The Role of AI in Reducing Maternal Mortality- Current Impacts and Future Potentials

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Abstract

Maternal mortality remains a significant global health challenge, disproportionately affecting low- and middle-income countries. While there has been a decline in maternal mortality rates, progress is slow, and innovative solutions are needed to accelerate progress toward achieving global targets. Artificial intelligence has emerged as a potential tool to revolutionize healthcare, including maternal health. This study investigates the role of AI in reducing maternal mortality, examining the current landscape of AI-driven applications in maternal healthcare globally and focusing specifically on the impact of AI-powered tools in Kenya. The study employed a mixed-methods approach, including a systematic review of research papers, analysis of patient records and health information system data, surveys of healthcare providers and AI developers, focus group discussions with healthcare workers, and site visits to healthcare facilities. The findings highlight the potential of AI to improve maternal health outcomes through various applications, including predictive analytics, decision support systems, medical imaging, remote monitoring, and virtual assistants. In Kenya, the study focused on two AI-powered tools: PROMPTS (PROmoting Mothers through Pregnancy/Postpartum Through SMS), an SMS platform for personalized health information and support, and POCUS (Point-of-Care Ultrasound), portable ultrasound devices for enhanced diagnostics. The study found that POCUS implementation was associated with significant improvements in key maternal and neonatal health indicators, including a reduction in obstructed labor and stillbirths, and an increase in the number of babies discharged alive. PROMPTS showed promise in enhancing healthcare access and efficiency, but client satisfaction with the platform's information delivery was low, indicating a need for improvement. The study also explored the future potential of AI in maternal healthcare, examining emerging technologies and identifying potential benefits and challenges. The policy implications of AI in maternal health were evaluated, including a critical review of existing policies and recommendations for responsible and ethical AI integration. The findings of this study contribute to the growing body of evidence supporting the potential of AI to improve maternal health outcomes and reduce maternal mortality. The study highlights the need for increased investment in AI research and implementation in LMICs, where the burden of maternal mortality is highest. The study also underscores the importance of addressing ethical considerations, data privacy, and user adoption challenges to ensure responsible and equitable AI integration in maternal healthcare.

Keywords: Artificial Intelligence, Maternal Mortality, Predictive Analytics, Telemedicine, Healthcare Innovation.

1. Introduction

Despite global declines, maternal and newborn mortality and morbidity remain stubbornly high, disproportionately impacting developing countries (Sibomana, 2023). The stark reality is that in 2020, an estimated 223 mothers died per 100,000 live births (UN, 2024, Mutabingwa et al., 2023). This burden falls heaviest on the African Region, where the maternal mortality ratio (MMR) soars to 531 deaths per 100,000 live births, accounting for a staggering 69% of global maternal deaths (Ajegbile, 2023). This crisis is further concentrated in Sub-Saharan Africa, which bears nearly two-thirds of global maternal mortalities and a devastating lifetime risk of maternal death of 1 in 26 (Mutabingwa et al., 2023, Musarandega, et al., 2021).

The leading causes of these tragic losses are preventable complications related to pregnancy and childbirth. Severe hemorrhage, infections, hypertensive disorders, obstructed labor, and indirect causes like malaria and anemia account for most maternal deaths (Vidler et.al., 2023). These grim statistics underscore the urgent need for effective interventions to achieve the Sustainable Development Goal (SDG) target of reducing the global MMR to less than 70 per 100,000 live births by 2030.

There are significant disparities in the availability of maternal health care services across the African region. These disparities have been well captured in (Mutabingwa et al., 2023). For example, the study highlighted that from 2015 to 2019, only 36% of emergency obstetric services were available in the African region. However, countries like Benin (96%) and Zambia (95%) showed high availability, while others like Burkina Faso (3%) and South Sudan (36%) had very low availability. Between 2015 and 2018, countries like Chad (92%) and Benin (90%) had high availability of basic obstetric care services. In contrast, countries such as Seychelles (16%) and Eswatini (17%) reported very low availability. In the same period, the availability of essential medicines for maternal health was high (73%) in Kenya and Seychelles (63%) compared to other countries (Mutabingwa et al., 2023).

Extensive research underscores the urgent need for targeted interventions to achieve the Sustainable Development Goal (SDG) of reducing maternal mortality by 2030. Various studies have proposed interventions focused on bolstering healthcare infrastructure, expanding access to services, and implementing targeted policies to guarantee comprehensive maternal care throughout pregnancy and childbirth, ultimately aiming to mitigate maternal and neonatal mortality within the African Region.

Effective maternity care interventions encompass a range of strategies aimed at optimizing maternal and newborn health outcomes across pregnancy, childbirth, and postpartum periods. These interventions include continuous health monitoring for both mother and baby, comprehensive health education, and skilled assistance during childbirth. Key components include Respectful Maternity Care (RMC), Emergency Obstetric and Newborn Care (EmONC), Essential Newborn Care (ENC), Focused Antenatal Care (FANC), and Malaria in Pregnancy (MIP) interventions (Namusonge, Wanzala, & Wamukoya, 2022).

To ensure impactful and high-quality maternity care, several factors warrant consideration. These include adherence to evidence-based practices for routine care and complication management, comprehensive training of healthcare providers, robust monitoring and evaluation systems, effective communication strategies, emotional support for mothers, respect for patient dignity, a competent and motivated healthcare workforce, and the availability of essential physical resources.

The timely provision of care is paramount in preventing maternal and newborn mortality and morbidity. Conditions such as postpartum hemorrhage (PPH), antepartum hemorrhage, eclampsia, obstructed labor, and sepsis necessitate prompt emergency care within critical time windows to avert adverse outcomes. Given the high prevalence of perinatal deaths during labor, delivery, and the immediate postpartum period, research on maternal and neonatal care has been recognized as a global health priority, particularly in low-income countries undergoing economic transitions (WHO, 2016).

In response to these challenges, innovative solutions are urgently needed to enhance maternal healthcare and reduce mortality rates. While improvements in healthcare infrastructure, access to services, and targeted policies are essential, technology, particularly artificial intelligence (AI), has emerged as a promising avenue for reducing maternal and newborn mortality. The integration of AI technologies in maternal and newborn healthcare holds significant potential, especially in low- and middle-income countries (LMICs), to address these critical issues.

AI offers novel approaches to tackle persistent challenges in maternal health, including early diagnosis, improved risk assessment, and personalized care delivery. Its potential to revolutionize maternal healthcare has been widely acknowledged, with numerous studies demonstrating its capacity to improve various aspects of maternal and newborn care, ultimately contributing to a reduction in mortality rates.

Despite the growing body of research on AI in healthcare, there is a notable lack of studies focusing on maternal health in developing regions, where maternal mortality rates remain disproportionately high (Khan et al., 2022). Driven by the urgent need to address the persistent challenge of maternal mortality in low- and middle-income countries (LMICs), this study investigates the transformative potential of AI in revolutionizing maternal healthcare. The research aims to comprehensively evaluate the impact of AI on maternal mortality rates and assess the effectiveness of AI-driven tools and interventions in LMICs with a particular focus on Kenya. To achieve this overarching goal, the study pursues the following specific objectives:

i. **Identify and evaluate** existing AI-driven tools and interventions currently utilized in maternal healthcare, both globally and within Kenya. This includes a detailed examination of their functionalities, applications, and reported effectiveness in improving maternal health outcomes.

ii. **Analyze the impact** of AI on maternal mortality rates by comparing pre- and post-implementation periods in regions with and without AI-enabled interventions. This analysis will utilize robust statistical methods to assess the effectiveness of AI in reducing maternal mortality and improving key health indicators.

iii. **Explore the future potential** of AI in maternal healthcare, examine emerging technologies and their potential to further enhance the quality and accessibility of maternal care. This exploration will involve analyzing current trends, forecasting future developments, and identifying potential challenges and opportunities.

iv. **Evaluate the policy implications** of AI in maternal health, including a critical review of existing national and international policies governing AI applications in this domain. This evaluation will identify potential gaps and challenges in current policies and provide recommendations for policymakers and stakeholders to ensure responsible and ethical AI integration in maternal healthcare.

By addressing these objectives, this study aims to provide a comprehensive understanding of the current and potential role of AI in reducing maternal mortality, contributing valuable evidence to inform policy and practice in LMICs and accelerating progress toward achieving the Sustainable Development Goals (SDGs).

2. Literature Review

The past two decades have witnessed a remarkable surge in the application of AI in healthcare, fundamentally transforming the diagnostic, treatment, and management paradigms for various health conditions. Early AI systems, primarily focused on expert systems and decision support tools for disease diagnosis, have evolved into sophisticated applications encompassing predictive analytics, personalized medicine, and even robotic surgery. These advancements have yielded substantial benefits, including improved patient outcomes, enhanced efficiency in healthcare delivery, and the provision of more personalized and precise care. This section explores the key AI technologies driving this transformation in maternal and infant healthcare, providing a critical overview of their applications and limitations and a general overview of challenges in implementation of these technologies.

2.1. The Evolving Landscape of AI in Maternal Healthcare: A Technological Overview

Several key AI technologies for promoting the accessibility and effectiveness of healthcare services for mothers and newborns have been proposed and applied in several studies. The AI technologies themselves have been very progressive in nature. There has been very rapid advancement in AI with outstanding key milestones that have occurred in the history of AI. Some of these technologies associated with key AI milestones include Machine Learning (ML), Deep Learning (DL)/Artificial Neural Networks (ANN) and Generative AI. Besides the typical AI technologies, there are other technologies that have been integrated with AI to provide effective services. The most highlighted technologies in this category include the Internet of Things (IoT), Mobile Computing and Cloud Computing, Fog, and Edge Computing. This section gives an overview of AI technologies in line with its progressive milestones and their potential applications in the field of maternal and neonatal health.

2.1.1. Machine Learning (ML)

Machine learning, a cornerstone of AI, has garnered significant attention for its potential to revolutionize maternal healthcare. ML systems extract knowledge from data by identifying previously unknown patterns, effectively learning from experience without explicit programming (IBM, 2024). Diverse ML techniques and algorithms are employed to analyze extensive datasets, generating predictions about maternal and neonatal health outcomes (Ahmad et al., 2022; Khan et al., 2022; Yaseen & Rather, 2024). These techniques empower the development of adaptive models that refine their predictive accuracy and effectiveness over time (Ahmad et al., 2022).

A significant portion of ML applications in maternal health focus on predictive analytics, with a particular emphasis on predicting pregnancy risks and complications, notably preterm birth. ML algorithms are also utilized to analyze diverse data sources, including hormone levels, physical symptoms, and physiological indicators, providing a comprehensive view of maternal health (Yaseen & Rather, 2024).

2.1.2. Artificial Neural Networks (ANNs) / Deep Learning & Computer Vision

Artificial Neural Networks (ANNs), inspired by the human brain, are capable of learning and adapting to complex patterns in data, enabling computers to make intelligent decisions with minimal human intervention (Soori, Arezoo & Dastres, 2023; Zador, 2019). ANNs form the foundation of deep learning algorithms, which have emerged as powerful tools for image recognition and computer vision, revolutionizing medical imaging analysis.

In maternal healthcare, ANNs can identify intricate patterns in feto-maternal medical data, aiding in risk assessment and intervention planning (Yaseen & Rather, 2024). Computer vision, coupled with ANNs, facilitates the analysis of medical images, enabling early detection of feto-maternal complications and enhancing diagnostic capabilities.

2.1.3. Natural Language Processing (NLP) and Generative AI

Natural Language Processing (NLP) empowers computers to understand, interpret, and manipulate human language, bridging the gap between human communication and machine understanding (Kumar et al., 2024). NLP plays a crucial role in various applications, including speech recognition, text classification, and sentiment analysis.

In maternal health, NLP is employed to analyze medical texts and patient records, aiding in diagnosis and treatment decisions (Yaseen & Rather, 2024). Furthermore, NLP research has paved the way for generative AI, a rapidly evolving field with the potential to transform maternal healthcare delivery.

Generative AI focuses on creating models capable of generating new content, including text, images, and even code. In maternal health, generative AI holds promise for automating administrative tasks, enhancing medical imaging analysis, and enabling personalized medicine. For instance, generative AI can enhance the quality of medical images, generate synthetic medical data for training ML algorithms, and assist in creating personalized treatment plans.

2.1.4. Integration of IoT, Cloud Computing, and AI

The convergence of the Internet of Things (IoT), cloud computing, and AI are creating intelligent and autonomous systems with profound implications for maternal healthcare. IoT devices, such as wearable sensors and pregnancy monitors, enable continuous data collection and transmission, facilitating real-time monitoring and timely interventions (Ahmad et al., 2022; Khan et al., 2022).

Cloud, fog, and edge computing platforms provide the infrastructure for managing and analyzing the vast amounts of data generated by these devices, enabling real-time health monitoring and alert generation (Ahmad et al., 2022). This integration empowers the creation of smart devices and telemedicine platforms, improving access to care, especially in rural or underserved areas.

2.2. AI-Driven Applications in Maternal Healthcare: A Critical Review

The integration of AI into maternal healthcare has garnered significant attention, driven by its potential to revolutionize care delivery and improve outcomes, particularly in reducing maternal mortality rates. A burgeoning body of research highlights the diverse applications of AI-driven tools in enhancing various aspects of maternal health services, spanning from diagnostic support and predictive analytics to personalized interventions and remote monitoring (Islam et al., 2022). This section provides a critical overview of these applications, examining their strengths, limitations, and the research gaps that warrant further investigation.

2.2.1. Predictive Analytics

Predictive analytics, fueled by machine learning (ML) techniques, has emerged as a powerful tool in maternal health, enabling personalized, targeted, and timely interventions (Khan et al., 2022; Ahmad et al., 2022). By analyzing vast datasets, AI algorithms can predict pregnancy risks and complications, notably preterm birth, empowering healthcare providers to make informed decisions and take proactive measures (Islam et al., 2022). This predictive capability has been applied to various aspects of maternal health, including predicting individual probabilities of pregnancy after specific procedures, such as laparoscopic tubal anastomosis (Ding et al., 2023).

While the potential of predictive analytics is undeniable, its reliance on large, high-quality datasets can be a limiting factor, especially in LMICs where data collection and standardization may be inadequate. Furthermore, the interpretability of these models and their ability to account for complex socio-economic and cultural factors that influence maternal health outcomes require further investigation.

2.2.2. Personalized Maternal Care Support

AI is increasingly being used to support personalized maternal care, recognizing that each woman's pregnancy journey is unique. ML-based recommender systems can provide tailored advice and recommendations, ensuring that interventions are aligned with individual needs and health states throughout the pregnancy (Yaseen & Rather, 2024). This personalized approach has the potential to optimize care delivery and improve maternal and neonatal outcomes.

While AI-driven personalized care offers promising benefits, ethical considerations surrounding data privacy and the potential for algorithmic bias need careful attention. Furthermore, ensuring

that these systems are culturally sensitive and accessible to diverse populations is crucial for equitable implementation.

2.2.3. Decision-Support Systems

AI-driven decision support systems are transforming maternal healthcare by assisting healthcare providers in making informed clinical decisions. These systems analyze vast amounts of patient data in real-time, providing evidence-based recommendations that can improve the quality of care and reduce the risk of complications during pregnancy and childbirth. Studies have demonstrated the positive impact of AI-driven decision support on maternal health outcomes, highlighting its potential to enhance the efficiency and effectiveness of care delivery.

The successful integration of decision-support systems in maternal health relies on seamless interoperability with existing electronic health record systems and the ability to provide clear, actionable recommendations that are readily interpretable by healthcare providers. Addressing potential biases in algorithms and ensuring that these systems augment, rather than replace, human clinical judgment are critical considerations.

2.2.4. Diagnostic Support

AI algorithms can analyze complex biological data from wearable sensors and other monitoring devices, enhancing the accuracy of diagnoses and providing insights into health trends over time (Ahmad et al., 2022). This capability empowers healthcare providers to make informed decisions regarding diagnosis, treatment plans, and interventions, leading to improved outcomes for both mothers and babies. AI is also being applied in medical imaging, with computer vision and generative AI technologies showing promise in speeding up the diagnostic process, improving accuracy, and enabling earlier detection of complications.

The effectiveness of AI in diagnostic support relies heavily on the quality and availability of data, particularly in LMICs where access to advanced imaging technologies and reliable data infrastructure may be limited. Furthermore, ensuring that AI-driven diagnostic tools are appropriately validated and integrated into clinical workflows is crucial for their successful adoption.

2.2.5. Remote Monitoring and Telemedicine Support

The integration of AI and IoT is transforming maternal healthcare by enabling remote monitoring of health parameters in real-time. AI-powered devices and applications can track vital signs, fetal movements, and other critical indicators, providing continuous care and support to expectant mothers, even in remote or underserved areas (Khan et al., 2022). These platforms not only improve care access but also facilitate early detection of complications, leading to timely medical interventions and improved health outcomes.

While remote monitoring and telemedicine offer significant potential, addressing challenges related to infrastructure limitations, digital literacy, and data security is essential for equitable and effective implementation, especially in LMICs.

2.2.6. Health Education and Support

AI-powered virtual assistants and chatbots are being explored as tools for providing health education and support to expectant mothers. These virtual assistants can deliver personalized medication reminders, adherence alerts, and educational content, improving patient engagement and promoting healthy behaviors. Their integration with electronic health record systems can also streamline administrative tasks and improve communication between patients and healthcare providers.

The effectiveness of AI-driven health education and support relies on ensuring that the information provided is accurate, culturally appropriate, and tailored to individual needs. Furthermore, addressing potential language barriers and digital literacy gaps is crucial for reaching diverse populations.

2.2.7. Operational and Administrative Support

AI offers significant potential for enhancing operational efficiency in maternal healthcare by automating routine tasks, optimizing resource allocation, and providing personalized care plans (Ahmad et al., 2022). This can free up valuable time for healthcare providers, allowing them to focus on direct patient care and improve the overall quality of service delivery. Generative AI is further streamlining healthcare operations by automating tasks such as appointment scheduling, documentation, and billing.

Even though AI can optimize healthcare operations, it is essential to ensure that these technologies are implemented in a way that complements, rather than replaces, human interaction and decision-making. Maintaining a patient-centered approach and addressing potential job displacement concerns are crucial considerations.

2.2.8. General Challenges in Implementation of AI-driven solutions

Despite the promising advancements in AI-driven applications and their immense potential for revolutionizing maternal healthcare, several overarching challenges and research gaps warrant attention. Some of these challenges include:

Data Dependency: ML, ANNs, and deep learning models heavily rely on large, high-quality datasets for training and validation. This presents a significant challenge in LMICs, where data collection and standardization may be limited. Future research should prioritize strategies for addressing data-related challenges, including data sharing initiatives, data augmentation techniques, and the development of data-efficient AI models.

Interpretability and Explainability: The "black box" nature of some ML and deep learning algorithms raises concerns about transparency, interpretability and explainability. Understanding

how these models arrive at their predictions is crucial for building trust and ensuring accountability in clinical decision-making. Research efforts should focus on developing more transparent AI models and providing clear explanations of their decision-making processes to healthcare providers and patients. This can foster trust and facilitate responsible AI adoption.

Ethical Considerations: The use of AI in maternal healthcare raises ethical concerns, including the potential for bias in algorithms, data privacy breaches, and the impact on the patient-provider relationship. It is essential to establish ethical guidelines and frameworks for responsible AI development and implementation, ensuring that these technologies are used equitably and do not exacerbate existing health disparities.

Access and Equity: Ensuring equitable access to AI-powered maternal healthcare is crucial, particularly in LMICs where disparities in healthcare access are prevalent. Addressing infrastructure limitations, digital divides, and affordability barriers will be essential to ensure that all women, regardless of their socioeconomic status or geographical location, can benefit from AI-driven advancements in maternal care.

Data Quality and Availability: The effectiveness of AI in maternal health relies heavily on the availability of large, diverse, and high-quality datasets. Addressing data scarcity, particularly in LMICs, through data sharing initiatives, data augmentation techniques, and the development of data-efficient AI models is crucial.

2.3. Review of the Policy Implications of AI in Maternal Health

The integration of artificial intelligence (AI) into healthcare holds immense promise for revolutionizing medical practice, particularly in the field of maternal health, where AI-powered tools have the potential to significantly impact the quality of care and pregnancy outcomes.

Despite AI's potential to improve various aspects of healthcare but faces challenges related to data privacy, ethics, integration, accessibility, and human-AI interaction (Udegbe et al., 2024). In addition to these challenges, integrating AI in maternal health raises important policy considerations that need to be addressed. Policymakers, healthcare providers, AI developers, and other stakeholders must collaborate to establish clear guidelines and regulations that protect patient privacy, promote equitable access to AI-powered maternal healthcare, and address potential biases and risks associated with AI algorithms. Some of the areas where policy issues need to be addressed include:

2.3.1. Data Privacy and Security

The collection, storage, and use of sensitive maternal health data raise critical privacy and security concerns. AI systems often rely on large datasets containing personal and medical information, making it crucial to establish robust data governance frameworks and implement strong data protection measures. Policies should address data ownership, consent for data use, and data sharing practices, ensuring compliance with relevant data protection laws and regulations. Additionally, addressing potential biases in data and algorithms is essential to prevent discrimination and ensure

equitable access to AI-powered maternal healthcare. While some studies have explored patient perceptions of data sharing and AI in healthcare (Aggarwal et al., 2021), further research is needed to understand the specific privacy concerns of pregnant women and how to address them effectively.

2.3.2. Regulation and Governance

The safety, effectiveness, and ethical use of AI in maternal health require clear regulations and guidelines. Policymakers must establish regulatory frameworks that govern the development, validation, and deployment of AI-powered tools and technologies. These frameworks should address issues such as informed consent, transparency in AI decision-making, and accountability for AI-related harms. Additionally, ethical guidelines should be developed to ensure that AI systems are designed and used in a manner that respects patient autonomy, promotes human well-being, and avoids harm. While some studies have proposed ethical guidelines for AI in healthcare (Mittelstadt et al., 2016), further research is needed to translate these principles into concrete policy recommendations for maternal health. Moreover, the rapid evolution of AI technology necessitates the development of flexible and adaptive regulatory frameworks that can keep pace with the changing landscape of AI in maternal health.

2.3.3. Access and Equity

AI has the potential to improve access to quality maternal healthcare, particularly for underserved populations. However, policies must be implemented to ensure that AI-powered solutions are affordable, accessible, and culturally sensitive. Addressing potential biases in AI algorithms is crucial to prevent discrimination and ensure that AI systems do not exacerbate existing health disparities. Additionally, policies should promote the development and implementation of AI solutions that address the specific needs of underserved populations, such as those in remote or low-resource settings. While some studies have explored the potential of AI to improve healthcare access in underserved areas (Sun & Medaglia, 2019), further research is needed to understand how to ensure equitable access to AI-powered maternal health solutions for all populations.

2.3.4. Liability and Accountability

The use of AI in maternal healthcare raises questions about liability and accountability. Clear frameworks are needed to determine who is responsible for harms caused by AI systems, whether it is the AI developer, the healthcare provider, or the institution implementing the technology. Policies should address the challenges of attributing responsibility for AI-driven decisions and establish mechanisms for redress and accountability. While some studies have discussed the potential liability for physicians using AI (Price & Gerke, 2019), further research is needed to develop comprehensive liability frameworks for AI in maternal health that consider the roles of all stakeholders.

2.3.5. Workforce Development

The integration of AI in maternal health may impact the healthcare workforce, requiring training and education to prepare healthcare professionals for the use of AI-powered tools and technologies. Policies should support the reskilling and upskilling of the workforce, addressing potential displacement or deskilling, and promoting interdisciplinary collaboration. While some studies have highlighted the need for workforce training in AI (Gama et al., 2022), further research is needed to develop specific training programs and curricula for maternal healthcare professionals.

2.3.6. Innovation and Reimbursement

Policies that incentivize the development and adoption of beneficial AI technologies in maternal health are essential for sustainable implementation. This includes reimbursement frameworks, funding for research, and policies that promote innovation and the development of AI-powered solutions. While some studies have proposed reimbursement frameworks for AI in healthcare (Abramoff et al., 2022), further research is needed to evaluate the cost-effectiveness of AI-powered maternal health solutions and develop sustainable reimbursement models.

2.4. Existing AI-driven tools for maternal healthcare in Kenya

While the global landscape of AI in maternal health is rapidly evolving, the context of LMICs, particularly in Sub-Saharan Africa, presents unique challenges and opportunities. The integration of artificial intelligence (AI) into maternal healthcare offers a promising avenue for reducing maternal mortality rates, particularly in low- and middle-income countries (LMICs) where the burden remains disproportionately high. AI-driven technologies hold the potential to transform maternal care through early diagnosis, personalized interventions, and improved clinical decision-making. Kenya, with its high maternal mortality rate and ongoing efforts to strengthen its healthcare system, provides a compelling case study for examining the impact of AI in maternal health. This section focuses on two notable AI-driven tools being largely implemented in Kenya, namely PROMPTS and POCUS.

2.4.1. PROMPTS (Promoting Mothers through Pregnancy and Postpartum) in Maternal Healthcare

PROMPTS is an AI-enabled digital health platform specifically designed to address delays in care-seeking behavior among pregnant women, a significant contributor to maternal mortality in Kenya (Ochieng' et al., 2024; Ronen et al., 2021). It operates through a two-way SMS system, delivering personalized messages to mothers based on their stage of pregnancy. These messages encourage essential behaviors such as attending prenatal check-ups, recognizing danger signs, and seeking timely care for potential complications.

According to Pennsylvania State University (2023), the platform also features an AI-powered helpdesk that triages mothers' questions and concerns Pennsylvania State University. When potential risks are identified, the system triggers rapid referrals to appropriate health facilities, ensuring timely medical interventions. With over 2.4 million mothers enrolled, PROMPTS has demonstrated a measurable impact on maternal health outcomes, including a 20% increase in

prenatal care visits and a twofold rise in postpartum family planning uptake. Notably, 90% of high-risk mothers identified by the system have received necessary hospital care (Jacaranda Health, 2024). The platform generally offers personalized maternal care support, remote monitoring and telemedicine support, and health education and behavioral support.

Designed for sustainability and scalability, PROMPTS is free for mothers and integrates seamlessly within government health systems at a low unit cost. This makes it a viable and potentially transformative solution for improving maternal health outcomes in Kenya and other LMICs.

2.4.2. Point of Care Ultrasound (POCUS)

POCUS (Point of Care Ultrasound) has emerged as a transformative technology in healthcare, particularly in maternal health, due to its portability, ease of use, and ability to provide immediate, real-time diagnostics at the bedside. This technology is especially valuable in settings with limited access to advanced imaging systems, offering practical solutions for managing pregnancy-related complications. POCUS empowers healthcare professionals, including midwives and frontline workers, to make accurate and timely decisions, which is particularly critical in low-resource settings where delays in diagnosis can be life-threatening.

Studies have highlighted the potential of POCUS to significantly improve maternal and neonatal outcomes by enabling early detection of complications such as placental abnormalities, fetal distress, and preeclampsia. For example, POCUS allows for the quick assessment of fetal well-being and amniotic fluid levels, critical factors in determining whether urgent medical interventions are needed (Shrestha et al., 2022). In regions with limited access to trained sonographers or advanced diagnostic tools, POCUS serves as an invaluable resource for delivering quality prenatal care.

In Kenya, trials have shown promising results, enabling healthcare workers in underserved areas to make informed decisions quickly, thus reducing reliance on expert technicians and providing immediate care to mothers. This AI-powered tool not only improves maternal outcomes by expanding access to quality prenatal diagnostics in rural and low-resource settings but also automates image interpretation, reducing the need for specialist involvement. By automating complex tasks like image interpretation, the system empowers midwives and other healthcare workers to confidently perform scans, identify risks early, and initiate timely interventions (Kornelsen et al., 2023). The real-time feedback provided by POCUS can help in identifying complications such as ectopic pregnancies, hemorrhages, or uterine ruptures, which are common contributors to maternal mortality in low-resource areas (Kornelsen et al., 2023).

POCUS also addresses the global shortage of trained sonographers, a significant barrier to maternal healthcare access in many parts of the world. By providing a tool that can be used by non-expert clinicians, it helps bridge the gap in diagnostic capacity, particularly in rural or underserved regions (Shaddock, & Smith, 2022). This democratization of diagnostic imaging plays a crucial role in reducing preventable maternal deaths, as it increases access to essential care and enables early diagnosis of life-threatening conditions.

In addition to improving diagnostic capacity, POCUS also contributes to enhanced training and skill development among healthcare providers. Studies indicate that with short, targeted training sessions, non-radiologists and mid-level providers can effectively use POCUS for obstetric assessments, further expanding the reach of this technology in low-resource settings (Nikhila, et al., 2023). This adaptability makes POCUS a scalable solution for improving maternal health outcomes in various contexts, contributing to broader global health goals such as reducing maternal mortality and morbidity.

By integrating POCUS into maternal healthcare strategies, particularly in low-income countries like Kenya, healthcare systems can achieve significant strides in reducing maternal mortality rates. Its ability to provide immediate, actionable insights ensures that critical complications are addressed promptly, thus supporting the global effort to improve maternal health outcomes.

3. Methodology

This study employed a mixed-methods approach, combining both qualitative and quantitative methods to thoroughly assess the role of Artificial Intelligence (AI) in maternal healthcare. The combination of qualitative and quantitative data offered a comprehensive understanding of AI's role, covering practical implementation as well as policy considerations. This methodology enabled an in-depth exploration of four key objectives mentioned in the introduction section of this report. This section outlines the methodology used for each objective.

3.1. Objective 1: Identifying and evaluating AI-driven tools and interventions currently utilized in maternal healthcare

To comprehensively identify and evaluate the AI-driven tools and interventions currently used in maternal healthcare, both in Kenya and globally, this study employed a descriptive and exploratory research design characterized by a robust mixed-methods approach.

For AI-driven maternal healthcare in Kenya, this study focused on two widely used solutions:

PROMPTS (Promoting Mothers through Pregnancy and Postpartum): This AI-powered SMS platform delivers personalized health information and support to expectant mothers, encouraging timely care-seeking behavior and facilitating early detection of complications.

POCUS (Point-of-Care Ultrasound): AI-enabled portable ultrasound devices empower healthcare workers in underserved areas to perform critical obstetric ultrasounds with minimal training, expanding access to essential diagnostic services.

Data Collection

A multi-faceted data collection strategy was implemented, incorporating both secondary and primary sources to ensure a holistic understanding of the AI tools and interventions utilized in maternal healthcare.

Secondary Data Collection: A comprehensive desk review was conducted, encompassing a thorough analysis of academic literature, policy documents, and case studies from local and

international settings. Reports from reputable international organizations, such as the World Health Organization (WHO) and the United Nations Population Fund (UNFPA), were meticulously examined to identify AI tools and interventions successfully implemented in maternal healthcare. Additionally, technical documentation and clinical trial results related to AI tools, including AI-powered ultrasound, predictive analytics, and decision support systems, were reviewed to assess their efficacy and potential impact.

Primary Data Collection: To gather first-hand insights, data was collected from stakeholders actively engaged in maternal healthcare and AI development through a combination of key informant interviews (KIIs), surveys, and focus group discussions (FGDs). KIIs were conducted with healthcare professionals (e.g., obstetricians, midwives), AI developers, and policymakers to gain an in-depth understanding of the specific AI tools being used, their perceived effectiveness, and the challenges encountered during implementation. Surveys were distributed to healthcare providers, including midwives and nurses, to assess their experiences with AI interventions, focusing on the types of AI tools used and their perceived impact on maternal health outcomes. FGDs were conducted with healthcare workers to foster interactive discussions on the role of AI in improving maternal outcomes and the challenges faced in integrating AI tools into clinical workflows.

Observational Data Collection: Site visits to healthcare facilities were conducted to directly observe the utilization of AI tools, such as AI-powered ultrasound devices, in real-world clinical settings. Observations focused on how AI was integrated into clinical workflows and its perceived impact on maternal healthcare outcomes, providing valuable contextual information to complement the data gathered through interviews and surveys.

This multi-pronged data collection approach ensured a comprehensive and in-depth understanding of the current landscape of AI-driven tools and interventions in maternal healthcare, enabling a robust evaluation of their potential to improve maternal health outcomes.

3.2. Objective 2: Analyzing the impact of AI on maternal mortality rates

To achieve the objective of analyzing the impact of AI on maternal mortality rates, this study employed a comprehensive mixed-methods approach, integrating quantitative and qualitative data from various sources.

Patient Records: Detailed information was extracted from patient records, including the number of prior pregnancies, delivery history (spontaneous vaginal deliveries and cesarean sections), maternal education level, occupation, last menstrual period (LMP), and expected date of delivery (EDD). Post-delivery conditions of both mother and baby, any abnormalities, and the date of demise in cases of mortality were also recorded. The actual date of delivery was used to calculate the actual gestational age at delivery and compare it with the EDD estimated by both POCUS and traditional methods. A sample size of 530 was used for this data collection.

Kenya Health Information System (KHIS): Annual summaries of key maternal and neonatal health indicators were extracted from the KHIS from 2020 2024. However, data from 2022 was

excluded due to inconsistencies in the implementation of POCUS across various healthcare facilities. Different facilities adopted POCUS at different points during 2022, which would have made the data from that year unreliable for direct comparison. These indicators included delivery outcomes (normal deliveries, Cesarean sections, breech deliveries, assisted vaginal deliveries, manual removal of the placenta), neonatal outcomes (live births, low birth weight, low Apgar scores, birth deformities, preterm births, babies discharged alive, fresh stillbirths), and maternal outcomes (maternal deaths stratified by age group, antepartum hemorrhage, postpartum hemorrhage, eclampsia, ruptured uterus, obstructed labor, sepsis). Data was collected from nine counties in Kenya, four implementing POCUS and five without POCUS, representing a mix of urban and rural settings.

POCUS Experience Survey: An online survey, administered by community health workers, collected data from 1201 mothers who had attended maternal health services in the past five years, including those who had used POCUS during pregnancy. The survey covered sociodemographic information, access to healthcare, POCUS experience (or experience with standard ultrasound if POCUS was not used), awareness and perception of POCUS, health-seeking behavior, and client sentiments.

PROMPTS Messaging Platform Survey: Another online survey focused on gathering data from 800 mothers who had used the PROMPTS messaging platform for expectant mothers, which provides automated health information and support. The survey covered sociodemographic information, information sources, message types received, client satisfaction, and outcomes for the client (e.g., number of clinic visits, hemoglobin level, maternal weight and height, time between onset of complications and hospital visit, severity of complications, referral to care, knowledge of pregnancy danger signs).

Study Setting

The study included hospitals implementing and not implementing AI-enabled ultrasound (POCUS) in rural, urban, and peri-urban settings across nine counties in Kenya. This diversity allowed for a comprehensive assessment of AI's impact on maternal health outcomes across different contexts.

In this study, data collection involved multiple approaches. Trained research assistants meticulously extracted information from patient records using standardized forms. Simultaneously, data was electronically retrieved from the Kenya Health Information System (KHIS) database. Furthermore, community health workers, equipped with comprehensive training on survey administration and ethical considerations, administered online surveys to participants. These surveys ensured informed consent and confidentiality maintenance. The study encompassed hospitals with and without AI-enabled ultrasound (POCUS) implementation across nine counties in Kenya, covering rural, urban, and peri-urban settings. This diverse representation allowed for a comprehensive assessment of AI's impact on maternal health outcomes across different contexts. In addition, community health workers facilitated the data collection process for the PROMPTS messaging platform survey, ensuring ethical considerations and informed consent procedures were followed.

3.3. Objective 3: Exploring the future potential of AI in maternal healthcare

To explore the future potential of AI in enhancing maternal healthcare outcomes, this study used a mixed-methods approach, combining insights from existing literature and expert opinions.

Literature Review: A thorough review of existing literature, including academic papers, white papers, and policy frameworks, was conducted to identify emerging AI technologies and their potential applications in maternal health. This involved analyzing case studies of successful AI implementation in various healthcare settings to understand the scalability and adaptability of these technologies.

Key Informant Interviews: Interviews were conducted with experts in AI, healthcare professionals specializing in maternal care, and policymakers to gather diverse perspectives on the potential of AI to transform maternal healthcare.

Surveys: Surveys targeted healthcare providers and AI developers, assessing their views on how AI could enhance personalized care, improve predictive analytics for risk assessment, and enable remote patient monitoring for better access to healthcare.

Focus Group Discussions (FGDs): FGDs were held with healthcare workers to delve deeper into their understanding of AI's potential benefits and challenges in maternal healthcare.

Site Visits: Visits to healthcare facilities actively using AI tools provided real-world insights into how these technologies function and their potential to evolve to meet future demands in maternal healthcare.

3.4. Objective 4: Evaluating the policy implications of AI in maternal health

To rigorously evaluate the policy implications of AI in maternal health, this study adopted a comprehensive approach encompassing legal, ethical, and practical considerations.

Analysis of Current Legislation and Guidelines Governing AI in Healthcare:

This section examines key legislative frameworks that govern the use of Artificial Intelligence (AI) in healthcare, focusing on how these regulations impact the protection of personal and sensitive health data. The analysis draws on three primary legal frameworks: the Kenya Data Protection Act (2019), the General Data Protection Regulation (GDPR), and the Health Insurance Portability and Accountability Act (HIPAA). The goal of this analysis is to understand the implications of these frameworks for AI systems in healthcare, particularly in areas such as data privacy, security, consent, and automated decision-making.

Data Privacy and Security: One of the primary areas of focus for AI in healthcare is the protection of sensitive patient information. The analysis assessed how each framework mandates the handling of personal data in AI systems, particularly with respect to data privacy and security protocols. Key requirements include data encryption, access controls, and mechanisms to prevent unauthorized access to sensitive health information. The GDPR and Kenya Data Protection Act

both emphasize robust data protection measures, while HIPAA sets stringent standards for the privacy and security of health information in the U.S. context.

Consent and Data Subject Rights: The frameworks were also evaluated based on their provisions for informed consent and the rights of individuals to control their personal data. This is particularly relevant in AI-driven healthcare systems, where patients' data is used for diagnostic or treatment purposes. Both the GDPR and the Kenya Data Protection Act require explicit consent before personal health data is processed by AI systems, and they provide individuals with the right to access, correct, or delete their data. HIPAA complements these protections by emphasizing the importance of patient privacy and the need for healthcare providers to obtain consent before sharing or using patient information in AI applications.

Sensitive Data Protection: Given the sensitive nature of health-related data, the analysis highlighted how each framework defines and protects sensitive personal data. The Kenya Data Protection Act and GDPR both classify health data as sensitive and impose additional safeguards on its collection and processing. In the context of AI in healthcare, this means that developers and healthcare providers must adhere to strict rules when handling medical records, diagnostic data, and other forms of sensitive information. HIPAA also provides strong protection for sensitive health information, particularly in the storage and sharing of electronic health records, which are often processed by AI systems.

Automated Decision-Making and AI Transparency: Another critical aspect of the analysis was the evaluation of rules regarding automated decision-making and the transparency of AI systems. Both the GDPR and Kenya Data Protection Act address the role of AI in making decisions about individuals, particularly in healthcare, where AI may be used to make diagnostic or treatment recommendations. The GDPR requires that individuals are informed when AI is used to make automated decisions, and it provides them with the right to challenge or appeal to such decisions. This transparency is crucial in ensuring that AI systems in healthcare operate ethically and that patients are fully aware of how their data is being used.

Cross-Border Data Transfers: The frameworks were also analyzed for their regulations on cross-border data transfers, an important consideration for AI systems that often involve cloud-based processing or storage in different countries. The GDPR places stringent restrictions on transferring personal data outside the European Union, ensuring that such transfers only occur to countries with adequate data protection standards. Similarly, the Kenya Data Protection Act restricts the transfer of personal data outside Kenya unless specific safeguards are in place. HIPAA, while primarily focused on U.S. healthcare systems, also mandates strong controls on how patient data is shared, particularly in cross-border scenarios.

Accountability and Governance: Finally, the analysis examined how each framework ensures accountability and governance in AI applications. Both the GDPR and Kenya Data Protection Act require organizations to conduct data protection impact assessments (DPIAs), particularly when deploying AI systems that involve sensitive health data. These frameworks also emphasize the need for clear governance structures that hold developers, healthcare providers, and institutions accountable for ensuring compliance with data protection regulations. HIPAA mandates rigorous

documentation and auditing processes to ensure that healthcare providers and AI developers comply with its privacy and security rules.

Comparative Analysis: A comparative analysis of the Kenya Data Protection Act (2019), GDPR, and HIPAA reveals significant similarities and differences in their approach to governing AI in healthcare. Both the Kenya Data Protection Act and GDPR align closely in their emphasis on data privacy, informed consent, and sensitive data protection, with both frameworks requiring explicit consent and imposing strict safeguards on health-related data. HIPAA, while more focused on the U.S. healthcare context, similarly emphasizes the protection of patient privacy and the secure handling of health information, with particular attention to electronic health records processed by AI.

3.5. Ethical Considerations

To enhance the ethical considerations section, the following aspects were considered:

Informed Consent: Informed consent was obtained from all participants before their enrolment in the study. This ensured that participants understood the study's purpose, procedures, potential benefits and risks, and their right to withdraw at any time without consequences.

Ethical Clearance: Ethical clearance for this study was obtained from the Ethics Review Committee of Jaramogi Oginga Odinga University of Science and Technology (JOOUST) (see Appendix B). This clearance ensured that the study design and methodology adhered to the ethical guidelines and principles for conducting research involving human subjects.

Research Permit: A research permit was obtained from the National Commission for Science, Technology, and Innovation (NACOSTI) (see Appendix C) before commencing data collection. This permit authorized the research team to conduct the study within the specified counties and healthcare facilities in Kenya.

County Authorization: In five of the nine counties where healthcare facilities were included in the study, authorization was obtained from the relevant department dealing with public health and sanitation. This ensured that the research team had permission to collect data within these facilities and that the study aligned with the counties' health data collection and research guidelines.

Data Anonymization: All collected data was anonymized by removing any personally identifiable information to protect participants' privacy. This ensured that individuals could not be identified from the data used in the study's analysis and reporting.

Data Security: Anonymized data was securely stored to prevent unauthorized access or misuse. This included using password-protected databases and encrypted storage devices to safeguard the data's confidentiality and integrity.

4. Findings/Results of the Study

This section presents the findings of this study based on the study’s objectives

4.1. AI-Driven Applications in Maternal Healthcare: A Global Perspective and the Case of Kenya

The integration of artificial intelligence (AI) into maternal healthcare is gaining momentum, driven by its potential to address persistent challenges and improve outcomes, particularly in reducing maternal mortality rates. This section examines the current landscape of AI-driven applications in maternal healthcare, drawing on evidence from various studies and highlighting the disparities in research and implementation between high-income countries (HICs) and low- and middle-income countries (LMICs).

4.1.1. Global Overview of AI Applications in Maternal Health

To understand the global distribution of AI applications in maternal health, a systematic review was conducted, analyzing 45 research papers sourced from diverse databases, including Google Scholar, ResearchGate, Semantic Scholar, Web of Science, PubMed, and Scopus. Several studies have demonstrated the potential of AI to address critical challenges in maternal health across various application areas. They have Most highlighted application areas in the study as presented in Table 1 below include

Predictive Analytics: AI algorithms are being used to predict pregnancy risks and complications, such as preterm birth (Jehan et al., 2022; Fergus et al., 2022; Debata & Mohapatra, 2022; Akbulut et al., 2022), enabling early interventions and personalized care. Furthermore, AI models are being developed to predict individual probabilities of pregnancy after procedures like laparoscopic tubal anastomosis (Ding et al., 2023), aiding in clinical decision-making and patient counseling.

Decision Support Systems: AI-powered decision support systems, such as the IBM Watson Health platform, are being implemented to enhance clinical decision-making during labor and delivery. A pilot study in Thailand reported a reduction in cesarean section rates and improved perinatal outcomes following the implementation of such a system. Other examples include the PreTRM® Test, which utilizes AI to predict preterm birth risk, and algorithms developed to detect postpartum hemorrhage early on, facilitating timely interventions.

Medical Imaging/Diagnostic support: AI systems assist in analyzing ultrasound images and fetal heart rate data to detect abnormalities with greater accuracy, improving prenatal care. For example computer ultrasound technology by use of computer vision. Generative AI technology is now being increasingly used in medical imaging.

Remote Monitoring and Telemedicine: AI-enabled remote monitoring platforms, like Babyscripts, are empowering expectant mothers to track their health metrics, receive personalized care plans, and communicate with healthcare providers remotely. A study published in the American Journal of Obstetrics & Gynecology demonstrated the effectiveness of Babyscripts in reducing preterm birth risk and improving maternal outcomes. Similarly, research from the University of Helsinki showcased the potential of AI in fetal health monitoring by analyzing electrocardiogram (ECG) signals to predict fetal distress.

Virtual Assistants and Chatbots: AI-powered chatbots, such as Ada Health, are providing personalized health information and support to pregnant women, answering their queries and offering evidence-based recommendations. User surveys have reported high levels of satisfaction and perceived usefulness of these tools in supporting maternal health.

Administrative and Communication Management: AI is being used to streamline administrative tasks, such as appointment scheduling and handling routine inquiries, freeing up healthcare staff to focus on more complex tasks.

Table 1: Some of AI-driven applications/interventions in maternal healthcare

Technology	Application Areas/use	Examples and use cases	Countries Implementing
Predictive Analytics for risk assessment (Machine Learning - recommender systems)	• promote personalized, targeted and timely and interventions • decision and diagnostic support	• predicting pregnancy risks and complications • diagnosing conditions and suggesting treatment plans Khan et al. (2022) • predicting preterm birth • analyze data from various sources such as hormone levels, physical symptoms, body temperature, and fertility tracking(Yaseen & Rather 2024) • preeclampsia prediction • predicting individual probability of pregnancy in women after receiving laparoscopic tubal anastomosis (LTA) (Ding et al. 2023)	• United States • United Kingdom • Germany • China • India • Canada • Australia • Netherlands

		• Predictive analysis for personalised of services - personalisation through ML based recommender systems which can enable tailored advice and recommendations to provide personalized guidance throughout the pregnancy period based on women's individual needs • enhances the accuracy of diagnoses and helps in understanding health trends over time(Ahmad et al. 2022).	
Integration of IoT, AI and Cloud computing (smart devices, wearable sensors and other monitoring devices)	• Remote Monitoring and Telemedicine • custom healthcare plans for personalised support • Diagnostic Support and Decision-Support	• Remote monitoring of maternal health indicators such as: Blood pressure, Heart rate, Fetal movements among others. • use of smart models that can scrutinize patient data to identify patterns and trends, enabling professionals to customize healthcare plans and follow-up care to meet individual needs • Use of smart devices to monitor health parameters in real-time allowing early detection of potential complications for timely medical intervention (Khan et al. 2022). • The smart maternal platform in reducing medical staff workload, raise overall productivity, and enhance obstetrical treatment and follow-ups	• United States • China • Germany • Japan • South Korea • India • Netherlands • United Kingdom • Canada • United Arab Emirates

Computer vision and Generative AI	• - diagnostic support through medical Imaging	• providing visual depictions of the internal structures of the human body, which are then utilized for clinical examination and medical intervention e.g ultrasound technology… by use of computer vision • Generative AI technology - in speeding up the diagnostic process and improving accuracy • POCUS	• United States • China • Germany • Japan • South Korea • India • United Kingdom • Canada • France • Singapore • Israel • Netherlands • Kenya

Natural Language Processing (NLP) and Large Language Models (LLM)	• Health Education and Support • Operation/ administrative support • Communication management	• Virtual health assistants offer patients convenient access to healthcare services through conversational interactions. • Integrated with major electronic health record systems, AI chatbots allow patients to schedule, reschedule, join waitlists, or cancel appointments without relying on human schedulers. • Virtual assistants in delivering personalized medication reminders and adherence alerts to patients. • support of medication adherence and compliance by sending timely notifications via mobile apps or smart devices, reducing the risk of treatment interruptions and adverse outcomes. • AI-powered communication systems can handle routine inquiries, appointment reminders, and follow-ups, which free healthcare staff to focus on more complex tasks • surgeons utilizing an LLM to quickly produce high-quality notes meeting clinical standards efficiency • Get AI administrate application areas include appointment scheduling, documentation and record-keeping, billing and claims processing, data entry and extraction, insurance verification, communication management, regulatory compliance checks workflow optimization, task prioritization, and patient outreach among others. • Use of NLP in analyzing text messages and flag those with language identifies as indicating a potential danger/predicting high-	• United States • China • United Kingdom • Germany • Japan • South Korea • India • Canada • France • Netherlands • Singapore • Israel • Brazil

		risk medical conditions from text messages sent by new and expecting mothers	
Virtual Health Assistants and	• Real-time health advice	• Babyscripts Maya: A virtual assistant that delivers personalized maternal health	• United States • United Kingdom

AI-Powered Chatbots	• Symptom checks • Reminders for appointments	advice based on patient data, tracks vitals like blood pressure, and flags abnormalities to healthcare providers. It provides continuous monitoring and engagement throughout pregnancy (Rodriguez et al., 2020). • AI Symptom Checkers: AI-driven tools like Ada Health use machine learning to evaluate maternal symptoms, providing guidance on when to seek medical advice or how to manage symptoms at home (Linnen et al., 2021).	• China • India • Germany • Canada • Australia • Singapore • South Korea • Japan • United Arab Emirates • Netherlands • Israel
Robotic Surgery and Remote Monitoring	• Monitoring tools improve the quality of maternal healthcare by allowing for minimally invasive procedures and real-time monitoring of vitals during pregnancy.	• Da Vinci Surgical System: AI-powered robotic systems like Da Vinci assist in performing complex surgeries, including cesarean sections, with greater precision and fewer complications (Brown et al., 2021). • Remote Monitoring Tools: AI-driven devices such as HeraBEAT monitor fetal heart rate remotely and transmit data to healthcare providers, helping reduce unnecessary hospital visits while ensuring continuous fetal health surveillance (Lévesque et al., 2022).	• United States • Germany • United Kingdom • Japan • South Korea • India • China • France • Canada • Australia • Italy • Israel • Singapore • Netherlands • South Africa • Sweden • Brazil • Spain • Mexico
Personalized Healthcare and Precision Medicine	Creates tailored maternal care plans based on individual genetic predispositions,	• Genomic Data Analysis for Pregnancy Risks: AI platforms analyze genomic data to assess the risk of genetic disorders in the fetus or pregnancy-related complications such as preeclampsia, providing precision	• United States • United Kingdom • Germany • China • Japan • South Korea • Israel

	lifestyle factors, and risk profiles	medicine for expectant mothers (Smith et al., 2021). Nurture Intelligence: This AI platform develops personalized prenatal care plans that adapt to each mother's unique pregnancy journey, optimizing both maternal and fetal care based on real-time data (Green et al., 2020).	• France • Singapore • Sweden • Netherlands • Canada • Australia • Italy • Brazil • Denmark • Finland • Norway
Telemedicine and Remote Care	• Remote management of pregnancies, especially for high-risk cases	• Analyzing patient data • Offering diagnostic insights • Generating treatment recommendations. • Obstetrix Medical Group AI-enabled Telemedicine Platform: Provides remote consultations and continuous monitoring of high-risk pregnancies. AI algorithms process the patient's medical data and suggest necessary interventions to ensure maternal and fetal safety (Bran et al., 2023).	• United States • United Kingdom • Germany • Canada • India • China • Australia • Singapore • France • Brazil • South Korea • Italy • Netherlands • Sweden • Mexico • Japan • Spain • Finland • Norway • Russia
Postpartum Care	• Monitoring and managing postpartum health issues, such as detecting postpartum depression or managing	• Woebot: An AI-based tool that uses natural language processing and machine learning to detect early signs of postpartum depression in new mothers by analyzing mood and conversational patterns (Darcy et al., 2020).	• United States • United Kingdom • Canada • Australia • Germany • Singapore • Netherlands • Sweden • Finland • India • China

	postpartum hemorrhage.		• Brazil • Japan • South Korea • Israel

While the reviewed studies demonstrate the potential of AI to address critical challenges in maternal health like enhancing patient safety, improving care outcomes, and supporting healthcare providers in managing maternal health more effectively, several limitations and research gaps warrant attention. For example, the review revealed a concentration of research activities in HICs, particularly in Europe, North America, and Asia (Islam et al., 2022). This geographical bias highlights a critical research gap in LMICs, where maternal mortality rates remain disproportionately high as shown in Table 1 below.

4.1.2. Focus on AI Applications in Kenya

While the global landscape of AI in maternal health is rapidly evolving, the context of LMICs, particularly in Sub-Saharan Africa, presents unique challenges and opportunities. The integration of artificial intelligence (AI) into maternal healthcare offers a promising avenue for reducing maternal mortality rates, particularly in LMICs where the burden remains disproportionately high. AI-driven technologies have the potential to transform maternal care through early diagnosis, personalized interventions, and improved clinical decision-making. Kenya, with its high maternal mortality rate and ongoing efforts to strengthen its healthcare system, provides a compelling case study for examining the impact of AI in maternal health. This section focuses on two notable AI-driven tools being largely implemented in Kenya namely PROMPTs and POCUS.

PROMPTS (Promoting Mothers through Pregnancy and Postpartum) in Maternal Healthcare

PROMPTS is an AI-enabled digital health platform specifically designed to address delays in care-seeking behavior among pregnant women, a significant contributor to maternal mortality in Kenya. It operates through a two-way SMS system, delivering personalized messages to mothers based on their stage of pregnancy. These messages encourage essential behaviors such as attending prenatal check-ups, recognizing danger signs, and seeking timely care for potential complications.

PROMPTS leverages AI to send tailored SMS messages to pregnant and postnatal mothers, providing timely health information and connecting them to clinical support when necessary.

The platform also features an AI-powered helpdesk that triages mothers' questions and concerns. When potential risks are identified, the system triggers rapid referrals to appropriate health facilities, ensuring timely medical interventions. With over 2.4 million mothers enrolled, PROMPTS has demonstrated a measurable impact on maternal health outcomes, including a 20% increase in prenatal care visits and a twofold rise in postpartum family planning uptake. Notably, 90% of high-risk mothers identified by the system have received necessary hospital care. The

platform generally offers personalized maternal care support, remote monitoring and telemedicine support and health education and behavioral support

Designed for sustainability and scalability, PROMPTS is free for mothers and integrates seamlessly within government health systems at a low unit cost. This makes it a viable and potentially transformative solution for improving maternal health outcomes in Kenya and other LMICs.

Point of Care Ultrasound (POCUS)

POCUS is AI-enabled portable ultrasound devices that empower healthcare workers in underserved areas to perform critical obstetric ultrasounds with minimal training, expanding access to essential diagnostic services. POCUS has emerged as a transformative technology in healthcare, particularly in maternal health. Its use enables immediate, real-time diagnostics at the bedside, offering a practical solution in settings where access to advanced imaging systems is limited. POCUS allows healthcare professionals to make more accurate, timely decisions in managing pregnancy-related complications particularly in low-resource settings.

In Kenya, trials have shown promising results, enabling healthcare workers in underserved areas to make informed decisions quickly, reducing the reliance on expert technicians. This AI-powered tool improves maternal outcomes by expanding access to quality prenatal diagnostics in rural and low-resource settings. By automating image interpretation, the system empowers midwives and other frontline workers to confidently perform scans, identify risks early, and facilitate timely interventions. This innovation addresses the global shortage of trained sonographers and supports the goal of reducing preventable maternal deaths by increasing access to essential care.

Functionality of POCUS in Maternal Healthcare

POCUS is a portable ultrasound tool used directly at the patient's bedside, providing immediate diagnostic images and data (Doll, 2019). Unlike traditional ultrasound devices, which require specialized sonographers and fixed locations, POCUS is operated by clinicians such as midwives, nurses, or obstetricians, allowing for quicker decision-making (Gottlieb et al., 2020). In maternal healthcare, POCUS is primarily used for diagnosing critical conditions such as fetal distress, placental abnormalities, amniotic fluid assessment, and fetal presentation, as well as guiding invasive procedures like amniocentesis (Nix et al., 2020). These functionalities are particularly important in emergency situations where timely diagnosis and intervention are critical for maternal and neonatal outcomes.

Clinical Benefits of POCUS in Maternal Healthcare

POCUS is a valuable tool in maternal healthcare, offering significant clinical benefits by enabling early diagnosis of pregnancy-related complications, improving maternal health monitoring, and reducing unnecessary interventions. It is particularly useful in low-resource settings, where it has the potential to significantly reduce maternal mortality rates.

Impact of POCUS on Reducing Maternal Mortality

The potential of POCUS to significantly reduce maternal mortality is well-documented. In many low-resource settings, access to diagnostic tools is limited, often delaying critical interventions. The timely diagnosis of life-threatening conditions like postpartum hemorrhage, placental issues, and fetal distress through POCUS has been shown to reduce maternal mortality rates (Dillman et al., 2021).

A study by Murray et al. (2020) found that the use of POCUS in sub-Saharan Africa led to a 30% reduction in maternal mortality rates in facilities that adopted the technology. The study highlighted that real-time imaging allowed clinicians to identify complications earlier and respond faster, leading to better maternal outcomes. Similarly, Arzola and Carvalho (2020) report that POCUS has been instrumental in identifying life-threatening conditions such as eclampsia and placenta previa, significantly improving the chances of survival for both mother and child.

Furthermore, POCUS has been particularly impactful in rural and underserved regions where traditional diagnostic tools are unavailable (Tariq et al., 2021). In these settings, maternal deaths often result from delayed or misdiagnosed complications. POCUS enables healthcare providers to deliver quality care without the need to transfer patients to larger hospitals, thereby reducing the risk of complications during transportation and ensuring timely intervention (Nelson et al., 2020).

POCUS reduces maternal mortality by providing timely, accurate, and portable diagnostic capabilities, which enable early detection of complications, improved fetal monitoring, better management of high-risk pregnancies, and enhanced care in low-resource settings. This results in quicker decision-making, timely interventions, and reduced delays in treatment, all of which are critical to saving lives in maternal healthcare.

Several studies highlight the significant clinical benefits of POCUS in maternal healthcare. One of its most notable advantages is the early detection of high-risk pregnancies. According to Nix et al. (2020), POCUS can quickly detect complications such as placental abruption or ectopic pregnancies, allowing for immediate medical intervention. Early identification of these complications is crucial for reducing maternal mortality, especially in low-resource settings where referral systems are slow.

Another benefit of POCUS is its role in reducing unnecessary interventions. Nix et al. (2020) found that POCUS helped reduce the number of unnecessary cesarean sections by providing more accurate fetal assessments. This is particularly important in rural areas where women may have limited access to hospital care, making it essential to avoid unnecessary surgeries that could lead to complications.

POCUS also enhances maternal health monitoring throughout the pregnancy. As emphasized by Arzola and Carvalho (2020), POCUS is invaluable for monitoring fetal growth, assessing amniotic fluid levels, and identifying fetal malpresentation in real-time. This frequent and non-invasive monitoring has been linked to better maternal and neonatal outcomes. Furthermore, POCUS is often the only imaging technology available in remote areas, which makes it an indispensable tool for maternal care in underserved regions (Tariq et al., 2021).

Challenges in the Adoption of POCUS

Despite the clear benefits, several challenges have been identified in the literature regarding the widespread adoption of POCUS. One of the key challenges is the lack of training. The effective use of POCUS requires skilled personnel who can accurately interpret ultrasound images (Murray et al., 2020). Many rural and low-resource healthcare settings lack the infrastructure and workforce to support continuous training programs. Moreover, healthcare professionals may need more time to become proficient in using POCUS in various clinical scenarios, leading to inconsistencies in care delivery (Nelson et al., 2020).

Another significant barrier is cost and maintenance. While POCUS devices are generally more affordable than traditional ultrasound systems, they still represent a significant investment for low-resource health systems. Additionally, maintaining and repairing these devices in harsh or rural environments can be challenging (Dillman et al., 2021). Studies have reported that POCUS devices in some regions break down frequently due to dust, extreme temperatures, or poor storage conditions, rendering them ineffective when needed most.

Furthermore, data management and storage issues pose another challenge. POCUS generates images and data that should ideally be stored and integrated into the patient's medical record. However, many healthcare systems, particularly in low-resource settings, lack the infrastructure to store and manage this data effectively. This can lead to difficulties in tracking patient progress or making informed decisions about maternal care (Arzola & Carvalho, 2020).

The full potential of POCUS in reducing maternal mortality is contingent upon overcoming the challenges related to training, infrastructure, and healthcare system integration. Without addressing these barriers, the impact of POCUS may be limited to certain regions or populations, thereby exacerbating inequalities in maternal health outcomes (Dillman et al., 2021). Overcoming these barriers will be crucial to ensuring that POCUS can be effectively integrated into maternal healthcare systems globally and that its benefits are realized on a larger scale.

4.2. Evaluating the Impact of AI on Maternal Mortality: A Focus on POCUS and PROMPTS in Kenya

These tools hold significant promise for improving maternal health outcomes in Kenya by addressing key challenges such as delays in care-seeking, limited access to skilled healthcare providers, and inadequate diagnostic capabilities. Rigorous evaluation of these interventions is crucial to understand their true impact on maternal mortality rates and inform their wider implementation and scale-up.

4.2.1. Impact of POCUS Implementation on Maternal Health Outcomes

To assess the impact of AI-enabled ultrasound (POCUS) on maternal health in Kenya, a paired t-test was conducted, comparing pre- and post-implementation periods across nine counties. This analysis revealed significant improvements in several key indicators:

Normal Deliveries: A significant decrease in normal deliveries was observed post-implementation (mean difference = 9530.22, $p = .001$, Cohen's $d = 1.585$). This suggests a potential shift towards

alternative delivery methods, possibly due to increased detection of complications with POCUS, enabling more informed decisions regarding delivery approaches.

Obstructed Labor: POCUS implementation was associated with a significant reduction in obstructed labor cases (mean difference = 309.11, p = .015, Cohen's d = 1.025). This finding indicates improved identification and management of this life-threatening complication, likely due to the enhanced diagnostic capabilities provided by POCUS.

Stillbirths: Both fresh stillbirths (mean difference = 199.78, p = .001, Cohen's d = 1.587) and macerated stillbirths (mean difference = 197.67, p = .001, Cohen's d = 1.652) showed significant reductions post-implementation. This suggests that POCUS may contribute to improved fetal outcomes, potentially through earlier detection of fetal distress or abnormalities.

Babies Discharged Alive: A significant increase in the number of babies discharged alive was observed (mean difference = 8683.56, p = .009, Cohen's d = 1.138), further supporting the positive impact of POCUS on neonatal outcomes. This finding aligns with the reduction in stillbirths and suggests that POCUS may contribute to improved overall neonatal survival.

However, it is important to note that several other indicators, including antepartum hemorrhage (APH), postpartum hemorrhage (PPH), and maternal deaths, did not show statistically significant changes following POCUS implementation. This suggests that while POCUS can contribute to improvements in specific areas, its impact may not be uniform across all maternal health outcomes.

An independent t-test comparing POCUS and non-POCUS counties revealed no statistically significant differences for most indicators. However, medium to large effect sizes were observed for APH, cesarean sections, and macerated stillbirths, suggesting that POCUS might contribute to reducing these adverse outcomes, even though statistical significance was not reached.

4.2.2. Impact of PROMPTS on Maternal Health Outcomes

Analysis of data collected from PROMPTS clients provides valuable insights into the impact of AI in reducing maternal mortality. Key findings include:

Sociodemographic Characteristics and Access to Care: PROMPTS is reaching a diverse population of expectant mothers across different age groups, educational backgrounds, and socioeconomic statuses. The high enrollment in Linda Mama, a government initiative providing free maternity healthcare, suggests that PROMPTS is effectively reaching and supporting women who may face financial barriers to accessing healthcare.

Client Engagement and Information Sources: While most clients reported having autonomy in making healthcare decisions, only 47.9% had used the PROMPTS platform. Community Health Providers (CHPs) were the most frequently interacted with sources of information, followed by friends and family members. PROMPTS had the lowest frequency of interaction, highlighting a potential gap in effectively engaging clients with the AI-enabled platform.

Impact on Health Behaviors and Outcomes: The average number of clinic visits among PROMPTS users was significantly lower than those who did not use the platform (mean difference

= 3.15, $p < .001$). This finding suggests that PROMPTS may be contributing to more efficient healthcare utilization by reducing the need for frequent clinic visits, potentially through timely provision of information and remote monitoring. However, further investigation is needed to understand the long-term impact of reduced clinic visits on maternal and neonatal health outcomes.

Client Satisfaction and Knowledge of Danger Signs: Client satisfaction with the appropriateness, timeliness, amount, and clarity of information provided by PROMPTS was generally low, with over 67% expressing dissatisfaction in each category. This highlights the need for improvements in the content and delivery of information through the platform to ensure that information is timely, relevant, and easy to understand, empowering clients to make informed decisions and seek timely care.

The findings of this study provide valuable insights into the potential of AI-driven tools like POCUS and PROMPTS to improve maternal health outcomes in Kenya. POCUS has demonstrated a positive impact on reducing obstructed labor and stillbirths, while potentially contributing to a shift towards more informed decision-making regarding delivery methods. PROMPTS shows promise in enhancing healthcare access and efficiency, particularly by reducing the need for frequent clinic visits. However, challenges remain in terms of client engagement and satisfaction with the platform's information delivery.

Further research is needed to explore the long-term impact of both POCUS and PROMPTS on maternal and neonatal health outcomes, as well as to evaluate their cost-effectiveness. Additionally, studies should investigate the factors influencing the differential effects of these AI tools on various health indicators and identify strategies to optimize their implementation and maximize their benefits for mothers and newborns. Addressing the identified challenges and optimizing these platforms can play a crucial role in improving maternal health outcomes and reducing maternal mortality in Kenya and other LMICs.

4.3. Objective 3: Explore the future potential of AI in maternal healthcare

To address the third objective, which explores the future potential of AI in enhancing maternal healthcare outcomes, this study employed a comprehensive mixed-methods approach, integrating insights from literature reviews, expert interviews, surveys, focus group discussions (FGDs), and site visits to healthcare facilities.

Results from the Literature Review

AI technologies in maternal healthcare are advancing rapidly, with several emerging tools such as predictive analytics, remote monitoring, personalized medicine, and clinical decision support systems showing substantial promise. These innovations could tackle long-standing challenges in maternal health, including the early detection of complications, enhancing access to care in remote areas, and enabling the development of personalized treatment plans tailored to individual needs.

However, the literature also underscores the importance of addressing ethical issues, such as data privacy and the fairness of AI algorithms. It highlights the need for further research and rigorous

validation of AI tools to ensure their safety, effectiveness, and equitable distribution across different populations. Without addressing these concerns, the full potential of AI to transform maternal health outcomes cannot be realized.

Results from Key Informant Interviews

Expert interviews revealed widespread optimism about AI's future potential to reshape maternal healthcare, particularly in LMICs where maternal mortality rates are high. Experts pointed out AI's ability to overcome systemic challenges, such as a shortage of skilled healthcare providers and limited access to maternal healthcare services. Predictive analytics and remote monitoring were cited as potential game-changers in mitigating maternal health risks.

However, experts emphasized the need for multi-stakeholder collaboration, involving healthcare professionals, AI developers, policymakers, and researchers, to ensure the responsible deployment of AI technologies. This collaboration would help to address ethical concerns, facilitate the acceptance of AI solutions by healthcare workers, and ensure that AI tools are designed in ways that are practical and effective for local healthcare settings. Key recommendations included incorporating healthcare workers into the AI design and implementation process, ensuring that AI is a supportive tool rather than a disruptive force.

Results from Surveys

Survey responses from healthcare providers and AI developers revealed a strong consensus on the potential benefits of AI in improving maternal care, particularly through personalized care plans, enhanced risk assessment, and the ability to monitor patients remotely. Respondents were enthusiastic about AI's ability to improve care quality and efficiency by allowing early interventions and reducing preventable complications.

Nevertheless, significant barriers to AI adoption were identified, including the lack of robust healthcare infrastructure, insufficient internet connectivity, and poor data quality. Respondents also stressed the importance of creating AI systems that integrate seamlessly into existing healthcare workflows and that are easy for healthcare workers to use, especially in low-resource settings where advanced technical expertise may be lacking.

Results from Focus Group Discussions (FGDs)

FGDs with healthcare workers provided deeper insights into both the potential and challenges of integrating AI into maternal healthcare. While participants acknowledged AI’s potential to streamline workflows and improve care outcomes, they expressed concerns about job displacement, fearing that AI tools might replace human judgment. Healthcare workers were adamant that AI solutions should complement, not substitute, their clinical expertise, maintaining the human-cantered aspect of maternal care.

The discussions also revealed a strong desire for culturally sensitive AI applications tailored to the unique needs of diverse populations. Healthcare workers stressed the importance of designing AI

tools that align with local healthcare systems and cultural norms, which would help foster greater trust and ensure higher adoption rates.

Results from Site Visits

Site visits to facilities utilizing AI tools provided practical, real-world insights into the application of AI in maternal healthcare. These visits showed that AI-powered ultrasound devices and remote monitoring systems can significantly improve the quality and efficiency of care. AI tools were seen to enhance diagnostic accuracy, enable timely interventions, and reduce the need for unnecessary hospital visits, thereby improving the overall maternal healthcare experience.

However, infrastructure limitations, particularly unreliable power supply and insufficient internet connectivity, were noted as critical obstacles to the effective implementation of AI technologies. Additionally, the need for ongoing training and support for healthcare workers using AI tools was identified as crucial for ensuring successful integration into clinical practice.

Overall Interpretation

The findings from this study indicate that AI holds significant promise for improving maternal healthcare outcomes by increasing accessibility, enhancing diagnostic accuracy, and promoting more personalized care. However, several key challenges must be addressed, including infrastructure limitations, data quality issues, and ethical concerns related to data privacy and equity. The successful future implementation of AI in maternal healthcare will depend on a coordinated effort among stakeholders, ongoing training for healthcare workers, and the development of culturally appropriate, user-friendly AI solutions. Moreover, policy frameworks and governance structures must be strengthened to ensure that AI technologies are used responsibly, ethically, and effectively to benefit all women, especially in LMICs.

4.4. Objective 4: Evaluate the policy implications of AI in maternal health

To address the fourth objective, which is to evaluate the policy implications of AI in maternal health, this study conducted a comprehensive review of national and international policy documents. This analysis included an examination of relevant legal frameworks, such as the Kenya Data Protection Act (2019), the General Data Protection Regulation (GDPR), and the Health Insurance Portability and Accountability Act (HIPAA), to understand their provisions regarding data privacy, security, consent, and automated decision-making in the context of AI applications in healthcare. Additionally, the Australian Government's "Policy for the responsible use of AI in government" (September 2024, Version 1.1) was reviewed to gain insights into a national-level approach to AI governance in the public sector. This policy provided valuable context on ensuring responsible and ethical AI implementation within government agencies, emphasizing transparency, accountability, and public trust.

The study also considered the ethical dimensions of AI in maternal health by analyzing international ethical guidelines and reports from leading organizations, such as the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD).

These documents were reviewed to identify core principles related to patient autonomy, consent, transparency, and inclusiveness in AI systems. A comparative analysis of ethical frameworks across different regulatory contexts was conducted to identify common themes and divergences in addressing ethical concerns.

In addition to the policy analysis, the study conducted a comprehensive literature review to examine the current state of AI in maternal healthcare, identify research gaps, and analyze the challenges and opportunities associated with implementing AI in this domain. The literature review drew on a wide range of sources, including academic papers, policy documents, and reports from international organizations.

Key Findings from the Policy and Literature Analysis

The combined analysis of policy documents and the broader literature revealed several key findings:

i. **Data Privacy and Security:** The protection of patient data is paramount. AI systems must be designed and implemented with robust security measures to prevent unauthorized access, use, or disclosure of personal health information.
ii. **Informed Consent and Patient Autonomy:** Patients should be fully informed about how AI is being used in their care and have the right to consent to or decline the use of AI-powered tools.
iii. **Transparency and Explainability:** AI systems should be transparent and explainable, allowing patients and healthcare providers to understand how AI-driven decisions are made.
iv. **Fairness and Non-discrimination:** AI systems should be designed to avoid bias and discrimination, ensuring that all patients have equal access to the benefits of AI in healthcare.
v. **Accountability and Governance:** Clear lines of accountability should be established for the development, deployment, and use of AI systems in healthcare.

Gaps and Challenges in Current Policies

The study also identified several gaps and challenges in current policies related to AI in maternal health:

i. **Lack of Specificity:** Many existing policies are not tailored to the unique challenges and opportunities of AI in healthcare, particularly in the context of maternal health.
ii. **Rapid Technological Advancements:** The fast-paced evolution of AI technology makes it challenging for policies to keep up, potentially leading to regulatory gaps.
iii. **Ethical Considerations:** The use of AI in maternal health raises complex ethical considerations that require careful policy attention, such as the potential for algorithmic bias and the impact on the patient-provider relationship.
iv. **Implementation Challenges:** Translating policy principles into practical guidance and ensuring effective implementation across diverse healthcare settings can be challenging.

Policy Recommendations

To address these gaps and challenges, the study proposes several policy recommendations:

i. Develop specific policies and guidelines for AI in maternal health, addressing the unique ethical, legal, and social implications of AI in this context.

ii. Establish clear regulatory frameworks for the development, validation, and deployment of AI-powered tools in maternal health.

iii. Promote transparency and explainability in AI systems, ensuring that patients and healthcare providers understand how AI-driven decisions are made.

iv. Address potential biases in AI algorithms and ensure that AI systems are used in a fair and non-discriminatory manner.

v. Invest in research and development to evaluate the effectiveness and impact of AI in maternal health, informing evidence-based policymaking.

vi. Foster collaboration among stakeholders, including policymakers, healthcare providers, AI developers, researchers, and patient advocates, to ensure responsible and ethical AI implementation.

By addressing these policy implications, this study aims to contribute to the development of a responsible and ethical framework for the use of AI in maternal health, maximizing its potential to improve maternal health outcomes while safeguarding patient rights and promoting equitable access to care.

5. Discussion, Conclusion and Recommendations

To address the first objective, the study conducted a systematic review of 45 research papers, revealing a global trend toward integrating AI in maternal healthcare. This includes using predictive analytics to forecast pregnancy risks, AI-powered decision support systems to aid clinical decisions, medical imaging for better diagnostics, remote monitoring for patient empowerment, virtual assistants for health information, and AI for streamlining administrative tasks. However, the study found a significant disparity in research and implementation between high-income countries (HICs) and LMICs, with LMICs lagging behind despite bearing a higher burden of maternal mortality. This disparity highlights the need for increased investment in AI research and implementation in LMICs to address the inequitable distribution of technological advancements in maternal healthcare.

In Kenya, the study focused on two AI-driven tools: PROMPTS, an SMS platform for personalized health information and support, and POCUS, portable ultrasound devices for improved diagnostics in underserved areas. These tools are designed to address delays in care-seeking and limited access to skilled healthcare providers, which are significant contributors to maternal mortality in Kenya. The selection of these tools reflects a strategic focus on leveraging AI to address specific challenges within the Kenyan healthcare context.

For the second objective, the study used a paired t-test to compare pre- and post-implementation periods of AI-enabled ultrasound (POCUS) across nine counties in Kenya. The results showed significant improvements in several key indicators, including a reduction in obstructed labor and stillbirths, and an increase in the number of babies discharged alive. These findings suggest that POCUS can significantly improve maternal and neonatal health outcomes in Kenya by enabling early detection and management of complications. However, some indicators, such as antepartum hemorrhage (APH), postpartum hemorrhage (PPH), and maternal deaths, did not show significant changes. This indicates that while POCUS can be a valuable tool in reducing maternal mortality, it is not a panacea and needs to be complemented by other interventions to address the multifaceted causes of maternal mortality.

Regarding the impact of PROMPTS, the study found that it reached a diverse population of expectant mothers, but only 47.9% had used the platform. This low utilization rate highlights the need for greater efforts to promote awareness and encourage the adoption of PROMPTS among expectant mothers. PROMPTS users had significantly fewer clinic visits, suggesting more efficient healthcare utilization. This finding indicates that PROMPTS can potentially reduce the burden on healthcare facilities and improve access to care, particularly for women in remote areas. However, client satisfaction with the information provided by PROMPTS was low, indicating a need for improvement in content and delivery. This suggests that the effectiveness of PROMPTS can be further enhanced by tailoring the information and support provided to the specific needs and preferences of expectant mothers.

For the third objective, the study used a mixed-methods approach, including literature review, expert interviews, surveys, focus group discussions, and site visits. The results indicated that AI has the potential to significantly improve maternal healthcare outcomes by enhancing accessibility, quality, and safety of care. This underscores the transformative potential of AI in revolutionizing maternal healthcare and achieving global maternal health goals. However, successful implementation requires overcoming challenges related to infrastructure, data quality, ethical concerns, and user adoption. This highlights the need for a comprehensive approach to AI implementation that addresses not only technological aspects but also infrastructural, social, and ethical considerations.

To address the fourth objective, the study conducted a comprehensive review of national and international policy documents, including legal frameworks and ethical guidelines. The analysis revealed key findings related to data privacy and security, informed consent, transparency, fairness, and accountability in the use of AI in maternal health. These findings emphasize the importance of establishing robust policy frameworks to guide the ethical and responsible implementation of AI in maternal healthcare. The study also identified gaps and challenges in current policies, such as lack of specificity, rapid technological advancements, ethical considerations, and implementation challenges. These gaps and challenges highlight the need for ongoing policy development and revision to keep pace with the rapid advancements in AI and ensure its responsible use in maternal health. Based on these findings, the study proposed several policy recommendations to ensure responsible and ethical AI implementation in maternal healthcare. These recommendations provide a roadmap for policymakers and stakeholders to harness the potential of AI for improving maternal health outcomes while safeguarding patient rights and promoting equitable access to care.

5.1. Limitations of the study

While this study offers valuable insights into the role of AI in reducing maternal mortality, it is essential to acknowledge its limitations:

Limited Generalizability: The study focused specifically on Kenya, limiting the generalizability of findings to other contexts. Different LMICs may have varying levels of technological infrastructure, healthcare system capacity, and sociocultural factors that influence AI adoption and impact.

Focus on Specific AI Tools: The study primarily evaluated POCUS and PROMPTS, potentially overlooking other AI applications relevant to maternal health. A broader scope might reveal a more diverse range of AI tools and their effects on maternal mortality.

Data Limitations: The study relied on specific datasets, such as KHIS, which may have limitations in data completeness and accuracy. Additionally, the exclusion of 2022 data due to variations in POCUS implementation timing might have influenced the overall analysis.

Short-Term Evaluation: The study primarily assessed the immediate impact of AI interventions, lacking long-term follow-up data. A longitudinal study design would provide a more comprehensive understanding of the sustained effects of AI on maternal health outcomes.

Confounding Factors: While the study attempted to control for confounding variables, other unmeasured factors might have influenced the observed outcomes. Further research could explore the complex interplay of social, economic, and healthcare-related factors that contribute to maternal mortality.

Subjective Measures: The study used surveys to assess client satisfaction and knowledge, which are subjective measures prone to bias. Employing more objective measures could strengthen the validity of these findings.

Limited Exploration of Ethical Challenges: While the study acknowledged ethical considerations, it did not delve deeply into the potential risks and unintended consequences of AI in maternal health. Further research could explore these ethical dimensions in greater detail.

Despite these limitations, this study contributes valuable insights into the potential of AI to reduce maternal mortality and improve maternal health outcomes in Kenya. The findings can inform policy and practice decisions regarding the implementation and scale-up of AI-driven interventions in maternal healthcare.

5.2. Conclusion

This study explored the transformative potential of AI in revolutionizing maternal healthcare, with a specific focus on reducing maternal mortality rates. By employing a comprehensive mixed-methods approach, the research examined the global landscape of AI-driven applications in maternal health, evaluated the impact of AI-powered tools in Kenya, and explored the future potential and policy implications of AI in this domain.

The findings revealed a growing trend of AI integration in maternal healthcare globally, with applications ranging from predictive analytics and decision support systems to medical imaging and remote monitoring. However, a significant disparity exists between high-income countries (HICs) and low- and middle-income countries (LMICs) in terms of research and implementation. This underscores the need for increased investment and targeted efforts to bridge this gap and ensure

equitable access to AI-powered maternal healthcare solutions, particularly in LMICs where the burden of maternal mortality is highest.

In Kenya, the study focused on two AI-powered tools: PROMPTS, an SMS platform for personalized health information and support, and POCUS, portable ultrasound devices for enhanced diagnostics. The evaluation of POCUS implementation showed significant improvements in key maternal and neonatal health indicators, including a reduction in obstructed labor and stillbirths, and an increase in the number of babies discharged alive. This demonstrates the potential of AI to enhance the quality and efficiency of maternal healthcare in low-resource settings, where access to skilled healthcare providers and diagnostic tools may be limited.

While PROMPTS showed promise in enhancing healthcare access and efficiency, client satisfaction with the platform's information delivery was low, highlighting the importance of user-centered design and ongoing evaluation to ensure that AI tools meet the needs and expectations of end-users. This suggests that the effectiveness of AI-powered solutions can be further enhanced by tailoring the information and support provided to the specific needs and preferences of expectant mothers, and by actively involving them in the design and implementation process.

The study also explored the future potential of AI in maternal healthcare, examining emerging technologies and identifying potential benefits and challenges. This forward-looking perspective provides insights into the potential trajectory of AI in maternal health and can guide future research and development efforts. The policy implications of AI in maternal health were evaluated, including a critical review of existing policies and recommendations for responsible and ethical AI integration. This analysis contributes to the ongoing policy discourse surrounding AI in healthcare and provides recommendations for policymakers to ensure that AI is used responsibly and ethically to improve maternal health outcomes.

The findings of this study contribute to the growing body of evidence supporting the potential of AI to improve maternal health outcomes and reduce maternal mortality. The study highlights the need for increased investment in AI research and implementation in LMICs, where the burden of maternal mortality is highest. The study also underscores the importance of addressing ethical considerations, data privacy, and user adoption challenges to ensure responsible and equitable AI integration in maternal healthcare.

AI has the potential to revolutionize maternal healthcare and contribute significantly to the reduction of maternal mortality rates, particularly in LMICs. However, realizing this potential requires a concerted effort from all stakeholders, including policymakers, healthcare providers, AI developers, researchers, and patients. By working together to address the identified challenges and optimize the implementation of AI-powered solutions, we can harness the transformative power of AI to improve maternal health outcomes and save lives.

5.3. Recommendation for further research

Based on the findings and limitations of this study, several areas for further research emerge:

i. **Expanding the Scope**: Future research should expand the scope to include a wider range of AI applications in maternal health, beyond POCUS and PROMPTS, to provide a more comprehensive understanding of AI's potential in this domain.

ii. **Longitudinal Studies**: Conducting longitudinal studies to track the long-term impact of AI interventions on maternal and neonatal health outcomes is crucial for assessing the sustained effects and cost-effectiveness of these technologies.

iii. **Diverse Contexts**: Replicating the study in different LMIC contexts with varying levels of technological infrastructure, healthcare system capacity, and sociocultural factors would enhance the generalizability of findings and provide insights into context-specific factors influencing AI adoption and impact.

iv. **Ethical and Societal Implications**: Further research should delve deeper into the ethical and societal implications of AI in maternal health, exploring potential biases, unintended consequences, and the impact on the patient-provider relationship.

v. **Data Quality and Interoperability**: Investigating strategies to improve data quality, standardization, and interoperability across different healthcare settings is essential for enhancing the effectiveness and scalability of AI solutions in maternal health.

vi. **Human-AI Collaboration**: Research should explore the optimal balance between human expertise and AI assistance in maternal healthcare, ensuring that AI tools complement rather than replace human judgment and maintain the patient-centered approach.

vii. **Policy Development and Evaluation**: Further research is needed to inform the development and evaluation of policies and guidelines specific to AI in maternal health, addressing ethical considerations, data privacy, and equitable access to care.

viii. **Community Engagement**: Studies should investigate strategies to effectively engage communities and address potential cultural barriers or misinformation surrounding AI in maternal health to promote acceptance and adoption of these technologies.

ix. **Economic Evaluation**: Conducting cost-effectiveness studies to assess the financial viability and sustainability of AI interventions in maternal healthcare, particularly in low-resource settings, is crucial for informing investment decisions and ensuring long-term impact.

x. **Capacity Building**: Research should explore effective strategies for capacity building and training healthcare professionals in the use and interpretation of AI-powered tools to ensure their confident and competent application in maternal care.

By addressing these research gaps, future studies can contribute to a more comprehensive understanding of the role of AI in reducing maternal mortality and inform the development and implementation of responsible, ethical, and effective AI-driven interventions in maternal healthcare.

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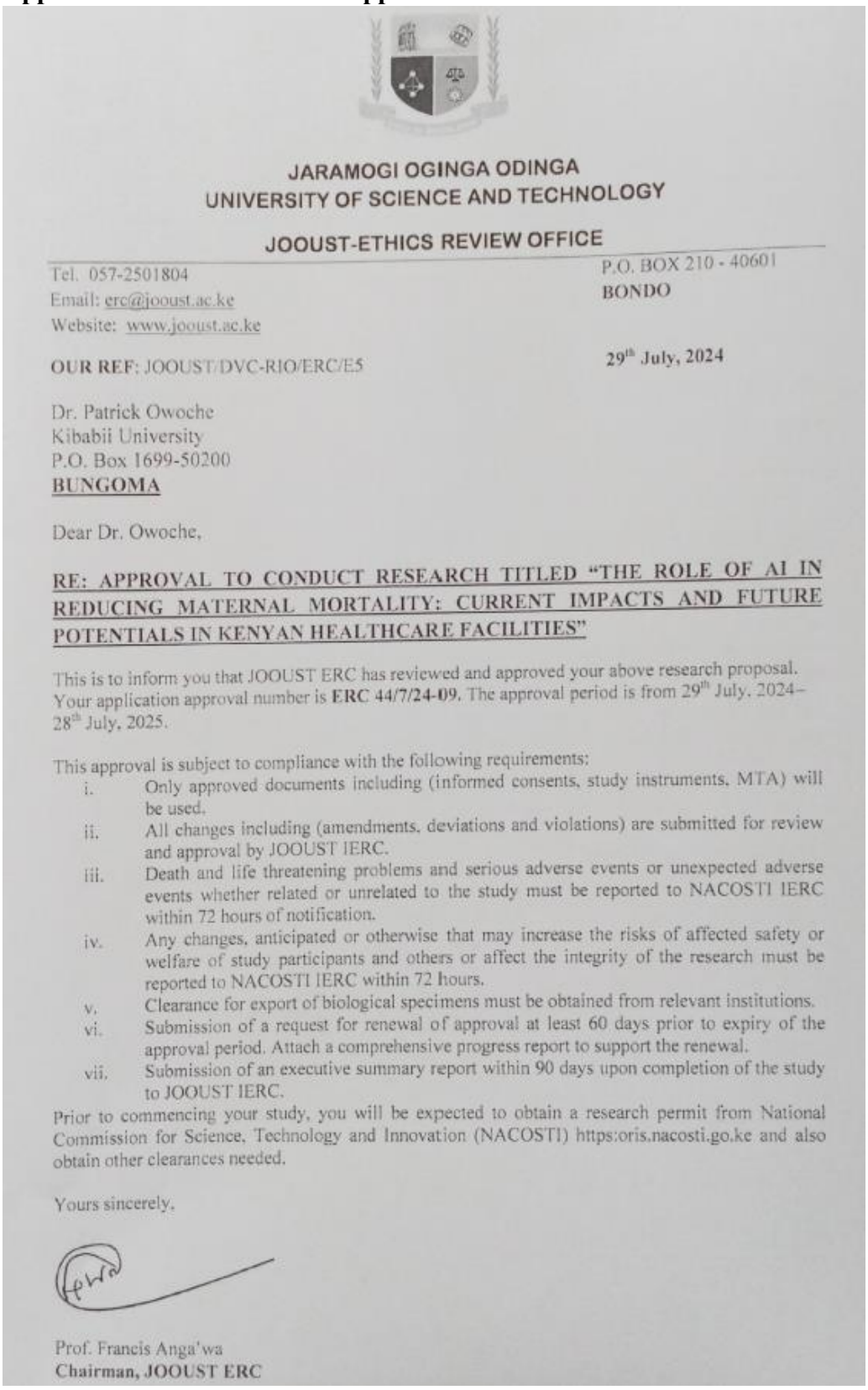
Appendices

Appendix A: Research Ethics Approval



JARAMOGI OGINGA ODINGA
UNIVERSITY OF SCIENCE AND TECHNOLOGY

JOOUST-ETHICS REVIEW OFFICE

Tel. 057-2501804
Email: erc@jooust.ac.ke
Website: www.jooust.ac.ke

P.O. BOX 210 - 40601
BONDO

OUR REF: JOOUST/DVC-RIO/ERC/E5

29th July, 2024

Dr. Patrick Owoche
Kibabii University
P.O. Box 1699-50200
BUNGOMA

Dear Dr. Owoche,

RE: APPROVAL TO CONDUCT RESEARCH TITLED "THE ROLE OF AI IN REDUCING MATERNAL MORTALITY: CURRENT IMPACTS AND FUTURE POTENTIALS IN KENYAN HEALTHCARE FACILITIES"

This is to inform you that JOOUST ERC has reviewed and approved your above research proposal. Your application approval number is **ERC 44/7/24-09**. The approval period is from 29th July, 2024–28th July, 2025.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations and violations) are submitted for review and approval by JOOUST IERC.
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 NACOSTI IERC within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks of affected safety or welfare of study participants and others or affect the integrity of the research must be reported to NACOSTI IERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
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 JOOUST IERC.

Prior to commencing your study, you will be expected to obtain a research permit from National Commission for Science, Technology and Innovation (NACOSTI) https:oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

Prof. Francis Anga'wa
Chairman, JOOUST ERC

Appendix B: National Research Approval Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 810954

Date of Issue: 28/August/2024

RESEARCH LICENSE

This is to Certify that Dr.. Patrick Oduor Owoche of Kibabii University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Bungoma, Kakamega, Kiambu, Kilifi, Kisumu, Kitui, Kwale, Mombasa, Nairobi, Nakuru, Uasin-Gishu on the topic: The Role of AI in Reducing Maternal Mortality: Current Impacts and Future Potentials in Kenyan Healthcare Facilities. for the period ending : 28/August/2025.

License No: NACOSTI/P/24/38649

810954

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

Appendix C: Bungoma County Research Approval Permit

REPUBLIC OF KENYA

COUNTY GOVERNMENT OF BUNGOMA
MINISTRY OF HEALTH
OFFICE OF THE COUNTY DIRECTOR HEALTH

Telephone: 0725393939
E-mail: heallth@bungoma.go.ke
When replaying please quote

COUNTY DIRECTOR OF HEALTH
BUNGOMA COUNTY
P. O. BOX 18-50200
BUNGOMA

OUR REF: CG/BGM/CDH/RESRC/VOL.1

DATE: 19th August,2024

Dr. Patrick Owoche
Kibabii University
P.O.BOX 1699-50200
BUNGOMA

RE: RESEARCH AUTHORIZATION.

Following your request for authority to carry out research on **"THE ROLE OF AI IN REDUCING MATERNAL MORTALITY CURRECT IMPACTS AND FUTURE POTENTIALS IN KENYA HEALTHCARE FACILITIES," In Bungoma County.** I am pleased to inform you that you have been authorized to undertake the research for the period ending *28th July, 2025.*

Kindly note that you shall deposit **a copy** of the final research report to the County Director of Health. The soft copy of the same should be submitted through the online Research Information System.

Thank you

COUNTY DIRECTOR OF HEALTH
BUNGOMA COUNTY
Box 18-50200,
BUNGOMA

Dr. Caleb Wanambisi Watta
County Director of Health
Bungoma

Appendix D: Kisumu County Research Approval Permit

REPUBLIC OF KENYA

COUNTY GOVERNMENT OF KISUMU

Telegrams: "PRO (MED)"
Tel: 254-057-2020105
Fax: 254-057-2023176
E-mail: kisumucdh@gmail.com

Director of Public Health, Preventive/
Promotion and Environmental Health
P.O. Box 721 – 40100
Kisumu.

DEPARTMENT OF MEDICAL SERVICES, PUBLIC HEALTH & SANITATION

Our Ref: GN 133 VOL. XVII/ (294) **Date:** 23rd August 2024

All SCMOH
All Medsupts

RE: AUTHORITY TO CONDUCT RESEARCH IN COUNTY

The Department has reviewed and approved this research titled '***The Role of AI in Reducing Maternal Mortality: Current Impacts and Future Potentials in Kenya Health Care Facilities.***'

Therefore, the purpose of this letter is to request you to allow **Dr. Patrick Owoche,** the **Principal Investigator** and the **County Co-principal Investigator**, **Fredrick Oluoch** to conduct the research.

Yours Sincerely,

COUNTY DIRECTOR OF HEALTH KISUMU

Fredrick O. Oluoch, MPH, MBA, HSC, OGW
Director - Public Health & Sanitation
Kisumu County

CC Patrick Owuoche

Appendix E: Kitui County Research Approval Permit

COUNTY GOVERNMENT OF KITUI

Office of the Chief Officer
Public Health and Sanitation
P.O. Box 460-90200
KITUI

MINISTRY OF HEALTH AND SANITATION

Ref: CGKTI/MOH/ADM/8/3(139) **Date:** 26th August 2024

- CHMT Unit Heads
- Sub County Health Services Coordinators
- Medical Superintendents

RE: APPROVAL FOR DATA COLLECTION

Kitui County in partnership with institutions of higher learning offers a platform to enhance capacity building.

A research team of four from Kibabii University is conducting a study titled "***THE ROLE OF AI IN REDUCING MATERNAL MORTALITY: CURRENT IMPACTS AND FUTURE POTENTIALS IN KENYAN HEALTHCARE.***" This research aims to evaluate the impact of Artificial Intelligence (AI) on maternal health outcomes, specifically focusing on the use of AI-enabled Ultrasound and the Jacaranda PROMPTS in Health Centres within Kitui County.

The project has been approved by the Jaramogi Oginga Odinga University of Science and Technology Ethics Review Office– **JOOUSTERC/44/7/24-09** and permitted by NACOSTI, License number: **NACOSTI/P/24/38649.**

The research team includes;

1. Principal Investigator (PI): Dr. Patrick Owoche
2. Co-Investigators (Co-I):
   i. Dr. Betty Mayeku (Computer Science);
   ii. Dr. Lucy Namusonge (Nursing Department);
   iii. Mr. Morris Senghor (Nursing Department).

The purpose of this letter is to request that you offer the team the necessary support upon the provision of the Jaramogi Oginga Odinga University of Science and Technology Ethics Review Office letter, NACOSTI Permit, and Letter of Introduction from Kibabii University.

26/08/2024

Lynn Kitwan
Chief Officer, Public Health and Sanitation
Ministry of Health and Sanitation
Copy to. CECM Health and Sanitation
Chief Officer, Medical Services

CHIEF OFFICER
PUBLIC HEALTH AND SANITATION
MINISTRY OF HEALTH AND SANITATION
26 AUG 2024
KITUI COUNTY

Appendix F: Kakamega County Research Approval Permit

REPUBLIC OF KENYA

E-mail: wpgh15@yahoo.com
Telephone: Kakamega 0702930346
When replying, please quote:

REF: CGH/KAK/ERC/VOL.1/283

COUNTY GENERAL HOSPITAL
P.O. Box 15-G.P. O-50100
KAKAMEGA

DATE: 12th September, 2024

COUNTY GOVERNMENT OF KAKAMEGA
MINISTRY OF HEALTH SERVICES

DR. PATRICK ODUOR OWOCHE
REF: NACOSTI/P/24/38649

RE: AUTHORIZATION FOR DATA COLLECTION – NO. ERC/269/09/2024

This is to inform you that Kakamega County General Hospital Ethics Review Committee (KCGH ERC) acting on behalf of the Kakamega County Department of Health has reviewed and authorized your data collection for the protocol titled: ***"The Role of AI in Reducing Maternal Mortality: Current Impacts and Future Potentials in Kenyan Healthcare Facilities."*** The approval period shall expire on **28/August/2025**.

This authorization is subject to compliance with the following requirements:

i. Only approved documents including informed consent, study instruments, will be used.
ii. All changes including amendments, deviations and violations are submitted for review and approval by the **KCGH ERC.**
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 **KCGH ERC** within 24 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety of welfare of the study participants and others or affect the integrity of the research must be reported to **KCGH ERC** within 24 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
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 **KCGH ERC**.
viii. Submission of quarterly progress report to the **KCGH ERC** and dissemination of preliminary findings at the end of the study is expected from the researcher

This authorization should be attached to your research license from National Commission for Science, Technology and Innovation (NACOSTI) and also other necessary clearances. Preliminary dissemination of your study findings to **KCGH ERC** is mandatory prior to publications.

COUNTY DIRECTOR OF HEALTH SERVICES
12 SEP 2024
SIGN.....
P. O. Box 389 - 50100 KAKAMEGA COUNTY

DR. AJEVI AUSTINE
CHAIRMAN; ETHICS AND RESEARCH COMMITTEE
CGH – KAKAMEGA

Copy to: Director, Health Services

Appendix G: Nakuru County Research Approval Permit

REPUBLIC OF KENYA
COUNTY GOVERNMENT OF NAKURU
DEPARTMENT OF HEALTH SERVICES

Office of the County Director Public Health
P.O. Box 2060-20100
Nakuru, Kenya

Email: info.health@nakuru.go.ke
Website: www.nakuru.go.ke

CGN/CDPH/RES/2024/1135

27th September, 2024

To
Dr. Patrick Owoche
PhD – Primary Investigator
Coordinator – Linkages and International Affairs

RE: RESEARCH AUTHORIZATION

This is to inform you that your request to conduct research titled "***The Role of AI in Reducing Maternal Mortality: Current Impacts and Future Potentials.***"' has been approved by Nakuru County Research Committee. You are free to proceed with the study.

Please note that this approval is subject to your adherence to the ethical considerations and the prevailing rules and regulations governing research work.

By a copy of this letter, the Medical Superintendents and Sub County Team Leads are requested to offer the necessary support.

Please note that the research aims to evaluate the impact of Artificial Intelligence (AI) on maternal health outcomes, specifically focusing on the use of AI – enabled Ultrasound and The Jacaranda PROMPTS in health centres within Nakuru County.

Thank you.

COUNTY DIRECTOR
PUBLIC HEALTH & SANITATION
NAKURU COUNTY
P.O. Box 2060-20100,
NAKURU

ELIZABETH KIPTOO
COUNTY DIRECTOR, PUBLIC HEALTH
NAKURU

C.C:

- All Medical Superintendents
- All Sub County Team Leads
  NAKURU