

Newman S .2016. Informing Patients About the Cancer Induction Risk of Undergoing Computed Tomography Imaging: The Radiographer's Perspective <https://doi.org/10.1016/j.jmir.2016.07.008> (Accessed 8 May 2022)

Nowel L.S, Norris J M, White, D E, Moules N J .2017. Thematic Analysis: Striving to Meet the Trustworthiness Criteria <https://journals.sagepub.com/doi/full/10.1177/16094069177333847> (Accessed 2 June 2022)

Omona J .2013. Sampling in Qualitative Research: Improving the Quality of Research Outcomes in Higher Education <https://www.ajol.info/index.php/majohe/article/view/90214> __ (Accessed 12 May 2022)

Partap A, Raghunanan R, White K ,Seepaul T.2019. Knowledge and practice of radiation safety among health professionals in Trinidad <https://journals.sagepub.com/doi/pdf/10.1177/2050312119848240> Accessed 10 August 2022)

Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K.2015. Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Adm Policy Ment Health*; 42(5):533-44. doi: 10.1007/s10488013-0528-y. PMID: 24193818; PMCID: PMC4012002. (Accessed 27 July 2022)

Pilarska, Justyna. .2021. "6 The Constructivist Paradigm and Phenomenological Qualitative Research Design". *Research Paradigm Considerations for Emerging Scholars*, edited by Anja Pabel, Josephine Pryce, and Allison Anderson, Bristol, Blue Ridge Summit: Channel View Publications, <https://doi.org/10.21832/9781845418281008> (Accessed 18 July 2022)

Stem W ,Pillay M .2008. Inspection of Lead Aprons: A Practical Rejection Model <https://www.infabcorp.com/downloads/lead-apron-inspection.pdf> (Accessed 18 August 2023)

Ploussi, A, Efstathopoulos, E.P. & Brountzoz, E .2021. The importance of radiation protection education and training for medical professionals of all specialties. *Cardiovasc Intervent Radiol* 44,829-834 <https://doi.org/10.1007/s00270-020-12744-7> (Accessed 28 August 2023)

Princeton University .2023. Radiation Safety Committee <https://ehs.princeton.edu/aboutehs/committees/radiation-safety-committee> (Accessed 28 September 2023)

Radiation Control .2016. Code of practice for users of medical for medical x-ray users <https://www.sahpra.org.za/wp-content/uploads/2020/01/Code-of-practice-for-users-of-medical-x-ray-equipment-01-2015-2.pdf> (Accessed 25 September 2023)

Ramdhani, Abdullah & Ramdhani, Muhammad & Amin, Abdusy.2014. Writing a Literature Review Research Paper: A step-by-step approach. International Journal of Basic and Applied Science. 3. 47-56. https://www.researchgate.net/publication/311735510_Writing_a_Literature_Review_Research_Paper_A_step-by-step_approach/citation/download (Accessed 23 April 2022)

Ross, P. T., & Bibler Zaidi, N. L.2019. Limited by our limitations. Perspectives on medical education, 8(4), 261–264. <https://doi.org/10.1007/s40037-019-00530-x> (Accessed 10 August 2023)

Salma Patel .2015. The research Paradigm methodology epistemology and Ontology explained in simple language <http://salmapatel.co.uk/academia/the-research-paradigmmethodology-epistemology-and-ontology-explained-in-simple-language/> (Accessed 07 July 2023)

Salmanvandi M.2015. Evaluation of Personal Shields Used in Selected Radiology Departments https://www.academia.edu/12328138/Evaluation_of_Personal_Shields_Used_in_Selected_Radiology_Departments (Accessed 19 May 2022)

Sarman I, Che Hassan Datin Hafizah .2016.Factors Affecting Radiographers' Compliance With Radiation Protection on All Areas of Hospital Settings World-wide Meta-Analysis https://lincolnuniversities.com/pdf/faculty_members/5.%20Factors%20Affecting%20Radiographers.pdf (Accessed 09 April 2022)

Shenton A.K .2004. Strategies for Ensuring Trustworthiness in Qualitative <https://www.researchgate.net/publication/> (Accessed 13 July 2022)

Singleton & Straits.2010.Conducting Educational Research
<http://korbedpsych.com/R05Population.html> (Accessed 23 June 2022)

Statistical Consulting Blog .2020. What is trustworthiness in qualitative research?
Internet. Available at <https://www.statisticssolutions.com/what-is-trustworthiness-in-qualitativeresearch/> (Accessed 13 July 2022)

Tongco, M. D. C. 2007.Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research and Applications*, 5, 147–158. Retrieved from <https://ethnobotanyjournal.org/index.php/era/article/view/126> (Accessed 15 August_2022)

Trustworthiness in qualitative research. .2022. IAHPCC Pallipedia
<https://pallipedia.org/trustworthiness-in-qualitative-research/>. (Accessed 13 July 2022)

Ukkola, H, Kyngas A, Henner H & Oikarinen .2020. Barriers to not informing patients about radiation in connection with radiological examinations: Radiographer's Opinion
<https://www.sciencedirect.com/science/article/pii/S1078817419302615> (Accessed 12 July 2022)

Vienna .2018. International Atomic Energy Agency, Radiation Protection, and Safety in Medical Uses of Ionizing Radiation, IAEA Safety Standards Series No. SSG-46, IAEA

Vienna.2022.Patients Radiation Protection
<https://www.iaea.org/topics/radiationprotection/patients> (Accessed 12 April 2022)

Vom, J., & Williams, I. 2017. Justification of radiographic examinations: What are the key issues?. *Journal of medical radiation sciences*, 64(3), 212–219.
<https://doi.org/10.1002/jmrs.211> (Accessed 20 September 2023)

Yara Arafat and Mohamed Izham Mohamed Ibrahim .2018. The Use of Measurements and Health Behavioral Models to Improve Medication Adherence <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecularbiology/theory-of-planned-behavior> (Accessed 12 May 2022)

APPENDICES

APPENDIX 1 INTERVIEW GUIDE

Section A: Demographics of participants

Select the most appropriate resupplies' applicable to you.

1. Gender

Male	
Female	
Other	

2. Name of Hospital

Name of hospital	tick	Region
Mbabane Government Hospital		
Pigg's Peak		
Hlatikulu		
Raleigh Fitkin Memorial		
Mankayane		
Good Shepherd		
Lubombo Referral		
Dvokolwako		
EMkhuzweni		
Matsanjeni		
Sithobela		
Nhlangano		

3. Age

AGE	Please tick
60 and above	
50-59	
30-49	
20-29	

5. Working Experience

Years	Please tick
15 and above	
10 to 15	
5 to 10	
1 to 5 years	

6. Radiation protection Gears available in your department

Gear available	Condition : good /bad/need new

Section B: in depth interview guide

1. What is your understanding of radiation protection?
2. How often do you apply radiation protection to your patients and caregivers in the room?
3. How is your attitude to radiation protection? why
4. What measures do you employ for radiation protection to yourself?
5. What measures do you employ to protect patients from radiation protection?
6. How is the compliance to radiation protection at this facility?
7. What challenges/obstacles do you face that hinder you in applying radiation protection?
8. What can be done to improve or encourage radiation protection adherence?
9. Describe the condition of the radiation protection gears in this department?
 Probing question: How can they be improved?
10. What can be done to foster compliance to radiation protection?

APPENDIX 2 a LETTER OF INFORMATION



Title of the Research Study: An exploratory study of compliance with radiation safety standards by radiographers employed in Eswatini public hospitals

Principal Investigator/s/researcher: Amelia Shungube: Master's Degree in Radiography

Co-Investigator/s/supervisor/s: Dr. Thandokuhle Emmanuel Khoza: PHD

Brief Introduction and Purpose of the Study: The study aims to explore compliance with patient radiation safety standards by radiographers at Eswatini public hospitals, to give recommendations regarding appropriate compliance standards to the Eswatini ministry of health

Good Day! I am a student at DUT doing research for my Master's degree in Radiography. I would like to invite you to participate in the research. Research is a systematic search or inquiry for generalized new knowledge

Outline of the Procedures: You will be expected to answer or respond to 15 questions of the in-depth one on one interview related to this study and it will be recorded in an audio recorder for approximately 30 minutes duration to be done. The information from the interview will be analyzed by the researcher and will be available for your departments as baseline information that could be employed. The study's results can be used by the involved departments to decide if there is a need for any improvement in radiation compliance. Data will be disposed of after 5 years in a way that is irreversible with any chance of recovery once the researcher is sure and convinced that it will not be needed again after analysis.

Risks or Discomforts to the Participant: There will be minimal risk of harm expected in this study.

Explain to the participant the reasons he/she may be withdrawn from the Study: The research may be terminated early in particular circumstances viz. Non-compliance, etc. You are entitled to withdraw from the study at any time should you wish to do so and will continue to receive the appropriate standard of care; the research may be terminated early in particular circumstances. The researcher may, under certain circumstances, decide to withdraw the participant from the study; You are also free to withdraw from the study without having to explain (but you will also be free to provide reasons for leaving the study) and this will not affect your job. The researcher will appreciate being alerted as early as possible if you wish to withdraw.

Benefits: Findings from the exploratory study of compliance with radiation safety standards by radiographers employed in ESwatini public hospitals will be shared or made available to your department as baseline information that could be used to make strategic decisions such as in-service training interventions with certificates of attendance. This will benefit the staff

/radiographers including patients towards the reduction of unnecessary occupational and patient radiation exposure. Moreover, the researcher will benefit by obtaining a master's degree qualification and publishing it in peer-reviewed journals. The results will also be presented at conferences within Eswatini, South Africa, and abroad.

Remuneration: You will not receive any monetary or other types of remuneration

Costs of the Study: You will not be expected to cover any costs towards the study.

Confidentiality: Anonymity and confidentiality will be preserved by not revealing the radiographers' names and identities in the data collection, analysis, and reporting /dissemination of the study findings. On top of this, the researcher will be the only one able to match your identity and voice recordings and the information collected from you will be confidential through the use of pseudo names, the collected information will be known by the researcher only and it would be used solely for the study and would be disposed of once it had been processed for research purposes. Data transcribing will be conducted in a private room using earphones to avoid the possibility of recordings being heard by other people and during the presentation of the study findings. You will be referred to by your pseudonym names in the verbatim quotes

Results: The researcher will share the study findings through a report a hard copy and a soft copy will be available

Research-related Injury: not applicable to this study

Storage of all electronic and hard copies including tape recordings: The recordings and notes taken during an interview will be kept in a locker that has access only by the researcher. It will be stored until the final report is finished. The notebook will be burnt and the recordings will be deleted completely

Persons to contact in the Event of Any Problems or Queries: My supervisor: Dr. Thandokuhle Emmanuel Khoza, Please contact the researcher (tell no: +26876869159/+26879782174), my supervisor (+2731 373 3092), or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Research Director: Research and postgraduate support on 0313732577 or researchdirector@dut.ac.za and Eswatini Health and Human Research Ethics Board (EHRRB), P. O BOX 5, Mbabane (tell: 24047751/6039).

SICESHANA B



INCWADZI LENIKA LWATI

Sihloko Selucwaningo: Lucwaningo loluchaza kabanti ngekucilikela kugcina emazinga laphakeme ekutivikela kwalabasebenta i-radiography etibhedlela tesive Eswatini

Umcwaningi Lomkhulu: Amelia Shungube: Master's Degree in Radiography

Ubambisene na/ Weluswe ngu: Dr Thandokuhle Emmanuel Khoza: PHD

Singeniso lesifisha nenjongo yalolucwaningo: Inhloso yalolucwaningo kuhlolisa kutfotjelwa nekugcinwa kwemazinga lafanele etekuphepha nekuvikeleka kwetigulane etandleni talbasebenta i-radiography etibhedlela tesive Eswatini, kucejisiwe litiko letemphilo ngalokubhekekile.

Lusuku loluhle! Ngingumfundzi lofundzela kutfolo ticu te-Master's ku Radiography. Ngingatfokota kukumema kutsi ube yincenye yalababamba lichaza kulolucwaningo Lucwaningo yindlela lehlekile yekuphenyisa kute sitfole lwati lolusha.

Outline of the Procedures Luhlaka lwalokutawentiwa Ulindzeleke kutsi uphendvule imibuto lengu-16 leyincenye yekucocisana lahambisana nalolucwaningo letawutsetjulwa itsatse sikhatsi lesingaba yimizuzu lengu 3o lokungenani. Lolwati lolutawutfolakala kuleto tingcogco lutawuhloliswa ngulomcwaningi luhinde lube ngulokhululekile kutsi lungasetjentiswa lube ngumkhombandlela kulelitiko losebentela kulo. Imiphumela yalolucwaningo ingasetjentiswa ngulamatiko letsintsekako kuncuma nangabe kukhona lokudzingwa kutfutukiswa mayelana nekutobela lokubhekekile kusasetjentwa i-radiography. Lolwati lutawuse luyalahlwa emva kweminyaka lesihlanu (5) ngendlela letawucinisekisa kutsi aluweli etandleni letingesito nasacinisekile umcwaningi kutsi alusenawuphindze ludzingekae.

Bungoti nalokungahle kungamphatsi kahle longenele lolucwaningo: Kute bungoti nome Kuhlukubeteka lokubhekekile ngenca yalolucwaningo.

Chazela longenele lolucwaningo ngetizatfu letingambangela aphume kulolucwaningo: Lolucwaningo lungayekelwa ngekushesha ngenca yetimo-tsite. Kungatfobeleki nalokunye. Ukhululekile kuphuma kulolucwaningo nome nini nawufisa kwenta njalo ube uchubeka unakekeleka ngendlela lafanele; lolucwaningo lungemiswa ngekushesha Etimeni- tsite. Umcwaningi angancuma etimeni- tsite kummisa umuntu kulolucwaningo; nawe uvumelekile kunyomuka kulolucwaningo kungadzingeki uchaze (kodvwa ungakhululeka kubala tizatfu letikuyekelisako) futsi loko angeke kuwutsikabete umsebenti wakho. Umcwaningi angakutfokotela kutsi usheshe umatise nawuhlela kunyomuka.

Inzuzo: Lwati lolutawutfolakala kulolucwaningo loluhlola kutfotjelwa nekugcinwa kwemazinga netimiso tetemphilo nekuvikeleka kusasetjentwa i-radiography etibhedlela tesive lapha Eswatini lutawendluliselwa etiko losebentela kulo lutoba sisekelo selwati lesingasita nakwakiwa tinhlelo letifana nekucechesha tisebenti letinganika titifiketi letigunyatako. Loko kutawusita letisebenti tetemphilokanye netigulane kunciphisa ekulinyatweni kusebenta kwabo ngalemisebe ye-radiography. Ngetulu kwaloko, lomcwaningi utawusitakala kutsi atfole ticu takhe te Master's tiphindze tishicilelwe kumaphephabhuku lasetjentiswa balingani. Lemiphumela itawuphindze yetfulwe emihlanganweni khona la Eswatini, kubomakhelwane esikhwahlane nemhlabeni wonkhe jikelele.

Imbadalo: You will not receive any monetary or other types of remuneration kute imali nome-ke lolunye luhlobo lwembadalo lolutfolela ngekungenela lolucwaningo.

6 August 2020

Appendix 3a Consent letter



CONSENT

Full Title of the Study: An exploratory study of compliance with radiation safety standards by radiographers employed in ESwatini Public Hospitals

Names of Researcher/s: Amelia Shungube

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Amelia Shungube about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 308/22.
- 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 computerized 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, Amelia Shungube herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study

<u>Amelia Shungube</u>	<u>February 2023</u>	_____
Full Name of Researcher	Date	Signature

Appendix 3 b



IMVUMO

Sihloko Selucwaningo: Kuhlola Kutfotjelwa Kwemazinga Emsenentini Wema-Radiographers Etibhedlela Tesive Eswatini

Libito Lemcwaningi: Amelia Shungube

Sivumo sekungenela lolucwaningo:

- Ngiyavuma kutsi ngatisiwe ngumcwaningi Amelia Shungube ngetimiso, kutiphatsa, benefits and risks of this study inzuzo kanye nebungoti balolucwaningo – Lolucwaningo lukhululiwe ngulababuke timiso tekutiphatsa Research Number: 308/22.
- Nginikiwe, ngafundza ngakuvisisa lolokungenhla (Incwadzi lecacisela lolungenele) mayelana nalolucwaningo.
- Ngiyati kutsi imiphumela yalolucwaningo, kufaka ekhatsi imininingwane ngami lephatselana nebulili, iminyaka, Lusuku lwekutsalwa, nalokunyenti kutawukhicitwa kube yincenye yembiko.
- Ngekubukalokufunwa ngulolucwaningo, ngiyavuma kutsi lwati lolubutfwe kusachutjwa lolucwaningo, umcwaningi angalungakhicita ngabongcondvomshina.
- Nginganyomuka kulolucwaningo nome nini, ngaphandle kwekuhlukubetwa.
- Nginikiwe litfuba lelenetisako kubuta imibuto futsi (lesuka kimi) ngivume kutsi ngilungele kungenela lolucwaningo.
- Ngiyacondza kutsi lwati lolubalulekile lolutawakheka kusachutjwa lolucwaningo loluphatselene nami kulo ngitawukhona kulubona.

_____	_____	_____	_____
Libito Leliphelele lalongenelako Sese kudla	Lusuku	Sikhatsi	Sayina / Sitfupha

Mine, Amelia Shungube

Ngiyafakaza kutsi lolongenihla watisiwe ngalokuphele ngetimiso, kutiphatsa kanye nebungoti lobuhambisana nalolucwaningo.

_____	_____	_____
Libito Lemcwaningi	February 2023	<u>I. D. Ngwenk</u>
	Lusuku	Sayina

_____	_____	_____
Libito Lafakazi (nakakhona)	Lusuku	Sayina

_____	_____	_____
Libito Lemtali (Nakakhona)	Lusuku	Sayina

6 August 2020



**ESWATINI
HEALTH AND HUMAN
RESEARCH REVIEW BOARD**
MBANDZENI HOUSE, 3RD FLOOR, CHURCH STREET
P.O. BOX 5, MBABANE, ESWATINI

ONE YEAR RESEARCH PROTOCOL APPROVAL CERTIFICATE

BOARD REGISTRATION NUMBER	FWA 00026661/IRB 00011253					
PROTOCOL REFERENCE NUMBER	EHHRB035/2022					
Type of review	Expedited	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Full Board	<input type="checkbox"/>	<input type="checkbox"/>
Name of Organization	Masters Student					
Title of study	An exploratory study of compliance with radiation safety standards by radiographers employed in Eswatini Public Hospitals					
Protocol version	1.0					
Nature of application	New	<input checked="" type="checkbox"/>	Amendment	<input type="checkbox"/>	Renewal	<input type="checkbox"/>
				Extension	<input type="checkbox"/>	CT updates
					<input type="checkbox"/>	<input type="checkbox"/>
List of study sites	Mbabane Government Hospital(MGH), Mankayane Hospital, Piggs Speak Hospital, Hlathikhulu Hospital, Lubombo Referral, Good Shepherd Hospital, Matsenjani Health Center, Nhlalanga Health Center, Mkhuzweni Health Center, Dvokolwako Health Center, Raleigh Pitkin Memorial Hospital, and Sithobela Clinic					
Name of Principal Investigator	Ms. Shungube Amelia					
Names of Co- Investigators	Dr. Thandokuhle Emmanuel Khoza					
Names of steering committee members in the case of clinical trials	N/A					
Names of Data and Safety Committee members in the case of clinical trials	N/A					
Level of risk (Tick appropriate box)	Minimal	<input checked="" type="checkbox"/>	More than minimal	<input type="checkbox"/>	High	<input type="checkbox"/>
Initial study Approval information	Approved	<input checked="" type="checkbox"/>	Study completion date	12/08/2023	Certificate expiry Date	11/04/2024
	Approval date	11/04/2023			End date	
Study renewal approval information	Renewal date				End date	
Study amendment approval information	Amendment date				End date	
Study extension approval information	Ext date				End date	
Signature of Chairperson						
Signing date	11/04/2023					
Secretary Contact Details	Name of contact officers	Babazile Shungwe				
	Email address	ehh@eswatini@gmail.com / es@ehhrb.org.sz				
	Telephone no.	+268 2404 7751				



Appendix 5



31 March 2023

Ms A Shungube
P.O. Box 1207
Manzini
M200

Dear Ms Shungube

An exploratory study of compliance with radiation safety standards by radiographers employed in Eswatini public hospitals
Ethical Clearance number IREC 308/22

The DUT-Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

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 DUT-IREC according to the DUT-IREC Standard Operating Procedures (SOP's).

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

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC



Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Matsanjani Health centre
P.O.Box 5410
Lavumisa

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

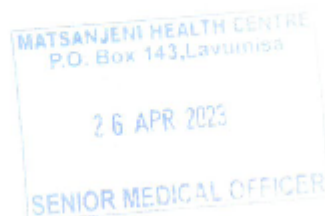
It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face-to-face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy of approval letter from Eswatini health and human research ethics board as well as a copy of the approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology



*26/04/2023
request approved*



Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Hlatikulu Government Hospital
P.O.Box 20
Hlatikulu

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards .

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face- to- face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy approval letter which I received from the Durban University Institutional Research Ethics Committee (IRREC) and a copy of approval letter from Eswatini health and human research ethics board .

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com . Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

Telegrams:
Telex:
Telephone: (+268 22178000)
Fax: (+268 2276004)



HLATIKULU HOSPITAL
P.O. BOX 20

HLATIKULU
ESWATINI

THE KINGDOM OF ESWATINI

17/04/2023

Ms Amelia Shungube
P. O. Box 1207
Manzini

Dear Sir/Madam

RE: RESEARCH APPROVAL

On behalf of Hlatikhulu Government Hospital, I am pleased to inform you that management has studied through your proposed research project on "**Assessing compliance to radiation safety standards**" in our institution which is one regional referral hospital in Shiselweni region which is Hlatikhulu Government Hospital.

Permission is granted to conduct research of compliance to radiation protection by radiographers in Eswatini public hospital. In addition, it has been gladly accepted we feel that your proposal is relevant and will be of great benefit to the facility.

As management we kindly request that any data and findings gathered during the course of the project be shared with the facility for better view.

Yours sincerely

Christian N. Baraka
Acting Senior Medical Officer





Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Piggs Peak Hospital
P.O.Box 46
Piggs Peak

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face-to-face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy of approval letter from Eswatini health and human research ethics board as well as a copy of the approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

PIGG'S PEAK



GOVERNMENT

HOSPITAL

P O Box 46
Pigg's Peak
Eswatini

Tel: 24371111, 24371432, 24373195/6

MINUTE

To Whom It May Concern:

12 April 2023

RE: Approval for Research Study at Facility for Amelia Shungube

In Reference to the above, Research study for Ms. Amelia Shungube; a Master's student at the Durban University of Technology, is approved at the facility.

The research study is an exploratory study of compliance to radiation protection by radiographers in Eswatini public hospitals.

It will therefore be directed at interviewing two radiographers in the facility.

Please note the above and assist where applicable.

Regards

Dr Brian Munro
Acting SMO
Piggs Peak Government Hospital





Ms Amelia Shungube
P.O.Box 1207
Mauziini

April 2023

The Senior Medical Officer
Mankayane Government Hospital
P.O.Box 6
Mankayane

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face- to- face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC) and a copy of approval letter from Eswatini health and human research ethics board .

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

MANKAYANE
GOVERNMENT
HOSPITAL
P.O. BOX 6 MANKAYANE
Tel: +268
25358311/2/3/4/5
Fax: +268 25388353



The MINISTRY OF
HEALTH
P.O. BOX 5
MBABANE
ESWATINI
Tel: +268 2404 2431
Fax: +268 2404 2093

THE KINGDOM OF ESWATINI

28th April 2023

To Whom It May Concern
Administration, Head of Departments and Staff Members

Dear Sir / Madam

Re: Permission for Ms Amelia Shungube to conduct Research Study in Mankayane Government Hospital

This letter serves to inform you that Ms Amelia Shungube (Protocol Reference number EHHRRB035/2022), a Masters degree student at Durban University of Technology, has been granted permission to conduct a research study in the facility.

The study title is 'An exploratory study of compliance with radiation safety standards by radiographers employed in Eswatini Public Hospitals'. She has already obtained approval and authority from the Eswatini Health and Human Research Review Board. We request that you cooperate and assist her as she conducts the study.

You are welcome to contact the Inservice Coordinator for further information.

MANKAYANE GOV HOSPITAL
INSERVICE
Yours Faithfully
2023-04-28
Jabu Dlamini-Aisu
Inservice Coordinator



Ms Amelia Shungube

P.O.Box 1207

Manzini

April 2023

The Senior Medical Officer

Dvokolwako

P.O.Box 141

Mliba

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face- to- face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy of approval letter from Eswatini health and human research ethics board

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube

Durban University of Technology



ESWATINI

GOVERNMENT

Dvokolwako Health Centre
P.O. Box 141
MLIBA
Tel: (+268) 2382 1255/001

13/06/2023

Ms. Shungube Amelia
Principal Investigator

Dear Sir/Madam

RE: APPROVAL TO CONDUCT RESEARCH ON "AN EXPLORATORY STUDY OF COMPLIANCE WITH RADIATION SAFETY STANDARDS BY RADIOGRAPHERS EMPLOYED IN ESWATINI PUBLIC HOSPITALS"

In response to the request from Durban University of Technology on your behalf accompanied by a letter of approval from Eswatini Health and Human Research Review Board, the management approve that you are allowed to do your research at Dvokolwako Health Centre.

The management further wishes you success in your studies.

Yours sincerely

DR. M.F. GULE
MEDICAL OFFICER IN-CHARGE





Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Lubombo Referral Hospital
P.O.Box 1474
Siteki

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face-to-face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy of approval letter from Eswatini health and human research ethics board as well as a copy of the approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

*Seen and Approved.
12:38 PM,
02/05/2023
Dr Enzya Mwanza*





20 April 2023

Amelia Shungube
P. O. Box 1207
MANZINI

Dear Ms Shungube

RE: AUTHORIZATION TO DO A RESEARCH IN THE HOSPITAL

Your request on the fore mentioned endeavors has been duly considered and permission granted on the following conditions please:

- a) That confidentiality is strictly observed
- b) That the hospital receives a copy of the report on the proposed research

Thank you.

Sincerely yours

Dr. R. A. Bitchong
SENIOR MEDICAL OFFICER

☎ (+268) 2508 4000
☎ (+268) 2505 5077

🌐 www.enhiswaziland.com
✉ info@enhiswaziland.com

📍 P.O.Box 14 Manzini M200



Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Good Shepherd Hospital
P.O.Box 2
Siteki

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face-to-face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

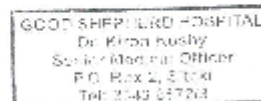
I have provided you with a copy of approval letter from Eswatini health and human research ethics board as well as a copy of the approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC).

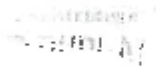
If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

*Seen - Approved - Forwarded to Radiology Dept -
Supervisor - 02-05-2023*





Ms. Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
Mbabane Government Hospital
P.O.Box 8
Mbabane

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face-to-face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy approval letter which I received from the Durban University Institutional Research Ethics Committee (IRIEC) and a copy of approval letter from Eswatini health and human research ethics board.

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology

MEMORANDUM

TO: THE HEAD OF DEPARTMENT
RADIOLOGY

FROM: SENIOR MEDICAL OFFICER
MBABANE GOVERNMENT HOSPITAL

DATE: 11TH APRIL, 2023

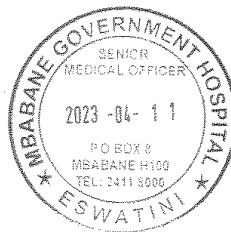
RE: COMPLIANCE TO RADIATION PROTECTION BY RADIOGRAPHERS IN MBABANE GOVERNMENT HOSPITAL

I write this letter to inform you that the management of Mbabane Government Hospital has granted **Amelia Shungube** permission to continue with the study of the above topic.

Please assist her with the information she needs as she carries out the study.

We would very much appreciate if the findings and recommendations of the study can be communicated back to the facility (**electronic and hard copy**).

DR T. TEMBE
SENIOR MEDICAL OFFICER





Ms Amelia Shungube
P.O.Box 1207
Manzini

April 2023

The Senior Medical Officer
EMkhuzweni Health center
P.O.Box M220
Mliba

Dear Sir/Madam

Request for Permission to Conduct Research

My name is Amelia Shungube, a master's degree student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves assessing compliance to radiation safety standards

It's an exploratory study of compliance to radiation protection by radiographers in ESwatini public hospitals. I am hereby seeking your consent to conduct research in your well recognized institution. The study will entail face- to- face interview of two radiographers, as hospital staff, which will be of approximately 30 minutes duration. Interview times will be scheduled in reference to the operational responsibilities of the employee.

I have provided you with a copy of approval letter from Eswatini health and human research ethics board as well as a copy of the approval letter which I received from the Durban University Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 79782174/76869159 ameliashungube@gmail.com . Thank you for your time and consideration in this matter.

Yours sincerely,

Amelia Shungube
Durban University of Technology



Seen and approved

An Exploratory of compliance with patient radiation safety standards among radiographers in Eswatini public hospitals

ORIGINALITY REPORT

19% SIMILARITY INDEX	14% INTERNET SOURCES	8% PUBLICATIONS	10% STUDENT PAPERS
--------------------------------	--------------------------------	---------------------------	------------------------------

PRIMARY SOURCES

1	Submitted to Durban University of Technology Student Paper	2%
2	scholar.ufs.ac.za Internet Source	1%
3	docplayer.net Internet Source	1%
4	www.researchgate.net Internet Source	1%
5	S. Lewis, C. Downing, C.M. Hayre. "South African radiographers' radiation protection practices, a qualitative study", Radiography, 2022 Publication	1%
6	www.ncbi.nlm.nih.gov Internet Source	1%
7	www.sahpra.org.za Internet Source	1%

8 Emmanuel Fiagbedzi, Philip Gorleku, Savanna Nyarko, Adomako Asare, Gideon Ackah Ndede. "Assessment of radiation protection knowledge and practices among radiographers in the central region of Ghana", Radiation Medicine and Protection, 2022
Publication 1%

9 www.ilo.org
Internet Source <1%

10 repository.up.ac.za
Internet Source <1%

11 Submitted to Asia Pacific University College of Technology and Innovation (UCTI)
Student Paper <1%

12 www.sid.ir
Internet Source <1%

13 Submitted to Moraine Santa Margarita
Student Paper <1%

14 Submitted to Pennsylvania College of Technology
Student Paper <1%

15 www.lonsburyconsulting.com
Internet Source <1%

16 www.nature.com 1%

17 www2.worcsacute.nhs.uk
Internet Source <1 %

18 uir.unisa.ac.za
Internet Source <1 %

19 worldwidescience.org
Internet Source <1 %

20 Submitted to Atlantic International University
Student Paper <1 %

21 www.science.gov
Internet Source <1 %

22 Patrick Muiga Maina, Jennifer Anne Motto,
Lynne Janette Hazell. "Investigation of
radiation protection and safety measures in
Rwandan public hospitals: Readiness for the
implementation of the new regulations",
Journal of Medical Imaging and Radiation
Sciences, 2020
Publication <1 %

23 regelwerk.grs.de
Internet Source <1 %

24 www.hindawi.com
Internet Source <1 %

25 www.intechopen.com
Internet Source <1 %

26 Submitted to University Of Tasmania
Student Paper

<1 %

27

sajr.org.za
Internet Source

<1 %

28

Submitted to University of Hertfordshire
Student Paper

<1 %

29

dspace.nwu.ac.za
Internet Source

<1 %

30

www-pub.iaea.org
Internet Source

<1 %

31

catalog.iyte.edu.tr
Internet Source

<1 %

32

Submitted to Intercollege
Student Paper

<1 %

33

Submitted to Sheffield Hallam University
Student Paper

<1 %

34

Submitted to Mancosa
Student Paper

<1 %

35

sphweb.bumc.bu.edu
Internet Source

<1 %

36

ir.lib.uwo.ca
Internet Source

<1 %

37

www.campuscareerclub.com

<1 %

38

www.tandfonline.com

Internet Source

<1 %

39

Malkisedek Taneo, Aleksius Madu.
"Implementation of Cultural Values of
Traditional Houses in Learning", Journal of
Intercultural Communication, 2023

Publication

<1 %

40

mrae.hu

Internet Source

<1 %

41

Submitted to Angeles University Foundation

Student Paper

<1 %

42

Submitted to AUT University

Student Paper

<1 %

43

Submitted to University of Southern
Queensland

Student Paper

<1 %

44

Submitted to University of West London

Student Paper

<1 %

45

Shahla Asadi, Mehrbakhsh Nilashi, Mahmood
Safaei, Rusli Abdullah, Faisal Saeed, Elaheh
Yadegaridehkordi, Sarminah Samad.

"Investigating factors influencing decision-
makers' intention to adopt Green IT in
Malaysian manufacturing industry",

Resources, Conservation and Recycling. 2019

<1 %

46 www.iaea.org
Internet Source <1 %

47 Submitted to Coventry University
Student Paper <1 %

48 Submitted to Midlands State University
Student Paper <1 %

49 Submitted to University of Western Sydney
Student Paper <1 %

50 Submitted to International University -
VNUHCM
Student Paper <1 %

51 cornerstone.lib.mnsu.edu
Internet Source <1 %

52 vtext.valdosta.edu
Internet Source <1 %

53 Submitted to Aspen University
Student Paper <1 %

54 Submitted to Nottingham Trent University
Student Paper <1 %

55 Submitted to University of Venda
Student Paper <1 %

56 vital.seals.ac.za:8080
Internet Source <1 %

Internet Source

<1 %

58

Submitted to National University of Singapore

Student Paper

<1 %

59

Shantel Lewis, Charlene Downing,
Christopher M Hayre. "Using the theory of
planned behaviour to determine radiation
protection among South African diagnostic
radiographers: a cross-sectional survey",
Journal of Medical Radiation Sciences, 2021

Publication

<1 %

60

Submitted to Universiti Teknologi MARA

Student Paper

<1 %

61

Submitted to University of Pretoria

Student Paper

<1 %

62

"Radiological Safety and Quality", Springer
Nature, 2014

Publication

<1 %

63

Submitted to EDMC

Student Paper

<1 %

64

link.springer.com

Internet Source

<1 %

65

Submitted to 2U George Washington
University-MPH

Student Paper

<1 %

66

S. Mehdizadeh. "The evaluation of the dose equivalent to the people accompanying patients in diagnostic radiology using the MCNP4C Monte Carlo code and TL dosimetry", International Journal of Low Radiation, 2009

Publication

<1%

67

Submitted to Queen's University of Belfast

Student Paper

<1%

68

Submitted to Technological University Dublin

Student Paper

<1%

69

Submitted to The Robert Gordon University

Student Paper

<1%

70

1library.net

Internet Source

<1%

71

digitum.um.es

Internet Source

<1%

72

dspace.knust.edu.gh

Internet Source

<1%

73

etd.aau.edu.et

Internet Source

<1%

74

journalppw.com

Internet Source

<1%

75

research.bangor.ac.uk

1

76 Submitted to University of KwaZulu-Natal
Student Paper <1 %

77 Submitted to University of Salford
Student Paper <1 %

78 cdr.lib.unc.edu
Internet Source <1 %

79 inis.iaea.org
Internet Source <1 %

80 pdfs.semanticscholar.org
Internet Source <1 %

81 www.cair.org.za
Internet Source <1 %

82 irep.iium.edu.my
Internet Source <1 %

83 www.arpansa.gov.au
Internet Source <1 %

84 www.grin.com
Internet Source <1 %

85 www.health.govt.nz
Internet Source <1 %

86 www.matthewdavison.net
Internet Source <1 %

87 Khethiwe Margaret Sethole Erika Ahrens 1

the Use of Personal Radiation Monitoring Devices by Qualified Radiographers at Provincial Hospitals in the Tshwane District Area", Health Physics, 2019

Publication

88

"Nuclear Medicine Textbook", Springer Science and Business Media LLC, 2019

Publication

<1%

89

"Patient safety in medical imaging: A joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS)", Radiography, 2019

Publication

<1%

90

hdl.handle.net

Internet Source

<1%

Exclude quotes On

Exclude matches Off

Exclude bibliography On

EDITING LETTER

696 Clare Road
Clare Estate
Durban
4091
10 October 2023

To: Whom it may concern

Editing of Master's thesis: Amelia Shungube (22290678)

**AN EXPLORATORY STUDY OF COMPLIANCE WITH PATIENT RADIATION
SAFETY STANDARDS AMONGST RADIOGRAPHERS IN ESWATINI PUBLIC
HOSPITALS**

This letter serves as confirmation that the aforementioned thesis has been language edited. The requisite grammatical conventions have been met.

Any queries may be directed to the author of this letter.

Regards



MP MATHEWS

Lecturer and Language Editor

Mercimathews4@gmail.com

083 676 4778