DETERMINANTS OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN SELECTED KENYA MEDICAL TRAINING COLLEGES, IN KENYA PUBLIC HOSPITALS.

BY

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DECLARATION

DECLARATION BY CANDIDATE

This research thesis is my original work and has not been presented for a degree in any other university. No part of this work may be reproduced without the permission of the author and/or Moi University.

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DEDICATION

I dedicate this noble work to My Husband, Richard Ng‘eny and my Children for their prayers, financial and moral support during my studies. A special dedication also goes to my supervisors Dr Joyce Lugulu, Dr Ann Ngeno and all other faculty members of School of medicine, department of Medical Education in Moi University for their guidance.

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ABSTRACT

Background: Ultrasound technology has become an effective clinical diagnostic tool in low and middle income countries (LMICs) to meet the objectives of improved primary health care (PHC). However, availability of ultrasound machines and skill training needed continue to limit expanded use of ultrasound in LMICs. In Kenya, concerns have been raised over the quality of work output of sonographers and clinicians practicing ultrasound (Kagima et al., 2021). All these increase the risks of poor diagnosis and patient management and could result in increased morbidity and preventable deaths. This can be attributed to the quality of training and student related factors.

Objectives: To determine how students 'perception of curriculum space limitations affect ultrasonography training outcomes, to analyze how availability of ultrasound machines for training affects ultrasonography training outcomes and to examine how students attitudes on training moderates the relationship between institutional factors and ultrasonography training outcomes.

Methods: Study was carried out using a mixed research approach employing both qualitative and quantitative methods. It targeted five Kenya Medical Training College (KMTC) campuses offering the radiography course that are based in four county (Level 6) and one level 5 teaching hospitals in the country, that is, Nakuru, Uasin Gishu, Nairobi Kisumu and Kericho respectively. The target population were final year KMTC students undertaking their radiography and imaging course, the faculty members and the hospital-based instructors. Systematic random sampling was used to select 98 students, of who 45 are females and 53 males, while the census method was used to select 26 faculty members and 10 hospital-based instructors. Questionnaires for students, interview schedules for lecturers, hospital-based instructors and Focus Group discussions for students were used for data collection. Quantitative data from the questionnaire were analyzed using both descriptive and inferential data analysis.

Results: Students' perception of curriculum space limitations did not significantly affect ultrasonography training outcomes. Availability of ultrasound machines for training significantly affects ultrasonography training outcomes and Students attitudes had a significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma Radiography students.

Conclusions: Students' perception of curriculum space limitations did not have a statistically significant effect on ultrasonography training outcomes. Availability of ultrasound machines for training had a statistically significant effect on ultrasonography training outcomes.

Recommendations: College management should establish clear guidelines and prerequisites for ultrasound training, ensuring that only students from relevant medical imaging or ultrasonography programs are prioritized. To address students' lack of confidence in using the simulators for training, a blended training approach is recommended, where simulators are used to build foundational skills before transitioning to human models. Further, greater emphasis should be placed on mentorship, career guidance, and the long-term relevance of radiography and sonography careers to boost student motivation.

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LIST OF ABBREVATIONS AND ACRONYMS

ALARA	As Low as Reasonably Achievable
ANOVA	Analysis of Variance
BI-POCUS	Bonn Internship Point-of-Care-Ultrasound Curriculum-
COLT	Conception of Learning and Teaching
CT	Computed Tomography
DRC	Democratic Republic of Congo
ED	Emergency Department
EFAST	Extended Focused Assessment with Sonography for Trauma
EM	Emergency Medicine
EUC	Emergency Ultrasound Course
FAST	Focused Assessment with Sonography for Trauma
FGDs	Focus Group Discussions
HCPs	Health Care Providers
JeffSPL	Jefferson Scale for Physician Lifelong Learning
KMTC	Kenya Medical Training College
LMICs	Low and Middle Income Countries
MD	Doctor of Medicine
MES	Managed Equipment Services
MMH	Mnazi Moja Hospital
MRI	Magnetic Resonance Image
MSKUS	Musculoskeletal ultrasound
NACOSTI	National Commission for Science Technology and Innovation
OSCE	Objective Structured Clinical Examination

PBL	Problem Based Learning
PHC	Primary Health Care
PoCUS	Point of Care Ultrasound
SLT	Student Learning Time
SPSS	Statistical Package for Social Sciences
UHC	Universal Health Coverage
UME	Undergraduate Medical Education
US	Ultrasound
USA	United States of America
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Curricular Space – refers to the allocation of time within the formal classroom teaching, medical clerkships, or electives for teaching of ultrasound in the medical curriculum

Diagnostic Ultrasound - also called sonography or diagnostic medical sonography, is an imaging method that uses sound waves to produce images of structures within your body. The images can provide valuable information for diagnosing and directing treatment for a variety of diseases and conditions.

Faculty Members Training – refers to activities and programs designed to assist faculty members in developing skills related to the 3 domains or pillars of academic medicine. These domains include skills related to the roles of teacher & educator, researcher & scholar, and administrator & leader

Ordinary Diploma – refers to is a non-degree post-secondary qualification awarded to an individual by a higher educational establishment to show that someone has successfully completed a course of study. The ordinary diploma is usually awarded after three years of study for most vocational courses in Kenya

Students Attitudes – refers to the tendency of students to respond a certain way towards something. Naturally, the student's response can be on a continuum of positive to negative or good to bad

Teaching - refers to the systematic rational and organized process of transmitting knowledge, attitudes and skills in accordance with professional principles

Ultrasonography Training – refers to the training of an individual in the techniques and applications of ultrasound in human medicine either as a specialist, that is, sonographer or as a non-specialist where one is required to take ultrasound as part of the other medical programs like clinical medicine

CHAPTER ONE

1.0 Introduction

This chapter outlines the background of the study, statement of the problem, objectives, justification, scope, limitations and conceptual framework in matters relating to determinants of ultrasonography training outcomes among Diploma radiography students in KMTC.

1.1 Background of the Study

Ultrasound, especially portable and affordable point-of-care ultrasound (POCUS), has emerged as a crucial diagnostic tool in low- and middle-income countries (LMICs) due to its versatility and mobility (Cevik et al., 2019). Its integration into primary healthcare strategies has the potential to achieve significant health improvements in resource-limited areas (Kim et al., 2018). By enabling bedside and home-based diagnostics, POCUS enhances healthcare delivery, particularly in underserved regions (Boivin et al., 2022). However, ultrasound's operator-dependent nature requires practitioners to develop technical proficiency and clinical judgment for accurate diagnosis (Wakefield et al., 2018). Despite its importance, ultrasound training faces significant challenges, including inadequate curriculum implementation, limited faculty expertise, and resource constraints (Lujan & DiCarlo, 2006).

Globally, there is no standardized approach to training duration, content, or trainer qualifications, complicating integration into medical education (Nicholas et al., 2021; Glass et al., 2021). Addressing these gaps, is critical for improving training outcomes (Solomon & Saldana, 2014; Hoffmann et al., 2019). Training outcomes for ultrasonography students vary across regions due to differences in resources, curriculum integration, and institutional support. In the US and EU, access to advanced

equipment and experienced instructors contributes to enhanced clinical competency (Smith & Patel, 2024; Yang et al., 2021). In China, institutional investment and standardized curricula are key determinants, while in India, financial constraints and resource limitations often hinder training quality, although innovations like mobile ultrasound units are gaining traction (Li et al., 2022; Sharma & Kumar, 2024).

Across Africa, determinants include curriculum design, clinical exposure, and faculty expertise. South Africa and North African states face challenges such as inconsistent faculty training and resource limitations, while mentorship and clinical opportunities remain barriers in Nigeria and Ethiopia (Müller et al., 2022; El-Tallawy et al., 2021; Adebayo et al., 2023). Rwanda, too, struggles with limited access to mobile units and quality instruction (Niyibizi et al., 2021). Despite regional differences, there is a need to address how these factors collectively influence long-term competency, particularly in rural healthcare settings post-COVID-19.

Ultrasound training among medical students in Kenya has gained traction as a critical component of medical education, given the increasing reliance on ultrasonography in clinical diagnostics. As a way of standardizing the practice, the Ministry of Health regulations require that for one to qualify as a licensed sonographer in Kenya, one has to undertake a higher diploma in the same. The training emphasizes both theoretical and hands-on practice to enhance diagnostic skills and to prepare students for effective use in resource-limited settings (Kagima et al., 2021). However, limited resources, including inadequate equipment and faculty shortages, challenge effective training, highlighting the need for improved infrastructure and curriculum design to optimize outcomes (Kagima et al., 2021; Smith & Patel, 2024). However, research gaps remain in understanding how individual and institutional factors, such as, students ‘perception

of curriculum space limitations, availability of ultrasound machines for training, and students' attitudes on training, such as mentorship and peer collaboration, influence training outcomes in Kenya's medical education context (Jones et al., 2024).

Institutions like the Kenya Medical Training College (KMTC) have integrated ultrasound education into their curricula, incorporating modules on sono-anatomy, pathology, and point-of-care ultrasound (POCUS) applications (Mungai et al., 2021). Access to portable ultrasound devices has improved hands-on training, enabling students to gain practical experience in real-world scenarios, such as bedside diagnostics and rural healthcare settings (Boivin et al., 2022). However, challenges persist, including limited access to modern equipment, inadequate faculty training, and high student-to-equipment ratios, which hinder skill acquisition (Smith & Patel, 2024).

While efforts have been made to enhance training, such as partnerships with international organizations for equipment donations and faculty development, the lack of a standardized curriculum remains a gap. Further, other issues such as availability technicians, maintenance of machines, and students' attitudes on future career prospects, mentorship, peer training, syllabus management, and time allocations have not received attention in local studies. Hence, their influence on how they impact student learning outcomes prior to the current study remained unknown. Establishing this is important against the backdrop of poor performance in the subject.

1.2 Statement of the Problem

Ultrasound training has become integral to medical education in Kenya, particularly for its role in clinical diagnostics and its potential to improve healthcare delivery in resource-limited settings (Kagima et al., 2021). At institutions like the Kenya Medical Training College (KMTC), ultrasound training emphasizes theoretical knowledge and hands-on practice, equipping students with the skills to perform bedside diagnostics and address rural healthcare challenges (Mungai et al., 2021; Boivin et al., 2022).

However, the work output of radiographers practicing ultrasound is especially worrying. Unlike other radiographers such as those in the MRI, CT and X-Ray departments who hand over their examinations to other professionals for interpretation, sonographers must interpret ultrasound results and produce diagnostic reports themselves, necessitating advanced knowledge, technical skills, and clinical judgment. In KMTC, for instance, most students perform well in the theoretical part of the training compared to practical sessions. Incompetent skills and knowledge will lead to inaccurate ultrasound reports hence wrong diagnosis and finally poor patient treatment and outcome.

Most student radiographers have difficulties in performing some of ultrasound examinations. This raises questions about the preparedness of graduates to deliver accurate diagnoses and high-quality patient care. Insufficient training for ultrasound operators could result in medical errors and increase mortality. The underutilization of advanced training programs, coupled with limited curricular time and evolving sonography technologies like handheld devices, further complicates efforts to enhance training outcomes (Teichgräber et al., 2022).

It, therefore, appears that there are significant challenges undermining effective training, including inadequate equipment, faculty shortages, and high student-to-equipment ratios but their effect has yet to be determined in KMTC. Studies done on ultrasonography training in Kenya has largely overlooked KMTC students leading to a critical gaps in understanding the determinants of ultrasonography training outcomes among ultrasonography students in Kenya.

Research gaps remain in understanding how individual and institutional factors, such as, students 'perception of curriculum space limitations, availability of ultrasound machines for training, and students attitudes on training, such as mentorship and peer collaboration, influence training outcomes in Kenya's medical education context. Further, other issues such as availability technicians, maintenance of machines, students' attitudes on future career prospects, mentorship, peer training, syllabus management, and time allocations have not received attention in local studies. Hence, their influence on how they impact student learning outcomes prior to the current study remained unknown. Establishing this is important against the backdrop of poor performance in the subject. Therefore, drawing from these discussions, the present study seeks to establish determinants of ultrasonography training outcomes among diploma level students in selected Teaching Hospitals in Kenya.

1.3 Research Questions

i. What is the student's perception of curriculum space in regards to training outcomes among diploma level KMTC students in selected Teaching Hospitals in Kenya?

ii. What is the relationship between availability of ultrasound training machines and training outcomes among diploma level KMTC students in selected Teaching Hospitals in Kenya?

iii. How does students' attitude moderate the relationship between institutional factors and training outcomes among diploma level KMTC students in selected Teaching Hospitals in Kenya?

1.4 Objectives

1.4.1 Broad Objective

To determine determinants of ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya.

1.4.2 Specific Objectives

The study was anchored on the following specific objectives.

i. To determine how students 'perception of curriculum space limitations affect ultrasonography training outcomes among Radiography Diploma level KMTC students in selected Teaching Hospitals in Kenya

ii. To analyze the relationship between availability of ultrasound training machines and training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya

iii. To determine how students attitudes on training moderates the relationship between institutional factors and ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya

1.5 Hypothesis

H01: Students' perception of curriculum space limitations have no significant effect on ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya

H02: Availability of ultrasound machines for training has no significant effect on ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya

H03: Students perception of training has no significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya.

1.6 Justification of the Study

Over the last two decades, ultrasound has seen increased clinical use by physicians in many specialties. Mastery of this imaging modality requires the development of spatial aptitude, sono-anatomy and sono-pathophysiology knowledge, as well as an understanding of the limitations of ultrasound. As such, the acquisition of sonographic skills is considered a longitudinal, if not a life-long, learning process. For the medical personnel, therefore, good training in ultrasound is important to augment the clinical skills and also make more accurate diagnosis.

Therefore, the present study seeks to address this by providing empirical information and recommendations on the determinants of ultrasonography training outcomes among Radiography diploma level students in selected Teaching Hospitals in Kenya of which majority are drawn from KMTC.

1.7 Significance of the Study

The healthcare policymakers are expected to be able to gain insight on the current status of ultrasonography training and practice in the country‘s medical learning institutions and make curriculum interventions. The government to improve on the healthcare infrastructure to better training.

The study will also give an insight on how to improve the training program in KMTC to produce Radiographers who are fit for purpose. The outcome of the study is meant to inform practice and policy recommendations so as to improve training and students performance in ultrasonography.

1.8 Scope of the Study

The study focused determinants of ultrasonography training outcomes among Radiography diploma level KMTC students in selected Teaching Hospitals in Kenya having ultrasonography facilities. Therefore, the County hospitals under consideration were Nairobi, Nakuru, Kisumu, Kericho and Uasin Gishu hospitals. The study also included faculty members and hospital-based instructors.

1.9 Limitations and delimitations of the Study

This study on the determinants of ultrasonography training outcomes among KMTC diploma students in Kenya had several limitations:

1. **Geographic Scope**: The study was limited to selected teaching hospitals in Kenya, which might not have fully represented the diversity of ultrasonography training experiences across all KMTC campuses and healthcare facilities in the country.
2. **Self-reported Data**: Some data relied on self-reported information from students and faculty, which might have been subject to recall bias or social desirability bias, potentially affecting the accuracy of the findings.

   This was addressed through pretesting the data collection instrument to identify and adjust questions that may be prone to misinterpretation or memory errors.

   This was also addressed by triangulating survey responses with interviews and administrative records to enhance further the reliability of the data collected.

3. **Focus on Diploma Students**: The study focused exclusively on diploma-level students, excluding those pursuing higher diploma programs or other specialized training. This narrow focus may have overlooked important insights related to advanced training and its impact on practice.
4. **Equipment Variability**: Differences in the availability and quality of ultrasound machines across teaching hospitals could have skewed the results, making it difficult to generalize findings to facilities with varying resource levels.

1.10 Theoretical Framework

The study was premised on three theories; Constructivism (Ertmer & Newby, 1993), Cognitive Load Theory and the Cognitive Theory of Multimedia Learning by Sweller et al., (1980) and Adult Learning Principles (Andragogy) by Knowles (1984).

1.10.1 Constructivism

Constructivism was originally a branch of cognitivism (Ertmer & Newby, 1993), as may be apparent from the notion of knowledge construction discussed in the above section. Constructivism assumes that all knowledge is constructed from prior knowledge, irrespective of how one is taught—even listening to a lecture involves the learner‘s attempts to construct knowledge (Bransford & Brown, 2000). Learning is not the simple transmission of Knowledge from the external world into the memories of the learner but an active process of knowledge construction on the part of the learner.

Constructivism is widely used to support some methods in medical education (Ertmer & Newby, 1993). A most prominent example is problem-based learning (PBL), for it stresses; students working with authentic clinical scenarios; students working together in discussion groups, and; students‘active engagement in identifying learning issues,

conducting independent studies, applying knowledge to the case situations, integrating new learning with what is already known, and reflecting on their learning. The theory was used to provide insight on how the approach to medical training and availing teaching and learning resources, for example, human models and availing of ultrasound equipment for training could improve medical learning among ultrasonography trainees in KMTC by providing authentic clinical scenarios.

In the context of ultrasonography active learning is fundamental, encouraging students to engage in simulation exercises and supervised patient scanning rather than passively receiving information. Leveraging learners' prior knowledge enables the integration of existing clinical understanding with new ultrasonographic techniques, thereby enhancing comprehension

Collaborative learning further enriches the educational experience by fostering peer discussions and mentor feedback, which promote shared problem-solving and deeper insight. Contextualized and authentic learning situates training within realistic clinical scenarios, bridging the gap between theory and practice.

Finally, reflection and metacognition are critical, as they encourage students to critically assess their performance and identify areas for improvement through self-assessment. Together, these principles provide a robust framework for improving ultrasonography training outcomes among KMTC students.

1.10.2 Cognitive Load Theory and the Cognitive Theory of Multimedia Learning

The cognitive load theory, developed in the 1980s by Sweller and colleagues, is based on the assumption that the human cognitive architecture consists of a limited working memory and an unlimited long-term memory holding cognitive schemas (Van Merrienboer & Sweller, 2010; Lauria et al., 2017). According to this theory, three types

of cognitive processing loads are placed on the working memory when it deals with information—intrinsic, germane, and extraneous loads. Teaching, therefore, should consider the appropriate difficulty levels of materials and use optimal manners of presentation so as not to inadvertently increase learners‘cognitive load or decrease learning effectiveness. Based on the cognitive load theory, Mayer (2010) developed a cognitive theory of multimedia learning and recommended design principles for multimedia instructional messages. Mayer (2010) recommended to medical educators evidence based principles that multimedia instructional designs can use for reducing cognitive load and for fostering understanding. Empirical studies (Issa et al., 2013; Issa et al., 2011) have yielded evidence that applying Mayer‘s principles to actual medical school lectures has significant positive effects on measures of student learning in terms of long- and short-term knowledge retention and knowledge transfer. This theory was used to provide insight into the teaching methods and other instructional facilitation address curricular space limitations for ultrasound students in KMTC.

1.10.3 Adult Learning Principles (Andragogy)

One of the most important ideas influencing medical education has been the adult learning theory put forward by Knowles. Knowles (2000) called his perspective ―andragogy‖ and defined andragogy as ―the art and science of helping adults learn. Rogers believed that, to have students‘eagerness to learn unleashed, they need an environment where they can work on problems that are meaningful to them, and where the teacher is genuine, warmly accepts them, provides positive regard, and empathizes with their feelings of fear and anticipation involved in meeting new materials (Zimring & Rogers, 1994). This is Rogers‘notion of facilitative learning—that learning will take place if the teacher acts as a facilitator whose job is to establish an atmosphere conducive to learning (Rogers & Freiberg, 1994).

This facilitative educational atmosphere is learner-centered and has the following main characteristics: the teacher shares with students the responsibility for the learning process, determining together the learning content and activities; the teacher provides learning resources and also encourages learners to add their own resources based on their knowledge and experience; students explore their interests and make choices about their individual learning directions and carry the responsibilities for the consequences of their choices; students reach personal goals through self-discipline rather than external discipline, and; students evaluate their own learning (Rogers & Freiberg, 1994).

Below are principles from Adult Learning Theory (Knowles, 1984) that can be applied to examine how student attitudes moderate the relationship between institutional factors and ultrasonography training outcomes among KMTC diploma students.

First, the **"Need to Know"** principle emphasizes that adult learners must understand the relevance and benefits of the training, which motivates them to engage deeply with ultrasonography practices. Second, the "**Self-Concept"** principle highlights that as adults, students value self-directed learning, making them more likely to take initiative in applying institutional resources effectively.

Third, the **"Experience"** principle recognizes that learners integrate their prior clinical experiences into new learning, thereby moderating how institutional factors translate into practical ultrasonography skills. Finally, the "**Orientation to Learning"** principle stresses that adult learning is most successful when it is problem-centered rather than purely theoretical, ensuring that training is directly applicable to real-world clinical scenarios.

These principles collectively inform strategies for aligning institutional training methods with the needs and attitudes of adult learners, ultimately improving ultrasonography training outcomes.

These theories were instrumental in examining the direct relationship between faculty members training on ultrasonography training outcomes and also the moderating influence of faculty members'attitude on training on ultrasonography training outcomes among KMTC students.

1.11 Conceptual Framework

Independent Variables **Moderating Variable**

Dependent Variable

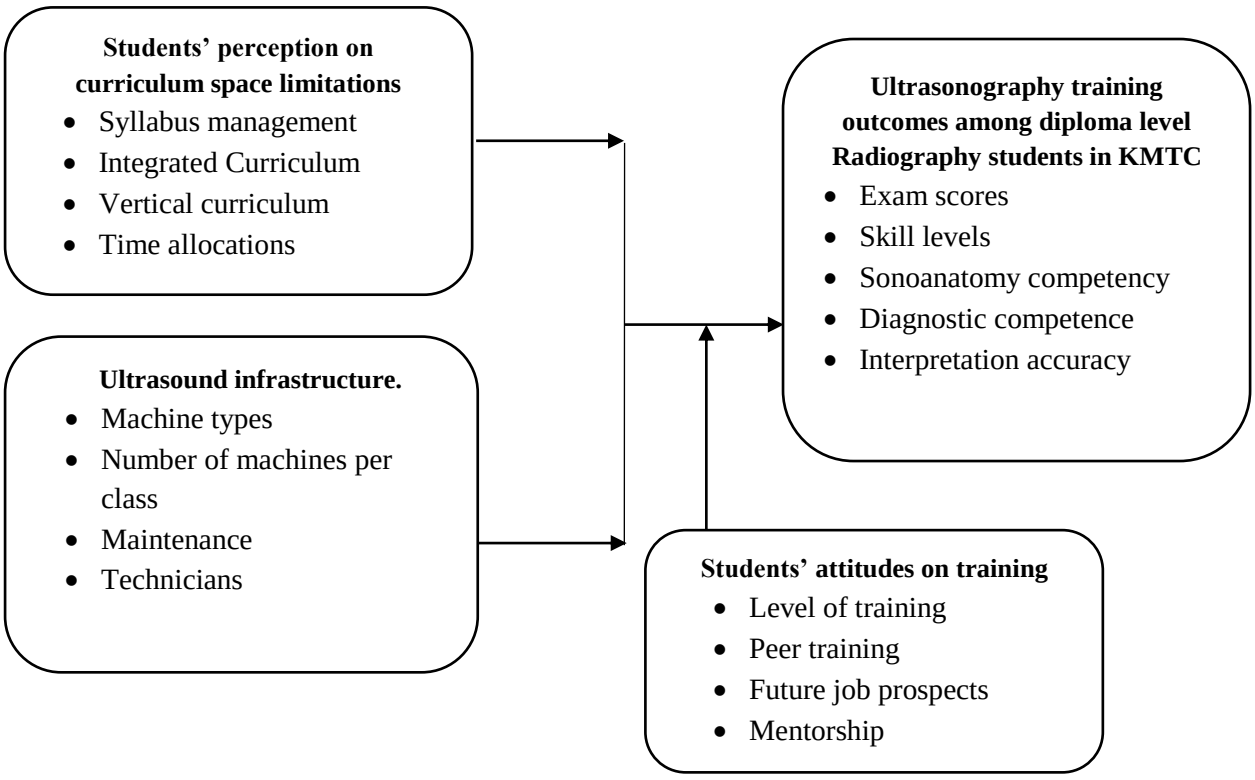

Figure 1: Conceptual Framework

Source: Researcher (2023)

NB: The two independent variables determine the outcome or the dependent variable.

The moderating variable is a multiplier of the effect of independent variable on the dependent variable.

1.12 Study Philosophy

The study was grounded on the pragmatist philosophy. Pragmatism emphasizes the utilization of both positivist and interpretivist philosophy and views both of them as continuum rather than contradictions (Smid, 2010). Precisely a pragmatist avoids going into argument on concepts of truth and reality. Rather they focus on studying the issues of interest and value and use different ways to bring out the consequences (Scott & Briggs, 2009). This philosophy also allowed for the application of the mixed method involving both qualitative and quantitative approaches used in the current study.

1.13 Assumptions of the Study

This study also assumes that all the respondents will give truthful and unbiased views of the problem being investigated.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter presents a discussion of previous studies on factors determining the ultrasonography training outcomes among students. Empirical literature is reviewed and gaps to be filled by the study were identified.

Ultrasound education has gradually found itself into the medical curriculum in a growing number of medical schools worldwide. The use of ultrasound within undergraduate medical education is also longstanding, with practical ultrasound teaching being reported in the literature since the 1990's (Teichgraber et al., 1996; So, Patel & Orebaugh, 2017). For instance, several reports indicate that medical schools in North America (Ma et al., 2020), Europe (Wolf et al., 2019), and Asia (Coiffier et al., 2020) continue to integrate ultrasound into undergraduate medical curricula. In Kenya, there is training of Sonographers in diploma, Higher Diploma and Bachelors degree.

2.2 Students perception of curriculum space limitations and ultrasonography students training outcomes

Students' perceptions of curriculum design are vital for creating relevant, inclusive, and engaging educational experiences. Perceptions influence engagement, with students more motivated when they find the curriculum aligned with their career goals and real-world applications (Brown et al., 2023). Feedback helps identify gaps, such as outdated content or insufficient practical components, and supports continuous improvement (Chen et al., 2021). Understanding diverse student needs promotes equity, ensuring inclusive learning environments (Smith & Lopez, 2022). Furthermore, students' insights into emerging trends enhance alignment with future societal and job market

demands (Jones et al., 2024). A curriculum shaped by student input fosters a sense of collaboration, enhancing trust and satisfaction (Taylor, 2020).

Ultimately, integrating students' perceptions strengthens the relevance, responsiveness, and effectiveness of educational programs. In ultrasonography training curriculum design, students' perceptions matter as they provide insights into the relevance, practicality, and effectiveness of teaching methods, ensuring the curriculum aligns with clinical demands, enhances skill acquisition, and meets learners' career aspirations and professional readiness (Alsharif et al., 2021; Özkurt & Yetim, 2023). Ultrasonography training curriculum design and the training requirements are very demanding given the fact that the course requires a firm understanding of the basic science behind the techniques and the equipment and also given its multidisciplinary nature (Burgess, McGregor & Mellis, 2014; Benè & Bergus, 2014). In this section, students' perceptions of ultrasonography training curriculum was viewed through the lens of syllabus management, integrated curriculum, vertical curriculum, and time allocations.

2.2.1 Syllabus Management

Syllabus management in ultrasound training involves structuring, organizing, and continuously updating course content to meet evolving clinical competencies and educational standards (Smith et al., 2022). Syllabus management in ultrasound training ensures organized content delivery, skill progression, and alignment with clinical competencies to enhance students' diagnostic proficiency (Müller et al., 2022). Syllabus management in ultrasonography training for medical students has been explored in a limited number of studies. For instance, Ahn et al. (2014) explored a combined ultrasound/physical exam curriculum using peer instructors, emphasizing practical, hands-on learning. This approach demonstrated the feasibility of integrating

ultrasound into physical examination training but revealed a challenge in balancing time allocation between traditional and emerging content. The study identified a gap in structured guidelines for incorporating such hybrid curricula without compromising core competencies.

Chen et al. (2022) compared in-person and virtual musculoskeletal ultrasound education during the COVID-19 pandemic. Their findings underscored the necessity of balancing online and physical training. Although virtual learning was effective in theory delivery, practical skill acquisition suffered. This highlighted a significant curriculum gap: ensuring adequate hands-on experience within limited instructional time. Their study called for hybrid models but noted that curriculum space constraints limit their broad adoption.

Eke et al. (2021) examined the global adaptation of point-of-care ultrasound (POCUS) education during COVID-19. They emphasized a shift towards remote learning, which expanded access but strained faculty resources and reduced hands-on training. Their research highlighted the challenge of maintaining curriculum rigor while expanding access to a broader audience. A critical gap emerged around creating scalable, standardized curricula that balance theoretical and practical training, particularly in resource-constrained environments.

Kameda et al. (2022) reviewed ultrasonography's integration into undergraduate medical education, focusing on Jichi Medical University's program. Their comprehensive approach aimed at longitudinal skill development throughout medical training. However, the study noted the challenge of integrating ultrasound into an already packed curriculum without overburdening students. The research emphasized the need for modular, flexible curriculum structures to accommodate ultrasound

training without reducing other essential subjects. Despite progress, the study identified a lack of consensus on optimal integration strategies, reflecting a broader gap in curriculum design research.

A significant research gap exists regarding how students' perceptions of syllabus management in ultrasonography training influence their attitudes toward the curriculum in Kenya. While studies such as Chen et al. (2022) and Eke et al. (2021) explore challenges in balancing theoretical and practical training in ultrasound education, they primarily focus on global or pandemic-specific contexts, leaving localized perspectives underexplored. Similarly, Kameda et al. (2022) highlights integration challenges in packed curricula, but its findings are not contextualized to Kenya's unique educational and healthcare system constraints. Research is needed to investigate how syllabus structuring, time allocation, and delivery methods impact students' attitudes in resource-constrained settings like Kenya, particularly in relation to alignment with clinical competencies and accessibility of hands-on training. This gap is crucial for optimizing ultrasonography training and improving student engagement and diagnostic proficiency in the Kenyan medical education landscape. This study, therefore, sought to examine the students' attitude on syllabus management in ultrasonography training at the KMTC to fill this gap.

2.2.2 Integrated Curriculum

An integrated curriculum combines various disciplines to create a holistic learning experience, fostering connections between theory, practice, and real-world application (Miller & Green, 2021). In the context of ultrasonography training, students' perceptions are crucial because they shape how well the curriculum addresses their needs for practical skills, theoretical knowledge, and career preparedness (Liu et al.,

2022). If students perceive the curriculum as relevant and engaging, they are more likely to actively participate and retain critical skills necessary for clinical settings (Clark et al., 2023).

Additionally, understanding students' perspectives helps educators fine-tune the integration of subjects, ensuring that both foundational and advanced ultrasonography concepts are effectively interwoven (Sharma & Kumar, 2024). This alignment enhances student competence, confidence, and readiness for professional practice. The integration of ultrasound into medical curricula has shown promise in enhancing students' anatomical understanding and clinical skills.

Studies on integrating ultrasound training into medical curricula emphasize its growing importance, with various approaches addressing curriculum space limitations. Feilchenfeld et al. (2017) conducted a systematic review on ultrasound in undergraduate medical education, revealing that while many institutions recognize its value, implementation is inconsistent. The review identified curriculum space limitations as a significant barrier, particularly in programs with rigid structures.

The study suggested more flexible, competency-based frameworks to accommodate ultrasound training, urging further research into scalable integration methods that balance traditional learning and emerging diagnostic tools. Notably, inconsistent implementation of ultrasound training was identified but lacked specific strategies for integrating ultrasound into already saturated curricula. There is limited research on how institutions can systematically overcome rigid curriculum structures or on the effectiveness of competency-based frameworks in diverse educational settings.

Curriculum integration challenges extend beyond ultrasound, as seen in Kligler et al. (2021) and Mohammed et al. (2017), who examined broader curriculum integration

issues. Kligler et al. highlighted difficulties in embedding ultrasound training due to limited curriculum space, while Mohammed et al. identified barriers to health policy curriculum implementation, including resistance to change and insufficient faculty training. These findings suggest that ultrasound curriculum integration faces similar obstacles, necessitating innovative solutions such as interdisciplinary approaches and faculty development to overcome space and resource constraints. Both studies explored challenges in integrating non-core subjects into medical curricula, such as environmental health and health policy, but did not offer specific solutions applicable to ultrasound training. There is a gap in research exploring interdisciplinary integration models that combine ultrasound with other subjects to optimize curriculum space. Additionally, Mohammed et al. pointed to a lack of faculty training research, suggesting that future studies should investigate how faculty development and interdepartmental collaboration can facilitate ultrasound curriculum integration.

Kim et al. (2018) explored the use of obstetric ultrasound in low- and middle-income countries (LMICs), emphasizing its role in reducing maternal and neonatal mortality. The narrative review highlighted the limited use of obstetric ultrasound in LMICs due to curriculum space and resource constraints arising from competing healthcare priorities. The study underscored the need for tailored curriculum models that incorporate ultrasound without overburdening existing training programs. However, it did not provide evidence-based models for integrating ultrasound training into existing medical curricula in resource-poor settings. There is a need for research on scalable, context-specific curriculum designs that balance ultrasound training with other essential medical content in LMICs, particularly focusing on cost-effectiveness and training outcomes. However, there are limited studies on students' perceptions of integrated

curriculum in ultrasononography curriculum design in KMTC and this was explored in the current study.

A key research gap exists regarding how students' perceptions of an integrated curriculum in ultrasonography training influence their attitudes toward the training in Kenya, particularly in institutions like KMTC. Currently in KMTC, Ultrasound Training has been integrated in the basic diploma at the level of 2nd year. While studies such as Feilchenfeld et al. (2017) and Mohammed et al. (2017) have explored integration barriers, including rigid curricula and faculty challenges, they lack insights into how students' perceptions shape their engagement and attitudes toward ultrasound training in low-resource settings. Additionally, there is limited research on context-specific, interdisciplinary integration models tailored to LMICs, which balance ultrasound training with other medical priorities while addressing students' perspectives on curriculum flexibility and relevance. This study, therefore, sought to examine the students' attitude on integrated curriculum in ultrasonography training at the KMTC to fill this gap.

2.2.3 Vertical Curriculum

A vertical curriculum involves the systematic organization of learning materials that builds upon previous knowledge across different levels of education. In integrated ultrasonography training, students' perceptions are crucial as they provide feedback on how well the curriculum connects foundational knowledge with advanced techniques, ensuring continuity and depth in learning (Khan et al., 2023). Students' insights into the integration of theory and practice can highlight areas for improvement in course content, teaching methods, or technology usage, fostering a more effective and relevant training experience (Yang et al., 2021). Understanding their perceptions ensures that

the curriculum aligns with both academic goals and real-world clinical applications, ultimately enhancing professional competence (Smith & Patel, 2024).

Elsie et al. (2010) evaluated ultrasound training within a problem-based learning (PBL) radiography curriculum at Makerere University. Their study demonstrated that integrating ultrasound into the PBL approach improved students' diagnostic skills and confidence. However, logistical issues such as limited access to ultrasound equipment and insufficiently trained faculty were significant barriers. These limitations often led to inconsistencies in skill acquisition, revealing gaps in hands-on training and equitable resource distribution. The study revealed a gap in the vertical integration of ultrasound within a problem-based learning (PBL) radiography curriculum. Although the study demonstrated short-term benefits in diagnostic skills, it did not address how ultrasound training could be systematically extended across different levels of learning. The lack of a progressive, multi-year training model leaves a gap in understanding the cumulative effects of ultrasound training on students’ proficiency and readiness for clinical practice.

Boivin et al. (2022) evaluated a vertical point-of-care ultrasound (POCUS) curriculum in undergraduate medical education, highlighting the effectiveness of integrating ultrasound across different learning phases. Despite its benefits in enhancing diagnostic skills, the study identified challenges in balancing the curriculum, with space limitations constraining the depth of coverage. This necessitates strategic scheduling and prioritization to ensure comprehensive ultrasound training without compromising other medical disciplines. The study evaluated a vertical POCUS curriculum but lacked long-term outcome assessments. It did not explore the impact of ultrasound training on clinical competency post-graduation or in various specialties. Additionally, it did not

address how different learning styles or prior knowledge affect the success of ultrasound training across student cohorts, indicating a need for more longitudinal, multi-center studies.

Hoppmann et al. (2015) detailed a nine-year experience with an integrated ultrasound curriculum (iUSC), illustrating its progressive impact on medical education. The study emphasized how early, vertical integration of ultrasound, spanning preclinical to clinical years, enhanced students' diagnostic capabilities across multiple disciplines. This longitudinal exposure fostered a deeper understanding of anatomy and clinical correlation, though sustaining faculty involvement and overcoming initial resistance posed significant challenges.

The study described a vertically integrated ultrasound curriculum (iUSC) spanning nine years, but the study left a gap in standardizing how vertical integration could be adapted across varying institutional contexts. The emphasis was on their institution's success, without addressing the broader scalability of the curriculum model. Further research is needed to explore how diverse medical schools can adopt a similar vertically integrated approach, considering variations in resources, faculty expertise, and student demographics. These studies on vertical curriculums collectively reveal a broader research gap: while the benefits of ultrasound integration are recognized, there is limited evidence on the optimal design, implementation, and evaluation of a vertical ultrasound curriculum. Hence the present study sought to examine the students' perceptions of vertical curriculum in in ultrasonography curriculum design in KMTC.

A significant research gap exists in understanding how students' perceptions of a vertical ultrasonography curriculum influence their attitudes toward training, particularly in Kenya. While Elsie et al. (2010) highlighted gaps in progressive, multi-

year ultrasound training within problem-based learning, Boivin et al. (2022) and Hoppmann et al. (2015) emphasized the benefits and challenges of vertical integration without addressing its adaptability across diverse educational settings. These studies lack evidence on the impact of such curricula on students' attitudes in resource-constrained environments, such as Kenya. Furthermore, they do not explore how student feedback shapes curriculum design, implementation, or sustainability in institutions like KMTC. This gap necessitates research into how perceptions of vertical curricula affect student engagement, skill acquisition, and readiness for clinical practice, particularly in regions with unique logistical and educational challenges. It is against this that the current study investigated whether vertical curriculum in ultrasound training curriculum affected ultrasonography students training outcomes

2.2.4 Time allocations

Time allocation in an integrated ultrasonography training curriculum is crucial for balancing theoretical knowledge with practical skills. Students' perceptions of time allocations influence their learning experience, as inadequate time for hands-on practice or theoretical understanding can impact skill proficiency and confidence (Williams & Zhang, 2021). Feedback from students helps optimize curriculum time, ensuring essential areas are given appropriate attention (O'Connor et al., 2022). Additionally, students' views on time distribution can highlight areas where pacing might affect their learning outcomes, aiding in the development of a more effective and responsive curriculum (Brown & Lee, 2023).

Moore et al. (2022) examined point-of-care ultrasound (POCUS) training in nephrology fellowships, revealing significant variability in training duration across programs. While some programs allocated extensive time to POCUS, others struggled to

incorporate it into already packed curricula. The study highlighted that time allocation greatly influenced skill acquisition, with fellows receiving more training hours demonstrating higher proficiency. However, limited curriculum space often led to insufficient practical exposure, thereby affecting the overall competence of trainees.

The survey emphasized the need for standardizing time allocation to ensure consistent competency levels across programs. The study identified a significant research gap concerning the inconsistent time allocation for point-of-care ultrasound (POCUS) training in nephrology fellowship programs. The study revealed that while some programs allocated ample time for hands-on ultrasound practice, others struggled to incorporate it due to rigid timetables and competing curricular demands. The lack of a standardized framework for time allocation in training schedules has led to disparities in skill acquisition and proficiency among fellows.

Shea, Knowlton, and Shaman (2020) assessed the integration of climate-health curricula in international health profession schools, indirectly shedding light on challenges related to curriculum space. Though focused on climate-health education, the study illustrated broader issues of competing priorities within medical curricula, where newer content like ultrasound training often faces time constraints. The research revealed that the lack of dedicated time hinders both the adoption and effectiveness of emerging medical technologies and techniques, such as POCUS. The study indirectly highlighted a research gap related to time allocation in integrating new content like ultrasound training within crowded medical school curricula. The study illustrated that the inclusion of emerging medical topics often results in time trade-offs, compromising the depth of instruction. A gap exists in determining how to allocate sufficient time for ultrasound training within existing timetables without displacing other essential

subjects. Further research is needed to examine time management strategies that balance traditional and emerging medical content.

Steinmetz, Oleskevich, and Lewis (2016) investigated the acquisition and retention of bedside ultrasound skills among first-year medical students. Their findings demonstrated that initial skill acquisition requires substantial time investment, but long-term retention benefits from periodic refresher sessions. They observed that when ultrasound training was compressed into short timeframes due to curriculum limitations, students exhibited lower retention rates. The study suggested that continuous, spaced training over time is critical for long-term proficiency, indicating that limited time allocation poses a significant barrier to effective ultrasound education. The study pointed out a research gap in how time constraints impact long-term retention of bedside ultrasound skills. Their findings showed that compressed training schedules led to lower retention rates, emphasizing the need for continuous training spread over longer periods. However, limited timetable space often prevents such ongoing training.

All three studies point to significant challenges in allocating sufficient time for ultrasound training within medical curricula. Moore et al. (2022) highlighted the lack of standardization, while Shea et al. (2020) illustrated the broader issue of competing curriculum priorities. Steinmetz et al. (2016) emphasized the negative impact of compressed training schedules on skill retention. A key research gap lies in developing effective strategies to integrate ultrasound training without overburdening existing curricula. Further studies are needed to explore how flexible scheduling, interdepartmental collaboration, or the use of digital training tools could optimize time allocation and address curriculum space limitations, ensuring sustained competency in

ultrasound practice. The current study, therefore, investigated whether time allocation in ultrasound training curriculum affected ultrasonography students training outcomes

Overall, the methodologies used in the studies on students' perception of ultrasonography training curricula in this section offer diverse approaches. Hoppmann et al. (2015) utilized a longitudinal, observational design to analyze the evolution of an integrated ultrasound curriculum, focusing on a nine-year span of curriculum changes. This method provided robust long-term insights but lacked direct student feedback. In contrast, studies by Smith and Patel (2024), and Yang et al. (2021) incorporated surveys and feedback mechanisms to directly capture students' perceptions of ultrasound curricula, offering valuable insights into immediate educational impact. Müller et al. (2022) emphasized the practical application of integrating theory and clinical training, which reflected a more hands-on approach. However, gaps remain in the comparative analysis of how these different methods impact the curriculum's adaptability to students' needs, especially in addressing real-time concerns and incorporating interdisciplinary feedback (Jones et al., 2024; Sharma & Kumar, 2024). The present study, therefore, sought to address these gaps by using a mixed methods approach.

2.3 Availability of ultrasound machines and ultrasonography students training outcomes

The availability of ultrasound machines is a critical factor in the training of medical students in ultrasonography, as it directly impacts their exposure to practical skills and clinical competency (Müller et al., 2022). In many low-resource settings, a lack of accessible, functional ultrasound machines can hinder students' ability to gain hands-on experience, which is essential for mastering the technology (Sharma & Kumar, 2024). Studies have shown that having sufficient access to ultrasound equipment enables

students to better understand imaging principles and improve diagnostic skills (Yang et al., 2021).

Moreover, exposure to diverse machine types enhances students' adaptability in clinical environments (Smith & Patel, 2024). Therefore, the integration of adequate resources, including ultrasound machines, is essential for effective curriculum delivery in medical education, ensuring that students are prepared to use ultrasound effectively in their future clinical practice (Jones et al., 2024). In this section, availability of ultrasonography training machines is viewed through the lens of Machine types, number of ultrasound machines per class, regular maintenance of ultrasound machines, and availability of technicians.

2.3.1Machine Types

Machine types in ultrasound refer to the various models and technologies used to perform imaging, such as portable, handheld, and full-sized ultrasound machines. These variations impact training by influencing ease of use, accessibility, and image quality, thus affecting medical students' ability to learn and retain skills (Smith & Patel, 2024; Yang et al., 2021).

Bahner et al. (2013) explored the integration of ultrasound into medical school curricula, focusing on its effectiveness in enhancing students' diagnostic and clinical skills. The study found that students using portable ultrasound machines developed a deeper understanding of anatomical structures and improved their diagnostic capabilities. The use of handheld ultrasound devices, which are more affordable and accessible, allowed for a more hands-on, practical approach to learning. However, the study highlighted a challenge in adapting ultrasound training to different machine types, especially when transitioning to larger, more complex machines in clinical

settings. A gap identified was the lack of comprehensive comparison between various ultrasound machine types, specifically how different models and sizes might influence the learning process and student outcomes. Further research is needed to determine the optimal machine types for different stages of ultrasound education and their impact on skill retention.

Dinh et al. (2016) examined the integration of ultrasound in U.S. medical schools, emphasizing its role in improving students' diagnostic skills and their preparedness for clinical practice. The study found that medical students using high-quality, full-sized ultrasound machines gained more detailed insights into anatomical structures, offering a more thorough understanding than those using portable models. The researchers suggested that combining portable and full-sized ultrasound devices in the curriculum could offer students both practical, real-time learning experiences and in-depth exploration of anatomical structures. However, the study also revealed that access to advanced machines was limited in some medical schools, leading to a disparity in training quality. A gap noted was the insufficient exploration of how machine types directly affect students' ability to transition from learning with portable devices to clinical practice with more advanced machines. Further studies are needed to assess the effectiveness of different machine types in developing long-term diagnostic skills.

Fasina et al. (2021) focused on the diagnostic imaging capacity in Zanzibar and evaluated the integration of ultrasound training in medical education. The study highlighted that while students were introduced to portable ultrasound machines, the limited access to advanced diagnostic machines posed challenges in skill development. The authors found that students trained on basic, portable devices often struggled when transitioning to more complex, stationary ultrasound machines in clinical environments.

This discrepancy impacted their ability to perform detailed assessments and gain a full understanding of diagnostic imaging. A notable gap was the lack of comparative analysis between different types of ultrasound machines and their effectiveness in skill acquisition. The study recommended improving access to advanced ultrasound equipment and tailoring training programs to ensure that students are prepared for both portable and clinical machines. More research is needed to determine how exposure to diverse machine types influences students' diagnostic capabilities and clinical confidence.

A significant research gap exists in understanding how different ultrasound machine types influence students' attitudes and skills development in ultrasonography training in Kenya. While studies by Bahner et al. (2013), Dinh et al. (2016), and Fasina et al. (2021) highlighted disparities in skill acquisition and diagnostic confidence when transitioning between portable and advanced machines, they lack context-specific insights for resource-constrained environments like Kenya. Investigating the impact of machine types, accessibility, and adaptability on Kenyan medical students' learning experiences could provide valuable insights into optimizing ultrasonography training in such settings. The current study, therefore, investigated whether limited number of ultrasound machines for training affected ultrasonography students training outcomes.

2.3.2 Number of machines per class

The recommended number of ultrasound machines per class for medical training varies, but generally, one machine per three to five students is considered ideal for hands-on learning (Zhang et al., 2023). This ensures adequate exposure to the equipment and practical experience, which are critical for mastering ultrasound techniques (Li et al., 2021). Access to multiple machines allows for more individualized training, promoting

skill acquisition and retention, and is particularly relevant in settings with high student-to-teacher ratios (Sharma & Kumar, 2024).

In their 2014 study, Henwood et al. (2014) examined the limited use of point-of-care ultrasound (POCUS) in Colombia, focusing on how the number of ultrasound machines available per class impacted the training of medical students. They found that the scarcity of machines hindered hands-on training opportunities, with students often unable to gain sufficient practical experience. This limitation led to reliance on theoretical instruction and reduced students' confidence in performing ultrasound procedures independently. The study highlighted that fewer machines per student restricted the ability to practice in real-time scenarios, undermining the acquisition of essential skills. However, the research did not explore specific strategies to mitigate this challenge. Future studies could examine the effectiveness of simulated environments or alternative teaching methods to address the issue of limited equipment in low-resource settings.

LaGrone et al. (2022) evaluated training opportunities for ultrasonography in low- and middle-income countries (LMICs), emphasizing the impact of the number of machines on ultrasound education. Their findings indicated that in many LMICs, the shortage of ultrasound machines significantly restricted student training, as multiple students often had to share a single machine during practice sessions. This led to less hands-on practice, resulting in students having limited exposure to the technology and a slower development of their ultrasound skills. The study further found that inconsistent machine availability often disrupted training schedules, limiting overall educational outcomes. However, LaGrone et al. did not investigate alternative training solutions or strategies to overcome the machine shortage. Future research could explore how

technologies like portable ultrasound devices might help alleviate these constraints and improve student access to training opportunities.

Shah et al. (2015) explored the perceived barriers to ultrasound use in developing countries, focusing on the effect of machine availability on training. The study revealed that the number of machines per class had a direct impact on the quality and quantity of ultrasound education. In many settings, the scarcity of ultrasound machines resulted in students sharing equipment, reducing the amount of time each student had for hands-on practice. This led to a superficial understanding of the technology, with students unable to develop proficiency in ultrasound skills. The research also pointed to the high cost of machines and maintenance as significant barriers. While the study highlighted the equipment shortage, it did not address potential solutions such as increasing machine donations or leveraging mobile ultrasound units. Future research could investigate the feasibility and effectiveness of such interventions in improving training access.

A key research gap lies in understanding how the number of ultrasound machines per class impacts students' attitudes toward ultrasonography training in Kenya. While studies by Henwood et al. (2014), LaGrone et al. (2022), and Shah et al. (2015) highlight the detrimental effects of limited machine availability on skill acquisition and confidence, they do not examine the psychological impact or students’ attitudes toward the training experience in resource-constrained environments. The current study, therefore, investigated whether inadequate access to equipment fosters negative attitudes, reduces motivation, or affects career aspirations in ultrasonography.

2.3.3 Maintenance

Regular maintenance of ultrasound machines is crucial for ensuring their reliability and effectiveness in medical training. Well-maintained equipment ensures that students

receive consistent and accurate training, fostering confidence in their diagnostic skills. According to LaGrone et al. (2022), machine malfunctions or outdated technology can hinder the learning experience, limiting students' exposure to modern ultrasound practices. Additionally, routine maintenance prolongs the lifespan of the machines, reducing costs in the long term (Shah et al., 2015). Thus, investing in machine upkeep is essential for sustaining quality ultrasound education.

Henwood et al. (2014) conducted a study in Colombia to understand the limited use of point-of-care ultrasound (POCUS) in clinical settings. The study found that despite the potential benefits of ultrasound in medical education and patient care, the lack of proper maintenance and limited access to ultrasound machines were major barriers to its effective use. The authors highlighted that many medical institutions faced technical challenges, including inadequate repair services and limited availability of functional equipment. These limitations affected the quality and continuity of ultrasound training for medical students, ultimately hindering their ability to use ultrasound effectively in practice. The study's gap lies in its focus on usage rather than exploring deeper into the specific maintenance challenges faced by training institutions, suggesting a need for further investigation into how equipment maintenance could improve POCUS training in under-resourced settings.

Shokoohi et al. (2019) assessed point-of-care ultrasound (POCUS) training for clinical educators in Malawi, Tanzania, and Uganda. The study emphasized the need for properly maintained ultrasound machines as essential for quality training. The authors noted that, in many cases, the lack of properly functioning equipment significantly impaired educators' ability to train students effectively, resulting in suboptimal learning experiences. Furthermore, the study highlighted that POCUS training was often

disrupted due to technical failures and a lack of repair services. Despite recognizing the importance of machine maintenance, the study also pointed out the inadequate infrastructure and funding for maintaining equipment in these regions. A gap in the research was the limited exploration of the specific technical support systems or training that could sustain equipment functionality and enhance the educational value of POCUS training programs, thus warranting further investigation into sustainable solutions.

Sippel et al. (2021) discussed the use of ultrasound in developing countries, focusing on the challenges faced by healthcare providers, including medical students, in regions with limited resources. The study noted that poor maintenance of ultrasound machines was a significant barrier to effective training and utilization. The lack of access to technical support, coupled with the high cost of repairs, led to extended periods of machine downtime, which directly impacted students' ability to practice ultrasound skills. Sippel et al. stressed that although ultrasound has proven to be a valuable tool in resource-limited settings, the sustainability of its use depends on regular maintenance and timely repairs. The study identified a gap in understanding how to establish long-term infrastructure for ultrasound machine upkeep and the integration of training on machine maintenance into the curriculum, which could ensure continuous use of the technology and improve educational outcomes.

A significant research gap exists regarding how the need for maintenance influences students' attitudes toward ultrasonography training in Kenya. While Henwood et al. (2014), Shokoohi et al. (2019), and Sippel et al. (2021) highlight maintenance barriers affecting ultrasound training in resource-limited settings, none focus on students’ perceptions of these challenges. Understanding how equipment downtime and

maintenance failures impact students' confidence, skill acquisition, and overall attitudes toward ultrasonography training remains unexplored. Addressing this gap could uncover practical solutions for integrating maintenance training into curricula and fostering positive attitudes, ultimately enhancing the effectiveness of ultrasonography education in Kenya. The current study, therefore, examined how availability of regular maintenance affected medical ultrasonography students' attitudes on training in KMTC.

2.3.4Technicians

Technicians play a crucial role in ensuring the effective operation and maintenance of ultrasound machines during medical student training. Their expertise is essential for troubleshooting machine issues, ensuring proper calibration, and providing technical support, which allows students to focus on learning ultrasound techniques. The need for skilled technicians is particularly high in resource-limited settings, where machine breakdowns are more frequent (LaGrone et al., 2022). Without proper technical support, the training environment could be disrupted, limiting students' opportunities for hands-on practice and hindering skill development (Shah et al., 2015).

Fasina et al. (2021) evaluated diagnostic imaging capacity in Zanzibar, highlighting significant gaps in the availability of qualified technicians for ultrasound training among medical students. The study revealed that while ultrasound equipment was available, there was a shortage of trained personnel to operate the machines effectively. This limitation hindered the ability of medical students to receive adequate hands-on experience with ultrasound technology. The study suggested that increasing the number of trained ultrasound technicians and providing more training opportunities could improve diagnostic imaging capacity and the quality of ultrasound education. However, the research did not provide detailed strategies for addressing these technician shortages

or the specific curriculum interventions needed. A gap exists in identifying long-term solutions for sustaining technician availability, particularly in low-resource settings.

LaGrone et al. (2022) examined training opportunities for ultrasonography in low and middle-income countries (LMICs), with a focus on the critical need for skilled ultrasound technicians to train medical students. The study identified that the lack of trained ultrasound technicians significantly constrained the implementation of ultrasound education programs. Despite an increasing demand for ultrasound services in LMICs, the study found that there was a limited supply of trained instructors to support the training of medical students. To address this, the authors recommended expanding training programs for technicians and creating partnerships between local institutions and international organizations. However, the study did not explore the sustainability of these training programs or the scalability of solutions in diverse LMIC contexts. This gap suggests a need for further research on how to ensure the long-term availability and retention of skilled ultrasound technicians in these settings.

Shokoohi et al. (2019) assessed point-of-care ultrasound (POCUS) training for clinical educators in Malawi, Tanzania, and Uganda, with a focus on the role of technicians in supporting ultrasound training for medical students. The study highlighted the critical need for qualified technicians to ensure that POCUS training is effective. It found that while clinical educators in these countries showed a strong interest in using POCUS for medical education, there were significant challenges due to a shortage of trained technicians who could support the educators and students in ultrasound training. The authors suggested that creating specialized POCUS technician roles could alleviate these challenges. However, the research lacked a detailed analysis of the training curricula or how these technician roles could be integrated into existing healthcare

systems. Future studies could address the logistical and financial challenges of establishing such positions in resource-constrained settings.

A research gap exists in understanding how the availability and role of ultrasound technicians influence medical students' attitudes towards ultrasonography training in Kenya. While studies highlight technician shortages in LMICs (Fasina et al., 2021; LaGrone et al., 2022; Shokoohi et al., 2019), none explore how this impacts student perceptions, motivation, or learning outcomes. Additionally, there is limited research on tailored strategies to integrate technician roles into existing curricula sustainably or on how cultural and institutional factors in Kenya specifically affect these dynamics. Addressing this gap could inform policies and interventions to enhance ultrasonography education in similar low-resource settings. The current study, therefore, examined how availability of technicians affected medical ultrasonography students' attitudes on training in KMTC.

Overall, in this section the methodologies used in the studies on availability of ultrasonography training machines in this section offer diverse approaches. Fasina et al. (2021), LaGrone et al. (2022), and Shokoohi et al. (2019) each provide valuable insights but differ in their approaches. Fasina et al. (2021) employed a cross-sectional survey method to evaluate the diagnostic imaging capacity in Zanzibar, focusing on equipment availability and technician capacity. This approach provided a snapshot of the current situation but lacked longitudinal data to assess the long-term trends and impacts of technician shortages. LaGrone et al. (2022) conducted a more comprehensive analysis through a review of training programs, but the study's focus was primarily on institutional reports, which may have led to bias in understanding technician availability in LMICs. Shokoohi et al. (2019), on the other hand, conducted

an assessment of point-of-care ultrasound (POCUS) training using qualitative interviews with clinical educators, providing a deeper understanding of the challenges faced by educators in these regions. However, none of the studies employed mixed methods or experimental designs to evaluate the effectiveness of technician training programs, which remains a significant gap in their methodologies.

2.4 Students attitudes on training and ultrasonography training outcomes

Student attitude toward training refers to the perceptions, beliefs, and feelings students hold regarding the learning process and its relevance to their professional development. In the context of ultrasonography training, a positive attitude is crucial for successful skill acquisition and retention, as it motivates engagement with complex material and enhances clinical competence (Müller et al., 2022). Research shows that students with a positive attitude toward ultrasound training are more likely to participate actively in hands-on sessions, leading to better outcomes (Yang et al., 2021). Conversely, negative attitudes, often shaped by anxiety or lack of confidence, can hinder learning and decrease the effectiveness of training programs (Smith & Patel, 2024). Therefore, fostering a supportive and encouraging learning environment is essential for improving medical students' attitudes toward ultrasonography training, which ultimately enhances their competency in clinical practice (Sharma & Kumar, 2024).

Previous studies have emphasized the importance of attitudes, showing that they are behavior-related, learned, and very stable. Attitudes towards teaching are learned later in life, which points to the importance of instructor education, during which attitudes are expected to develop (Tok, 2021). In the current study, students’ attitude towards training was hypothesized to affect ultrasonography training outcomes among students.

In this section, students' attitudes on level of training, Peer training, Future job prospects, and Mentorship in ultrasonography training.

2.4.1 Level of training

The level of training in medical education plays a critical role in preparing students for advanced skills such as ultrasonography. Training typically progresses from basic theoretical learning to more advanced hands-on clinical practice (Müller et al., 2022). Ultrasonography training, which often starts with basic image interpretation, advances to more complex diagnostic techniques, is essential in ensuring competency (Steinmetz et al., 2016). The integration of ultrasound into medical curricula helps bridge the gap between theory and clinical application, emphasizing the importance of practical exposure to improve diagnostic accuracy and patient care (Smith & Patel, 2024).

Kessler and Bhandarkar (2010) conducted a needs assessment on ultrasound training for medical students and internal medicine residents, highlighting the importance of early integration of ultrasound training in medical curricula. Their findings revealed a strong positive attitude towards ultrasound education, with participants expressing the need for more structured training during their medical education. Medical students and residents reported that ultrasound skills would be highly beneficial in clinical practice. However, the study also found gaps in the availability of standardized ultrasound training, with many students and residents lacking access to formal education or hands-on training. The study suggested that better curriculum integration and more consistent exposure to ultrasound technology are necessary. A key research gap is the limited long-term evaluation of the effectiveness of such training programs on clinical competency (Kessler & Bhandarkar, 2010).

Vennemann et al. (2020) explored the short- and long-term effects of a sonography training program on medical students, focusing on knowledge, skills, and attitudes. The study found that participants showed significant improvements in their ultrasound knowledge and skills immediately after the training, with sustained retention of knowledge over time. The students' attitudes towards ultrasound training were overwhelmingly positive, with many recognizing the value of sonography in clinical practice. However, some students expressed concerns about the complexity of the technique and the challenges in mastering it without more time dedicated to practical experience. The study identified a gap in the training's ability to fully integrate ultrasound into clinical settings, suggesting the need for ongoing practice opportunities and greater emphasis on the clinical applications of ultrasound (Vennemann et al., 2020).

Teichgräber et al. (2022) examined the integration of ultrasonography training into undergraduate medical education to meet the professional needs of healthcare providers. Their study highlighted a growing recognition of the importance of ultrasound in clinical practice, with medical students showing a positive shift in their attitudes towards ultrasound after exposure to structured training programs. The study found that while students appreciated the value of ultrasound skills, many felt inadequately prepared to apply these skills in real clinical scenarios due to limited training hours. The research pointed to a gap in the depth of training, as many students were only introduced to basic ultrasound techniques. The study emphasized the need for further integration of ultrasound in clinical rotations and the development of specialized training to match the increasing demand for ultrasound competency in modern medical practice (Teichgräber et al., 2022).

Overall, exploring the relationship between early exposure to ultrasound education and its long-term impact on students' confidence and skill retention in resource-limited settings like Kenya remains underexplored. Therefore, the current study examined how level of training among medical ultrasonography students affected their attitudes on the training in KMTC.

2.4.2 Peer training

Peer training in medical education involves the process where medical students or healthcare professionals learn from each other through collaboration and shared knowledge. This approach is vital in ultrasonography training, as it allows students to practice and refine their skills in a supportive environment, often enhancing their confidence and competence (Smith & Patel, 2024). Peer training fosters active learning, critical thinking, and feedback exchange, which are crucial for mastering complex skills like ultrasound scanning (Müller et al., 2022). Moreover, it provides cost-effective and scalable training, especially in resource-limited settings (Sharma & Kumar, 2024).

Vennemann et al. (2020) evaluated the effects of a sonography training concept on medical students' knowledge, skills, and attitudes. The study focused on both short-term and long-term outcomes of peer-led ultrasound training programs. Results indicated that students' attitudes towards ultrasound training improved significantly after participating in peer-based sessions. The hands-on, interactive nature of peer-led training increased student confidence and competence, leading to a positive shift in their approach to ultrasound. However, the study also highlighted a gap in evaluating the specific influence of peer training on future clinical application. Additionally, the authors suggested that while peer-led training may foster enthusiasm and a collaborative learning environment, there is limited evidence on its comparative

effectiveness against instructor-led methods, suggesting an area for further exploration in future research (Vennemann et al., 2020).

Barth et al. (2024) examined the current views and controversies surrounding ultrasound education, focusing on who should be responsible for teaching. The study highlighted a growing trend of peer-led training for medical students, with positive attitudes towards peer teaching due to its cost-effectiveness and ability to foster a collaborative environment. Medical students who engaged in peer training felt more confident in their practical skills, with peers often seen as more approachable than instructors. However, the study identified a critical gap in evaluating the consistency and quality of peer-led instruction, especially in ensuring that students receive adequate foundational knowledge. The authors also noted that the lack of formal, standardized peer training curricula poses a challenge to its widespread adoption and effectiveness (Barth et al., 2024).

Smith et al. (2020) explored the attitudes of medical residents toward interprofessional learning in ultrasound, particularly following peer-led, student-directed point-of-care ultrasound training. The study found that residents appreciated the opportunity to learn from peers, as it offered a fresh perspective on collaborative clinical practices. The students' leadership in the training enhanced their engagement with ultrasound, and they reported feeling more confident in utilizing ultrasound in clinical scenarios. However, the study noted a gap in how these peer-led training sessions affected long-term retention and professional integration of ultrasound skills. Furthermore, while residents were generally receptive to student-led initiatives, there was a concern regarding the variability in teaching quality, pointing to the need for more structured guidelines for peer-led ultrasound education (Smith et al., 2020).

While previous studies have highlighted the effects of structured training and instructor roles, there is limited research on peer-led ultrasound education and its impact on student perceptions and learning outcomes in Kenyan medical contexts. Therefore, the current study examined how peer training among medical ultrasonography students affected their attitudes on the training in KMTC.

2.4.3 Future job prospects

Future job prospects in the medical field, especially in specialized fields like ultrasonography, are crucial for medical students. As technological advancements increase, there is a growing demand for healthcare professionals with expertise in diagnostic imaging, particularly in ultrasound (Sharma & Kumar, 2024). Medical schools are increasingly integrating ultrasonography into their curricula to prepare students for future clinical practice, responding to industry needs (Smith & Patel, 2024). As such, training in ultrasonography enhances employability, providing students with in-demand skills that align with global healthcare workforce demands (Jones et al., 2024).

Abuzaid (2024) investigated the education, skills, and job prospects within the sonography profession, focusing on the challenges and future prospects in the field. The study revealed that medical students generally perceive ultrasound training as a valuable asset for their future careers, as it enhances their diagnostic abilities and practical skills. However, students also expressed concerns about the limited exposure to advanced sonographic techniques in their medical curricula, which could hinder their professional development, (Abuzaid, 2024). The study highlights a need for curricula to better align with evolving job market demands, ensuring students are adequately prepared for future roles. A significant gap identified is the lack of a comprehensive

framework that integrates sonography education within broader medical curricula, particularly in regions where ultrasound training is not yet standardized. Future research could address how curricular innovations could bridge these gaps and better prepare students for ultrasound-related roles in healthcare settings (Abuzaid, 2024).

Leung et al. (2024) explored the utility and challenges of ultrasound education for medical and allied health students in Asia, focusing on how these students perceive ultrasound as part of their future career prospects. The study found that students in Asia recognize the value of ultrasound training for improving their diagnostic skills and job prospects in both clinical and non-clinical settings. However, students reported challenges in obtaining sufficient hands-on experience and exposure to diverse clinical scenarios, which limited their confidence in applying ultrasound in practice. Additionally, the study noted that despite enthusiasm for ultrasound training, students often felt that current curricula do not adequately prepare them for the range of applications they may encounter in their future careers. The research gap lies in the variability of ultrasound training across different countries and healthcare systems in Asia, highlighting the need for more standardized, regionally relevant training models (Leung et al., 2024).

Recker et al. (2024) examined current trends and debates surrounding ultrasound training in medical education, focusing on didactics and hands-on learning. Their findings indicated that students perceive ultrasound training as crucial for enhancing their future career prospects, particularly in terms of improving diagnostic accuracy and patient care. However, the study also revealed that while students value ultrasound education, there are concerns about its integration into already dense medical curricula, with some students feeling overwhelmed by the added content. Additionally, students

expressed a desire for more structured and formalized training programs, particularly in hands-on practice. The study highlighted a gap in consistent, evidence-based approaches to integrating ultrasound training across diverse medical schools. Future research could focus on developing more cohesive curricula that balance ultrasound training with other critical areas of medical education while ensuring adequate preparation for future career opportunities in ultrasound (Recker et al., 2024).

A potential research gap exists in examining how medical students' perceptions of future career opportunities influence their attitudes toward ultrasonography training in Kenya. While studies explore ultrasound education's utility and challenges, there is limited research specifically addressing how job prospects in Kenya shape students' engagement with ultrasonography training, particularly in terms of career aspirations and job market competitiveness. Hence, the current study examined how perceptions of future job prospects among medical ultrasonography students affected their attitudes on the training in KMTC.

2.4.4 Mentorship

Mentorship in medical education involves a collaborative relationship where experienced professionals guide students, providing support, knowledge, and feedback to enhance their skills and professional development (Patel et al., 2022). In ultrasonography training, mentorship plays a crucial role, offering students the opportunity to develop technical proficiency and clinical judgment through hands-on guidance. Research highlights that effective mentorship improves students' competence in ultrasound procedures, boosts confidence, and fosters a deeper understanding of the technology's clinical applications (Müller et al., 2022; Sharma & Kumar, 2024).

Therefore, mentorship is essential for shaping skilled and confident ultrasound practitioners.

Taggart et al. (2014) explored the use of mobile mentoring in an ultrasound training initiative, emphasizing its potential for improving medical students' ultrasound skills. The study focused on the accessibility of mobile technology to provide mentorship and guidance, especially in underserved or remote areas. Findings suggested that mobile mentoring was well-received, with students appreciating the flexibility and convenience it offered. The ability to access mentorship via mobile devices facilitated more consistent practice and feedback, enhancing students' learning experiences. However, the study did not address the long-term effectiveness of this form of mentorship in terms of skill retention or student confidence in clinical settings. A gap in this research is the lack of comparative analysis with traditional in-person mentorship methods, which would help in evaluating the relative benefits and limitations of mobile-based mentorship (Taggart et al., 2014).

Jeppesen and Bahner (2012) conducted a randomized trial to examine the effectiveness of peer mentoring in teaching bedside sonography to medical students. The study found that peer mentoring, where more experienced students guided novices, was as effective as traditional instructor-led teaching in enhancing students' sonographic skills. The medical students reported a positive attitude toward the peer mentoring process, noting that it fostered a collaborative and supportive learning environment. Peer mentoring also allowed students to engage in real-time learning, where they could practice and refine their skills with immediate feedback. The study's limitations included a small sample size and a short duration, which restricted the ability to assess long-term outcomes. Further research could explore the sustainability of peer mentoring in

ultrasound training and how it impacts skill development in the long term (Jeppesen & Bahner, 2012).

Celebi et al. (2019) evaluated three different approaches to training medical students as ultrasound tutors: conventional instructor-led training, peer tutoring, and a hybrid model combining both. The study revealed that students who received mentorship through peer tutoring demonstrated comparable or even superior performance in ultrasound skills compared to those trained by instructors. The hybrid model was particularly effective in creating a collaborative learning environment, where students felt more engaged and motivated. Despite these positive findings, the study did not explore how these models affected student attitudes toward mentorship in the long term or in various clinical settings. A notable gap in this research is the absence of a follow-up on the long-term impact of these training models on the students' clinical confidence and ultrasound proficiency (Celebi et al., 2019).

A significant research gap exists in understanding how mentorship among medical students influences their attitudes toward ultrasonography training in Kenya. While studies such as Taggart et al. (2014) and Jeppesen and Bahner (2012) highlight the role of peer and mobile mentoring in ultrasound education, they primarily focus on Western settings. Similarly, Celebi et al. (2019) investigate various training approaches but do not address mentorship's socio-cultural dynamics in resource-limited environments like Kenya. Therefore, the current study sought to explore how mentorship programs tailored to Kenyan medical schools impact students' perceptions, confidence, and adoption of ultrasonography skills, considering unique contextual factors.

Overall, in this section the methodologies used in the studies on Students attitudes on training and ultrasonography training outcomes in this section offer diverse approaches.

The methodologies used in the studies by Kessler and Bhandarkar (2010), Vennemann et al. (2020), and Teichgräber et al. (2022) each have their strengths and weaknesses. Kessler and Bhandarkar (2010) employed a needs assessment approach, utilizing surveys to gather data on the perceived need for ultrasound training. While this method provided valuable insights into students' attitudes, it lacked a longitudinal component to track long-term changes in knowledge and skills.

In contrast, Vennemann et al. (2020) used a longitudinal study design to assess short- and long-term effects of sonography training, which allowed for an evaluation of retention. However, their sample size was limited, and they did not assess the influence of clinical application on skills retention. Teichgräber et al. (2022) utilized an observational study to investigate ultrasound integration into medical education, but the study was limited by its lack of control group and failure to compare outcomes across different curricula.

These gaps highlight the need for more diverse and longitudinal methodologies to assess ultrasound training's impact (Kessler & Bhandarkar, 2010; Vennemann et al., 2020; Teichgräber et al., 2022). The present study, therefore, sought to address these gaps by using a mixed methods approach focusing on KMTC.

2.5 Summary

Students' perceptions of curriculum space limitations and the availability of ultrasound machines significantly influence ultrasonography training outcomes. Insufficient curriculum space often reduces practical exposure, hindering skill acquisition and readiness for clinical practice, particularly in resource-constrained settings like Kenya. Limited access to functional ultrasound machines exacerbates these challenges, leading to disparities in skills, reduced motivation, and negative attitudes toward training.

Addressing these issues requires innovative curriculum designs, flexible scheduling, and investments in infrastructure, including machine maintenance and technician support. Involving students in curriculum and resource planning enhances inclusivity, fosters positive attitudes, and ensures ultrasonography training aligns with academic and clinical demands. Students' perceptions of curriculum space limitations and their attitudes toward ultrasonography training are crucial factors influencing training outcomes. In resource-limited settings like Kenya, space constraints can hinder the depth and quality of training, reducing students' hands-on experience and exposure to essential equipment. Overcrowded schedules and inadequate facilities often lead to fragmented learning, decreasing students' motivation and engagement, which negatively impacts skill acquisition and clinical competence.

Conversely, students with positive attitudes toward ultrasonography, such as enthusiasm and confidence, tend to engage more actively in both theoretical and practical components of the curriculum. This heightened engagement results in better clinical competence and skill retention. However, negative attitudes, arising from anxiety or perceived difficulty, can prevent effective learning, limiting students' ability to apply ultrasonography in clinical settings. To optimize training outcomes, it is essential to address curriculum space limitations and foster positive student attitudes. This requires providing adequate resources, creating a supportive learning environment, and emphasizing the relevance of ultrasonography in students' future clinical practice. The current study aims to explore how these factors affect ultrasonography training in Kenya.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This chapter highlights the overall description of the research design, study site, target population, sampling procedure, data collection instruments, instruments pre-testing/piloting, data collection procedures, data analysis, and ethical considerations.

3.2 Research Design

The study adopted a mixed methods research design (Cooper & Schindler 2014). The choice of this design was founded on the fact that there was no attempt to alter the phenomena (Saunders, Lewis, & Thornhill, 2009); rather, data was collected from respondents based on their observations and perceptions concerning the subject of interest to the study. The study adopted both descriptive research design and quantitative approach. This implies that data were numerical for easy interpretation in tandem with the study objectives.

The choice of quantitative approach is premised on the fact that it ensured generalizability of study findings (Weinreich, 2009). Quantitative provided the general descriptive view of the variables by use of questionnaires from the respondents. Qualitative design provided the in-depth perspective as seen in open ended interviews, Focus group discussion and in inferential statistics.

3.3 Study Site

Radiography and imaging courses are undertaken by students in campuses attached to teaching hospitals where the radiography and imaging equipment are available to augment the theoretical part with the practical/clinical part of the training. The study was, therefore, conducted in both the training institutions and Teaching Hospitals in Kenya where KMTC students undergo training for their radiography and imaging

courses. The Teaching Hospitals providing radiography and imaging course in Kenya currently are some County Hospitals. Therefore, the County hospitals in the study were Nairobi (Level 6), Nakuru (Level 6), Kisumu (Level 6), Uasin Gishu (Level 6) and Kericho (Level 5) respectively. These hospitals are in different parts of Kenya with different student population in respective KMTC campuses.

3.4 Target Population

The study targeted five Teaching Hospitals in Kenya where the KMTC students train for their radiography and imaging courses. The Kenya Medical Training College (KMTC) is the premier training school for majority of the medical professionals currently practicing in the country and in the region. It has approximately a student population of over 51,000 students undertaking specialized training in 83 medical courses and a faculty team of more than 3,000, serving at in the 71 campuses countrywide which are located adjacent to Teaching Hospitals.

KMTC has seven faculties which include: 1. Faculty of Clinical Sciences (2 departments); 2. Faculty of Diagnostic Sciences (2 departments); 3. Faculty of Information Technology and Medical Education (2 departments); 4. Faculty of Nursing (1 department); 5. Faculty of Pharmaceutical Sciences (1 department); 6. Faculty of Public Health (4 departments); 7. Faculty of Rehabilitative Sciences (6 departments). The study focused in the faculty of Diagnostic Sciences, Radiography and Imaging only. Not all campuses train Radiography and Imaging, and therefore only the campuses training were part of the study population.

3.4.1 Inclusion Criteria

The study focused on the current cohort ordinary (3-year) diploma students and staff members drawn from the department of radiography and imaging in the Faculty of Diagnostic Sciences and also hospital-based instructors as its unit of observation. The study further focused only on final year radiography and imaging students. According to the regulations, a maximum of 60 students are allowed to take the Radiography course each year as radiographers. However, due to other factors such as attrition and deferment, the final year composition of students varies across the campuses. Therefore, the total population under consideration were 263 Radiography and Imaging students and 26 full-time faculty members drawn from the Faculty of Diagnostic Sciences across 5 KMTC campuses and also 10 hospital based instructors (2 from each teaching hospital) bringing the entire population to 299 persons.

3.4.2 Exclusion Criteria

Students who never consented to the study. Part-time lecturers were not included in the study and hospital based instructors from other non-radiography fields.

The sampling frame for the target population is shown in Table 3.1.

Table 3.1: Sampling Frame

County	Hospital Level	Students	Staff	Hospital Based Instructors
Nairobi	Level 6	55	10	3
Kisumu	Level 6	49	5	2
Uasin Gishu	Level 6	55	5	3
Nakuru	Level 6	54	3	2
Kericho	Level 5	50	3	2
Totals		263	26	12

Source: Faculty of Diagnostic Sciences, KMTC (2023)

3.5 Sampling Procedure

3.5.1 Sample Size Determination

The approximate number of final year radiography and imaging students drawn from the 5 KMTC campuses is 263 as shown in Table 3.1 (KMTC, 2023). To obtain the required sample size from these target population, the study adopted the formula by Nassiuma (2000).

$$n = \frac{Nc^2}{c^2 + (N-1)e^2}$$

Where n = sample size, N = population size, and e = error margin (≤ 4%), c = coefficient of variation (≤ 50%).By substituting the formulae, therefore, we obtain;

$$n = \frac{263 * (0.5)^2}{(0.5)^2 + (263-1) * (0.04)^2} = 98.51 \approx 98$$

The population of full time staff members in the department of radiography and imaging in the Faculty of Diagnostic Sciences across the 5 KMTC campuses is 26 members (Table 3.1). This population is small enough to warrant the use of the census method. Therefore, all the 26 faculty members were included in the study. The teaching hospitals have 2 hospital-based instructors each, hence, 12 hospital-based instructors were also included in the study using the census method. Therefore, the total sample size were 136 respondents.

3.5.2 Sampling Technique

The study selected 5 KMTC campuses with teaching hospitals shown in Table 3.1 with the exception of Nyeri KMTC campus and teaching hospital which was used for the pilot study. The census method was used to select the faculty members, that is the teaching staff and the hospital-based instructors. Finally, systematic random sampling was used to select the students from their respective campuses.

3.6 Systematic random sampling procedure.

The following steps were followed.

The Population was defined and the total group ((N)) to be sampled was identified.

Determine Sample Size (n) and Calculate the Interval (k):

Divide the population by the sample size (k=N/n)) and Select a Random Starting Point.

Choose a random starting point between 1 and (k) and Select the Sample.

Select every (k)-th member thereafter

Example: To survey 98 individuals out of a population of 260 calculate the interval: 260/98 = 3). Randomly pick a starting number between 1 and 10 (e.g., 3). The sample will include the, 3rd, 6th and the 9th.

The sample respondents were then be proportionally stratified as shown in Table 3.2.

Table 3.2: Distribution of Sample Size

County	Students	Staff	Hospital Based Instructors
Nairobi	24	11	2
Kisumu	14	5	2
Uasin Gishu	23	4	2
Nakuru	20	3	2
Kericho	19	3	2
Totals	98	26	10

Source; Researcher 2023

3.7 Data Collection Instruments

The study used questionnaire, interview schedule and Focus Group Discussions to collect primary data and to facilitate the collection of data pertinent to the objectives of the study. In line with Mugenda and Mugenda ‘s (2009) assertion, questionnaires are suitable because of their ability to reach a wide population such as those normally encountered in survey studies easily and conveniently. However, the data from questionnaires tend to be limited and superficial. This is because they need to be fairly brief since respondents are unlikely to complete and return a long and time-consuming

questionnaire. Therefore, questionnaires may not probe deep into the issues being investigated. However, they were adopted in the study since they are able to provide a general perspective of the issues being investigated after statistical computation.

Interview schedules offer structured data collection, ensuring consistency and comparability across respondents. They allow clarification of questions, enhancing data accuracy. However, interviewer bias and the time-consuming nature of administration can impact the reliability and efficiency of the research process. Focus group discussions offer rich, qualitative insights by fostering interactive dialogue, revealing diverse perspectives, and uncovering nuanced opinions. They encourage dynamic participant engagement, enhancing idea generation. However, they can be time-consuming, risk groupthink, and may suffer from dominant voices overshadowing others, potentially limiting individual expression and generalizability of findings. Combining questionnaires, interview guides, and focus group discussions enriches research by providing a comprehensive data set. Questionnaires offer quantitative insights, while interviews and focus groups provide qualitative depth, capturing diverse perspectives and complex behaviors. This triangulation enhances data reliability, validity, and allows for a more nuanced understanding of the research problem.

Focus group discussions and interview schedule on the other hand are meant to provide in-depth understanding on the research problem being investigated from a key respondent perspective. The questionnaires and the focus group discussions were administered to the students while the interview schedules were administered to the lecturers and hospital-based instructors. The need to have interviews for the lecturers and hospital-based instructors was meant to provide the view points from the faculty members on the study variables and, hence, reduce the bias that may arise when only one group of respondents, that is students in this case are involved in the study.

3.8 Pre-testing /Piloting

A pilot test emanates from a pilot study. The latter refers to a small-scale study which is often conducted prior to a full-scale study with the intent of determining the feasibility of the study, and also probable weaknesses that might be in the data collection tool (Teijlingen van, Rennie, Hundley, & Graham, 2001). The pilot study was conducted in the Nyeri teaching hospital, KMTC Nyeri campus. Afterwards, the questionnaires were pre-tested for validity and reliability.

3.8.1 Validity

To ascertain validity of the questionnaires, the questionnaires were subjected to analysis by a team of specialists in the area of study. The specialists assessed the relevance of the contents used in the instruments for purpose of improvement and reinforcement of the instrument before embarking on the actual data collection. Issues found with the layout, content and constructs of the questionnaire were noted and adjusted according to the recommendations of the team prior to administering the questionnaire to the respondents for the actual study.

Kamau et al., (2019) explain that validity concerns in the interview schedules often arise in content analysis which is a technique of ensuring that the content analysis has a high level of integrity of findings bearing on the content of the completed instrument. The content validity of the questionnaire was achieved by applying explicitly formulated rules and procedure to systematically include or exclude relevant sign-vehicles. This ensured objectivity in the data analysis as it is intended to minimize or eliminate the researcher ‘s bias. The validity of the content analysis was also be achieved by training raters to independently assess the text as recommended by Boettger and Palmer (2015).

3.8.2 Reliability

In order to improve the reliability of the questionnaire, the research employed the internal consistency method. This was done by calculating the Cronbach‘s alpha coefficient for the questionnaire from the results of the pretest study. A value of 0.7 or below of the Cronbach‘s alpha coefficient shows low internal consistency (Cronbach & Azuma 1962). The individual constructs of the questionnaire together with the overall instrument reliability coefficient was assessed to ascertain whether their Cronbach‘s alpha coefficients are above the recommended threshold value of 0.7. This was meant to ensure that the questionnaire was in its form and was reliable for data collection purposes as it met the threshold requirements. Therefore, the questionnaire was administered to the respondents for data collection after some minor adjustments.

Reliability is an integral part of content analysis of the interview schedules and the focus group discussions which is intended to establish coder consistency as opposed to data consistency (Gavora, 2015). The reliability of the content analysis manifests itself through the coding process and usually ascribes to three forms; stability, reproducibility and accuracy (Miller & Whacker, 2019). In this study, the accuracy reliability method was used as it closely corresponds to the standard for assumed truth and is the strongest of all the three forms (Krippendorff, 2004). It was also used as it addressed all possible variations occurring due to inconsistencies within observers and between observers and also deviation from the standard.

3.9 Data Collection Procedure

The study commenced after obtaining a research permit from the National Commission for Science Technology and Innovation (NACOSTI) through the Moi University Ethical Review Board. The letters obtained from these institutions were copied to the

respective county commissioners of the selected counties requesting them to approve the research to be carried out in their counties. The researcher then made necessary preparations for the actual exercise, visit the relevant institutions on respective confirmed appointment dates, and administered the questionnaires and interview schedules (see appendices B to D) and also carry out the focus group discussions. The questionnaires were self-administered in that the respondents filled them on their own time and collected afterwards while the interviews were administered by the researcher, completed and retrieved on the material date same as the FGDs.

3.10 Data Analysis

The data analysis was facilitated by the use of the Statistical Package for Social Sciences (SPSS) tool. Specifically, descriptive and inferential statistics were used in the analysis. Descriptive statistics that were factored in included measures of distribution (frequencies and percentages), measures of central tendencies (means), and measures of dispersion (standard deviations). Assumptions of a multivariate regression analysis was tested followed by correlation analysis, then the coefficient of determination, ANOVA, regression, and t-statistics to constitute all inferential statistics. Multiple regression analysis was applied to analyze the relationship between the dependent variable and each of the independent variables respectively. The beta (β) coefficients for each independent variable was generated from the model. The regression proceeded as follows; before moderation and after moderation with the moderator variable. The regression model used before moderation was:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

Where;

Y = Ultrasonography Students Training Outcomes in KMTC

β_0 = constant

$\beta_1 \ldots \ldots \beta_2$ = parameter estimates

X_1 = Students' Perceptions

X_2 = Availability of ultrasonography machines

ε is the error of prediction.

After the introduction of the moderating variable, student attitudes, as an interactive term, equation (1) becomes;

$$y = \beta_0 + \beta_1 X_1 M + \beta_2 X_2 M + M + \varepsilon$$

Where;

Y = Ultrasonography Students Training Outcomes in KMTC

β_0 = constant

$\beta_1 \ldots \ldots \beta_2$ = parameter estimates

X_1 = Students' Perceptions

X_2 = Availability of ultrasonography machines

M = Students attitudes

ε is the error of prediction.

The quantitative analysis involving both descriptive and inferential statistics was used to analyze data from the questionnaire. All the constructs in the questionnaires were measured on a 5-point scale of Lickert-type items, therefore, there was dimensional homogeneity between the dependent and independent variables. As such, scale effects were not anticipated in the analysis of the questionnaire data. Therefore, the data in the questionnaire was first converted to numerical forms in spreadsheets as per the respective scoring using the measurements of the Lickert scale. The data was then entered into the software (SPSS) for further numerical analysis such as descriptive and inferential statistics. Specifically, the data in the SPSS software was transformed by

summation techniques to enable it to support inferential statistical analysis such as Pearson Correlations and Multiple Linear Regressions, which were used to establish the relationships between the independent variables and the dependent variable and also to test the hypotheses.

Content analysis was done to analyze the data yielded from the interviews and the FGDs.

Since the variables were expected to have varying expressions in the different KMTC campuses, the study stratified the results according to the campuses to get a more in-depth view of the behavior of the variables within the individual campuses. Afterwards, the results across the campuses were compared and generalizations made at the end. The triangulation method was used in the analysis to bring in the different viewpoints of the lecturers and hospital-based instructors so as to provide a more robust analysis and discussions of the variables.

3.11 Ethical Considerations

All ethical considerations were observed in carrying out the study, such as, confidentiality and benefits. Participants were informed of voluntary involvement in the study and that they were allowed to withdraw from it at any stage without any victimization. Consent was sought from the participants before the commencement of the study. Questionnaires and interview schedules as well as the FGD guides were marked with serial codes and the participants were not to write their names or any other identification numbers. Permission was sought from the relevant authorities.

All information obtained during the information gathering and therapy sessions was treated with extreme levels of confidentiality and this was communicated to the

respondents. Pre-selection of the participants for interview was from a centralized register, which use admission numbers and the same numbers were used hence the client‘s name didn’t feature anywhere. Privacy was maintained all through from data collection, analysis and presentation. The researcher further explained to the respondents the real goal of the research, which is basically for academic purpose.

The participants were also informed of the benefits of participating in the study. Further, the study did not pose any significant risk to the respondents, however, there were several benefits for participating in the study among them the opportunity to air their opinions on their training with the view of improving their training prospects in the future. The student respondents also benefitted by being exposed to an actual research study which provided them with insight on how to conduct a research study.

Approval of the study was obtained from the following institutions.

1. Moi university Research Ethical Committee (IREC)
2. Kenya Medical Training College Research Committee.
3. (National Commission for Science Technology and Innovation (NACOSTI).

CHAPTER FOUR

4.0 DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter presents results arising from the analysis of data collected using questionnaires. The data collected was analyzed using descriptive and inferential statistical methods for each variable and the findings presented in tables, and their implications discussed. The findings are organized in terms of the objectives of the study.

4.1.1 Response Rate

Table 4.1 shows the response rate of the instruments.

Table 4.1: Response Rate

Instrument	Issued	Returned	Response Rate	Non-Response Rate
Questionnaires	98	79	81%	19%
Focus Groups episode	5	5	100%	0%
Interview guides	36	22	61%	39%

The study achieved both a high questionnaire response rate (81%) and interview guides response rate (61%) and (70 %) for focused group discussion (FGD) as shown in Table 4.1 which resulted from the self-administered method of administration of the instrument which optimized the response rates (Dillman, 2011). This method also ensured that the respondents' queries concerning clarity were addressed at the point of data collection; however, caution was exercised so as not to introduce bias in the process The response rate was high and met the threshold set by several studies for instance Babbie (2020) who recommended a response rate of 50% as being acceptable while according to Fincham (2008) a response rate of at least 60% is good as the nonresponse bias is much less than the response rate hence upholds the reliability and

validity of survey study findings. Focus group discussion was done to participants once at ago where the respondents were 70 % for students

4.2 Demographic Characteristics of the Respondents

The study sought to determine the demographic characteristics of the respondents so as to give some basic insight about the respondents. The demographic characteristics were grouped into students' demographic characteristics and the lecturers' demographic characteristics. The findings on these are summarized and discussed as follows.

4.2.1 Students Demographic Characteristics

The students' demographic characteristics are summarized in Table 4.2.

Table 4.2: Demographic Characteristics of the Student Respondents

Variable	Category	Frequency	Percentage(%)
Gender	Male	50	62.8
	Female	29	37.2
Age in Years	18 - 23 yrs	75	70.1
	24 - 29 yrs	15	17.3
	30 - 35 yrs	10	12.6
Level of study	Third Year	100	73.5

The findings in Table 4.2 suggest that majority (62.8%) of the Radiography students who participated in the study were male. However, there was also a considerable number of female students. Majority (70.1%) of the students were between 18 and 23 years and all of them were in their 3rd year of study. This vital information enhanced the validity of the current study. Veal (2017) explains that for a reliable study to be conducted, the respondents' background characteristics, such as, educational qualifications to be established so as to ascertain that one sampled from a reliable population that is likely to give valid answers for the study.

4.2.2 Lecturers Demographic Characteristics

The students' demographic characteristics are summarized in Table 4.3.

Table 4.3: Demographic Characteristics of the Lecturers and Hospital instructors.

Variable	Category	Frequency	Percentage(%)
Gender	Male	12	57.9
	Female	10	42.1
Age in Years	23-25 yrs	1	5.3
	26 - 35 yrs	7	31.5
	36 - 45 yrs	8	36.8
	46-55 yrs	5	21.1
	56 yrs and above	1	5.3
Highest level of Education	Diploma	1	5.3
	Higher Diploma	11	47.4
	Bachelors Degree	8	36.8
	Masters Degree	2	10.5
	PhD	0	0
Length of Work Experience as a lecturer or instructor of radiology	Less than 3 years	1	5.3
	4 - 6 yrs	2	10.5
	7 - 9 yrs	5	21.1
	10 – 12 yrs	8	36.8
	13 yrs and above	6	26.3

The results in Table 4.3 show that the majority (57.9%) of lecturers and hospital instructors were male, while the females accounted for 42.1%. While these show that the gender distribution among respondents was biased towards males, the representation was fair and met the required one-third gender requirement. The results also indicate that the majority (36.8%) of respondents were between 36 and 45 years of age, indicating that most colleges were hiring young managers who were perceived to have a great potential to make a complete and successful contribution to the growth and development of the radiology department which was so much technology oriented. Most of the lecturers and hospital instructors had higher diploma qualifications (47.4%), although a similar proportion had higher levels of education such as Bachelor's Degrees and Masters Degrees.

Most (36.8%) had working experience spanning 10 to 12 years as lecturers or instructors of radiology. According to Olaison et al., (2018) the length or the durability of work experience plays a major role on how managers and key decision makers and implementers make decisions. Experienced employees describe how they deviate from the guidelines at times in order to create an increased scope of action in their decision-making process. Those with less time in their profession describe greater difficulties in this respect.

4.3 Descriptive Analysis Results

This section presents the results of the descriptive statistical analyses of the data and their interpretations. The descriptive statistics helped to develop the basic features of the study and form the basis of virtually every quantitative analysis of the data. The results were presented in terms of the study objectives.

4.3.1 Students' Perception of Curricular space limitations and ultrasonography students training outcomes

The first objective of the study was to determine the influence of curricular space limitations on ultrasonography students training outcomes among diploma level KMTC students in selected Teaching Hospitals in Kenya. This variable was measured in terms of; syllabus management, integrated curriculum, vertical curriculum and time allocations. A five point Likert scale was used to rate responses of this variable and it ranged from; 1 = strongly disagree to 5 = strongly agree and was analysed on the basis of the mean score and standard deviation. The closer the mean score on each item was to 5, the more the agreement concerning the statement. A score around 2.5 would indicate uncertainty while scores significantly below 2.5 would suggest disagreement regarding the statement posed. The findings are presented in Table 4.4.

Table 4.4: Students' Perception of Curricular space limitations and ultrasonography students training outcomes

	SA	A	N	D	SD		Std.
Statement	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Mean	Dev.
Our timetable has allocated few lessons for ultrasound training	15(19)	30(38)	12(15)	12(15)	10(13)	3.42	0.748
Due to the need to cover other units we are not able to have enough time to complete all the ultrasound lessons	14(18)	42(53)	19(24)	2(3)	2(3)	3.81	0.824
The ultrasound courses are well linked in the curriculum	12(15)	44(56)	16(20)	5(6)	2(3)	3.75	0.752
It is easy to see the connections between what we learnt at early stages and later stages of the course	12(14)	39(49)	22(28)	3(4)	3(4)	3.68	0.629
The ultrasound course has several linkages to other areas of medicine	17(22)	37(47)	9(11)	9(11)	7(9)	3.61	0.814
The ultrasound course teaches us both diagnostic applications and anatomical applications	18(23)	40(51)	13(16)	7(9)	1(1)	3.85	0.752
Students from different disciplines also take part in ultrasound classes making them overcrowded	23(29)	20(25)	14(18)	9(11)	13(17)	3.39	0.749
Aggregate	.	.	.	.	.	3.644	0.753

Table 4.4 shows that the aggregate mean scores of the items describing ultrasonography students' perception of curricular space limitations was mean = 3.644 and standard deviation = 0.753. The means is high above the mid value of 2.5 which indicates that the respondents agreed with most of the statements posed describing the state of curricular space limitations in their college. There were indications that the timetable had allocated few lessons for ultrasound training as suggested by most of the students

who agreed with the statement (38%; mean = 3.42). Majority of the students also felt that due to the need to cover other units they are not able to have enough time to complete all the ultrasound lessons (53%; mean = 3.81). However, the students' were of the view that the ultrasound courses are well linked in the curriculum (56%; mean = 3.75), and that it was easy to see the connections between what they had learnt at early stages and later stages of the course (49%; mean = 3.68). Further, most students were of the view that the ultrasound course has several linkages to other areas of medicine (47%; mean = 3.61). Majority of the students also agreed that the ultrasound course teaches them both diagnostic applications and anatomical applications (51%; mean = 3.85). There were also indications that students from different disciplines also take part in ultrasound classes making them overcrowded as indicated by most students who strongly agreed (29%; mean = 3.39).

The limited time for ultrasound lessons, as reported by the majority of ultrasonography students, likely stems from the broad and demanding nature of medical curricula, where students must balance ultrasound training with other foundational medical subjects. The challenge of allocating enough time for hands-on practice and theory may be exacerbated by crowded curricula that prioritize core units, often leaving little room for specialized training. As a result, students may not have sufficient exposure to ultrasound applications in clinical scenarios, hindering skill development and retention. Further, the issue of students from non-ultrasonography disciplines attending ultrasound lessons could be caused by the growing recognition of ultrasound as a versatile diagnostic tool, with an increasing number of healthcare professionals, including those in non-imaging roles, seeking to enhance their clinical capabilities. The inclusion of ultrasound in various medical fields, such as emergency medicine, internal medicine, and even obstetrics, might explain the rising demand for ultrasound

education across disciplines. Additionally, a lack of clear curricular boundaries between imaging and non-imaging departments might contribute to this overcrowding.

4.3.2 Availability of ultrasound machines and ultrasonography students training outcomes

The second objective of the study was to determine the influence of availability of ultrasound machines on ultrasonography students training outcomes among diploma level KMTC students in selected Teaching Hospitals in Kenya. This variable was measured in terms of; machine types, number of machines per class, maintenance and technicians. A five point Likert scale was used to rate responses of this variable and it ranged from; 1 = strongly disagree to 5 = strongly agree and was analyzed on the basis of the mean score and standard deviation. The closer the mean score on each item was to 5, the more the agreement concerning the statement. A score around 2.5 would indicate uncertainty while scores significantly below 2.5 would suggest disagreement regarding the statement posed. The findings are presented in Table 4.5.

Table 4.5: Students' Perception of Curricular space limitations and ultrasonography students training outcomes

	SA	A	N	D	SD		Std.
Statement	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Mean	Dev
We have enough non-portable ultrasound machines in our department	9(11)	11(14)	15(19)	15(19)	29(37)	2.44	1.046
Most students have access to portable Point of Care Ultrasound machines (PoCUS)	9(11)	11(14)	8(9)	23(29)	28(35)	2.37	0.679
The ultrasound machines are well maintained	16(21)	8(10)	5(6)	17(20)	33(42)	2.46	0.712
All the accessories required for ultrasound applications are always availed in good condition	5(6)	4(5)	13(16)	16(21)	41(52)	1.94	0.677
We do get enough practice with the ultrasound machines in our department	9(11)	9(11)	6(7)	38(48)	17(20)	2.43	0.814
Students are allowed to acquire their own PoCUS machines and come with them for training	27(34)	17(21)	16(20)	13(17)	6(8)	3.49	0.737
We do not experience difficulties in recruiting human models for our training	8(10)	12(16)	15(19)	16(21)	28(35)	2.44	0.991
We have adequate simulators for ultrasound training in our department	6(7)	13(17)	14(18)	20(25)	26(33)	2.42	1.108
Use of simulators is just as good if not better than human models due to flexibility	14(18)	6(7)	13(17)	20(25)	26(33)	2.51	1.108
Aggregate						2.456	0.846

The findings in Table 4.5 shows that the aggregate mean scores of the items describing availability of ultrasound machines was mean = 2.456 and standard deviation = 0.846. The means is below the mid value of 2.5 and the standard deviation is less than unity which indicates that there was little variations regarding the statements posed describing the availability of ultrasound machines for training in their college. Most students disagreed that their departments have enough non-portable ultrasound machines in their department (37%; mean = 2.44). Most students also strongly disagreed that they have access to portable Point of Care Ultrasound machines (PoCUS) (35%; mean = 2.37). Further, there were indications that the ultrasound machines were not well maintained as indicated by majority of students who strongly disagreed (42%; mean = 2.46). Also, most of the students strongly disagreed that all the accessories required for ultrasound applications are always availed in good condition (52%; mean = 1.94). The findings also indicate that most of the students disagreed that they do get enough practice with the ultrasound machines in our department (48%; mean = 2.43). There were, however, indications that the students were allowed to acquire their own PoCUS machines and come with them for training (34%; mean = 3.49). Most students disagreed that they do not experience difficulties in recruiting human models for their training (35%; mean = 2.44). The results also indicated that the departments did not have adequate simulators for ultrasound training (33%; mean = 2.42). There was, however, uncertainty among the students on whether use of simulators was just as good if not better than human models due to flexibility (33%; mean = 2.51).

The uncertainty about simulators among students highlights a need to bridge the perception and training gaps in ultrasonography education. Students may view simulators as less realistic or flexible compared to human models due to limited

exposure or understanding of their benefits. As an instructor, this underscores the importance of integrating simulators into the curriculum more effectively. Demonstrating their ability to replicate diverse clinical scenarios, offering structured feedback, and combining simulator training with human models can help address these concerns and enhance student confidence in their utility.

4.3.3 Students attitudes on training and ultrasonography training outcomes

The third objective of the study was to determine the influence of students attitudes on ultrasonography training among diploma level KMTC students in selected Teaching Hospitals in Kenya. This variable was measured in terms of; level of training, peer training, future job prospects and mentorship. A five point Likert scale was used to rate responses of this variable and it ranged from; 1 = strongly disagree to 5 = strongly agree and was analysed on the basis of the mean score and standard deviation. The closer the mean score on each item was to 5, the more the agreement concerning the statement. A score around 2.5 would indicate uncertainty while scores significantly below 2.5 would suggest disagreement regarding the statement posed. The findings are presented in Table 4.6.

Table 4.6: Students attitudes on training and ultrasonography training outcomes

	SA	**A**	**N**	**D**	**SD**		**Std.**
Statement	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Mean	Dev
The ultrasound classes are usually overcrowded	31(39)	17(22)	10(13)	10(13)	11(14)	3.59	0.902
I am not sure whether I would want to become an ultrasound medical professional after the learning exposure	20(25)	29(37)	13(16)	9(11)	8(10)	3.56	0.657
The ultrasound machines are so big and it affects our learning	18(23)	25(32)	12(15)	13(16)	11(14)	3.33	0.679
My colleagues are thinking of dropping the ultrasound unit if it is possible	17(22)	35(44)	8(10)	10(13)	9(11)	3.52	0.799
With the rise of PoCUS and the fact that it is being used widely by other medical professionals, I would rather pursue other radiology courses to make me more relevant	15(19)	31(39)	14(18)	9(11)	10(13)	3.41	0.925
We do not have enough mentors to develop us into ultrasound professionals	16(20)	30(38)	11(14)	14(18)	8(10)	3.41	0.784
We do not have enough lecturers for the course	13(17)	28(36)	12(16)	18(21)	8(10)	3.25	1.046
Peer training is often encouraged in our classes in order for us to practice more	24(30)	19(24)	8(10)	8(10)	20(25)	3.24	0.854
Our lecturers show a lot of depth in ultrasound applications	24(30)	20(25)	19(24)	8(10)	8(10)	3.56	0.854
Aggregate						3.399	0.831

The findings in Table 4.6 shows that the aggregate mean scores of the items describing students attitudes on ultrasonography training was mean = 3.399 and standard deviation = 0.8431. The aggregate mean value is higher than the mid value of 2.5 and the standard deviation is less than unity which indicates that the respondents agreed with little variations with the statements describing the students' attitudes on ultrasonography training in their colleges. Most students strongly agreed that the ultrasound classes are usually overcrowded (39%; mean = 3.59). The students were, however, uncertain on whether the big sizes of ultrasound machines affects their learning (32%; mean = 3.33). Most of the students were also not sure whether they would want to become an ultrasound medical professional after the learning exposure (37%; mean = 3.56).

Most students also said that their colleagues were thinking of dropping the ultrasound unit if it is possible (44%; mean = 3.52). There were also indications that with the rise of PoCUS and the fact that it is being used widely by other medical professionals, most student felt they would rather pursue other radiology courses to make them more relevant (39%; mean = 3.41). Most students also agreed that they did not have enough mentors to develop them into ultrasound professionals (38%; mean = 3.41). Other findings indicated that the colleges did not enough lecturers for the course (36%; mean = 3.25). Also, there were indications that peer training is often encouraged in the classes in order for the students to do more practice (30%; mean = 3.24). Most students also strongly agreed that their lecturers show a lot of knowledge in ultrasound applications (30%; mean = 3.56).

The findings indicate that a significant number of ultrasonography students were dissatisfied or unsure about the relevance of ultrasound training in the current medical

landscape. The possibility of dropping the ultrasound unit may reflect concerns about the perceived difficulty or limited career opportunities in the field, particularly with the rise of Point-of-Care Ultrasound (PoCUS), which is becoming more widely used by other medical professionals. This shift might make students question the value of pursuing specialized ultrasonography training when more general medical professionals are incorporating ultrasound into their practices

4.3.4 Ultrasonography Training Outcomes Among Radiography Diploma Level Students At The Kenya Medical Training College

Finally, the study sought to determine the status of ultrasonography training outcomes among radiography diploma level students at the Kenya Medical Training College. This was the dependent variable and the status of this variable was measured through; examination scores, skill levels, sonoanatomy competency, diagnostic competence and interpretation accuracy. The status of this variable was rated on a 5 point Likert scale ranging from; 1 = strongly agree to 5 = strongly disagree and was analysed on the basis of the mean score and standard deviation. The closer the mean score on each score was to 5, the more the agreement concerning the statement. A score around 2.5 would indicate uncertainty while scores significantly below 2.5 would suggest disagreement regarding the statement posed. These results are presented in Table 4.7.

Table 4.7: Ultrasonography Training Outcomes among Radiography Diploma Level Students at the Kenya Medical Training College

	SA	**A**	**N**	**D**	**SD**		**Std.**
Statement	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Freq(%)	Mean	Dev
I perform better in ultrasonography theory exams compared to other radiology subjects	14(18)	32(41)	20(24)	9(11)	5(6)	3.51	0.51
I perform better in ultrasonography practical exams compared to other radiology subjects	17(22)	8(10)	7(9)	16(20)	31(39)	2.54	0.814
Sonography training has improved my diagnostic capabilities	9(12)	31(39)	8(10)	20(25)	11(14)	3.09	0.773
Sonography has also improved my understanding of the human anatomy	12(15)	29(36)	12(15)	15(19)	11(14)	3.20	0.831
I am confident in my interpretation of ultrasound scans	12(14)	19(23)	12(14)	26(33)	10(12)	2.96	0.748
My interpretations of results sometimes get rejected and I have to redo the process again	15(19)	24(30)	16(20)	14(18)	10(13)	3.25	0.712
Aggregate Score						3.09	0.731

The findings in Table 4.7 shows that the aggregate mean scores of the items describing ultrasonography training outcomes among radiography diploma level students at the KMTC was mean = 3.091 and standard deviation = 0.731. The means is a score around the mid value of 2.5 implying that there was uncertainty on the performance of students on ultrasonography. Further, the standard deviation is less than unity which indicates

that there was little variations regarding the statements describing ultrasonography training outcomes among radiography students. Most students agreed that they perform better in ultrasonography theory examinations compared to other radiology subjects (41%; mean = 3.51). However, there were strong indications that most students did not perform better in ultrasonography practical exams compared to other radiology subjects (39%; mean = 2.54).

Most students were, however, uncertain on whether sonography has improved their diagnostic capabilities (39%; mean = 3.09). Most students were also uncertain on the effect of sonography training on improving their understanding of the human anatomy (36%; mean = 3.20). There were indications that most students were not confident in their interpretation of ultrasound scans (33%; mean = 2.96). The students also indicated that their interpretations of results sometimes get rejected and they have to redo the process again (30%; mean = 3.25).

4.4 Inferential Statistical Results

Inferential statistical test was done to test the relationship between dependent and independent variables. Correlation and multiple regression analysis and results were discussed in the following subsections.

4.4.1 Correlation Analysis

A description of the correlation analysis was presented in this chapter. It tried to determine the intensity and direction of the linear relationship that occurs between each independent variable and the dependent variable. The significance of the correlations was calculated at $p \leq 0{,}05$. The findings are summarized in Table 4.8.

Table 4.8: Summary of Pearson's Product Moment Correlations

		Curricular space limitations	Availability of US machines	Students attitudes	Ultrasonography Training Outcomes
Curricular space limitations	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	79			
Availability of US machines	Pearson Correlation	0.199	1		
	Sig. (2-tailed)	0.069			
	N	79	79		
Students' attitudes	Pearson Correlation	-0.001	0.184	1	
	Sig. (2-tailed)	0.994	0.094		
	N	79	79	79	
Ultrasonography Training Outcomes	Pearson Correlation	0.096	.268*	.517**	1
	Sig. (2-tailed)	0.386	0.047	0.000	
	N	79	79	79	79

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The first correlation was done to determine whether students' perception of curriculum space limitations significantly affects ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. The results in Table 4.8 showed that there was no significant between the variables ($r = 0.096$, $p>.05$). This implies that as things were at the moment, the curriculum space limitations were not high enough to cause significant effect on ultrasonography training outcomes among students.

The second correlation was done to examine whether availability of ultrasound machines for training significantly affects ultrasonography training outcomes among

diploma level KMTC students in Teaching Hospitals in Kenya. The correlation results in Table 4.8 indicated that a significant relationship existed between the two variables ($r = 0.268$, $p<.05$). The Pearson's product moment coefficient of correlation is moderate and suggested that a moderate relationship existed between the variables. This implies that increase of availability of ultrasound machines for training would lead to a moderate improvement in ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

The third correlation was done to examine whether students attitudes on training significantly affects ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. The results of the correlation in Table 4.8 showed that there was a significant relationship between the variables ($r = 0.517$, $p <.05$). The Pearson product moment coefficient of correlation indicated that there was a strong relationship between the variables. This meant that ultrasonography training outcomes largely depended on the students attitudes on training.

4.4.2 Regression Analysis

Multivariate regression analysis was used to determine the significance of the relationship between all the independent variables pooled together and the dependent variable. The results were then used to test the corresponding hypotheses stated for the study. The hypotheses were tested at $t\geq2.0$ and $p < .05$. The decision rule was to reject the null hypotheses if the corresponding p-value was less than .05.and fail to reject the null hypotheses if the corresponding p-value is greater than .05. The findings, explanations and supporting discussions also included the r-squar**ed**, which was the model coefficient of determination, the model F-statistical values and the beta

coefficient values. Table 4.9 shows the results of the regression model before moderation.

Table 4.9: Overall Regression Model before moderation

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	**Std. Error**	**Beta**		
(Constant)	1.535	4.087		0.376	0.708
Curricular Space	0.108	0.115	0.075	0.940	0.349
Availability of US machines	0.205	0.099	0.145	2.069	0.040
R	0.504		F	15.447	
R Squared	0.254		Sig.	0.000	
Adjusted R Squared	0.238				

Dependent Variable: Ultrasonography training outcomes among diploma

Table 4.9 showed that the overall model adjusted R^2 is 0. 238.This indicated that the model could explain up to 23.8% of the variations in the dependent variable. The rest are explained by the variables not fitted in the model. Field (2019) reported that the suitability of the multiple regression model as a whole can be checked using an F-test. Therefore, the F-statistic computed was 15.447 with a p-value of .000 which implied that the explanatory variables were jointly significant in explaining variations in the dependent variable and, therefore, the model before moderation was fitting to explain the interactions between the variables and could be further analyzed to explain the relationships.

Regarding the model coefficients, the findings suggested that the most influential variable in the model was availability of ultrasound machines ($\beta = 0.145$; $p \leq .05$), and this was the only significant variable in the joint model. The findings also indicate that taking all other independent variables at zero, a unit increase in availability of ultrasound machines would lead to a 0.205 increase in the ultrasonography training outcomes among diploma students at KMTC. Curricular space limitations was,

however, not found to significantly influence the ultrasonography training outcomes among diploma students as per the joint model (β =0.075; p>0.05). The findings, therefore, suggest that only the independent variable, availability of ultrasound machines, matter most compared to curricular space limitations and in the joint model explaining ultrasonography training outcomes among diploma students.

4.4.3 Moderating effect of Strategic Investment

To test the moderating effect of students' attitudes on training moderates the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya, Students attitudes as the moderator variable was introduced into the regression model as a multiplier. The regression results are presented in Table 4.10.

Table 4.10: Multiple linear regression results with moderation

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.01	4.759		0.4224	0.6733
Curricular space. Students attitudes	0.098	0.049	0.116	2.0204	0.0469
Availability of US Machines. Students attitudes	0.358	0.117	0.279	3.0598	0.0025
Students attitudes	0.444	0.084	0.407	5.2857	0.0000
R	0.622		F	7.9126	
R Squared	0.387		Sig.	0.001	
Adjusted R Squared	0.345		df	3,75	

Table 4.10 shows that the coefficients for the interactive terms are all significant where Curricular space. Students attitudes coefficient is β = 0.116, p = 0.047 and Availability of US Machines. Students attitudes coefficient is β = 0.279, p = 0.003 and the Students attitudes coefficient (without interaction) is also significant at β = 0.407, p = 0.000. Mackinnon et al., (2007) observes that when the coefficients in the model with the

moderating variable as a multiplier is significant and the coefficient of the moderating variable in the model with the moderating variable included but not as a multiplier is significant, then there is a moderating effect. Therefore, the study concludes that Students attitudes had a significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

4.4.4 Hypothesis Testing Results

All hypotheses were tested at 5% level of significance.

H01: Students' perception of curriculum space limitations have no significant effect on ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya

This hypothesis was accepted since its p-value of 0.349 was greater than the .05 significance level. Hence, the study concluded that Students' perception of curriculum space limitations have a statistically significant effect on ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. This finding suggests that while there were curricular space limitations, they were not large enough to significantly influence the ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

H02: Availability of ultrasound machines for training has no significant effect on ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

This hypothesis was rejected since its p-value of 0.040 was less than the .05 significance level. Hence, the study concluded that Availability of ultrasound machines for training had a statistically significant effect on ultrasonography training outcomes

among diploma level KMTC students in Teaching Hospitals in Kenya. Therefore, this study adopted the view that Availability of ultrasound machines was an important factor of ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

H03: Students attitudes of training has no significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya

This hypothesis was rejected since the R^2 after moderation ($R^2 = 0.387$) was higher than the R2 before moderation ($R^2 = 0.254$) and the R^2 change was significant ($p \leq 0.05$). Hence, the study concluded that Students attitudes of training has a significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction

This chapter summarizes the discussion on research findings and compare with the literature review.

5.2 Discussion of the Findings

5.2.1 Students' Perception of Curricular space limitations and ultrasonography students training outcomes

Findings from the correlation and regression analysis revealed that students' perception of curriculum space limitations did not significantly affect ultrasonography training outcomes (aggregate mean of 3.6) among diploma level KMTC students in Teaching Hospitals in Kenya. Other findings revealed that some Radiography students agreed that there were curricular space limitations in their college. There were indications that the timetable had allocated few lessons for ultrasound training as suggested by most of the students. However, the students' were of the view that the ultrasound courses are well linked in the curriculum, and that it was easy to see the connections between what they had learnt at early stages and later stages of the course. This is in line with a study done by Chen et al. (2022) where he stated a significant research gap exists regarding how students' perceptions of syllabus management in ultrasonography training influence their attitudes toward the curriculum in Kenya. While studies such as and Eke et al. (2021) explore challenges in balancing theoretical and practical training in ultrasound education, they primarily focus on global or pandemic-specific contexts, leaving localized perspectives underexplored

Majority of the students also agreed that the Lecturers teach them both diagnostic applications and anatomical applications. Majority of the students also felt that due to

the need to cover other units they are not able to have enough time to complete all the ultrasound lessons which was a new finding in this area. This is in agreement with study done by Moore et al. (2022) who examined point-of-care ultrasound (POCUS) training in nephrology fellowships, revealing significant variability in training duration across programs. While some programs allocated extensive time to POCUS, others struggled to incorporate it into already packed curricula. This study findings supports Moore et al. (2022) who stated that time allocation greatly influenced skill acquisition, with fellows receiving more training hours demonstrating higher proficiency

The limited time for ultrasound lessons, as reported by the majority of ultrasonography students, likely stems from the broad and demanding nature of medical curricula, where students must balance ultrasound training with other foundational medical subjects. The challenge of allocating enough time for hands-on practice and theory may be exacerbated by crowded curricula that prioritize core units, often leaving little room for specialized training.

There were also strong indications that students from different disciplines also take part in ultrasound classes making them overcrowded which was also a new finding. The issue of students from non-ultrasonography disciplines attending ultrasound lessons could be caused by the growing recognition of ultrasound as a versatile diagnostic tool, with an increasing number of healthcare professionals, including those in non-imaging roles, seeking to enhance their clinical capabilities. The inclusion of ultrasound in various medical fields, such as emergency medicine, internal medicine, and even obstetrics, might explain the rising demand for ultrasound education across disciplines. Additionally, a lack of clear curricular boundaries between imaging and non-imaging departments might contribute to this overcrowding.

5.2.2 Availability of ultrasound machines and ultrasonography students training outcomes

Findings from the correlation and regression analysis revealed that availability of ultrasound machines for training significantly affects ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. The findings also revealed that most students disagreed with the statements on availability of ultrasound machines for training in their college implying that the machines were limited in availability. These findings concur with (Müller et al., 2022) who stated that availability of ultrasound machines is a critical factor in the training of medical students in ultrasonography, as it directly impacts their exposure to practical skills and clinical competency.

(Sharma & Kumar, 2024) is in support by saying a lack of accessible, functional ultrasound machines can hinder students' ability to gain hands-on experience, which is essential for mastering the technology Studies have shown that having sufficient access to ultrasound equipment enables students to better understand imaging principles and improve diagnostic skills (Yang et al., 2021).

Most students also disagreed that their departments have enough non-portable ultrasound machines in their department. Most students also strongly disagreed that they have access to portable Point of Care Ultrasound machines (PoCUS). Further, there were indications that the ultrasound machines were not well maintained as indicated by majority of students who strongly disagreed. Also, most of the students strongly disagreed that all the accessories required for ultrasound applications are always availed in good condition. The findings also indicate that most of the students disagreed that they do get enough practice with the ultrasound machines in our

department. There were, however, indications that the students were allowed to acquire their own PoCUS machines and come with them for training.

The results also indicated that the departments did not have adequate simulators for ultrasound training. There was, however, uncertainty among the students on whether use of simulators was just as good if not better than human models due to flexibility, this was a new finding. The uncertainty about simulators among students highlights a need to bridge the perception and training gaps in ultrasonography education.

5.2.3 Students attitudes on training and ultrasonography training outcomes

The results showed that Students attitudes had a significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. Further, most students had attitudes on ultrasonography training in their colleges. Most students strongly agreed that the ultrasound classes are usually overcrowded.

The study findings support (Müller et al., 2022) who suggested that in the context of ultrasonography training, a positive attitude is crucial for successful skill acquisition and retention, as it motivates engagement with complex material and enhances clinical competence. He further explained that students with a positive attitude toward ultrasound training are more likely to participate actively in hands-on sessions, leading to better outcomes. These findings also supports (Yang et al., 2021) who stated that negative attitudes, often shaped by anxiety or lack of confidence, can hinder learning and decrease the effectiveness of training programs.

Most students also agreed that they did not have enough mentors to develop them into ultrasound professionals. Other findings indicated that the colleges did not enough

lecturers for the course. Also, there were indications that peer training is often encouraged in the classes in order for the students to do more practice. These findings mirror (Smith & Patel, 2024) who stated that Peer training fosters active learning, critical thinking, and feedback exchange, which are crucial for mastering complex skills like ultrasound scanning.

Most students also strongly agreed that their lecturers show a lot of depth in ultrasound applications. Most students also said that their colleagues were thinking of dropping the ultrasound unit if it is possible, this was a new finding in this area. This could be explained by the observation that the possibility of dropping the ultrasound unit may reflect concerns about the perceived difficulty or limited career opportunities in the field, particularly with the rise of Point-of-Care Ultrasound (PoCUS), which is becoming more widely used by other medical professionals. This shift might make students question the value of pursuing specialized ultrasonography training when more general medical professionals are incorporating ultrasound into their practices. This was further corroborated by the students' views that with the rise of PoCUS and the fact that it is being used widely by other medical professionals, most student felt they would rather pursue other radiology courses to make them more relevant.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Introduction

This chapter draws conclusions and makes recommendations for the stakeholders. The implications of the research are discussed and suggestions made on areas of further study.

6.2 Conclusion

6.2.1 Students' Perception of Curricular space limitations and ultrasonography students training outcomes

Students' perception of curriculum space limitations did not significantly affect ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. Hence, the study concluded that, despite students feeling constrained by the time and space available in the curriculum, these factors may not directly hinder their ability to acquire essential ultrasonography skills. This could imply that other factors, such as the quality of instruction, hands-on experience, or resource availability, may play a more significant role in shaping training outcomes. It also suggests that, while curriculum space may be perceived as a limitation, it may not be the primary barrier to effective learning in this context. However, this finding might also indicate that the current curriculum, although perceived as limited, might still be sufficiently structured to allow students to achieve the desired training outcomes. It is also possible that students' expectations regarding the amount of content covered or time allocated to ultrasonography training may not align with the actual educational approach or objectives.

6.2.2 Availability of ultrasound machines and ultrasonography students training outcomes

Availability of ultrasound machines for training significantly affects ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. Hence, the study concluded that hands-on experience with ultrasound equipment is critical to skill development in this field and, therefore, the lack of sufficient access to ultrasound machines may hinder students from gaining the practical experience necessary to master ultrasound techniques, impacting their diagnostic accuracy and overall competence. This underscores the importance of ensuring that training institutions are adequately equipped to provide students with the resources they need for effective learning.

6.2.3 Students attitudes on training and ultrasonography training outcomes

Students attitudes had a significant moderating effect on the relationship between institutional factors and ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya. Hence, the study concluded that students' perceptions, motivation, and engagement play a crucial role in determining the effectiveness of the training process. While institutional factors such as curriculum design, equipment availability, and faculty expertise are important, the way students approach their learning—whether positively or negatively—can either enhance or hinder the impact of these factors on their overall performance. This implies that fostering a positive attitude toward the ultrasound discipline is essential for improving training outcomes. It also highlights the need for institutions to not only focus on providing resources and structuring the curriculum effectively but also to invest in cultivating students' motivation, commitment, and understanding of the value of their training.

6.3 Recommendations

Drawing from the foregoing findings, the study makes the following recommendations'

6.3.1 Students' Perception of Curricular space limitations and ultrasonography students training outcomes

The study recommends that the college management allocate more time for ultrasound training in the timetable as the students need to cover other units we are not able to have enough time to complete all the ultrasound lessons. There is also need to incorporate dedicated ultrasound modules that focus on core concepts such as sono-anatomy, basic and advanced imaging techniques, and pathology within the current curriculum. Additionally, integrating more time for practical bedside scanning and point-of-care ultrasound (POCUS) applications would better prepare students for real-world diagnostics. Offering elective or intensive ultrasound courses with focused sessions, or restructuring the timetable to allow more concentrated ultrasound training, would also improve students' ability to develop proficiency and confidence in their skills.

The study, further recommends establishing clearer guidelines and prerequisites for ultrasound training, ensuring that only students from relevant medical imaging or ultrasonography programs are prioritized. Specializing ultrasound training for students from other disciplines could be an option, but it should occur separately from the core ultrasonography curriculum to prevent disruption.

6.3.2 Availability of ultrasound machines and ultrasonography students training outcomes

There is need for the college management to invest in modern ultrasound machines and teaching methods so as to ensure that they have available machines for all their students. The machines also need to be well maintained and ultrasound students should

be given enough practice with the ultrasound machines in their department as specialists. To address students' lack of confidence in using the simulators for training, a blended training approach is recommended, where simulators are used to build foundational skills before transitioning to human models. Realistic, case-based scenarios on simulators, coupled with peer discussions and structured feedback sessions, can normalize their use. Regular assessment of learning outcomes from both methods can highlight their effectiveness. Additionally, professional development for instructors to integrate advanced simulation technologies will further support students in appreciating simulators as effective tools in ultrasonography training.

6.3.3 Students attitudes on training and ultrasonography training outcomes

There is need for the college management to avail career information to students through the use of the counselling department and also through mentorship programs with other practicing ultrasound specialists in the field. The study further recommends reinforcing the importance and career prospects of specialized ultrasound training by integrating PoCUS concepts into the ultrasonography curriculum. This could help students recognize the growing demand for specialized skills in ultrasonography, especially in resource-limited settings. Additionally, greater emphasis should be placed on mentorship, career guidance, and the long-term relevance of radiography and sonography careers to boost student motivation. Partnerships with healthcare facilities offering PoCUS applications could also provide students with exposure to diverse opportunities in the field, making the curriculum more appealing and career-focused.

6.4 Recommendations for Future Studies

The study recommends that future studies should be done on the effect of lecturer factors on ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.. There is also need to assess the effect of changing technologies on ultrasonography training outcomes among diploma level KMTC students in Teaching Hospitals in Kenya.

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APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

Nancy C. Chepkwony

P.O Box 4606 -30100,

21ST March, 2023

The Principal

Kenya Medical Training College…….Campus
P.O. Box ……
…….

Dear Sir/Madam,

RE: REQUEST TO CARRY OUT RESEARCH WITHIN THE KMTC CAMPUS

I am a Master of Science in Medical Education student at the Department of Medical Education, School of Medicine of Moi University-Eldoret Campus. As part of the requirement of my degree, I am carrying out research on the *DETERMINANTS **OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA***. I, therefore, request your permission to collect data within the campus among lecturers and students of the Faculty of Diagnostic Sciences.

The information obtained will be used entirely for academic and learning purposes and will be treated with utmost confidentiality. Every care will be taken in the data collection procedure to ensure that it is within ethical limits. Thank you in advance for your cooperation.

Yours faithfully,

Nancy C. Chepkwony

Appendix II: Questionnaires for Students

The questions below are for the purpose of finding out ***DETERMINANTS OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA*.** Therefore, you are requested to fill this questionnaire in the most free and honest way possible.

Instructions: Please tick (√) the appropriate answers in the boxes provided or write down the appropriate answers in the spaces provided. Do not write your name on the questionnaire. Thank you in advance for your time and cooperation.

Section A: Background Information

Please tick ☐ on the most appropriate option that applies to you

1. What is your gender?
   - Male ☐
   - Female ☐
   - Any other …….
2. What is your age?
   - Below 18 - 23 yrs ☐
   - 24 - 29 yrs ☐
   - 30 - 35 yrs ☐
   - 36-40yrs ☐
   - 41 yrs and above ☐
3. What is your year of study?
   - First Year ☐
   - Second Year ☐
   - Third Year ☐
4. What influenced your career decision for ultrasonography?

   ……
   …

5. What made you prefer your current campus?

   ……
   …
   ……
   …

SECTION B: Students' Curricular space and ultrasonography training outcomes

The following statements relate to the influence of curricular space limitations on ultrasonography students training outcomes**.** Please rate them according to your understanding by ticking (√) where it is appropriate using the key:

Key: SA=Strongly Agree; A=Agree; N=Neutral; D=Disagree and SD=Strongly Disagree

Statements	**SA**	**A**	**N**	**D**	**SD**
Our timetable has allocated few lessons for ultrasound training					
Due to the need to cover other units we are not able to have enough time to complete all the ultrasound lessons					
The ultrasound courses are well linked in the curriculum					
It is easy to see the connections between what we learnt at early stages and later stages of the course					
The ultrasound course has several linkages to other areas of medicine					
The ultrasound course teaches us both diagnostic applications and anatomical applications					
Students from different disciplines also take part in ultrasound classes making them overcrowded					

SECTION C: Availability of ultrasound machines and ultrasonography students training outcomes

The following statements relate to the influence of Availability of ultrasound machines on ultrasonography students training outcomes. Please rate them according to your understanding by ticking (√) where it is appropriate using the key:

Key: SA=Strongly Agree; A=Agree; N=Neutral; D=Disagree and SD=Strongly Disagree

Statement	SA	A	N	D	SD
We have enough non-portable ultrasound machines in our department					
Most students have access to portable Point of Care Ultrasound machines (PoCUS)					
The ultrasound machines are well maintained					
All the accessories required for ultrasound applications are always availed in good condition					
We do get enough practice with the ultrasound machines in our department					
Students are allowed to acquire their own PoCUS machines and come with them for training					
We experience difficulties in recruiting human models for our training					
We have adequate simulators for ultrasound training in our department					
Use of simulators is just as good if not better than human models due to flexibility					

SECTION D: Students attitudes on training and ultrasonography training outcomes

The following statements relate to the influence of Students attitudes on training and ultrasonography training outcomes. Please rate them according to your understanding by ticking (√) where it is appropriate using the key:

Key: SA=Strongly Agree; A=Agree; N=Neutral; D=Disagree and SD=Strongly Disagree

Statement	SA	A	N	D	SD
The ultrasound classes are usually overcrowded					
I am not sure whether I would want to become an ultrasound medical professional after the learning exposure					
The ultrasound machines are so big and it affects our learning					
My colleagues are thinking of dropping the ultrasound unit if it is possible					
With the rise of PoCUS and the fact that it is being used widely by other medical professionals, I would rather pursue other radiology courses to make me more relevant					
We do not have enough mentors to develop us into ultrasound professionals					
We do not have enough lecturers for the course					
Peer training is often encouraged in our classes in order for us to practice more Our lecturers show a lot of depth in ultrasound applications					

SECTION E: Ultrasonography Training Outcomes Among Radiography Diploma

The following statements relate to the Ultrasonography Training Outcomes Among Radiography Diploma Level Students At The Kenya Medical Training College. Please rate them according to your understanding by ticking (√) where it is appropriate using the key:

Key: SA=Strongly Agree; A=Agree; N=Neutral; D=Disagree and SD=Strongly Disagree

Statement	SA	A	N	D	SD
I perform better in ultrasonography theory exams compared to other radiology subjects					
I perform better in ultrasonography practical exams compared to other radiology subjects					
Sonography has improved my diagnostic capabilities					
Sonography has also improved my understanding of the human anatomy					
I am confident in my interpretation of ultrasound scans					
My interpretations of results sometimes get rejected and I have to redo the process again					

Thank you for your time

Appendix III: Interview Schedules for Lecturers

My name is Nancy Chebet and I am a postgraduate medical education student from Moi University. I am carrying out a study on the ***DETERMINANTS OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA***. I kindly request you to take part in the research by filling the interview schedule below. All the information you give will be treated with utmost confidentiality.

Instructions: Do not write your name on the interview schedule. Thank you in advance for your time and cooperation.

SECTION A:

1. What is your gender?

Male ☐ Female ☐ Any other…….

2. What is your age?

Below 25 yrs ☐ 26 - 35 yrs ☐ 36 - 45 yrs ☐

46-55 rs ☐ 56 yrs and above ☐

3. What is your highest level of education?

Diploma ☐ Higher Diploma ☐ Degree ☐ Masters ☐

Other (specify)

……

4. How many years have you worked as a lecturer of radiology?

0-3 yrs ☐ 4 - 6 yrs ☐ 7 - 9 yrs ☐

10 – 12 yrs ☐ 13 yrs and above ☐

SECTION B: Curricular spaceand ultrasonography training

What is your view on the time allocated in the curriculum for ultrasound theory and applications training?

……

……

Are you always able to complete the curriculum in good time for revision?

……
……

Would you say opting for online classes helps manage large numbers of students?

……
……

In your opinion, are there adequate linkages between the foundation classes for ultrasonography and the advanced modules based on the curriculum?

……
……

Would you say the curriculum is well designed to impart ultrasound training for other medical fields in your college?

……

SECTION C: Availability of ultrasound machines and ultrasonography

What types of ultrasound machines do you have in training students in the hospitals?

……
……

How many ultrasound machines do you have per class?

……
……

How current are the ultrasound machines in in the hospitals?

……

Is cost a very limiting factor in acquiring the ultrasound machines in in the hospitals?

……
…

What would you comment about the condition of the ultrasound machines used for training in the hospitals?

……

What would you comment about the availability of ultrasound machines accessories for training in the hospitals?

……

SECTION F: Students attitudes on training and ultrasonography training outcomes

Would you say your students get adequate training in ultrasound theory and applications?

……

How do you find your students interest for ultrasound theory and applications training?

……

What concerns do your students raise regarding their future career prospects as ultrasound specialists?

……

Do you have mentorship in ultrasound for your students?

……

SECTION G: Ultrasonography Training Outcomes Among Radiography Diploma

How do your students perform in ultrasound theory and applications exams?

……..……

……

How would you rate your students' skill levels in diagnostic ultrasound applications?

……

……

How would you rate your students' competency levels in ultrasound sonoanatomy?

……

…

What level of confidence do your students show in interpreting ultrasound results?

……

……

In your opinion, what challenges do you think affect the students' performance in ultrasonography?

……

……

Appendix IV: Interview Schedules for Hospital Based Instructors

My name is Nancy Chebet and I am a postgraduate medical education student from Moi University. I am carrying out a study on the ***DETERMINANTS OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHINGHOSPITALS IN KENYA***. I kindly request you to take part in the research by filling the interview schedule below. All the information you give will be treated with utmost confidentiality. Do not write your name on the interview schedule. Thank you in advance for your time and cooperation.

SECTION A:

6. Gender: Male ☐ Female ☐
7. Age : Below 25 yrs ☐ 26 - 35 yrs ☐ 36 - 45 yrs ☐

   46-55 yrs ☐ 56 yrs and above ☐
8. Highest level of education:

   Diploma ☐ Higher Diploma ☐ Degree ☐ Masters ☐

   Other (specify)

   ……
9. Work experience in as a lecturer of radiology in years ;

   0-3 yrs ☐ 4 - 6 yrs ☐ 7 - 9 yrs ☐

   10 – 12 yrs ☐ 13 yrs and above ☐

SECTION B: Availability of ultrasound machines and ultrasonography students training outcomes

What types of ultrasound machines do you have in training students in the hospitals?

……

……

How many ultrasound machines do you have per class?

……

……

How current are the ultrasound machines in in the hospitals?

……

……

Is cost a very limiting factor in acquiring the ultrasound machines in in the hospitals?

……

……What would you comment about the condition of the ultrasound machines used for training in the hospitals?

……

……

What would you comment about the availability of ultrasound machines accessories for training in the hospitals?

……

……

SECTION C: Students attitudes on training and ultrasonography training outcomes

Would you say your students get adequate training in ultrasound theory and applications?

……

……

How do you find your students interest for ultrasound theory and applications training?

……

……

What concerns do your students raise regarding their future career prospects as ultrasound specialists?

……

……

SECTION D: Ultrasonography Training Outcomes Among Radiography Diploma Level Students At The Kenya Medical Training College

How do your students perform in ultrasound theory and applications exams?

……

……

How would you rate your students' skill levels in diagnostic ultrasound applications?

……

……

How would you rate your students' competency levels in ultrasound sonoanatomy?

……
…

What level of confidence do your students show in interpreting ultrasound results?

……
……

In your opinion, what challenges do you think affect the students performance in ultrasonography?

……
……

……
……

……
……

Appendix V: Focus Group Discussion for Students

Dear respondents,

My name is Nancy Chebet and I am a postgraduate medical education student from Moi

University. I am carrying out a study on ***DETERMINANTS OF ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA***. I kindly request you to take part in the **Focus Group Discussion**. All the information you give will be treated with utmost confidentiality. Thank you in advance for your time and cooperation.

Welcome from the facilitator, introduction and instructions

I realize you are busy and appreciate you taking your time to participate in this focus group discussion. Your point of view is important.

Introduction: This discussion is engineered to assess your thoughts about the ***Determinants of Ultrasonography Training Outcomes Among Radiography Diploma Level Students at the Kenya Medical Training College***. The discussion should not exceed two hours. May I tape the discussion to enhance data collection? (To switch on the recorder the reply is Yes)

Anonymity: Even though the discussion is taped, it will be anonymous and the tapes will be locked in safety. They will be destroyed after transcription which contained the information linking individuals to specific statements. Please try and be accurate and truthful in your comments, the other group members and I would also appreciate if your refrain from discussing comments from other group members outside this focus group discussion. You do not have to participate if there are other questions or discussions that you do not wish to participate in. However, please try to be involved as much as possible.

Discussion rules

a) The most important rule is that we allow one person to speak at a time. Let‘s try to be as patient as we can irrespective of the urge to jump in.
b) Speaking does not have to be in any particular order

c) You realize that there are many of you in the group but it is important that I obtain views from each of you. please try to be involved as much as you can

d) In the discussion, you do not have to agree with view of the other people

FGD Schedule

1. How would you rate the quality of ultrasound teaching in the college?
2. What brings about this negative or positive reaction?
3. How do you find peer training?
4. How is the time allocation for ultrasound teaching compared to other subjects?
5. Are you able to complete all the lectures in time?
6. How do you find the linkages between the foundation classes and advanced classes in ultrasound?
7. What about linkages with other subjects like say anatomy?
8. What about simulators, do you have them in your department for practice and are they adequate?
9. In your opinion, how does training using live human models compare to simulators?
10. What type of ultrasound machines do you have access to in your department?
11. Are they old or new models and are they well maintained?
12. Are you confident in pursuing a career as an ultrasound specialist?
13. How would you rate your exams performance in theory and practicals in ultrasound?
14. How about the skill levels in diagnostics and sonoanatomy
15. Do you have confidence in your ultrasound interpretations and report writing?
16. What of those done by your colleagues do they show competence?

Conclusion Question

What can you say is the future of ultrasonography training in Kenya?

Conclusion

I appreciate you taking your time and participating, it has been a success. Your opinions will be of great importance and I once again would like to assure you of anonymity.

FGD Schedule

How would you rate the quality of ultrasound teaching in the college?

What brings about this negative or positive reaction?

How do you find peer training?

How is the time allocation for ultrasound teaching compared to other subjects ?

Are you able to complete all the lectures in time?

How do you find the linkages between the foundation classes and advanced classes in ultrasound?

What about linkages with other subjects like say anatomy?

What about simulators, do you have them in your department for practice and are they adequate?

In your opinion, how does training using live human models compare to simulators?

What type of ultrasound machines do you have access to in your department?

Are they old or new models and are they well maintained?

Are you confident in pursuing a career as an ultrasound specialist?

How would you rate your exams performance in theory and practicals in ultrasound?

How about the skill levels in diagnostics and sonoanatomy

Do you have confidence in your ultrasound interpretations and report writing?

What of those done by your colleagues do they show competence?

Conclusion Question

What can you say is the future of ultrasonography training in Kenya?

Conclusion

I appreciate you taking your time and participating, it has been a success. Your opinions will be of great importance and I once again would like to assure you of anonymity.

Appendix VI: IREC Approval

MTRH/MU-INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/568/2023
Approval Number: 0004543

10th November 2023

Nancy Chebet Chepkwony,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Ms. Chepkwony,

FACTORS AFFECTING ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA

This is to inform you that ***MTRH/MU-IREC*** has reviewed and approved the above referenced research proposal. Your application approval number is ***FAN: 0004543.*** The approval period is **10th November, 2023- 9th November, 2024.** This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, Material Transfer Agreements (MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***MTRH/MU-IREC***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***MTRH/MU-IREC*** within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***MTRH/MU-IREC*** within 72 hours.
v. Clearance for export of biological specimens must be obtained from ***MOH at the recommendation of NACOSTI*** for each batch of shipment.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***MTRH/ MU-IREC.***

Prior to commencing your study; you will be required to obtain a research license from the National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and other relevant clearances from study sites including a written approval from the CEO-MTRH which is mandatory for studies to be undertaken within the jurisdiction of Moi Teaching & Referral Hospital (MTRH) and its satellites sites.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc	CEO	-	MTRH	Dean	-	SOP	Dean	-	SOM
	Principal	-	CHS	Dean	-	SON	Dean	-	SOD

Appendix VII: Hospital Approval

An ISO 9001:2015 Certified Hospital

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: (+254)-0532033471/2/3/4
Fax: 0532061749
Email: ceo@mtrh.go.ke/ceosoffice@mtrh.go.ke

NANDI ROAD
P.O. BOX 3-30100
ELDORET, KENYA

Ref: ELD/MTRH/R&P/10/2/V.2/2010

14th November 2023

Ms. Nancy C. Chepkwony,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

FACTORS AFFECTING ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA

You have been authorised to conduct research within the jurisdiction of Moi Teaching and Referral Hospital (MTRH) and its satellites sites. You are required to strictly adhere to the regulations stated below in order to safeguard the safety and well-being of staff, patients and study participants seen at MTRH.

1. The study shall be under Moi Teaching and Referral Hospital regulation.
2. A copy of MTRH/MU-IREC approval shall be a prerequisite to conducting the study.
3. Studies intending to export human bio-specimens must provide a permit from MOH at the recommendation of NACOSTI for each shipment.
4. No data collection will be allowed without an approved consent form(s) to participants unless waiver of written consent has been granted by MTRH/MU-IREC.
5. Take note that **data** collected must be treated with due confidentiality and anonymity.

The continued permission to conduct research shall only be sustained subject to fulfilling all the requirements stated above.

The approval period is **14th November, 2023 – 13th November, 2024.**

4/11/2023

DR. WILSON K. ARUASA, *MBS, EBS*
CHIEF EXECUTIVE OFFICER

MOI TEACHING AND REFERRAL HOSPITAL
CEO
APPROVED
14 NOV 2023
SIGN.....
P. O. Box 3-30100, ELDORET

c.c. - Senior Director, Clinical Services
- Director, Nursing Services
- HOD, HRISM

Appendix VIII: Nacosti License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **249271**

Date of Issue: **08/January/2024**

RESEARCH LICENSE

This is to Certify that Ms.. NANCY CHEBET CHEPKWONY of Moi University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kericho, Kisumu, Nairobi, Nakuru, Nandi on the topic: FACTORS INFLUENCING ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA FACTORS INFLUENCING ULTRASONOGRAPHY TRAINING OUTCOMES AMONG RADIOGRAPHY DIPLOMA STUDENTS IN KENYA MEDICAL TRAINING CAMPUSES USING SELECTED TEACHING HOSPITALS IN KENYA for the period ending : 08/January/2025.

License No: **NACOSTI/P/24/32416**

249271

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)
Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
   i. Endanger national security
   ii. Adversely affect the lives of Kenyans
   iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
   iv. Result in exploitation of intellectual property rights of communities in Kenya
   v. Adversely affect the environment
   vi. Adversely affect the rights of communities
   vii. Endanger public safety and national cohesion
   viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and Innovation(NACOSTI),
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623 - 00100 Nairobi, KENYA
Telephone: 020 4007000, 0713788787, 0735404245
E-mail: dg@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix IX: Study Site Maps


K.M.T.C