

**STRATEGIES TO ENHANCE THE UTILIZATION OF DIGITAL HEALTH IN EARLY
DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN IN
EMALAHLENI LOCAL MUNICIPALITY, MPUMALANGA PROVINCE**

By

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DISSERTATION

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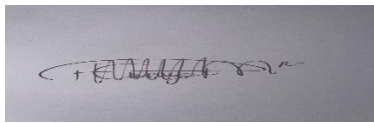
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DECLARATION

I declare that the study titled **“THE STRATEGIES TO ENHANCE THE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN IN EMALAHLENI LOCAL MUNICIPALITY, MPUMALANGA PROVINCE”** is my work and that all sources used or quoted have been acknowledged and designated by complete references and the study has not been submitted at any institution for any degree.

A rectangular box containing a handwritten signature in black ink on a light-colored background. The signature is cursive and appears to be the name of the author.

Signature

OCTOBER 2022

Date

DEDICATION

I dedicate this study to my mother, Christina Shekwa-Ngwenya for being a supportive parent and for always reminding me to not settle for less. Thank you for always remaining the pillar of my strength and the continuous reminders to study. I love you to the moon and back mom. To my late dad, the dream continues, and pretty sure you are proud of me wherever you are.

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Amathonga amakhulu ngiyabonga kini, boNkanyezi naboThambo baka Nkuna naLusiba, Kanye nawe Tjekwase Hlongwane nebandawe benu. Ngiyathokoza madlozi ami ngenhlanganipho eningiphe yona. "Gogo Star"

ABSTRACT

Background: Gestational Hypertension and Pre-Eclampsia are the most prevalent conditions in Sub-Saharan Africa leading to undesirable perinatal and maternal outcomes. In South Africa, a high rate of maternal death was noted due to Pre-Eclampsia. However, the use of digital maternal health in South Africa has become of significance for the reinforcement of health care. Digital health initiatives such as mobile health initiatives were developed to improve better access to communities in low and middle-income countries. The implementation and practices of digital health seem to be growing and expandable to achieve the Universal Health Coverage goals in the provision of care to all globally and nationally.

Purpose: To develop strategies to enhance the utilization of digital health in the early detection and treatment of Pre-Eclampsia by gravid women in Emalahleni Local Municipality, Mpumalanga Province.

Methodology: A mixed convergent parallel research method was adopted in this study. In this study, the data was collected using quantitative and qualitative strands. The quantitative data was collected from midwifery practitioners using self-developed Likert scale questionnaires with a total of 64 items. The questionnaires were administered to 109 midwifery practitioners and the data was analyzed using descriptive statistics. The qualitative data was collected from the 10 gravid women using semi-structured one-on-one interviews and was analyzed using Tesch open coding method. A pilot study was conducted before conducting the main study to measure the validity and reliability of the questionnaire and interview guide. Thereafter the findings were merged to determine the extent to which they converge, diverge, and correlate. The integrated findings informed the development of the strategies. Thereafter a McKinsey 7s Model along with Appraisal of Guidelines for Research & Evaluation II guided the development of the strategies to enhance utilisation of digital health. The ethical standards were adhered to in this study. Ethical approval was obtained from Turfloop Ethics Committee (TREC/81/2022:PG).

Results: The integrated findings showed that there are inconsistencies on the knowledge and importance of digital health utilization in the management of Pre-Eclampsia. Moreover, there are barriers to the utilization of digital health such as lack of awareness, shortage of digital and human resources, power supply inconveniences

impacting network connectivity, lack of training about the use of digital health, and lack of digital health initiatives validation and policies. These results informed the development of the strategies to enhance the utilization of digital health in early detection and treatment of pre-Eclampsia.

Conclusion: For South Africa to succeed in achieving the Universal Health Coverage goals, midwifery practitioners should adopt digital health practices in clinical practice. The implementation of digital health should be reinforced and emphasized. Although there are more barriers to the implementation of digital health, the implementation of the developed strategies could possibly facilitate a successful digital health use among midwives and gravid women and possibly reduce perinatal and maternal mortalities and morbidities associated with lack of knowledge and access to healthcare information

KEY CONCEPTS

Strategies, Utilization, early detection, gravid, women, pre-eclampsia, treatment and digital health, midwifery practitioners

DEFINITION OF CONCEPTS

- Digital health** is the utilization of digital, mobile, and wireless technologies for health (Mehl, Tamrat, Bhardwaj, Blaschke & Labrique, 2018). In this study, digital health is the use of mobiles for interaction with pregnant women to provide preventive interventions such as dietary measures and risk factors identified (i.e. Internet, mom connect, pregnancy plus, facebook, etc).
- Early detection** is a disease that is caught early by recognizing possible warnings and compelling action which leads to a quick diagnosis (Washington Health Alliance, 2021). In this study early detection is regarded as an early diagnosis of Pre-Eclampsia through using digital health to identify risk factors and warning.
- Gravid** the state of being pregnant (Nursing dictionary, 2016). In the context of the study, is when a woman conceives and carries a developing embryo to term.
- Midwifery practitioners** are any persons registered with the South African nursing council as a midwife/accoucheurs in terms of the nursing act 33 of 2005. In the context of this study, Midwifery practitioners refer to any individual trained at accredited institutions by the nursing council to provide midwifery care to improve patient perinatal wellbeing at primary health care facilities.
- Pre-eclampsia** is the elevation of systolic blood pressure greater than 140mmHg or equal to 140mmHg with a diastolic of 90mmHg or greater with the presence of proteinuria after 20 weeks of gestation (Sellers, 2018). In this study Pre-Eclampsia is the increase of blood pressure to greater than 140/90mmHg as evidenced by proteinuria in gravid women.

Strategies	are ideas of action intended to achieve an overall aim (Oxford Dictionary, 2010). In this study, strategies are supportive ways to improve identified problems in the use of digital health through achieving the aim of the contextual study.
Treatment	is medical intervention rendered to the gravid women for a specific illness (Oxford Dictionary of Nursing, 2017). In this study, it refers to the midwifery care and treatment provided to gravid women to achieve optimal health.
Utilization	is the practical and effective action of making use of something (Miller, 2012). In the context of the study, utilization is the use of technical methods such as digital health to improve foetal and maternal wellbeing.
Women	is defined as an adult female (Nursing dictionary, 2016). In this study women refers to any female at childbearing age.

LIST OF ABBREVIATIONS

ANC	Antenatal Care
AGREE	Appraisal of Guidelines for Research & Evaluation
CARMMA	Campaign on Accelerated Reduction of Maternal Mortality in Africa
DoH	Department of Health
e-Health	Electronic health
EM	Essential Medicine
FDA	Food and Drug Administration
HCP	Health Care Providers
HDP	Hypertensive Disorders in Pregnancy
HELLP	Haemolysis, Elevated, Liver enzymes, Low Platelet count
HIT	Health Informational Technology
HIV	Human Immunodeficiency Virus
IT	Information Technology
IUD	Intrauterine Death
IUGR	Intrauterine Growth Restriction
MDGs	Millennium Development Goals
MDoH	Mpumalanga Department of Health
mHealth	mobile Health
MMR	Mixed Method Research
MNCWH	Maternal, New-born, Child and Women's Health
MPNH	Maternal, Perinatal and Neonatal Health
NDHSSA	National Digital Health Strategy for South Africa
NDoH	National Department of Health
NHS	National Health Services
NQF	National Qualification Framework
PHC	Primary Health Care

SDG	Sustainable Development Goals
SIGN	Scottish Intercollegiate Guideline Network
SPSS	Statistical Package for Social Sciences
SA	South Africa
SSA	Sub-Saharan Africa
UHC	Universal health coverage
UN	United Nations
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS	iii
ABSTRACT	iv
DEFINITION OF CONCEPTS	vi
LIST OF ABBREVIATIONS	viii
LIST OF FIGURES	xv
LIST OF TABLES	xvi
CHAPTER 1	1
OVERVIEW OF THE STUDY	1
1.1. INTRODUCTION AND BACKGROUND	1
1.2. PROBLEM STATEMENT	3
1.3. AIM OF THE STUDY	3
1.3.1. Objectives of the study	3
1.4. RESEARCH QUESTIONS	4
1.5. OVERVIEW OF RESEARCH METHODOLOGY	4
1.6. BIAS	6
1.7. ETHICAL CONSIDERATIONS	6
1.9. CONCLUSION	7
1.10. LAYOUT OF THE STUDY	7
CHAPTER 2	10
LITERATURE REVIEW AND THEORETICAL FRAMEWORK	10
2.1. INTRODUCTION	10
2.2. LITERATURE REVIEW METHODOLOGY	10
2.2.1. Purpose of the literature review	10

2.2.2. Literature review sources identification	11
2.2.3. Selection of search terms	11
2.2.4. Literature search findings	13
2.2.5. Identified themes	13
2.3. PRIMARY HEALTH CARE IMPLICATIONS ON MATERNAL CARE	14
2.4. PRE-ECLAMPSIA PATHOPHYSIOLOGY AND IMPLICATIONS	15
2.5. PERINATAL AND MATERNAL OUTCOMES OF PRE-ECLAMPSIA	17
2.6. EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA	18
2.7. DIGITAL HEALTH AND MATERNAL CARE	19
2.8. PURPOSE, IMPLICATIONS, AND IMPACT OF DIGITAL HEALTH	20
2.9. DIGITAL HEALTH METHODS	21
2.9.1. Mobile health initiatives	22
2.9.1.2. Sub-Saharan Africa	23
2.9.1.3. South Africa	23
2.9.2. Telemedicine and telehealth	24
2.9.3. Medical social media	24
2.9.4. Digitized health record platforms	24
2.10. CHALLENGES, BARRIERS AND KNOWLEDGE OF DIGITAL HEALTH	25
2.11. CONCLUDING STATEMENTS	27
2.12. THEORETICAL FRAMEWORK	28
2.13. CONCLUSION	31
CHAPTER 3	33
RESEARCH METHODOLOGY	33
3.1. INTRODUCTION	33
3.2. RESEARCH METHODOLOGY	33
3.2.1. Mixed Methods Research	34
3.2.2. Justification for mixed method research	35

3.3. RESEARCH SETTING	35
3.4. RESEARCH DESIGN	36
3.4.1. Convergent parallel mixed research design	37
3.4.2. Quantitative strand of the study	38
3.4.3. Qualitative strand of the study	46
3.5. BIAS	53
3.5.1. Participants' bias	53
3.5.2. Sampling bias	53
3.5.3. Researchers Objectivity	54
3.6. FINDINGS INTEGRATION AND INTERPRETATION	54
3.7. DEVELOPMENT OF THE STRATEGIES	54
3.8. ETHICAL CONSIDERATIONS	54
3.8.1. Ethical clearance	55
3.8.2. Permission	55
3.8.3. Informed consent	55
3.8.4. Confidentiality and privacy	55
3.8.5. Principle of beneficence and maleficence	56
3.9. CONCLUSION	56
CHAPTER 4	57
RESULTS AND DISCUSSION OF FINDINGS	57
4.1. INTRODUCTION	57
4.2. DATA ANALYSIS	57
4.3. INTEGRATION OF THE QUANTITATIVE AND QUALITATIVE FINDINGS	92
4.4. INTEGRATION, INTEPRETATION AND DISCUSSION OF BOTH QUANTITATIVE AND QUALITATIVE FINDINGS	93
4.5. INTEGRATION OF FINDINGS TO THEORETICAL FRAMEWORK	105
4.5.1. Systems	105

4.5.2. Staff	106
4.6. CONCLUSION	107
CHAPTER 5	108
DEVELOPMENT OF STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN	108
5.1. INTRODUCTION	108
5.2. ALIGNING SUPPORTIVE LEGISLATIVE AND POLICY FRAMEWORK	109
5.3. DEVELOPMENT OF THE STRATEGIES	112
5.4. GUIDING DOMAINS FOR DEVELOPMENT OF STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN	114
5.5. STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN	122
5.6. CONCLUDING ON THE STRATEGIES	133
5.7. CONCLUSION	134
CHAPTER 6	136
6.1. INTRODUCTION	136
6.2. SUMMARY	136
6.2.1. Quantitative strand	136
6.2.2. Qualitative strand	137
6.2.3. Summary of the integrated findings	138
6.3. RECOMMENDATIONS	140
6.4. LIMITATIONS	141
6.5. CONCLUSION	142
REFERENCES	143
ANNEXURE A: Turfloop Research Ethical Committee Certificate	162

ANNEXURE B: Department of health permission letter	163
ANNEXURE C: letter from language editor	164
ANNEXURE D1: Consent form for midwifery practitioners	165
ANNEXURE D2: Consent form for Gravid women (English)	166
ANNEXURE D3: Consent form for gravid women (Zulu)	167
ANNEXURE E: Questionnaire for Midwifery practitioners	168
ANNEXURE F: Interview guide for gravid women	174
ANNEXURE G: Interview transcripts with one of the participants	176

LIST OF FIGURES

Figure 1.1. Layout of the study	9
Figure 2.1. Literature review process	13
Figure 2.2. Risk factors of pre-eclampsia	17
Figure 2.3: Integration of McKinsey model with literature review	31
Figure 3.1. Geographical area	36
Figure 3.2. Schematic presentation of convergent parallel method	38
Figure 4.1. Age of the participants	59
Figure 4.2. Gender	60
Figure 4.3: Qualification in nursing	61
Figure 4.4. Specialty in nursing	62
Figure 4.5. Work experience	63
Figure 5.1. Process of strategies development	109
Figure 5.2. Summarised strategies	132

LIST OF TABLES

Table 2.1. Keywords search terms	12
Table 3.1. Advantages of mixed methods	35
Table 4.1. Response rate	59
Table 4.2. Facility related variables	63
Table 4.3. Knowledge of digital health	64
Table 4.4. Digital health methods	67
Table 4.5. Barriers to digital health	69
Table 4.6. Barriers: staffing and staff development	72
Table 4.7: Barriers: workload	73
Table 4.8: Demographic data of participants	74
Table 4.9: Characteristics of participants	75
Table 4.10: Themes and Sub-themes	76
Table 4.11: Theme 1 related to significant roles of knowledge	77
Table 4.12: Theme 2 related to barriers to digital health	86
Table 4.13: Theme 3 related to suggestions to improve digital health utilization	91
Table 4. 14: Joint display of the integrated findings using case-cross comparison	100
Table 5.1. Guiding domains for strategies development	115
Table 5.2. Strategies to enhance the utilization of digital health in early detection and treatment of eclampsia by gravid women in Emalahleni local Municipality	123

CHAPTER 1

OVERVIEW OF THE STUDY

1.1. INTRODUCTION AND BACKGROUND

Maternal mortality remains a burden across the globe with 295 000 maternal deaths reported by the World Health Organisation in 2017 (WHO, 2021). This burden continues to increase despite Primary Health Care (PHC) being regarded as the cornerstone to curve the rise of maternal deaths due to pregnancy-related complications (WHO, 2021). One of the leading causes of maternal death is reported to be Pre-Eclampsia (WHO, 2021) - the elevation of blood pressure (> 140 systolic mmHg and >90mmHg diastolic) after 20 weeks of gestation with a proteinuria in a gravid women (Sellers, 2018). Pre-Eclampsia accounts for approximately 63 000 yearly maternal mortality worldwide from 5% to 11% of pregnancies, thus being remaining the leading cause of maternal and perinatal morbidity and mortality worldwide (Ross & Pierce, 2019; Townsend, O'Brien & Khalil, 2016).

According to the National Health Services (2018) of the United Kingdom (UK), approximately 6% of pregnancies develop mild pre-eclampsia and 1% to 2% develop severe Pre-Eclampsia. Furthermore one in six women with a history of Pre-Eclampsia is predicted to be most likely to have the condition in their next pregnancy (Dunsmuir, Payne, Cloete, Petersen, Gorges, Lim, Von Dadelszen, Dumont & Ansermino, 2014). As a result, the development of digital health solutions such as mobile health initiative applications, tele monitoring and SAFE@HOME to diagnose and manage pre-eclampsia has been implemented and designed for use in health facilities and homes by health care providers and patients respectively (Van den Heuvel, Lely, Huisman, Trappenburg, Franx & Bekker, 2020; Dunsmuir et al., 2014). The digital health applications assist by providing recommendations on treatment, reassessment and referral (Van den Heuvel, et al., 2022; Dunsmuir et al., 2014). On the other hand, over the past five years remarkable progress had been made in defining digital health and technologies use in the healthcare sector worldwide. Evolving of the healthcare system improve patient care, as a result pregnant women are able to access information about nutrition, complications and fetal development as well as information

about emerging risk (Arnaert, Ponzoni, Debe, Meda, Nana & Arnaert, 2019 & Tehrani, 2017). Globally, countries like China and United Kingdom proven the digital use in maternal health has significant benefits for the maternal well-being. Therefore this alludes a significant need to develop strategies to support the use of digital health in low and middle income countries to reduce perinatal and maternal mortalities and morbidities (Bosamia, 2013; Amoakoh-Coleman, Borgstein, Sondaal, Grobbee, Miltenburg, Verwijs, Ansah, Browne & Klipstein-Grobusch, 2016).

Digital Health is the utilization of digital, mobile, and wireless technologies for health, (Mehl, Tamrat, Bhardwaj, Blaschke & Labrique, 2018). Digital health innovation is significant in Sub-Saharan Africa for the reinforcement of health care services and assist in preventing the burden healthcare system (Sukums, Radovanovic, Ngowi, Noll, & Winkler, 2020). For example, Nipendeni (2015) the Health Information Technology consultant (HIT), alluded that digital health initiative is designed to improve maternal health through reduction of the maternal morbidity and mortality in Tanzania. Feroz, Saleem and Seto (2020) stated that digital health initiative such as tele-monitoring was applied in Parkinstan to support women at risk of developing pre-eclampsia by close monitoring of blood pressure at home for earliest signs. Feroz et al (2020) further stated that the use of tele-monitoring could possibly lead to early detection of Pre-Eclampsia and the required need for treatment and admission of women with pre-eclampsia.

South Africa implemented mobile health initiatives such as Mom-Connect to improve foetal-maternal well-being at home by targeted communications to pregnant women with various disorders including Pre-Eclampsia (Mehl et al., 2018). Mom Connect has over one and a half million end-users (LeFevre, Dane , Piennaer & Copley, 2018), thus indicating its significance in the maternal health. In 2018, the Mpumalanga Province was reported to have approximately 12% pregnant women registered for the mobile health initiative (Xiong, Kamunyoru & Sebidi, 2018). Furthermore, Mpumalanga was reported to have approximately 8.6% frequency of helpdesk messages and questions. The questions were based on the clinical signs of Pre-Eclampsia such as headache and proteinuria at 8.4% and 9.8% respectively; showing the awareness of gravid women of digital health and Pre-Eclampsia (Xiong, et al., 2018). However, there's limited studies pertinent to utilization of digital health in Mpumalanga to strengthen the maternal health systems by detecting and treating Pre-Eclampsia conditions.

1.2. PROBLEM STATEMENT

Countless number of women die due to complications may exist before pregnancy, but however worsens during pregnancy and childbirth. One of the major complications in pregnancy is Pre-Eclampsia (WHO, 2019). Nathan, Seed, Hezelgrave, De Greeff, Lawley, Conti-Ramsden, Anthony, Steyn, Hall, Chappell, and Shennan revealed that approximately out of 1547 Pre-Eclampsia pregnant women complicates leading to undesirable perinatal and maternal outcomes in SA. This has increased the use of digital health in managing maternal and child health problems mostly in urban areas with rural areas receiving less attention. However, the use of digital health in managing maternal and child health problems has received little attention in rural areas. Therefore, this study seek to assess the knowledge of midwifery practitioners on utilization of digital health at primary health care facilities.

During clinical practice, the researcher observed several admissions of uncontrolled blood pressure progressing to Pre-Eclampsia which digital health can play a role in assessing, detecting and monitoring the problem. Furthermore, the knowledge and barriers of gravid women and midwives on the use of digital health in early detection of Pre-Eclampsia is unknown. Based on the researcher's clinical observations and the background, this prompt to investigate the knowledge and barriers of gravid women and midwifery practitioners in utilization of digital health in early detection and treatment of Pre-Eclampsia. Thus, to develop strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia by gravid women.

1.3. AIM OF THE STUDY

The aim of the study was to develop strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia by gravid women in Emalahleni Local Municipality, Mpumalanga Province.

1.3.1. Objectives of the study

The objectives of the study were to:

- Determine and describe the knowledge and importance of utilization of digital health by of gravid women and midwifery practitioners at primary health care facilities

- Identify and describe barriers on utilization of the digital health by of gravid women and midwifery practitioners.
- Develop strategies enhancing the utilization of the digital health in early detection and treatment of pre-eclampsia by gravid women in Emalahleni local municipality, Mpumalanga province.

1.4. RESEARCH QUESTIONS

The researcher was guided by following the research questions throughout the study:

- What is the knowledge and importance of utilization of digital health by gravid women and midwifery practitioners at primary health care facilities?
- What are barriers on utilization of the digital health by gravid women and midwifery practitioners and gravid women?
- What are the strategies to enhance the utilization of the digital health in early detection and treatment of pre-eclampsia by gravid women in Emalahleni local municipality, Mpumalanga province?

1.5. OVERVIEW OF RESEARCH METHODOLOGY

A convergent parallel design of mixed research methodology was followed to conduct the study. Mixed research method is a research approach that utilizes both qualitative and quantitative research methods in collection and analysis of data in particular study (Shorten & Smith, 2017). Almeida (2018) noted that convergent parallel design aims to gather quantitative and qualitative data at the same time and provide deep relationship between the measured variables. The convergent parallel design was followed to gather gravid women and midwifery practitioners perspectives regarding the utilization of digital health which grounded the development of strategies to enhance the utilization of the digital health in early detection and treatment of Pre-Eclampsia in Emalahleni Local Municipality, Mpumalanga Province. The quantitative strand was followed to collect the numerical data of the midwifery practitioners regarding their knowledge of utilization of digital health. Whereas the qualitative strand was followed to gather the narrative perspective of the gravid women in utilization of

the digital health. The adopted mixed methods was advantageous as the strands complemented each other.

The study was conducted in 10 primary health care facilities at Emalahleni local municipality in Mpumalanga Province. The target population of the study was all midwifery practitioners working at any of the 10 primary health care facilities at Emalahleni Local Municipality. Moreover also the gravid women with Pre-Eclampsia attending antenatal care visits at any of the PHC facilities in Emalahleni Local Municipality. A simple random sampling method was used to select the 109 midwifery practitioners who completed a self-developed English questionnaire for the quantitative strand. The validity and reliability of the quantitative data collection tool was ensured through a thorough review of the literature of the prospective study and pilot study was effected to further ensure credibility of the instrument tool. The data collected for quantitative strand were analysed using descriptive statistics on a Statistical Package of Social Sciences Software (SPSS) version 28.0 with the help of the statistician. The analysed data was summarize, organised and presented in graphs and frequency distribution tables and percentages.

The qualitative strand focused on exploring the gravid women knowledge and barriers of utilization of digital health. The non-probability purposive sampling method was used to sample the gravid women. Moreover, data saturation was reached with the 10th gravid women. Semi structured one-on-one interviews were conducted with the gravid women to collect data which was analyzed using Tesch's open coding method of qualitative data analysis. . Trustworthiness of the qualitative data was ensured by following the Lincoln and Guba criteria namely, transferability, confirmability, dependability, and credibility.

The findings of the quantitative and qualitative strand were integrated together to further compare the results. Furthermore, the findings were interpreted to check the extent which the findings converged, diverged, and relate to each other. The integrated findings informed the development of the strategies. A McKinsey 7s Model and Appraisal Guidelines for Research & Evaluation II (AGREE II) guided the development of the strategies to enhance utilization of digital health in early detection and treatment of Pre-Eclampsia by gravid women. Chapter 3 will discuss the research methodology in detail.

1.6. BIAS

Bias was minimized by selecting of participants using simple random sampling in the quantitative strand providing those equal chances to participate. The researcher abstained from adding on his opinions during the interviews and the use of the standardized questionnaires assisted in minimizing bias. Bias will be thoroughly explained in chapter 3.

1.7. ETHICAL CONSIDERATIONS

Ethical considerations is the preservation of the rights and wellbeing of the participants involved in a research study (Joubert & Ehrlich, 2014). The ethical standards and principles were adhered during the study namely; informed consent, permission, confidentiality, ethical clearance and the principle of beneficence and non-maleficence. The ethical considerations will be elaborated in detail in chapter 3.

1.8. SIGNIFICANCE OF THE STUDY

- **Department of health**

The department of health may also benefit from the study through the provided significant strategies to optimize the utilization of digital health and improve effective quality antenatal care through utilization of the mHealth in pre-eclampsia gravid women.

- **Clinical midwifery practice**

The study may also improve the midwifery practitioners' knowledge on utilization of the digital health to early detect and treat Pre-Eclampsia. Further establish a therapeutic relationship between midwifery practitioners.

- **Nursing research**

The study may also identify areas that further needs research to strengthen the utilization of digital health in minimising the maternal and perinatal morbidity and mortality globally and nationally.

- **Midwifery education**

The midwifery education and training institution may benefit from the study by acknowledge the importance of digital health in curving perinatal and maternal

mortalities, and thereafter integrate the digital health subject into the midwifery learning curriculum.

1.9. CONCLUSION

In this chapter a background and problem statement of the context of the study was elaborated and further addressed the purpose and the objectives of the study. In addition a brief highlight of the research methodology was discussion on how the study was conducted and how validity and reliability and trustworthiness were approached prior to collection of the data.

1.10. LAYOUT OF THE STUDY

CHAPTER 1 THE OVERVIEW OF THE STUDY

This chapter extensively described the introduction and background of the study, problem statement, aims and objectives of the study, research questions, and significance of the study. Furthermore it highlighted the theoretical framework that guided the study

CHAPTER 2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter outlines the literature review and the literature review methodology adopted in this study. Moreover it further describe the adopted theoretical framework and integrates it with the literature.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter discusses the research methodology and the adopted research design, study site, population, sampling, data collection in-depth and data analysis.

CHAPTER 4 PRESENTATION, INTEPRETATION AND DISCUSSION OF FINDINGS

This chapter outlines the quantitative findings, qualitative findings and integrated findings. It further outlines the process of

integrating the results and integrating the results with the theoretical framework.

CHAPTER 5 DEVELOPMENT OF STRATEGIES

This chapter outlines the development of the strategies and the process guided the development of the strategies and also the supporting legislative and regulatory framework.

CHAPTER 6 SUMMARY, RECOMMENDATIONS, LIMITATIONS AND CONCLUSIONS

This chapter outlines the summary of the results, limitations, and recommendations of the study. However, the figure 1.1 illustrates the layout of the study.



Figure 1.1: layout of the study

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. INTRODUCTION

Literature review is pragmatic method to collecting and retrieving of all published research studies for the purpose of gathering data on a topic of interest for development of guidelines, strategies and models based on the summarised information relevant to the topic of interest (Brink, Van der Walt & Van Rensburg, 2017). The literature review acknowledged current studies in relation to the study from peer reviewed journals and sources. Qualitative, quantitative and reviews from electronic data base were used to support the study and provide a theoretical framework. The scholarly sources were critically evaluated, synthesized, summarized, and analysed to give a clear picture of information relevant to the study.

2.2. LITERATURE REVIEW METHODOLOGY

Literature review is a survey of good scholarly sources that summarizes, evaluate, synthesizes and analyses information to give a clear understanding and knowledge of the proposed subject of the current study (McCombes, 2019). The current study adopted a narrative literature review methodology to identifies and summarizes the previously published studies and avoid duplications; and further seek new study areas (Ferrari, 2015). Adoption of the narrative literature review methodology allowed the researcher to identify, evaluate, synthesize, and critically analyse the published studies regarding digital health utilization in the care of Pre-Eclampsia. Moreover, the narrative literature review assisted with drafting an evidence based global and national perspective picture underpinning the digital health utilization by patients and health care providers. The steps of narrative literature review were adopted below as applied by Ferrari (2015),

2.2.1. Purpose of the literature review

The literature review is aimed at retrieving current empirical evidence underpinning the utilization of digital health in early detection and treatment of Pre-Eclampsia at primary health care facilities. Furthermore, the literature review was subjected to

identify the extensive existence of research gaps of what is currently known to develop strategies to enhance the utilization of digital health in early detection and treatment of Pre-Eclampsia at primary health care facilities. Making use of the practical evidence determined and identified through the literature review to expedite an ingenious background, comprehensive clinical judgment, and standardized quality care for gravid women with Pre-Eclampsia. This was achieved by answering the following questions.

- What is the knowledge and importance of utilization of digital health by midwifery practitioners at primary health care facilities?
- What is the knowledge of gravid women on the utilization of digital health?
- What are the barriers on utilization of the digital health by midwifery practitioners and gravid women?

2.2.2. Literature review sources identification

A thorough literature sources review was initiated as early as August 2021 using electronic databases with peer-reviewed journals such as PubMed, google scholar, and science direct, to obtain information about digital health utilization which was managed with paperpile and Mendeley. Moreover, other sources such as websites and textbooks were reviewed to identify and synthesis the literature of relevance to the current study through cross-referencing of other published articles.

2.2.3. Selection of search terms

The selection of literature was achieved through using several key words and various combinations of words to select the appropriately relevant literature and exclude the irrelevant literature. Truncation, phrase searching, keywords searching, and Boolean operators were adopted using the nesting logic to gather extensive literature relevant to the topic. Truncation and wild card searching permit the researcher to search the roots and portion of words with the variant ending; whilst Boolean operators are based on the Boolean algebra mostly used in databases and further provide the ability to combine variant concepts to access the relevant items. The use of “AND, OR and NOT” are the basic Boolean connectors (Coughlan, Cronin & Rya, 2013). Meanwhile, nesting is used to reveal search logic and the order in which Boolean commands will be executed using parentheses.

2.2.3.1. Key words

The literature search was broadened using; “NOT, OR, AND, Vs, asterisk, exclamation mark, and question mark. The literature search included keyword search, Boolean operators, and truncation such as; (digital health AND utilization), Digital health*, digital health vs pre-eclampsia, digital health in primary health care facilities? ((pre-eclampsia NOT eclampsia), (Pre-eclampsia AND primary health care facilities)), knowledge OR utilization of digital health. Pre-eclampsia trends*, “digital health utilization in primary health care facilities”, “Digital health”. Each mechanism used with the key words searching revealed a broad spectrum of literature and the irrelevant literature was excluded.

Table 2.1. Keywords search terms

Digital health related terms	digital health methods, digital health in primary facilities, digital health in pregnancy, digital health vs pre-eclampsia
Utilization of digital health related terms	knowledge of digital health, implications of digital health
Pre-Eclampsia Related Terms	pathophysiology, perinatal and maternal outcome

2.2.3.2. Inclusion criteria

The literature review included studies published from the year January 2010 to July 2021. Moreover, the quantitative, qualitative, mixed methods, narrative and systematic analyses were included in the literature. Lastly, the written English sources concentrating on and relevant to digital health utilization in early detection and treatment of Pre-Eclampsia were included (Patino & Ferreira, 2018). The study only included studies focusing on digital health, digital health initiatives, and Pre-Eclampsia to gather extensive data on the problem under study.

2.2.3.3. Exclusion criteria

Literature that was published before 2010 and not English-based was excluded. Moreover, literature irrelevant to digital health utilization in early detection and treatment of Pre-Eclampsia was excluded (Patino & Ferreira, 2018). The excluded studies were outdated, some were duplicates and others were irrelevant to the problem under study.

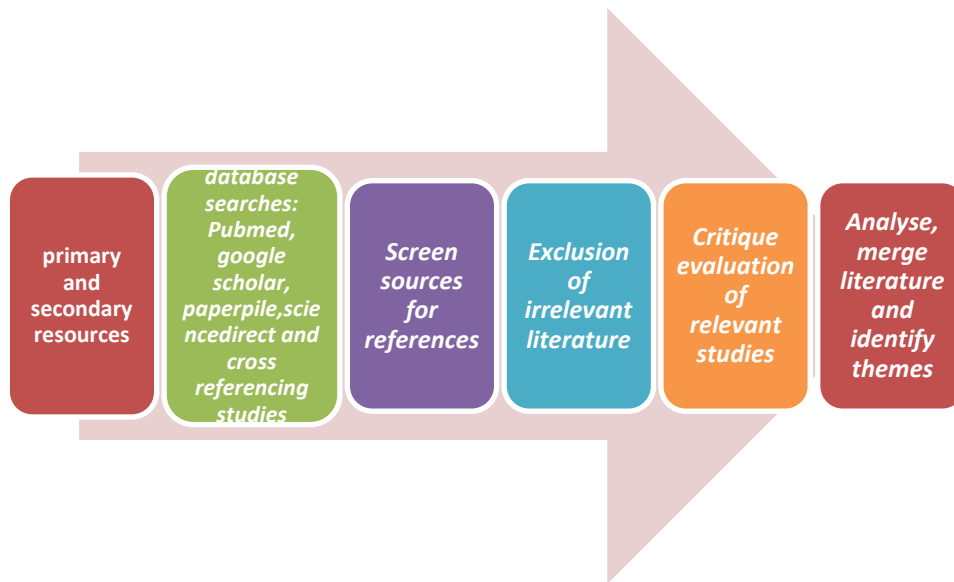


Figure 2.1. Literature review process (Polit & Deck, 2012)

2.2.4. Literature search findings

The findings of the literature search were as follows:

The literature has a total of 46 studies which were qualitative, quantitative, mixed research methods, systematic reviews, meta-analysis reviews and narrative reviews. Other 11 kinds of literature were from websites and one book was also reviewed. In addition, this literature review only included literature of relevance.

2.2.5. Identified themes

The thorough literature review identified the following themes of the current evidence underpinning digital health utilization;

- Primary health care implications on maternal care
- Pre-eclampsia pathophysiology and implication
- Perinatal and maternal outcomes
- Early detection and treatment of pre-eclampsia

- Digital health in health and maternal care
- Purpose, implications and impact of digital health
- Challenges, barriers and knowledge of digital health

2.3. PRIMARY HEALTH CARE IMPLICATIONS ON MATERNAL CARE

Primary Health Care (PHC) is a whole of society approach to the well-being of persons that targets optimal health standards. It warrants standardized quality and unbiased care taking into consideration the individual's needs in the context of the prevention of illnesses such as Pre-Eclampsia and promotion of health, furthermore interventions of the PHC across the developing countries expected to save approximately 60 millions of lives and possible upsurge the life expectancy by 3.7 years by the year 2030 (WHO, 2021).

Warren, Mohammed, Hossain, Ishaku, Armbruster and Hillman (2020) indicated that the global health community endorsed an obligation to appoint PHC as a keystone to endeavor the sustainable development goals (SDGs) by the year 2030. However, the achieved decrease in maternal mortality between 1990 and 2015 by 44% and 49% correspondingly. Hypertensive disorders in pregnancy (HDPs) such as Pre-Eclampsia included remain the cause of death accounting for 11% and 16% of maternal deaths and stillbirth amongst gravid women globally respectively (Warren et al., 2020). The aspects of classification, diagnosis, and management of HDPs remain disparity globally. Thereafter, leading to a lack of consensus that hinders the aptitude not only to study the immediate rates of adverse effects of perinatal outcomes for the classified HDPs but also the long-term effects on the maternal and new-born's health that survived the condition, (Brown, Magge, Kenny, Karumanchi, McCarthy, Saito, Hall, Warren, Adoyi & Ishaku, 2018).

Salomon, Ishaku, Kirk & Warren (2019) showed that PHC accomplished significantly worse than tertiary institutions in all elements of quality of care in assessment, diagnosis and treatment of HDPs. Furthermore, aforementioned authors substantiated that to provide optimal standard care, PHC must seek to regenerate ANC programs through training to reduce disparity in quality of care. Salomon et al (2019) in Etopia showed that the prevalence of HDPs and Pre-Eclampsia in Etopia were 6.82% and 4.74%, indicating that the prevalence of such conditions is relatively higher compared

to previously therefore further encouraging stakeholders and government to reinforce ANC practice to include identification of risk factors of HDPs at early ANC visits.

Naaido and Pattison (2020) stated that 78% of maternal deaths in South Africa at the secondary and tertiary levels of care are due emergencies such as Pre-Eclampsia emerged from PHC facilities and district hospitals. Moreover, such deaths were due to preventable factors at community health centers accounting 60% of cases of maternal deaths because of poor assessment, faults in diagnosing, delayed or no referrals to a higher level of care as well as non-adherence to treatment protocols and inadequate monitoring (Naaido & Pattison, 2020).

As a result of such maternal mortalities resulting from preventable factors, South Africa implemented mobile health initiatives such as mom connect to improve fetal-maternal well-being at home by targeted communications to pregnant with all of disorders pre-eclampsia included and breastfeeding women via messages with the provision of information reflecting on their gestational age or postpartum period twice weekly, (Mehl Et al., 2018). Mom-Connect has over one and a half million end-users (LeFevre, Dane & Piennaer & Copley, 2018).

2.4. PRE-ECLAMPSIA PATHOPHYSIOLOGY AND IMPLICATIONS

Pregnancy results in physiological adaptation in all the body system, however, failure of such adaptation could lead to several illnesses within the gravidas. For instance, pregnancy-induced by hypertension resulting from the failure of the trophoblast to invade the spiral arteries causing vasoconstriction and damage to the endothelial layer such as the impact on gravidas causes impact and compromise placental foetal unit likely to lead to negative perinatal outcomes, (Sellers, 2018).

Pre-eclampsia has multifaceted pathophysiology, abnormal placentation being the primary cause (Uzan, Leimone, Granger & Karumanchi, 2011). The pathogenesis of Pre-Eclampsia progresses in 2 stages; being abnormal placentation in the first trimester and maternal syndrome in the second and third trimesters characterized by antiangiogenic factors. A non-conclusive number of theories have been proposed for placental dysfunction; being oxidative stress, abnormal natural killer cells, and genetic and environmental factors (Rana, Carbonnel, Piconne, Asmar & Ayoubi, 2019). The progressive stages are as follows;

Stage 1: Abnormal placentation

In normal placentation implantation, cytotrophoblasts invade the maternal spiral arteries, to form a maternal-fetal crossing point for nutrition and other functions. However, during pre-eclampsia development, there's a failure of the cytotrophoblast to migrate into the spiral arteries. This leads to incomplete spiral artery remodeling causing spiral artery narrowing causing oxidative stress and placenta ischemia (Rana et al 2019, Uzan et al., 2011). The placental ischemia will result in fetal complications such as intrauterine growth restrictions (IUGR) and intrauterine death (IUD). The oxidative stress due to decreased oxygen tension results in maternal peripheral endothelial cells dysfunction causing systemic inflammatory response leading to the second stage namely; maternal syndrome (Burton, Redman, Roberts & Moffett, 2019; Rana et al 2019; Uzan et al., 2011).

Stage 2: Maternal syndrome

The effects of stage results in decreased blood flow to the maternal organs leading to multi-organs failure in the maternal systems. The biological assessment will then indicate vasospasm, coagulation cascade activation, and decreased plasma levels (Burton et al., 2019). As a result of the endothelial cell dysfunction, a hepatic system will be affected contributing to Haemolysis, elevated liver enzymes and Low platelet count (HELLP) syndrome, and neurological system impairment (cerebral endothelial damage) causing neurological disorders (Uzan et al., 2011). Moreover the endothelial dysfunction results in renal system impairment, i.e. acute kidney failure and proteinuria (Kattah, 2020). Lastly, endothelial dysfunction promotes microangiopathic hemolytic anemia and hyperpermeability linked with low albumin levels causing pulmonary and peripheral edema (Uzan et al., 2011). Burtons et al., (2019) pre-eclampsia is associated with several risk factors (table).

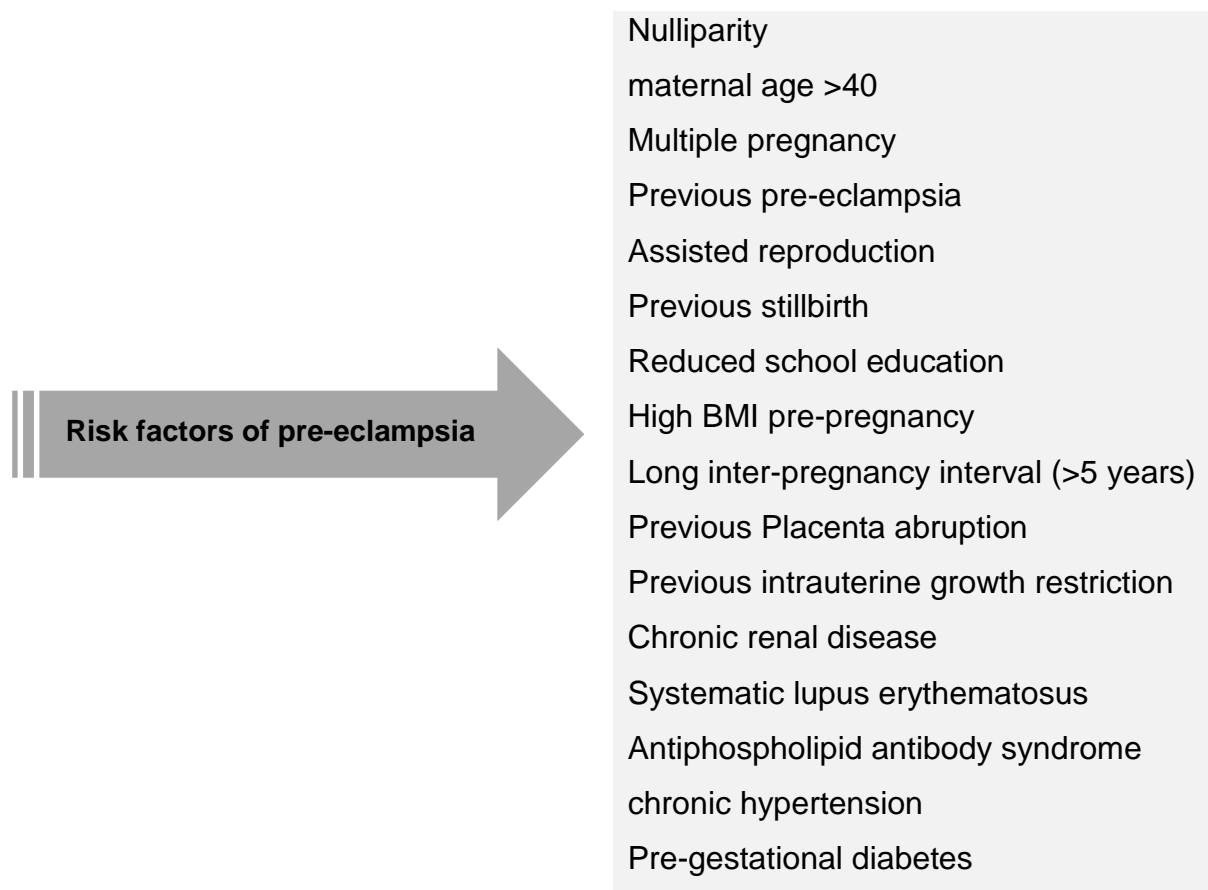


Figure 2.2: **pre-eclampsia risk factors (Burtons et al., 2019)**

2.5. PERINATAL AND MATERNAL OUTCOMES OF PRE-ECLAMPSIA

Globally, approximately 10% of pregnant women develop hypertension during pregnancy and 2% to 8% of pregnancies are complicated by pre-eclampsia (WHO, 2011). Approximately 10%-15% of direct maternal deaths lead to undesirable physiological changes in the kidneys, liver, brain, and clotting systems, further associated with poor fetal outcomes such as poor fetal growth and prematurity, (Luger & Kight, 2017). According to Deng, De Klerk Li, Lou, and Jacoby (2010), more than a half-million women died during pregnancy and childbirth across the globe in 2000 and 2002. It was also estimated that half of these maternal deaths occurred in Africa (251 000) and about 48% in Asia (253 000) (Deng et al., 2010).

In Sub-Saharan Africa (SSA), a meta-analysis of thirteen studies in Etopia by Mersha, Abegaz and Seid (2019) revealed that 4% died and 13% had HELLP syndrome out of 5894 women diagnosed with hypertensive disorder. Moreover, adverse perinatal

outcomes were reported with perinatal death at 25% and prevalence of low birth weight at 37%. Hence the researcher recommends the development of strategies and policies to enhance quality maternal health services (Mershia, Abegaz & Seid, 2019). Osungbade and Ige (2011) stated that WHO estimates that the prevalence of Pre-Eclampsia in developing nations is seven times that of developed nations. Furthermore, the rates of Pre-Eclampsia in African countries vary from 1.8% to 7.1%. Nathan, et al., (2018) reported that hypertensive disorders remain a burden amongst pregnant women at three South African tertiary hospitals. It was also reported that the incidence of pre-eclampsia is relatively in obese women and pregnant teenagers. Nathan et al (2018) further reported that obese women and pregnant teenagers were more prone to pre-eclampsia complications such as perinatal deaths and preterm deliveries. Furthermore, Nathan et al (2018) further reported that out of 1547 women having Pre-Eclampsia 1% died, 0.3% had a stroke whilst approximately 9.5% progressively developed eclampsia and kidney injury at 17.6%. Moreover, it was reported Out of 1589 births were associated with perinatal deaths at 21% and 84.5% of stillbirths; 1308 live births were preterm deliveries. Mhlophe, Bhana-Pema and Peu (2019) corroborated that hypertensive disorders pose a significant risk to the well-being of the mother and the fetus. It was reported that approximately 12% of the women admitted at Witbank hospital had stillbirths due to hypertensive disorders in pregnancy. Thus, the need for evaluation of midwifery practitioners and gravid womens' knowledge and barriers to utilisation of digital health in early detection and treatment of pre-Eclampsia. For the purposes of development of strategies which can mitigate perinatal and maternal deaths due to avoidable factors.

2.6. EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA

Detection of early onset Pre-Eclampsia can be achieved through effective screening as early as the first trimester. Moreover, screening can be achieved via certain methods such as maternal history screening by a combination of maternal risk factors, placental growth factor, mean arterial blood pressure, and uterine artery Doppler (Poon & Nicolaides, 2014). To deal with this major concern digital health initiatives are being increasingly used especially in maternal health, as it show potential to improve maternal health (Arnaert et al., 2019). A retrospective study for early prediction of pre-eclampsia using machine learning through analysis of clinical and laboratory data in

previous ANC visits; revealed that a significant set of features for prediction of pre-eclampsia were identified which showed significantly elevated prediction performances of the risk of pre-eclampsia (Maric, Tsur, Aghaeepour, Montanari, Stevenson, Shaw & Winn, 2020). Espinilla, Medina, Garcia-Fernandez, Campana and Londono (2017) corroborated that early detection of pre-eclampsia is a global burden that should be addressed. The study developed a wearable device to monitor women at risk of pre-eclampsia using the identified risk factors and blood monitoring the prototype yielded good results for identification of the biomedical signals. However, comparison of the methodology is still to be done with another facility.

Digital health can overcome access limiting factors and lack of trained HCP in low-resourced settings through mHealth solutions. Studies have proven mHealth can benefit pre-eclampsia women through early detection and symptoms control. mHealth has a great potential on improving clinical practice as positive results were reported on maternal health improvement through digital health (Rivera-Romero Et al., 2018). Keasbery, Scott, Sullivan, Staib and Ashby (2017) substantiated that use of digital health such as electronic health (eHealth) showed improved efficiency and suitability of care, moreover had an effect on mortality, readmissions, and total costs. Ganapathy, Grewal and Castleman (2016) further corroborated that the use of digital health such as mobile technology through self-monitoring of blood pressure among women at risk of pre-eclampsia reduces perinatal and maternal mortalities and morbidities due to pre-eclampsia and reduce the number of hospitalizations.

2.7. DIGITAL HEALTH AND MATERNAL CARE

Digital health is a comprehensive category entailing mobile health, electronic health, and telehealth and health data. It strengthens health systems by bringing such services directly to their homes and to unprivileged communities; further mapping illness outbreaks and digital tool integration to make health care to be more productive and approachable (WHO, 2020). Over the past 20 years, digital health technology has been splendidly growing to improve health and maternal health. Furthermore, digital health technologies vary some are client-focused meaning they provide women enhanced capabilities to raise their health and risk consciousness, self-participated monitoring and management during preconception, antenatal and postnatal period. In addition provide awareness of any pregnancy-related complications such as pre-

eclampsia and treatment as well as lifestyle and health choices (Mackintosh, Gong & Verdezoto, 2021).

While some digital health technologies are provider-focused digital health technologies; they enable substantial management of obstetric complications during primary consultation, admission, and referral process. Telemedicine and telecare are common examples of digital systems that encompass access to specialist services behind the limitations of the clinic. In addition, the systems are developed for healthcare professionals and introduced to the high-risk patients, i.e., pre-eclamptic women (Mackintosh et al., 2021).

Digital health innovations are not replacements for the health system in place, however, they empower and enhance the components of the health systems to make informed decisions and optimize health outcomes (Government of Canada, 2020). The National Department of Health (NDoH) on the national digital health strategy for South Africa for 2019-2024 (NDHSSA) substantiated that digital health enables support for health sectors for a health life for the population through health systems strengthening to enable service delivery. Moreover further enable effective patient care and personal empowerment needed to achieve universal health coverage (UHC), (NDHSSA, 2019). A case study conducted by West (2015) showed that mobile communications encourage the provision of fast and accessible care. Moreover, it was found that digital health through mobile devices increases workplace efficient and enables faster decision-making among health care providers (HCP).

Pillay and Motsoaledi (2018) detailed that the public health system is distorted to more comprehensive and cohesive health systems in South Africa. The use of public health services across the scale of care was highest in SSA. Approximately 94% of pregnant women attended ANC and 76% attended the recommended ANC visits showing active utilization of such services to achieve the MDG 5. However, this use of public services was linked to digital health initiatives such as mom connect (Pillay & Motsoaledi, 2018).

2.8. PURPOSE, IMPLICATIONS, AND IMPACT OF DIGITAL HEALTH

Digital health primarily aims to provide widespread reachable and digestible information to all stakeholders. It provides high-quality information essential to

researchers, patients, health care providers, social scientists, industries and government (Dahlhausen, Zinner, Bieskie, Ehlers, Boehme & Fehring, 2022). Digital health includes variants of sets such as mobile health, telehealth, telemedicine, health information technology, wearable devices and personalized medicine. Digital health can improve the diagnosing and treating of illnesses, further heightening the rendering of health care for each person (Food Drug Administration (FDA), 2020).

The use of digital health can assist in reaching a well informed decision about one's health and provide alternative options for facilitating prevention, early diagnosis of life-threatening diseases, and management of diseases outside the health care facilities. The stakeholder's implications with regards to the utilization of digital health were that it optimizes patient care and personalize individual's care through reduction of inefficiencies and costs, improved accessibility, optimal quality, and more patient-oriented care (FDA, 2020; Ronquillo, Meyers & Korvek, 2017).

Gopalakrishnan, Buback, Fernald, Walker, and Diamond-Smith (2020) in India revealed that mHealth was accepted by community health workers because it sought to improve their status in their communities. However, there was a mix of negative and positive perceptions surrounding the use and impact of the mHealth software such as underlying mistrust, socio-economic barriers in engagement, and technological barriers in implementation (Gopalakrishnan et al., 2020).

2.9. DIGITAL HEALTH METHODS

According to Mol, Roberts, and Thangaratinam (2015) approximately 3%-10% of pregnancies are complicated by hypertensive disorders. Kassebaum, Bertozzi & Coggeshall (2013) corroborated that around 30 000 women yearly die due to hypertensive disorders during pregnancy. This shows that the use of digital and telehealth can considerably benefit women at risk of hypertensive disorders and ensure early detection of symptoms and treat the symptoms and improve maternal and perinatal outcomes during and after pregnancy (Mercer, 2021; Rivera-Romero et al 2018). Tobe, Haque and Mori (2018) documented that using digital health such as mobile can make great contributions to reducing maternal and neonatal mortalities. The digital methods below will be client focused and provider-focused from global, SSA and South Africa. However, below are the digital health methods used by various

countries to strengthen the maternal digital health system for high-risk and low-risk pregnancies.

2.9.1. Mobile health initiatives

The surge of mobile health can transform the mode as well as the quality of clinical research at a universal scale. Mobile health is the utilization of mobile phones to support health. The implementation of such is reportedly to have a great impact on the healthcare system (Steinhubl, Muse & Topol, 2015; Iyengar, 2020). Below mobile health initiatives are presented at the international, Sub-Saharan, and national level.

2.9.1.1. International

- ***Text4Baby***

Whittaker, Matoff-Stepp, Rhee and et al., (2012) is a mHealth initiative in the United States that provides timely messages to pregnant women and puerperia's with regards to their wellbeing. Furthermore, mHealth addressed the prenatal and postnatal being of the women with messages addressing pregnancy, labor, nutrition, and when to reach health care. Text4Baby is one of the patient education strategies to help curve the rise of maternal and perinatal morbidity and mortality due to pre-eclampsia (Roberts, August, Bakris & et al., 2013).

- ***Smart-mom***

Smart-mom is a Canadian mHealth initiative focused on prenatal education for pregnant women through text messages (Smart mom mobile health education, 2021). Smart-mom guide women throughout pregnancy by the provision of evidence-based information developed by experts in maternal and child health (Smart mom mobile health education, 2021).

- ***Mobile4Health***

In response to significantly high maternal mortality rates in Bangladesh due to maternal pregnancy-related conditions such as Pre-Eclampsia, the Mobile4Health initiative was developed. The mobile health initiative aimed to provide pregnant women with information via messages for self-care relating to their conditions and postpartum care (West, 2015).

2.9.1.2. Sub-Saharan Africa

- ***Pigia daktari***

Pigia Daktari is a Tanzanian telemedicine mobile app developed for use by HCP and patients to access specialized care, especially for patients in communities with no specialized care. Moreover, it encourages the utilization of a referral system and it user-friendly interactive box; it aims to identify and solve existing barriers to access and provide consistent and timely optimized health services (Dar es Salaam, 2021).

- ***Wazazi Nipendeni***

Nipendeni (2015), the HIT consultant reported that mHealth initiative is used by Tanzanian pregnant women to receive tailored messages with regards to pregnancy and gestational age as well as the health of their infant. The mHealth was implemented to reduce high Tanzania's maternal and infant mortality ratio.

2.9.1.3. South Africa

- ***Mom-connect***

Mom-connect is a South African client-focused digital mHealth initiative utilized by pregnant women and puerperia's through any mobile device integrated with maternal and child health services via messages in all 11 official languages (National department of health, 2014). Mom-connect has registered more than 60% of gravid women nationally, and registered approximately 1.7 million subscribers since 2014, maternal health service will improve maternal health services and most patients were enthusiastic on utilization of the mHealth (Peter Et al., 2018).

- ***Essential Medicine guidance***

Essential medicine (EM) guidance is a provider-focused digital health app initiative that encompasses 12 local clinical guidelines and decision-making tools for HCP. Moreover, EM guidance assists the HCP in accurately diagnosing and management of conditions such as Pre-Eclampsia utilizing South Africa's comprehensive evidence-based medicine sources (EMGuidance, 2021).

2.9.2. Telemedicine and telehealth

- ***SAFE@HOME***

Van den Heuvel, Lely, Huisman, Trappenburg, Franx, and Bekker (2020) describe SAFE@HOME as a digital health platform designed to monitor daily blood pressure monitoring and symptoms amongst women with chronic hypertension, history of Pre-Eclampsia, and Pre-Eclampsia in the Netherlands. The evaluation of the care telepath noted a significantly minimal admission amongst women with hypertension and suspected Pre-Eclampsia with the utilization of the SAFE@HOME tele monitoring. According to Van den Heuvel et al (2020), SAFE@HOME tele monitoring of blood pressure amongst women is feasible in high-risk patients for early detection and has the potential to change antenatal care (ANC).

2.9.3. Medical social media

Social media platforms are regarded as one of the digital health initiatives widely. Dekker, King, and Lester (2016) stated that women were highly engaged in utilizing social media to access and share maternity information. Fatema and Lariscy (2020) supported that utilization of maternal health care services was significantly higher among women who were exposed to mass media across countries and such women were 46% to 86% likely to receive ANC.

Igbinoba, Soola, Omojola, Odukoya, Adekeye and Salau (2020) corroborated that the internet was the most used source to access maternal health awareness services at 49% and followed by adverts and campaigns at 30.6%. Johnson (2014) supported that apps claim to sanction for greater convenience, connectivity, and efficiency. Social media such as Facebook have many users and allow women to access and share information with other moms with regard to their pregnancy.

2.9.4. Digitized health record platforms

Digitized health records systems are technological innovations adopted by numerous health institutions (Celi, Marshall, Lai & Stone, 2015). Meghea, Corser and You (2015) indicated that the use of electronic medical records for maternal and child care and health most like improves health care, as supported by the results that the women who

had prenatal care visits with the HCP who adopted the Electronic Health Record (EHR) were most likely to have well-child visits.

A qualitative analysis of the user of EHR in the maternity care environment described it as being favourably, whilst other midwives showed limited understanding of the EHR (Hawley, Jackson, Hepworth & Wilkinson, 2014). However, Munyaradzi, Katurura, and Cilliers (2018) identified social, technical and environmental barriers, i.e. lack of supporting infrastructure, political influence, legislation and regulations, user's training and commitment, and lack of structure implementation and management.

2.10. CHALLENGES, BARRIERS AND KNOWLEDGE OF DIGITAL HEALTH

Despite the standard benefits and implications of digital health in clinical practice to diagnose, treat, disease management and prevention and wellness, challenges and issues arose such as doctors not having adequate information for prescription and the use of digital health technologies, (Ronquillo et al., 2017). A perspective review by Lupton (2015) on critical perspectives on digital health technologies reported several complexities on patients' perspectives on the use of digital health such as telehealth; some patients felt that they had slight control over their doctors' decision to use technologies and wish to continue using the ordinary patient-doctor model.

Matthews, McShea, Hanley, Ravitz, Labrique and Cohen (2019) in the United States of America (USA) stated that the concept of digital health continues to evolve and digital health technologies are being used world-wide in medicine to diagnose, treat and clinical decision support. Kostkova (2015) corroborated that the impact of digital health technologies on optimizing an individual's health and well-being is extraordinary as the technologies have transformed clinical practice from prevention to disease management and self-management. However, despite the uprising of digital health in clinical practice, challenges were noted during the path to validation of digital health hindering the extensive implementation of evolving approaches such as health digital scorecards and requirements-driven approach (Matthews et al., 2019).

In a study conducted in the United States, lack of technical support, lack of authentication of expertise, and lack of expertise usability were the barriers of implementation of digital health by patients with hypertension, (Palacholla, Fischer, Coleman, Agboola, Kirley, Felsted, Katz, Llyod & Jethwani, 2019). There is a number

of contributing factors hindering the implementation of electronic health (e-Health) programs in Uganda such as poor coordination and communication, untrained health personnel, loss of network connection, lack of knowledge and skills about telehealth, illiterate community, and people's financial status, (Kiberu, Mars & Scott, 2017).

Littman-Quinn, Antwin, Mabinge, Chandra, and Kovarik (2013) conducted a study on the implementation of digital health technology such as mHealth applications in Botswana aiming to reduce patients and HCP barriers in accessibility to care and knowledge respectively. The implementation of the mHealth technologies indicated that numerous social and technical challenges were faced; such as cultural misalignment between the Information technology (IT) and HCP, unreliable IT, infrastructure accidental damage to mobile devices, and malfunctioning mobile devices (Littman-Quinn et al., 2013).

Ohia, Ongolo-Zogo and Fawole (2021) substantiated that there are unraveling barriers in the adoption of digital health at the primary health care level in African Countries by health care providers such as lack of technology knowledge, lack of innovation acceptance, limited knowledge and abilities of the utilization of digital health, absence of enthusiasm and poor organizational and management level. Furthermore study conducted in Iran shown significant poor knowledge of health care providers in the utilization of digital health and most probably due to lack of training (Ohia et al., 2021).

Approximately 79% of pregnant women utilizing mom connect in the year 2017 asked question-related health and others were about disrespect and abuse from midwifery practitioners, showing significant utilization of digital health (Peter et al., 2018). Further showing that improper communication between the midwifery practitioners and gravid women can further hinder the utilization of digital health by gravid women. However, despite the improper communications, approximately 2.5 million pregnant women registered for the digital health initiate by 2019, thus showing effective usage of digital health among pregnant women (National Digital Health Strategy for South Africa, 2019).

The working conditions can hinder optimal midwifery care to the patient such as the implementation of digital health; this is supported by Mathebula and Thopola (2016) that absenteeism, shortage of staff, work overload of staff, and overcrowding of patients in healthcare facilities are contributing factors to perinatal morbidity and

mortality. This significantly remains a major common barrier in the provision of standardized care such as improper teaching of pregnant women as the utilization of mom connect.

2.11. CONCLUDING REMARKS

As South Africa thrives moving towards the universal health coverage for better access to health care services through health care systems (Fusheini & Eyles, 2016). Digital health initiatives such as mobile health technologies were developed to improve better access to communities in low- and middle-income countries. The implementation and practices of digital health seems to be growing expandable to achieve the UHC goals in provision of care to all global and nationally.

However, it is clear from evidence in the findings that South Africa had limited studies on utilization of digital health initiatives in early detection and treatment of pre-eclampsia. These evidently shows the significant need of increased awareness of digital health to mass communities and pregnant women as this could possibly lead to achievement of the SDG 3 which includes reduction of maternal and infant mortalities. Moreover pre-eclampsia has be categorized as the one of the leading cause of maternal mortalities across the globe (Ghulmiyyah & Sibai, 2012). Pre-eclampsia and eclampsia accounts for about 63 000 maternal mortalities yearly globally (Ross & Pierce, 2019). Pre-eclampsia further affects the maternal-foetal unit resulting into perinatal morbidities and mortalities such stillbirths and prematurity. A population-based cohort study to estimate gestation risks of pregnancies complicated by pre-eclampsia identified risk of stillbirths was 3.6 per 1000 overall and 5.2 per 1000 among pre-eclampsia pregnant women (Harmon, Haung, Umbach, Klungsoyr, Engel, Magnus, Skjaerven, Zhang & Wilcox, 2016). Subsequently emphasize the need of digital health initiatives for pregnant women and health care providers to assist with early detection and treatment of pregnant women at risk of pre-eclampsia.

Despite the digital health initiatives in maternal health services, significant number of studies identified a number impedimental factors of implementation of the initiatives from both users; pregnant women and health care providers. The impediments included poor coordination and communications, unreliable technology, lack of knowledge of technology, people financial status and untrained personnel (Kiberu et al 2017, Littman-Quinn et al 2013 & Ohia et al 2021). As it may be, strategies and

guidelines of implementation of digital health at all levels of health must be in place to improve the effectiveness and efficient use of digital health by pregnant women and health care providers.

However overall studies acknowledged pertinent to digital health in maternal services outlined the significance of digital health in effectiveness and efficiency of maternal health care services; these included reduced admission among pre-eclampsia women, raise awareness of pregnancy related complications, lifestyle modification, symptom control and improved accessibility (Keasbery et al 2017, Mackintosh et al 2021 & West 2015).

2.12. THEORETICAL FRAMEWORK

2.12.1. Introduction

A theoretical framework is the blueprint for the entire dissertation inquiry. Furthermore, it supports a theory of the research study and further binds the theory of research, and further address the theory in line with the literature review and the concept of the research on how the research study became of concern to the researcher (Grant & Osanloo 2014; Kivunja 2018; Corvellec 2013). It is based on the existing theory and serves as a foundation on the ground on which the research is constructed (Grant & Osanloo, 2014 and Adom, Hussein & Agyem, 2018). The study was guided by McKinsey 7s framework to develop strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia by gravid women. Peters, Waterman and Philips, McKinsey consultants developed the 7s model in 1980s to identify whether efficiently align and assist the institution achieve set objectives. Moreover, the McKinsey 7s model is divided into two models, soft S (staff, style, shared values, & skills) and hard S (systems, structure & systems) these components interconnect and ensure effective change within an organization (Ravanfar, 2015).

2.12.2. Rationale for adoption of the framework

McKinsey's 7s model analyze an institution's design taking into consideration of the seven key internal components namely; systems, strategy, shared values, structure, style, staff, and skills, (Jurevicius, 2013). Ranvanfar (2015), McKinsey 7s framework commonly utilized to implement strategy, to enable organizational change and merger of companies, to identify how an area can change in the future. In this study, the

researcher adopted the McKinsey framework to analyze the midwifery practitioner utilization of digital health in maternal health within the health institutions to formulate strategies that can enhance the utilization of digital health in early detection and treatment of pre-eclampsia. By initial identifying areas that need change with regards to utilization of digital health in early detection and treatment of pre-eclampsia within the facilities.

2.12.3. Elements of McKinsey 7s framework

The study adapted McKinsey 7s elements as follows:

Systems: systems are methods, daily operations, and techniques and how decisions are made within the organizations. Systems are part of organizations that determines how business is done (Ravanfar, 2015; Channon & Caldart, 2014). In this study, systems were regarded as resources and equipment the facilities had to function on daily operations when managing Pre-Eclampsia. This includes the availability of technical support such as Wi-Fi connections and computers/tablets to utilize digital health in the early detection and treatment of Pre-Eclampsia.

Structure: Structure represents the institution's division and lines of communication within the institution and accountability between the employees and employers, (Ravanfar, 2015; Channon & Caldart, 2015). In this study, the structure was the PHCs structure specifically for the provision of maternal services and clear lines of communication from midwifery practitioners to top management. This was determined by the working conditions and availability of clear lines of communication within the facility.

Strategy: Strategy represents a plan developed to achieve the organization goals, vision and mission and effectively compete in the market (Ravanfar, 2015; Channon & Caldart, 2015). However, following a review of the literature no significant strategies were in place to enhance the utilization of digital health in pregnancy-related conditions. Therefore, strategies will be formulated to enhance the utilization of digital health in the early detection of pre-eclampsia in primary health facilities to enhance effectiveness within the organization and significantly reduce maternal mortalities associated with pre-eclampsia

Skills: Skills represent employees' competency and their capabilities in performing their relevant duties within the institution (Ravanfar, 2015; Channon & Caldart, 2015). In the context of the study, the researcher was concerned with whether midwifery practitioners have the required and acquired skills in the utilization of digital health to teach gravid women about the utilization of digital health. Furthermore, the researcher investigated the midwifery practitioners' knowledge of the utilization of digital health in the early detection and treatment of Pre-Eclampsia. In addition, this includes the skills of gravid women in the utilization of digital health initiatives for self-services and self-preventative management for pre-eclampsia.

Staff: Staff represents the type and number of employees within the organization trained and competent in carrying out their duties, (Ravanfar, 2015; Channon & Caldart, 2015). In this study the researcher was concerned about the midwifery practitioners' awareness and knowledge of digital health in Emalahleni Local Municipality. Moreover, the availability of staff, working conditions, and workload were the precise concern whether they were the reason for not utilization of digital health. Furthermore assessing the availability of staff could have influenced the teaching of gravid women on utilization of digital health in the early detection of pre-eclampsia. Moreover, it further focused on the training programs and protocols in the facilities with regard to digital health.

Style: According to Ravanfar (2015) and Channon and Caldart (2015), represents the way the organization is managed by the higher management and how they interact and actions they take, and their emblematic value. However in this study, the midwifery practitioners were the perceived bearers of knowledge by the gravid women, therefore are expected to be good listeners and approachable. In this component, the researcher was concerned with the midwifery practitioners' style when rendering care including their behavior and attitude towards gravid women and whether it influenced the gravid women with regard to utilization of digital health.

Shared values: Shared values are the organisations' norms and standards that guide the organization, (Ravanfar, 2015; Channon & Caldart, 2015). All the institutions are under the department of health they share a common goal, vision, and mission statement in the provision of the optimal patient care. The study addressed the shared values of institutions based on the empirical findings from the midwifery practitioner's

knowledge on the utilization of the digital health in reducing maternal morbidity and mortality ratio within Mpumalanga province. Figure 2.11 illustrates the integration of the reviewed literature and the McKinsey 7s Model elements.

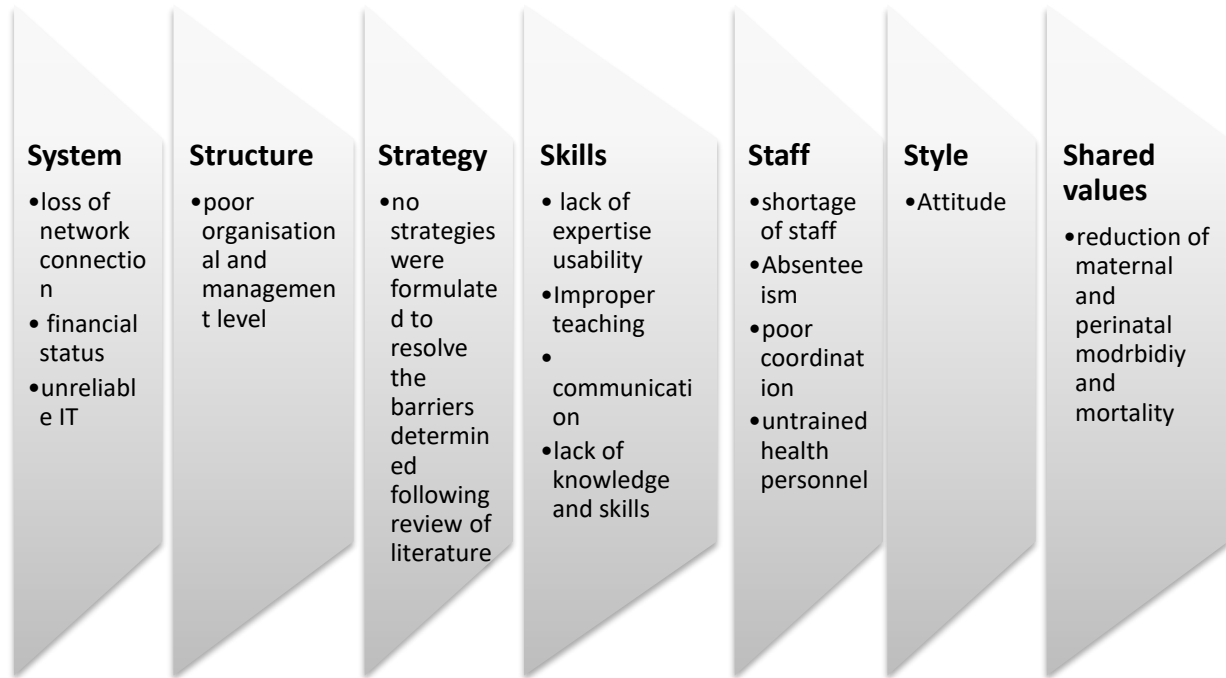


Figure 2.3. Integration of the McKinsey 7s framework with literature review

2.13. CONCLUSION

Despite the digital health initiatives and digital health methods utilization growing expandable across the globe, the empirical evidence pertinent to digital health utilization to maternal health services to early detect and treat pre-eclampsia was limited. The extensive literature review showed significant extensive existence of research gaps in digital health utilization in maternal services. Therefore, it remains within the jurisdiction of the Department of Health and researchers to research beyond to identify facilitators and impediments of digital health, to develop quality standards and more evolved digital health initiatives supporting maternal and child health. Moreover for South Africa to achieve the UHC goals, more context-rich digital health solutions need to be developed to improve the accessibility of services and further achieve the Sustainable Development Goal 3.

However, the preceding chapter discussed the literature review. Primary health care role and implications on maternal health were discussed. Moreover Pre-Eclampsia

pathophysiology was described and the perinatal and maternal mortality and morbidity trends of pre-eclampsia. The literature review further focused on digital health as an emerging branch in health. Challenges, barriers, and knowledge of utilizing digital health were extensively reviewed. In addition, the theoretical framework that guided the study was explained in detail and its relevance in achieving the research aims. The next chapter will focus on discussing the research methodology in detail. The above chapter has been published with Intech open publications as a book chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. INTRODUCTION

This chapter discusses the research methodology and the research design adopted to answer the researcher question with justification for their application in the current study. Moreover, the process of data collection for the chosen research design of mixed method research approach is explained in-depth according to the specific strands. Lastly, the researcher discusses measures to ensure data quality.

3.2. RESEARCH METHODOLOGY

Research methodology is a pragmatic technique employed to guide research and to conduct research through investigations, designates and analysis methods, (Igwenagu, 2016). A mixed research methodology approach was employed to obtain a broad understanding of digital utilization which grounded the development of the strategies to enhance the utilization of digital health in the early detection and treatment of Pre-Eclampsia by gravid women in Emalahleni Local Municipality, Mpumalanga Province.

The researcher adopted the mixed research methodology to gather context-rich data on the knowledge and barriers of midwifery practitioners and gravid women in the utilization of digital health. The study was conducted concurrently according to two strands namely; quantitative and qualitative research strands. Furthermore, the researcher used MMR in rectifying the identified problem statement and answered the research questions through the development of strategies that enhance the utilization of digital health in the early detection and treatment of Pre-Eclampsia in clinical practice. The quantitative and qualitative data were collected concurrently, and quantitative data provided descriptive and numerical findings of the midwifery practitioners on utilization of digital health. The qualitative data provided the narrative findings of the gravid women on utilization of digital health.

3.2.1. Mixed Methods Research

Mixed Methods Research (MMR) is a research approach that utilizes both qualitative and quantitative research approaches in the collection and analysis of data in a particular study (Shorten & Smith, 2017). In contrast to the study, mixed methods will permit the researcher to explore miscellaneous perspectives and expose the existing relationship between the complex layers of multi-layered research questions (Shorten & Smith, 2017). Mixed methods research is a systematic approach that integrates qualitative and quantitative within one investigation (Creswell, 2013). Further allows more completeness and synergistic use of data, and provides deep context-rich information to multifaceted questions (Johnson, 2019; Wisdom & Creswell, 2013). Through mixed methods research, the researcher was able to use the strengths of the qualitative and quantitative research approaches (Groove, Gray & Burns, 2012) when addressing the research problem. The dichotomy between quantitative and qualitative research represents a key methodologic discrepancy in social, behavioral and health sciences. It is believed many skeptical areas can be improved and the evidence-based practice enhanced through the judicious triangulation of quantitative and qualitative research designs (Polit & Beck, 2021). The table below represents the advantages of mixed research methodology as cited by Polit and Beck (2021) and their applicability to the current study.

Table 3.1. Advantages of mixed methods research (Polit & Beck, 2021)

ADVANTAGE	DESCRIPTION	APPLICABILITY TO THE STUDY
complementarity	Qualitative and quantitative design uses numbers and words, they are two fundamentals language that complement each other (Polit & Beck, 2021).	In this study, the researcher conducted a thorough quantitative analysis to answer the research questions and further utilised the qualitative design gather a context rich narrative data to complement the numeric data in achieving the aim of the study.

Incrementality	Improvement on a topic tends cumulative relying on the feedback loops. Qualitative results can be measured quantitatively and quantitative results occasionally need clarification through in-depth probing (Polit & Beck, 2021).	In this study, the researcher utilized the qualitative design to gather a thorough narrative information through gathering relative insight and views of the other group of participant to clarify and support the quantitative data in achieve the research study aim. This presented new knowledge and assisted in achieving the aim.
Enhanced validity	A hypothesis or a model can be supported by numerous and complementary data. The triangulation of methods can provide testing of alternatives interpretation of the data and for examining the extent to which the context help shaped the results, (Polit & Beck, 2021).	In this study the researcher collected data concurrently, then triangulated and compared the findings to determine a point the findings communicate to each other, congregate and deviate.

3.2.2. Justification for mixed method research

The researcher adopted a mixed method research in this study to gather extensive data from the participants to address the problem statement and answer the research questions. Moreover, for continuum self-development in the utilization of mixed research methodology; the mixed research methodology was adopted.

3.3. RESEARCH SETTING

The study was conducted at primary health care facilities at Emalahleni Local Municipality of Nkangala District in Mpumalanga. Nkangala District is comprised of a total population of 1 357 744 and 50.6% were females; Midyear estimates 2013 (Dorrington, 2013). Emalahleni Local Municipality is one of the six municipalities in

Nkangala district with a total of 15 PHCs rendering maternal care services to the population within the municipality (cooperative governance & traditional affairs, 2020). The Emalahleni local Municipality forms part of the western regions of Mpumalanga Province and borders Gauteng Province. The Thembisile Hani, Victor Khanye and the City of Tshwane Metro in Gauteng border the Municipality to the north and Steve Tshwete borders its east; and the Gert Sibande borders to it south. The area of Emalahleni is approximately 2 678 kilometers square, known for its mining industries and transport network connecting to Johannesburg and Pretoria in Gauteng Province through N12 and N4 respectively (Municipalities of South Africa, 2021).



Figure 3.1. Geographical area (www.municipalities.co.za)

3.4. RESEARCH DESIGN

Research design is a series of rational steps used by researchers to respond to the research question that shapes the design of the study, (Brink, Van Der Walt & Van Rensburg, 2018). Convergent parallel research design approach was used to develop strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia at primary health care facilities, Emalahleni local municipality, in Mpumalanga province. The study was conducted in two strands concurrently namely, quantitative and qualitative research design.

3.4.1. Convergent parallel mixed research design

Triangulation design is the convergent parallel design most common research approach focusing on collecting different but corresponding data and interpretation of the quantitative and qualitative findings (Almeida, 2018). Almeida (2018) concurrent triangulation design purpose is gathering of quantitative and qualitative data at the same time and provide a deep relationship between the measured variables.

Edmonds and Kennedy (2016) substantiated that the convergent parallel approach is also known as the concurrent triangulation design involves the gathering of different but complementary data and analyzed separately on the same situation and use it for converging and interpretation of the data. A study conducted by Razali, Aziz, Rasli, Zulkefly and Salim (2019) using a convergent parallel design that the design collects qualitative and quantitative data independently and combined for comparison and contrast for validation and corroboration purposes.

The researcher used the convergent parallel design to collect, analyse and interpret the quantitative and qualitative data of the midwifery practitioners and gravid women. The quantitative strand focused on collecting data of midwifery practitioners' knowledge and barriers to utilization of digital health. Whilst the qualitative strand was used to collect data to explore, identify and describe the gravid women's knowledge and barriers to utilization of digital health. The qualitative data was examined and clustered in themes and subthemes, whilst the quantitative data was examined in descriptive statistics and graphical representations. The researcher analysed, compared, and interpreted the data for validation purposes, furthermore, the triangulation of the contextual and systemic data apprised the design with the achievement of the aim of the study which is:

“To develop strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia by gravid women in Emalahleni local municipality, Mpumalanga province.”

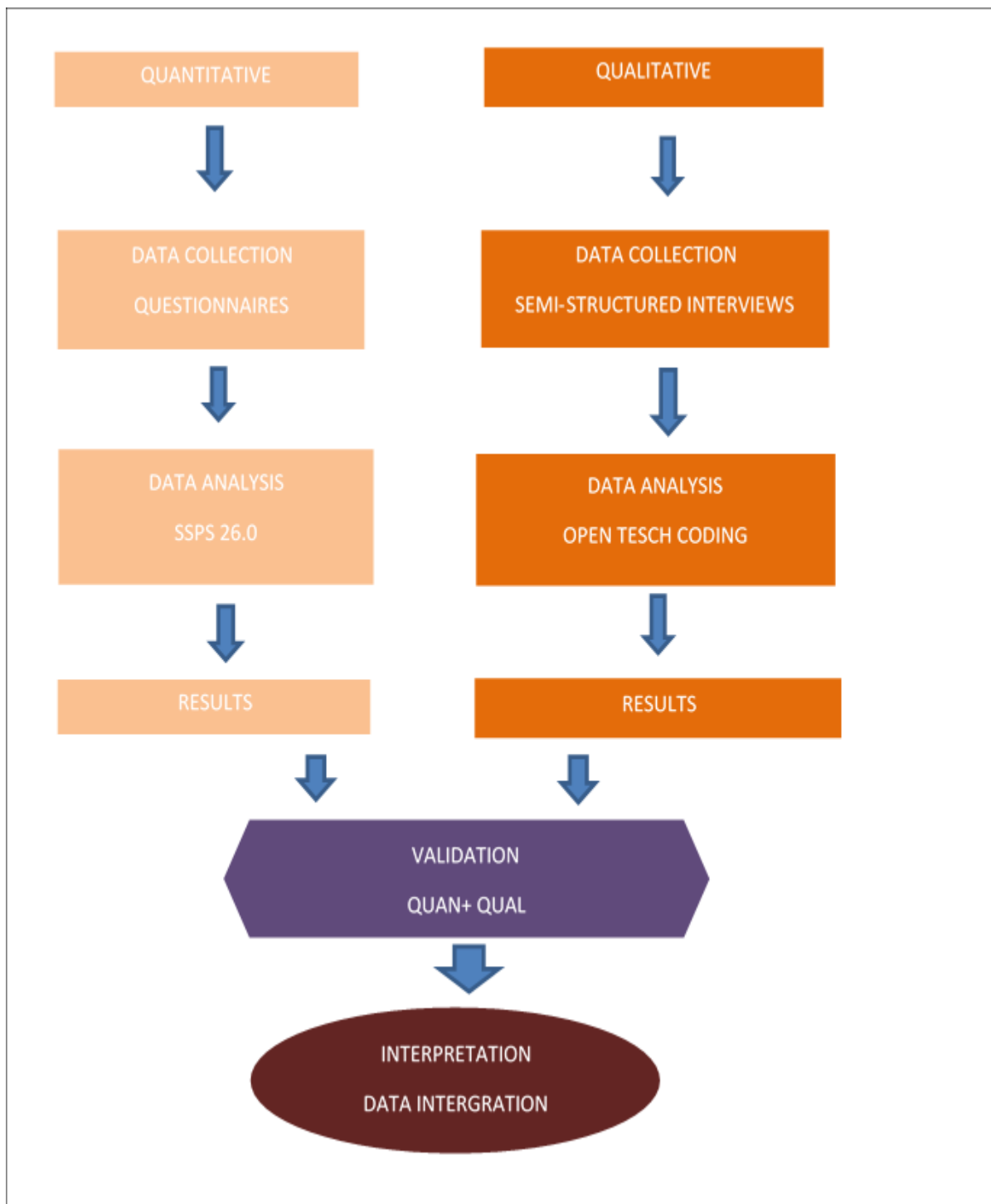


Figure 3.2. Schematic presentation of the convergent parallel method

3.4.2. Quantitative strand of the study

Babbie and Mouton (2016) describe quantitative research as a systematic factual study of social phenomena and presenting the gathered information in a form of statistical and numerical data. Brink et al., (2018) substantiated that the quantitative

research approach stresses the use of mathematical values, and computational and statistical analysis techniques. Quantitative research comprises methodologies such as questionnaires and structured observations or experiments; it permitted the researcher to conduct simple to complex statistical analysis that cumulates the data (Ahmad, Wasim, Irfan, Gogoi, Srivastava & Farheen, 2019). Albers (2017) corroborated that quantitative research methods is concerned with measuring data and the findings generated from the quantitative research uncover behaviors and trends. In the quantitative strand, the researcher determined and described the knowledge of midwifery practitioners on the utilization of digital health at primary health care facilities.

3.4.2.1. Purpose of quantitative strand

The purpose of the quantitative strand was to identify measurable variables of the study and how the variables interrelate subsequently to each other in achieving the aim and objectives of the quantitative research design.

3.4.2.2. Objectives of quantitative strand

The objectives of the quantitative strand were to:

- Determine and describe knowledge and importance of utilization of digital health by midwifery practitioners at primary health care facilities.
- Identify and describe barriers to utilization of the digital health by midwifery practitioners.

3.4.2.3. Study population

De Vos, strydom, Fouche and Delpont, (2011) population is regarded as the number of people, case records, and events involved to address a research problem. A population is a particular group of individuals who meet the sampling criteria (Groove, Gray & Burns, 2012). The study population was the midwifery practitioners working at Emalahleni primary health care facilities providing maternal and perinatal care. The study included 10 selected PHCs located within Emalahleni Municipality. Primary health care facilities within the area have average of eight to ten midwifery practitioners in each facility and the study population included approximately 150 midwifery practitioners across the centres.

3.4.2.4 Sampling

Brink et al (2018) sampling is the process of selection of a certain population for inclusion in the research study. Groove, Gray, and Burns (2012), substantiated that sampling includes selecting a group of individuals, and events of other elements with which a certain study will be concerned. The researcher used the simple random sampling probability method to select midwifery practitioners to ensure equal opportunities for participation. Simple random sampling is the subsequent selecting of participants out of the total number of a participant in the sampling frame, providing all participants equal chances to participate in the study (Bhattacharjee, 2012). The sampling strategy used in the study ensured that the participants had equal and independence chances to participate in the study. The sample of the study was 109 as calculated using the solving formula below. However, the researcher adopted the fishbowl technique to select the participants randomly. The researcher assigned the numbers 1-150 and each number was written on a piece of paper and then placed in a box. The number picked out by the participant was removed from the box and not replaced, all the participants who picked a number below 110 participated in the study, and those who picked a number above 110 were excluded from the study. The sample size of the midwifery practitioners was determined using slovin formula (Simamora, 2004).

n = sample size

N = population size

e = error of margin (0.05)

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{150}{1 + 150(0.05)^2}$$

$$n = \frac{150}{1 + 150(0.0025)}$$

$$n = \frac{150}{1.375}$$

$$= 109$$

- *Inclusion criteria*

All the midwifery practitioners working at Emalahleni primary health care facilities providing maternal and perinatal care who were randomly selected and willing and able to participate were included to ensure free-of-will participation. Moreover, the midwifery practitioners who were on duty during the day or night of data collection were included in the study.

- *Exclusion criteria*

All midwifery practitioners on leave were excluded from the study. Furthermore, those midwifery practitioners who were not willing to participate in the study were excluded in the study to endorse voluntarily participation

3.4.2.5. Developing Instrument tool for midwifery practitioners

The researcher developed the questionnaire of the midwifery practitioners based on the extensive literature review which identified the implications of digital health in maternal health and its effective use at primary health care facilities. The challenges and barriers to the utilization of digital health led to the construction of questions focusing on the barriers of digital health in relevance to the topic of study. All the questions of the questionnaire came from the extensive literature review. Professors and experts in the proposed field of study were consulted, and questionnaires were then reviewed and rectified any discrepancies and errors before the use of the instrumentation in the collection of data.

3.4.2.6. Pilot Study

A pilot study intensifies research quality and examines the practicalities of the major study in respect of its utility and implementation, usually including examination of resources for the major study (Malmqvist, Hellberg, Möllås, Rose & Shevlin, 2019). A pilot Study involves certain design features and is carried out on a limited scale than the major study, moreover crucial for the improvement of the quality and effectiveness of the major study (Junyong, 2017). The researcher provided approximately five midwifery practitioners with questionnaires to complete and for their opinions on the question's relevance and the quality of the content and errors of the questionnaires focusing on the readability of the questions and the extent on the difficult of the questions. The midwifery practitioners took approximately 35 minutes to complete the questionnaires. The results showed that some of the questions needed to be corrected

in spelling and reconstructed into the participants' understanding. However, the midwifery practitioners who participated in the pilot study were not included in the main study.

3.4.2.7. Preparation for data collection

Burns and Groove (2011) define data collection as a structured way to accumulate information in relevance to the study purposes, questions, and specific objectives. The collection of data is critically vital for the success of the study as it provides the necessary information to address the concerned research question and hypothesis (Brink et al,2018). Self-administered questionnaires were used for data collection. The researcher obtained ethical clearance from the University of Limpopo and permission from the Mpumalanga Department of Health and the district manager. Once permission was granted the researcher called each primary health care facility's operational manager to organize a telephonic meeting. During the meeting, the researcher discussed the purpose and the aim of the research as well the benefits of the study were clarified in detail. Following the meeting dates and times were then set for data collection, the planned dates didn't interfere with clinical services rendered to the patients. Before data collection the researcher gathered the midwifery practitioners in an empty consultation and explained the research topic, its purpose, and ethical standards, then informed consent was then granted. Thereafter data was collected from the day and night staff in the 24 hours services facilities. The researcher tried to meet the required sample by consequently alternating days to meet all midwifery practitioners from the different shifts from the day and night staff. Since the study was conducted during a pandemic, the Covid-19 rules and regulations were adhered to during the data collection. The researcher always wore a mask during the data collection, and hand hygiene and social distancing were maintained.

3.4.2.8. Outline and description of the instrument tool

In the context of the study self-administered, English questionnaires consisting of a total of 61 closed-ended questions were used for data collection. The questionnaires had approximately three sections and a Likert scale type of questions. The questionnaire is outlined as follows:

- Section A Demographic data:** This section had eight questions based on the demographic data of the midwifery practitioners; this included age, qualification, experience, gender, etc. These demographic data were identified and explored in the relevance of the midwifery practitioners' knowledge of the research topic and questions.
- Section B Knowledge of digital health:** This section consisted of 22 questions based on the knowledge of midwifery practitioners of digital health. The questions included the digital health use in early detection of pre-eclampsia and treatment as well as digital methods known by the practitioners. 9-23 answering options ranged from disagreeing to agree. While 24-30 answering options ranged from never to always.
- Section C1 Barriers of digital health:** This section consisted of 19 questions based on the barriers to utilization of digital health, this included workload, internet and technical competency. The answering options ranged from disagreeing to agree. Furthermore, it includes subsections that also focus on barriers to digital health utilization.
- Section C2 Staffing and staff development:** This section had nine questions based on the staffing and staff development of the midwifery practitioners in their facilities of relevance; this included training, workshop attendance and staff ratio. This data was explored to identify their effect on knowledge and barriers of the utilization of digital health. The answering options ranged from disagreeing to agree.
- Section C3 Workload:** this section consisted three questions that were based on the workload; this included working conditions and workload. This data was explored to assess the effect of the workload on utilization of the digital health. These answering questions ranged from never to always.

3.4.2.9. Data collection procedure

The researcher visited every selected PHC facility and provided the midwifery practitioners with questionnaires and consent forms to be completed. The researcher then introduced himself and explained the research topic and its significance. The participants participated of their own free will and signed the informed consent forms

following a thorough explanation of the study's purpose and benefits. The participants took an average of 35 minutes to complete the questionnaires. The role and responsibility of the researcher which is to minimize bias and protection of the rights of the participants were then assumed. The completed questionnaires were given back to the researcher. The quantitative data were collected over an overall period of 2 months, from June 2022 to August 2022 in all the selected primary health care facilities. There was a total of 102 completed questionnaires. During the data collection procedure, the sampling method rules and ethical standards were adhered to. Bias was minimized by the researcher by keeping self-knowledge and opinions to self.

3.4.2.10. Data analysis

Burns et al., (2011) data analysis summarises, organises, and provides a clear understanding of collected data and the studied variables by including descriptive as well as exploratory procedures. Descriptive statistical procedures were used with the assistance of a statistician for facilitation and interpretation of the data gathered with the self-administered questionnaire following analysis of the data with the Statistical Package for Social Sciences (SPSS) version 28.0 computer software. Descriptive statistics is the measurement of principal inclination, median, mode, and mean utilizing averages, frequencies, and percentages (Lo-Biondo & Haber, 2010). Descriptive statistics were used to reflect the frequencies and percentages of the categorical variables. The results were presented in bar graphs, pie charts and table format.

3.4.2.11. Validity and reliability

The instrumentation was pre-tested for the determination of truthfulness and exactness before data collection. They were given to five midwifery practitioners for pre-testing and the identified discrepancies such as spelling errors were modified and corrected.

- **Validity**

Heale and Twycross (2015), define validity as the measures taken to measure the accuracy of the concept quantitative Study. The researcher ensured validity through direct literature review to determine, identify and describe the midwifery practitioners knowledge and barriers in the utilization of digital health.

- ***Content validity***

Lo-Biondo and Haber (2010) content validity is the determination of whether the instrumentation tool appends all the vital elements relevant to the items to be measured. Brink Et al., (2018) define content validity as a pre-test tool used to determine if the instrument includes all the entities of the variable measured. The instrument content was reviewed and verified by the supervisor and co-supervisor to ensure content validity.

- ***Face validity***

Heale and Twycross (2015) state that face validity is the extent to where field experts are requested to identify whether the measuring tool measures the intended concept. The researcher ensured face validity, all questions in the questionnaire addressed the midwifery practitioners' knowledge and barriers to utilization of digital health, and experts were given the tool to validate the concept of the proposed study.

- ***Reliability***

In a quantitative study, reliability is a second process to measure the data quality and accuracy of the instrument tool, it further measures the consistency of the research tool if it has similar outcomes when utilized on repeated same occasions (Heale & Twycross, 2015). As cited by Daud, Khidzir, Ismail and Abudllah (2018) instrument reliability refers to the stability and consistency of the developed questionnaire. Therefore in this study the reliability of the questionnaire was tested through the utilization of a pilot study to identify and rectify errors, and discrepancies to ensure reliability. To further enhance the reliability of the questionnaire Cronbach alpha reliability test was used to measure the internal consistency for the measurement scale. Haradhan (2017) regards Cronbach alpha test as the most adopted test to measure internal consistency of the measurement scale. Furthermore, the indicated by score between 0 and 1; where any score near the value of 1 indicate high dependability and reliability. Whereas near the value of 0 indicate poor and low reliability (Haradhan, 2017). However in this study the overall Cronbach alpha of the standardised items was 0.624. This indicates that the instrument tool is moderately reliable and acceptable as stated by Daud et al, 2018.

3.4.3. Qualitative strand of the study

Qualitative research design is mostly based on the humanistic and idealistic approach to understanding as a research query. Qualitative research is primarily used to understand an individual's beliefs, attitudes, perceptions and lived experiences, (Pathak, Jena & Kalra, 2013). Cresswell (2014) substantiated that the qualitative research method is exploratory research utilized to gain insight and understanding of underlying rationales, motivations, and ideas. The researcher employed qualitative research design to explore and identify of the gravid women's knowledge and barriers in the utilization of digital health.

3.4.3.1. Purpose of qualitative strand

The researcher gathered relatively in-depth the gravid women's knowledge, and insight with regards to digital health.

3.4.3.2. Objectives of qualitative strand

The objectives of the qualitative strand were to:

- Explore knowledge of gravid women on utilization of digital health.
- Identify and describe barriers to utilization of the digital health by gravid women.

3.4.3.3. Study population

Brink et al., (2018) define a population as a group of persons who meets the study criteria that a researcher is focussed on investigating. The study population was all the gravid women, attending ANC diagnosed with pre-eclampsia within Emalahleni Local Municipality PHCs.

3.4.3.4. Sampling

Purposive sampling is a non-probability method employed in selecting cases based on experts' judgment or with a certain purpose in mind, most often used when a hard-to-reach population must be measured (Brink et al., 2018). Purposive sampling was used to select 10 gravid women as guided by data saturation, and based on their condition and the clinic where they attend ANC which was of the relevance of the study and data saturation.

- ***Inclusion criteria***

All gravid women diagnosed with Pre-Eclampsia attending ANC at PHC within Emalahleni local municipality willing to participate were included in the study to endorse voluntary participation.

- ***Exclusion criteria***

All gravid women who were not willing to participate were excluded to promote voluntary participation.

3.4.3.4. Pilot study

A pilot study is a mini-study carried out to test the small scale of the study before the main study (Joubert & Elrich, 2012). A pre-test study was conducted at the primary health care facilities to determine the practicability of the study. Approximately five participants were used to conduct the pilot study. The researcher used a semi-structured interview guide with central questions and probing questions. The gravid women diagnosed with Pre-Eclampsia who participated in the pre-test were excluded from the main study. The identified incredibility and errors were corrected; such as close ended questions were reconstructed. The supervisors who were skilled in qualitative researcher were consulted and errors were modified. The results of the pre-test revealed that some of the questions needed to be reconstructed and then modified.

3.4.3.5. Preparation of Data collection

Data collection is a method utilized to gather data on variables of concern in response to the hypothesis, research questions and evaluation of outcomes, (Cresswell, 2018). Data collection in qualitative studies is concerned with the analysis of the non-verbal language in observations and interviews, even the analysis of one self (Vanderstoep & Johnston, 2009). Without high-quality data collection methods, the precision of evidence is subject to challenge (Polit & Beck, 2021). Before data collection, the researcher conducted meetings telephonically with the operational managers and the means of conducting the study was explained taking into consideration the research problem, aim, objectives and benefits of the study. The days when the gravid women come to the facilities for ANC were discussed and, on those days, the operational managers introduced the researcher to the women present at that time. The

operational managers orientated the researcher to the facility sphere and the room available for data collection on that day. During that collection, the researcher adhered to the rules and regulations of covid-19. Furthermore, the chairs during the interview were placed in a way that a social distance of 1.5 meter was always maintained and the participants were encouraged to always wear their masks.

3.4.3.6. Data collection process

The researcher established a rapport with participants before data collection to promote trust, a sense of belonging, and free will to further relieve anxiety. This included establishing the rules of conducting the interviews and an explanation of the aim and objectives of the interviews. The researcher adhered to the sampling techniques in selecting the participants and bias was minimized. Qualitative research experts were consulted on the quality of the data collection methods. The researcher used semi-structured one-on-one interviews and field notes for data collection. The qualitative data collection took approximately 30 minutes, and the interviews were conducted in a private space with minimal disturbances so that the participants can participate freely. The interview session was audio taped for data analysis upon consent request from the participants. The audio recording device was pretested to ascertain that it's in a good working condition. The interviews were conducted in language of preference by the participants which is isiZulu. Moreover, this allowed the participants express themselves relatively in-depth about the topic of study. The data was then transcribed and translated in English and the supervisors were consulted to check for verbatim of the transcriptions. Ground rules were established, and subjects' letters were allocated amongst participants after permission granted to ensure privacy and confidentiality. The researcher adapted the following methods and techniques during data collection:

Semi-structured one-on-one interviews: the one-on-one interview is a data collection technique where the researcher asks questions from a particular participant at a time and audio record the answers; this further allows the researcher to get in-depth the experiences of the participant (Clark & Cresswell, 2015). Semi-structured interviews are utilized when the researcher poses broad questions that must be addressed in an interview; to ensure all the questions relevant to the topic are broadly covered the interviewers use an interview guide (Polit & Beck, 2021). The researcher conducted

semi-structured one-on-one interviews with each participant at a time, an interview guide shown in appendix 4 was used to guide the researcher in covering all the basics of the topic. This assisted the researcher in gathering the relative knowledge and barriers to digital health. All the answers were recorded following consent from the participant. The interviews were guided by an open-ended central question; *“Elaborate in-depth your experiences and knowledge of digital health use in pregnancy?”*

Probing: Probes are subsequent questions following the main questions that researchers ask to gather in-depth information. In a qualitative study, researchers use probes to clarify what the participants said and urge them to elaborate on their answers and ideas (Clark & Cresswell, 2015). To gather context-rich narrative data the researcher used probing questions to get the participants to elicit in-depth information relevant to the study. This stimulated the interviews and more information was collected.

Field notes: Field notes are comprehensive and more interpretive; they represent the observers' effort to record information to synthesize and understand the information (Polit & Beck, 2021). The researcher observed the non-verbal cues of each interview and was written down after each interview.

Paraphrasing: it's the state where the researcher rephrases what the participant said differently however still gives the same meaning (de Vos et al., 2011). The researcher repeatedly rephrased the participant's responses to the participant to explicit more insight into the asked questions.

Minima verbal response: minimal verbal response is a response mechanism adopted by the researchers to show that they are listening to the participants this includes nodding (de Vos et al., 2011). The researcher used minimal verbal responses such mm, yes and tell me more; to stimulate participants in sharing more information about the relevantly asked questions.

Clarifications: Clarifications are adopted by researcher to get more clarity from the participants (de Vos et al., 2011). The researcher adapted probing questions like “based on what you, so you think...” this assisted to get explicit information from the participants, moreover some of the questions were reconstructed to get more insight into the study topic.

Reflections: this is a mechanism that occurs when the researcher reflects on what was said by the participant with the aim to gather more information (de Vos et al., 2011). The researcher adopted the reflective style by summarising the participants' responses to provoke them in adding more information.

3.4.3.7. Data analysis

Tesch open coding is a qualitative data analysis method focusing on accurate naming and categorization of the situation by close examination of the gathered data, (de Vos et al., 2011; Cresswell; 2014). Tesch's open coding approach was used to thoroughly read and understand the transcript data, and further categorize and cluster the data in themes and subthemes. The Tesch's open coding steps assisted the researcher to avoid any inadvertent disclosure of participants' responses by categorizing the data into codes and cluster into themes and subthemes. Supervisors who are qualitative research experts were consulted to assist with the coding and steps of Tesch's coding were applied as follows:

- Step 1: All transcripts were read by the researcher and noted any significant thoughts coming to mind.
- Step 2: The researcher selected each interesting interview and analysed it to relatively get the specific meaning of the data, noting down views coming to mind
- Step 3: Following a thorough analyzing of the transcripts, the researcher clustered the comparable topics in groups by forming columns labeled main topics and unique topics.
- Step 4: The researcher reduced the topics as codes and wrote the codes subsequently to the appropriate section. Further observe the clustering of the data to identify any new categories or codes developed.
- Step 5: The researcher searched for the chief descriptive wording the topics and converted them into groups. The objective was to minimize the overall list of categories by grouping topics relating to each other. Lines drawn between the groups indicated interrelationship of categories.
- Step 6: Results were achieved through abbreviation of each category and the codes were organized on the relationship of the coded data.

- Step 7: Data belonging to each category were categorized together in one section and preliminary analysis was performed.
- Step 8: Each category was then clustered into themes and subthemes accordingly to the established categories with the help of the independent coder who was not part of the conceptualization of the study.

3.4.3.8. Measures to ensure trustworthiness

Carey (2012) defines trustworthiness as the magnitude to which a researcher adapts several strategies to ensure the quality and trustworthiness of the data. The study adopted the Lincoln and Guba criteria (cited de Vos Et al., 2011) namely, credibility, confirmability, dependability, and transferability to ensure trustworthiness in this study.

- *Credibility*

Polit and Beck (2018) refer to the confidence in how precisely the gathered data address the concerning focus. The researcher adopted the following credibility strategies to further the trustworthiness of the study.

Prolonged engagement: The researcher established a good rapport relationship with participants through ongoing prolonged engagement, further encouraging openness and free lines of communication. The researcher further established truth values by interviewing participants of relevance to the proposed study for 30-40 minutes. The prolonged engagement with the participants allowed the researcher to gain insight into the context of the study (Anney, 2014). However, before the interviews, arrangements were made with the participants further ensuring a well-established relationship between the participants and the researcher.

Peer debriefing: The researcher asked for support and guidance during the qualitative data collection and analysis from the supervisors who are qualitative research experts. A consensus was reached by the researcher and supervisors on the identified themes and sub-themes that emerged from the data analysis. Furthermore, the findings were presented to the supervisors and scholarly peers to gather their perceptions to further assist in developing conclusions of the study (Anney, 2014). This allowed the researcher to improve the quality of the qualitative findings.

Triangulation: The researcher used triangulation during the data collection process by using different research instruments. In the context of the study, semi-structured interviews, observations of non-verbal signs, and field notes were used to ensure triangulation and further enhance the data quality and integrity (Anney, 2014).

Persistent observations: During the interaction with the participants the researcher observed the participants non-verbal responses and behaviour to gain a detailed context of the study. The persistent observations of the non-verbal signs allowed the researcher to understand the participants world view (Anney, 2014).

- *Confirmability*

Confirmability is defined as the ability of the researcher to ensure that the data transcribed represents the participant's answers not the researcher's biases, (Polit & Beck, 2018). All the transcripts, audio recordings, and field notes were given to the supervisors for analysis, verbatim, and review of the fresh data.

- *Dependability*

De Vos et al (2011) define dependability as providing of evidence whether repetition of the study with similar questions and similar participants will yield similar responses or findings. The following techniques were employed to ensure the dependability of the study;

An Audit Trail: The voice recordings, and field were kept safe on a laptop with a password only known by the researcher.

Stepwise replication: The researcher further ensured dependability by giving the supervisors with an extensive experience and experts in qualitative research the detailed research methods and the raw data of the study to analyze the same data and compare. This allowed the researcher to achieve dependability by determining that if were to repeat the study with similar content and similar participants by another researcher would yield the same results.

- *Transferability*

Transferability is the magnitude to which results of a particular study are significant to individuals in other settings and that other researchers determine how applicable the

results are to their phenomenon, (Polit & Beck, 2018). The following strategies were employed to facilitate transferability;

Thick description: Extensive context-rich literature and detailed description of the research methods and the study findings were achieved to ensure transferability to optimize the application of the study findings to other aspects of research. the thick description is in details in chapter two, three and four.

Purposive sampling: the researcher utilized participants who are knowledgeable of the subject investigated. Furthermore, the participants used for the study were gravid women having pre-eclampsia. This facilitated the transferability of the study.

3.5. BIAS

Brink et al., (2018) delineate bias as a maneuver that minimizes falsifications that affect the efficiency of the evidence of study.

3.5.1. Participants' bias

The researcher provided the participants with comprehensive and clear information using their language of understanding regarding their role and participation in the study before data collection. In the quantitative strand, all the provided questions were written in English and all errors and incredibility in all the questionnaires were rectified with means of a pre-test, to avoid any misapprehensions leading to bias. All arising questions were answered and clarified to participants. In the qualitative strand, the interviews were conducted in participants' language of preference and in a private room to promote comfortability. All the recordings were transcribed and translated into English with the assistance of the qualitative research experts.

3.5.2. Sampling bias

Sampling bias arises when some participants of a population are systematically more likely to be chosen in a sample over others, this serves as a threat to external validity (Bhandari, 2020). Sampling bias was avoided in the study by adhering to the research methodology. In the quantitative and qualitative strand the researcher adhered to the rules of simple random sampling and purposive sampling respectively, researcher's opinions and preferences were disregarded during sampling.

3.5.3. Researchers Objectivity

The researcher avoided objectivity by keeping own's self-expectations and opinions to self.

3.6. FINDINGS INTEGRATION AND INTERPRETATION

The researcher collected the quantitative and qualitative data concurrently. The data from the quantitative and qualitative strands were then analyzed independently. When findings were available following analysis, the researcher merged the findings during the data interpretation to contrast and compare the findings. Furthermore, to validate the findings the researcher converged, diverged, and related the findings to each other. This allowed the researcher in achieving the aim of the study and answering the research questions. In addition, both the quantitative and qualitative were given equal lengths of time and they were equally prioritized; this assisted the researcher to gather the different perspectives of the research topic and relatively in-depth complementary data.

3.7. DEVELOPMENT OF THE STRATEGIES

The third objective of the study was to develop strategies to enhance utilisation of digital health in early detection and treatment of pre-Eclampsia by gravid women in Emalahleni Municipality, Mpumalanga province. Therefore, the development of the strategies was informed by the integrated findings of the convergent parallel research design. Moreover, the McKinsey 7s Model along with the AGREE II guided the development of the strategies and each component of the model was related to the integrated findings. Lastly legislative policies were reviewed to justify and support the development of the strategies to enhance the utilization of digital health. More details will be explained and discussed in chapter 5.

3.8. ETHICAL CONSIDERATIONS

Ethical considerations are the preservation of the rights and well-being of the participants involved in a research study (Joubert & Ehrlich, 2014). Ethics involves the subjects of wrong and right, particularly when humans are used as the study participants therefore rights of the participants must be protected and prevent undue harm (Iphofen & Tolich, 2018).

3.8.1. Ethical clearance

Ethical clearance was acquired from the University of Limpopo Turfloop Research Ethics Committee (TREC) for approval to conduct the study in the proposed field. The ethical clearance was granted by TREC and was then submitted to the department of health (DoH) and selected institutions' district managers for approval to conduct the study within the facilities.

3.8.2. Permission

National Health Act of South Africa (section 73 act 61, 2003), health research must be carried out in a health institution which has access to a health research ethics committee registered with the National Health Research Ethics Council. The researcher was granted permission to conduct by the Mpumalanga department of health (MDoH) and the district manager of the Nkangala District. Upon obtaining permission the researcher then commences data collection on the relevant primary facilities.

3.8.3. Informed consent

Consent is legally binding authorization forming part of the research process given by participants provided that the researcher shared all necessary information before the completion of the survey (Connelly, 2014). During data collection, the researcher invited the participants to participate of free will. The purpose and objectives of the study were explained in participants' language of understanding and questions raised were clarified before data collection. The participants were then given informed consent forms and the responsibility of the researcher to protect the rights of the participants was then assumed. In cases where the participants are minors, informed consent will be obtained from their parents or guardians to interview the participants.

3.8.4. Confidentiality and privacy

Mellish, Oosthuizen and Paton (2010), define confidentiality obligation as not sharing any person information without the person consent, breach of such obligation results in a dispute between the participant and the researcher. The personal profile of the participants such as names and surnames were kept confidential. The data was collected and analyzed by the researcher and supervisors to further ensure

confidentiality. The participants during interviews were asked not to mention their names during the audio recording. During the interviews, the participants were identified by using numbers instead of names to protect their identity. To further ensure privacy, during data collection the interviews was also be conducted in a separate private room.

3.8.5. Principle of beneficence and maleficence

Beneficence is regarded as the researcher's responsibility to reduce any harm and maximize benefits to the research participants, (Polit & Beck, 2018). In the context of the study no harm was done to the participants since the study is non-experimental; interviews and questionnaires were utilized to collect information with regards to the study. No harmful procedures were conducted throughout the study. The questionnaire was carefully structured in a manner that does not cause physical or psychological harm to the participants, this was achieved by monitoring the respondents for any sign of distress. Furthermore, the participants were assured that should there be any form of distress resulting from the study, they will be referred to a psychologist.

3.9. CONCLUSION

In this chapter, the research methodology of the study was discussed in detail. The researcher adopted the convergent parallel design where the quantitative and qualitative data were collected concurrently. The subsequent research design was given equal length of time and priority. The data collection and instrumentation development process were clarified in detail. The data integration and interpretation process were discussed in detail. Furthermore, the chapter explained in detail the relevance of mixed research methodology and its applicability to the study. The ethical standards were defined and the systematic process of obtaining the ethical standards was explained in relevance to the study. However, the next chapter will focus on the presentation, analysis of the quantitative and qualitative findings, and the merging of the findings.

CHAPTER 4

RESULTS AND DISCUSSION OF FINDINGS

4.1. INTRODUCTION

The previous chapter discussed research methodology used to address the research problem. The chapter also reflect on data analysis method which was applied to obtain the findings. This chapter presents the results and discussion of the quantitative and qualitative since the study was guided by convergent parallel design, the findings are presented in accordant order; starting with quantitative findings then following with qualitative findings. The primary purpose of the study is to develop strategies to enhance utilization of digital health in early detection and treatment of pre-eclampsia

4.2. DATA ANALYSIS

Since the study was guided by convergent parallel design, the findings of quantitative and qualitative strands are presented and interpreted separately, which are merged for discussion purpose. The quantitative data was analysed using descriptive statistics on SPSS 28.0 with the assistance of the biostatistician. The qualitative strand data from semi-structured interviews was analysed using Tesch`s coding method of analysis. The qualitative strand used eight steps of tesch open coding for the analysis of the interviews.

4.3. PRESENTATION AND INTERPRETATION OF QUANTITATIVE FINDINGS

The objectives of the quantitative strand were to assess the knowledge and importance of utilization of digital health by midwifery practitioners at primary health care facilities. Furthermore, the strand aimed to identify and describe barriers to utilization of the digital health by midwifery practitioners. The results are presented in graphs, charts, tables, frequencies, and percentages for better visualisation to the readers. Cronbach alpha test was used to test the internal consistency of the instruments. The Cronbach alpha of the standardised items was at 0.624 indicating it to be moderately reliable and acceptable.

4.3.1. Response rate

A total of 109 questionnaires were administered to midwifery practitioners and 103 questionnaires were returned, but only 102 of 103 of the questionnaires were completed. The table below shows the response rate of the study.

Table 4.1. Response rate

Descriptive information	Number of questionnaires	Percent (%)
Questionnaires administered	109	100
Questionnaires returned	103	94.5
Questionnaires completed	102	93.5

4.3.2. Section A: Demographic factors

This section presents the demographic profile of the midwifery practitioners. The demographic data is characterised by age, gender, qualification type, specialty in nursing, number of midwives at the workplace, work experience, operational time at the facility and number of maternal consultation room. The variable age is first presented;

- Age

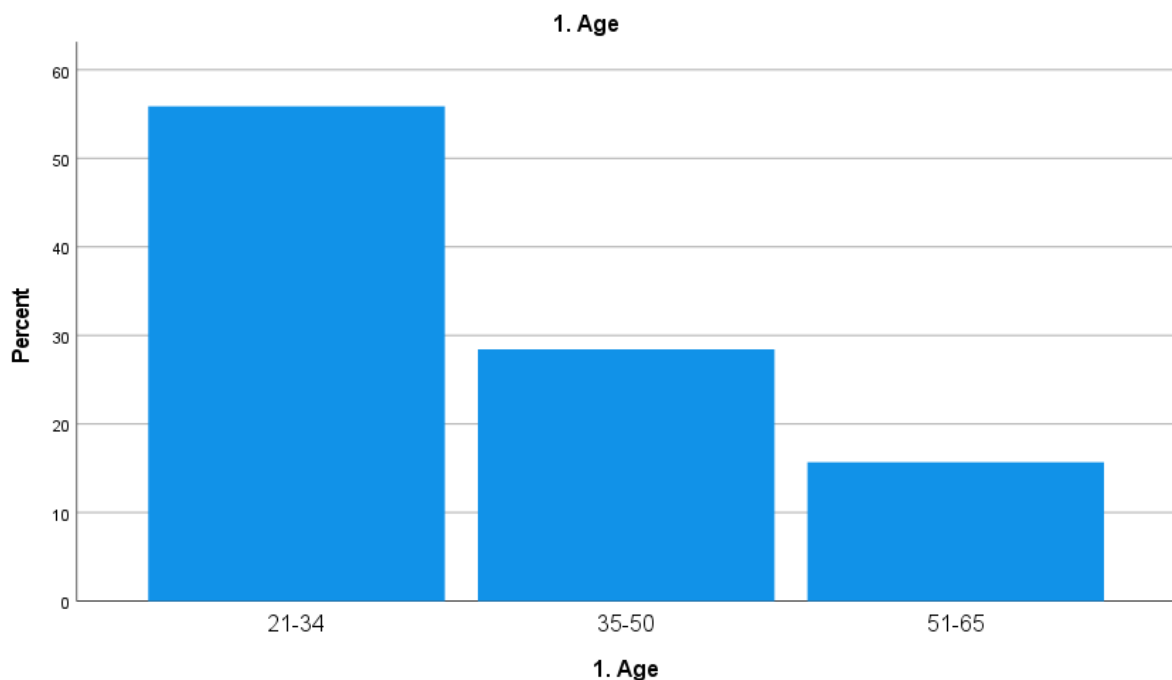


Figure 4.1. Age of participants

The study revealed that majority of the midwifery practitioners were on the age group of 21-34 years at 57(55.9%) ; whilst the age of 35-50 years are the second highest at 29(28.4%). However the midwifery practitioners were the lowest at 16(15.7%). The majority of the midwives of the study were between the age of 21 years and 35 years old. This could be that most midwives of the age greater than 50 years old are retiring leaving the field infested with younger midwives.

- *Gender*

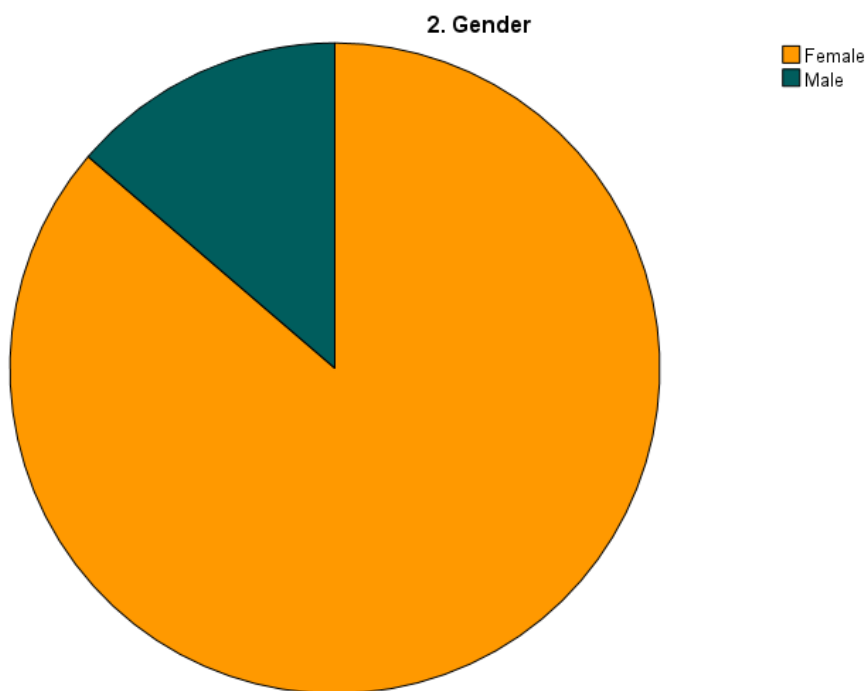


Figure 4.2. Gender

Figure 4.2 shows that 88 (86.3%) of the midwifery practitioners are females, whilst 16 (13.7%) are males. Hildingsson, Gamble, Sidebotham, Creedy, Guilliland, Dixon, Pallant and Fenwick (2016) affirmed that the midwifery profession is a field predominated by females. This shows that there's a need of more males in the field of midwifery.

- *Qualification in nursing*

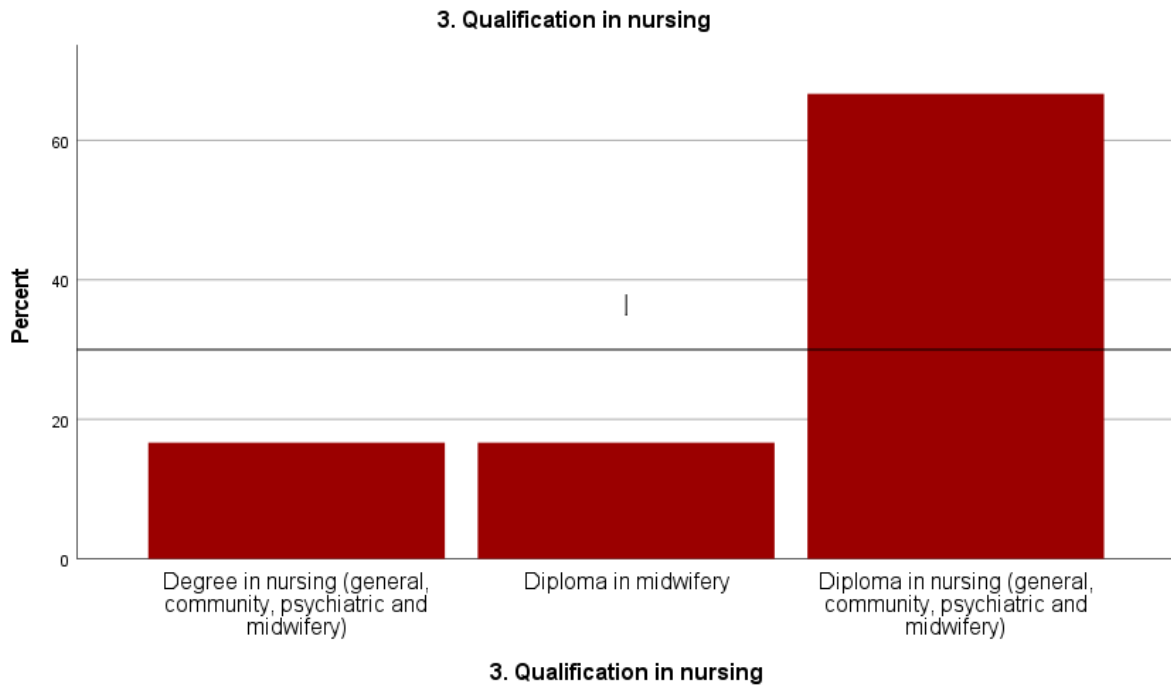


Figure 4.3. Qualifications in nursing

Figure 4.3 depicts that 68 (66.7%) of the midwifery practitioners have a diploma in nursing (general, community, psychiatric and midwifery), whilst 17 (16.7%) of the midwifery practitioners have a degree in nursing (general, community, psychiatric and midwifery) and 17 (16.7%) have a diploma in midwifery.

- *Specialty in nursing*

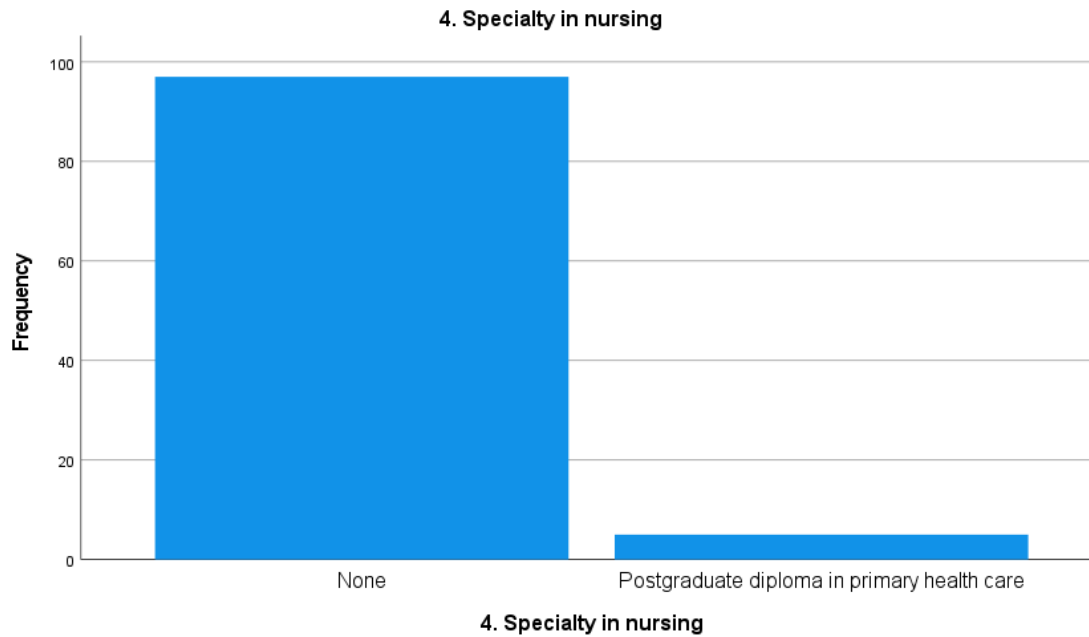


Figure 4.4. Specialty in nursing

Figure 4.4 depicts that 97(95.1%) of the midwifery practitioners had no specialty in advanced midwifery. While 5(4.9%) had a postgraduate diploma in primary health care. This shows that there's a need of midwifery practitioners with advanced skills to provide optimal midwifery care. Therefore, most midwives should advance their skills through education and training.

- *Work experience*

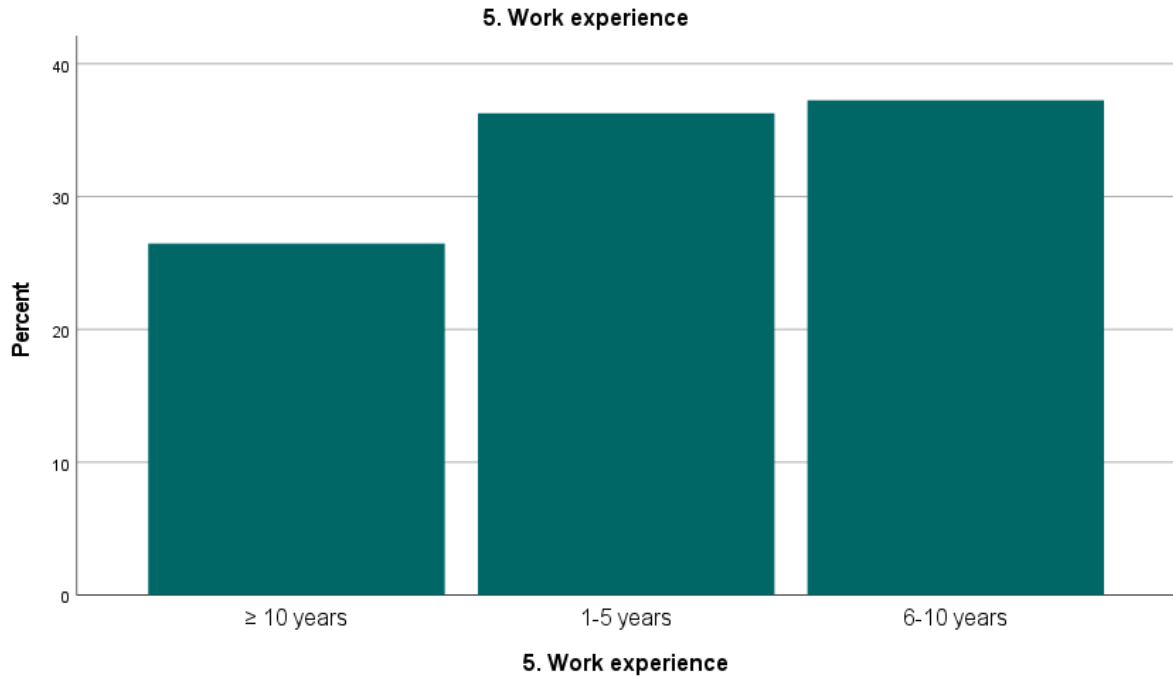


Figure 4.5. Work experience

Figure 4.5 shows that 38 (37.3%) of the midwifery practitioners have 6-10 years' experience in the profession; whilst 37 (36.3%) have 1-5 years' experience in the profession. Furthermore 27 (26.5%) midwives have an experience of ≥10 years in the profession.

- *Facility related variables*

Table 4.2 depicts that most facilities had midwifery practitioners ranging 3-4 midwives at 10 (9.8%), 5-6 midwives at 50 (49%), 7-8 midwives at 18 (17.6%) and > 10 midwives at 24 (23.5%).

Table 4.2. Facility related variables

Variables		Frequency	Percent	TOTAL
Number of midwifery practitioners in the facility	1-2	0	0	102 (100)
	3-4	10	9.8	
	5-6	50	49.0	
	7-8	18	17.6	
	9-10	0	0	
	>10	24	23.5	
Operational time of the facility	8	65	63.7	102
	24	37	37.3	(100)
	1	22	21.6	

Number of consultation for maternal services	2	40	39.2	102
	>3	40	39.2	(100)

Moreover, the highest percentage of the midwifery practitioners were working in an eight (8) hours operational facility at 65 (63.7%) as compared to 37 (37.3%) were working in a 24 hour operational facility. In addition, the facilities had different number of maternal services consultation rooms with 40 (39.2%) of the midwifery practitioners reporting that their place of employment have greater than three (>3) consultation rooms for maternal services.

4.3.3. Section B: Knowledge and importance of digital health utilization by midwifery practitioners

Table 4.3 depicts that midwifery practitioners have significant knowledge on utilization of digital health in early detection and treatment of pre-eclampsia. 82.4% midwifery practitioners agreed that digital health is the utilization of digital, mobile, and wireless technologies for health.

- **Knowledge of digital health**

Table 4.3. Knowledge of digital health

N- Number **F-** Frequency

KNOWLEDGE	DISAGRE E		AGREE		TOTAL
	F	%	F	%	N (%)
1. Digital health is the utilization of digital, mobile, and wireless technologies for health	18	17.6	84	82.4	102 (100)
2. The purpose of digital health is to minimize maternal mortality and morbidity through active communication with gravid women using mobile initiatives such as mom connect	14	13.7	88	86.3	102 (100)

3. digital health apps to assist midwives help in accurate diagnosing of pre-eclampsia patients	17	16.7	85	83.3	102(100)
4. Digital health help me reach an informed decision of when to refer patient to higher facility	21	20.6	81	79.4	102(100)
5. Use of digital health help detect early conditions such as pre-eclampsia in gravid women	18	17.6	84	82.4	102(100)
6. In the pandemic era digital health helps curve the spread of COVID-19	13	12.7	89	87.3	102(100)
7. Digital health provide midwives with up to date treatment for pre-eclampsia	18	17.6	84	82.4	102(100)
8. Digital health apps provide nurses with nutritional advices for pre-eclampsia women	16	15.7	86	84.3	102(100)
9. Digital health provide midwives with proper assessment guide of pre-eclampsia women	17	16.7	85	83.3	102(100)
10. Can you register a multiparity to mom connect every each pregnancy	13	12.7	89	87.3	102(100)
11. Mom connect have no effect on pre-eclampsia women	37	36.3	65	63.7	102(100)
12. I advise patient on utilization of digital health apps	17	16.7	85	83.3	102(100)
13. Digital health initiatives such as mom connect informs pre-eclampsia patient on how to care for themselves and foetus	8	7.8	94	92.2	102(100)
14. Digital health apps help identify women at risk of pre-eclampsia early	28	27.5	74	72.5	102(100)

15.1 advise pre-eclampsia women to consult the internet for information about pre-eclampsia danger signs	46	45.1	56	54.9	102(100)
Cronbach alpha		0.841			

The study revealed that 88 (86.3%) midwifery practitioners pointed out that the purpose of digital health is to minimize maternal mortality and morbidity through active communication with gravid women using mobile initiatives such as mom connect. Moreover 85 (83.3%) reported that digital health apps assist them in accurate diagnosing of pre-eclampsia patients in their workplace. For instance 81 (79.4%) midwifery practitioners further reported that the use of digital health helps them reach an informed decision on whether to refer a patient to another facility for further management

Midwifery practitioners (82.4%) revealed that digital health use is of significant in detecting early conditions such as Pre-Eclampsia amongst gravid women. Moreover, 89 (87.3%) of midwifery practitioners stated that the use of digital health during the pandemic era further assisted them to curve the spread COVID-19. Furthermore, 84 (82.4%) and 86 (84.3%) of midwifery practitioners revealed the use of digital health helps them be updated on recent treatments of pre-eclampsia and it provides them with nutritional advice for Pre-Eclampsia women respectively. In addition, the results from table 4.3 further show that use of digital health by midwives assist and provide them with proper guide for assessment of Pre-Eclampsia women. Also, midwives use digital health to provide optimal quality care and 85 (83.3%) pointed out that they advise their client on the use of digital health to keep the client informed and involved in their care and treatment such as advising clients to use digital health. Midwifery practitioners (54.9%) reported to advise Pre-Eclampsia women to consult the internet for information about danger signs of the condition. Approximately 94 (92.2%) midwifery practitioners agreed that digital health initiatives such as mom connect informs pre-eclampsia patient on how to care for themselves and foetus. This follows 74 (72.5%) agreed that digital health apps help identify women at risk of pre-eclampsia early. In addition 89 (87.3%) women reported that they registered multiparas women to mom-connect with each pregnancy. However, 65 (63.7%) argued that mom-connect

have no effect on Pre-Eclampsia women with 37 (36.3%) agreeing that the use of mom-connect have a certain effect on the condition of the women.

However, the Cronbach alpha of the subsection of knowledge and importance of digital health was found to be 0.841 indicating high reliability. Haradhan (2017) affirms that the internal consistency level of >0.8 is very good and is associated with higher dependability.

- **Digital health methods**

Table 4.4. Digital health methods

N- Number F- Frequency

Digital health methods (mobile initiatives)	N	Never F (%)	Hardly ever F (%)	Sometimes F (%)	Often F (%)	Always F (%)
1. EM guidance	102	66(64.7)	4 (3.9)	14 (13.7)	4 (3.9)	14 (13.7)
2. Mom connect	102	17 (16.7)	16 (15.7)	26 (25.5)	8 (7.8)	35 (34.3)
3. EML clinical guide	102	53 (52.0)	3 (2.9)	31 (30.4)	3 (2.9)	12 (11.8)
4. Nurse connect	102	77 (75.5)	18 (17.6)	3 (2.9)	4 (3.9)	0 (0)
5. Medical Social media	102	82 (80.4)	4 (3.9)	13 (12.7)	3 (2.9)	0 (0)
6. Digital gestational wheel	102	27 (26.5)	6 (5.9)	16 (15.7)	8 (7.8)	45 (44.1)
7. Digital gestational calculator	102	27 (26.5)	3 (2.9)	13 (12.7)	15 (14.7)	44 (43.1)

There are variety kinds of digital health methods used in maternal health. However 64.7% midwifery practitioners reported that they never used EM guidance and 52% never used the EML clinical guide. Majority of Midwifery practitioners (75.5% and 80%) reported not using the nurse connect and medical social media in consulting and

assisting gravid women in treatment and care. The findings shows that midwifery practitioners are familiar with digital methods such as mom- connect since 35 (34.3%) of them always used them. Midwifery practitioners (44.1%) always use digital health methods such as digital gestational wheel and (15.7%) sometimes use it for determination of the gestational age of the gravid women. They also use digital gestational calculator always (43.1%) to determine the gestational age of the gravid women. Although the midwifery practitioners have knowledge of digital health utilization, they are sufficiently familiar with the mobile health applications to use to diagnose and treat Pre-Eclampsia amongst gravid women. In support of the findings, a study conducted by Karamolahi, Khalesi and Niknami (2021) affirmed that healthcare providers, midwifery practitioners included they should familiarize themselves with various features of digital health apps as they may need it to instruct pregnant women on self- care. Moreover, the digital health methods variables were only 7 items. The Cronbach alpha of the standardised items was 0.655, which indicate moderate reliability as indicated by Tasber (2017).

4.3.4. Section C: Barriers to utilization of digital health

Table 4.5. Barriers to digital health utilization

N- Number **F-** Frequency

C1	DISAGREE		AGREE		TOTAL
	F	%	F	%	N (%)
1. Lack of technology validation	26	25.5	76	74.5	102 (100)
2. Patients don't have mobile phone	63	61.8	39	38.2	102 (100)
3. Poor network connection in the facility	38	37.3	64	62.7	102 (100)
4. Patients not interested in the mHealth initiatives	70	68.6	32	31.4	102 (100)
5. Interferes with patient-nurse relationship	54	52.9	48	47.1	102 (100)
6. I find digital health unreliable	67	65.7	35	34.3	102 (100)
7. Most of the patients are technological illiterate	64	62.7	38	37.3	102 (100)
8. Lack of awareness of digital health	26	25.5	76	74.5	102 (100)
9. Don't have enough time to use digital health during patient consultation	30	29.4	72	70.6	102 (100)
10. I find digital health app difficult to use	59	57.8	43	42.2	102 (100)
11. The digital health doesn't covers relevant treatment to pre-eclampsia	74	72.5	28	27.5	102 (100)
12. I don't have a smartphone to access digital health apps	78	76.5	24	23.5	102 (100)
13. The facility don't have electronic devices such as tablets, Wi-Fi or computers	39	38.2	63	61.8	102 (100)
14. Electronic health record system not implemented in the facility	58	56.9	44	43.1	102 (100)

15. Digital health don't have enough information therefore I don't use it	69	67.6	33	32.4	102 (100)
16. Lack of policies, programmes and strategies to optimize utilization in digital health among pregnant women within the facility	46	45.1	56	54.9	102 (100)
17. Digital health requires more mental efforts	74	72.5	28	27.5	102 (100)
18. Experience electricity problems in the area	28	27.5	74	72.5	102 (100)
19. Overcrowding within facility	27	26.5	75	73.5	102 (100)
Cronbach alpha		0.569			

The results from Table 4.5 depicts that despite the significant knowledge of the midwifery practitioners, there is several perceived barriers to the utilisation of digital health amongst midwives and gravid women. For example, about (61.8%) of Midwifery practitioners reported that patient not have mobile phones however, due to barriers such as lack of technology validation (74.5%), poor network connection in the facility (62.7%) and lack of awareness of digital health initiatives (74.5%), there is limited utilization of digital health. The results further indicate that (68.6%) of midwifery practitioners disagreed that patients are not interested in the mHealth initiatives and (52.9%) also disagreed that digital health interferes with patient-nurse relationships. Moreover, 65.7% disagreed that they find digital health unreliable and (62.7%) disagreed that most of the patients are technologically illiterate nor that they find it difficult to use (57.8%). This is chiefly because of numerous perceived barriers, the midwifery practitioners pointed out that they don't have enough time to use digital health during the consultation (70.6%) and facilities don't have electronic devices such as tables and computers.

The barriers denote the shortage of resources, hence resulting in the non-utilization of digital health amongst midwives and gravid women, consequently affecting the optimal quality care supposed to be received by the pre-eclampsia women. A study conducted by Wit, Lucassen, Beulen, Faessen, Bos-de Vos, Wagemakers and Brouwe-Brolsma (2021) revealed about half of midwives reported that there are dozens of digital innovations to keep up with; however, midwifery practitioners either don't have time to get familiar with the innovations, or don't even consider the use of digital health innovations. Furthermore, the results revealed that lack of policies programmes and strategies to optimize utilization in digital health among pregnant women within the facility (54.9%); overcrowding within facility (73.5%) and electricity problems (72.5%) seems to hinder the utilization of digital health by most midwifery practitioners. Although the midwifery practitioners have significant knowledge of digital health utilization in early detection and treatment of Pre-Eclampsia, there are barriers inhibiting them from use of digital health in practice. This concur with results of a study conducted by Raj et al (2019) that lack of infrastructure like access to Wi-Fi and lack of awareness are biggest barrier to digital health usage. However, the Cronbach alpha of the standardised items under the barriers of utilization of digital health was found to be 0.569 which indicates the level of acceptable as specified by Taber (2017).

Table 4.6. Barriers: Staffing and staff development

N- Number F- Frequency

C2: Staffing and staff development	Disagree		Agree		Total
	F	%	F	%	N (%)
1. Shortage of staff in facility	28	27.5	74	72.5	102 (100)
2. Absenteeism high in the facility	66	64.7	36	35.3	102 (100)
3. Trained in digital health in past 2 years	96	94.1	6	5.9	102 (100)
4. Trained about the digital health authorised app	96	94.1	6	5.9	102 (100)
5. In-service training of pre-eclampsia	19	18.6	83	81.4	102 (100)
6. Attendance perinatal mortality meetings	14	13.7	88	86.3	102 (100)
7. Allowed to further educational level in maternal and child services and nursing informatics	24	23.5	78	76.5	102 (100)
8. Poor patient midwives ratio	40	39.2	62	60.8	102 (100)
9. Too much workload	22	21.6	80	78.4	102 (100)

The results from Table 4.6 above demonstrates inconsistencies in staffing and staff development amongst midwifery practitioners regardless that (81.4%) and (86.3%) of midwifery practitioners received in-service training about Pre-Eclampsia and attended perinatal meetings respectively. Majority of midwifery practitioners (94.1%) pointed out the lack of training with about digital health and digital health authorised apps. For this purpose lack of awareness about digital health utilization in early detection and treatment of Pre-Eclampsia amongst midwifery practitioners and gravid women is significantly high. In addition, the table 4.6 depicts that poor patient midwives ratio (60.8%) and too much workload (78.4%) are the impediments of digital health utilization amongst midwives.

Table 4.7. Barriers: workload

N- Number **F-** Frequency

C3 : Workload	N	Never F (%)	Hardly ever F (%)	Someti mes F (%)	Often F (%)	Always F (%)
1. Able to cope with workload in the facility	102	8 (7.8)	29 (28.4)	42 (41.2)	5 (4.9)	18 (17.6)
2. Staff in facility always manage to complete all the duties and patient for day	102	7 (6.9)	22 (21.6)	45 (44.1)	5 (4.9)	23 (22.5)
3. Working conditions in the unit pleasant	102	2 (2.0)	19 (18.6)	51 (50.0)	14 (13.7)	16 (15.7)

The findings of study in table 4.7 shows that despite too much workload amongst the midwifery practitioners. Midwifery practitioners (41.2%) pointed out that they are sometimes able to cope with the workload in their place of work; while only 18 (17.6%) reported to always manage to cope with their workload. However, only 8 (7.8%) of midwifery practitioners reported that the never cope with workload and 29 (28.4%) reported they hardly ever cope with the workload.

4.4. PRESENTATION AND INTEPRETATION OF QUALITATIVE FINDINGS

The objectives of the qualitative strand were to explore knowledge of gravid women on utilization of digital health. Furthermore, the strand aimed to identify and describe barriers on utilization of the digital health by gravid women. Themes and sub-themes emerged from the data analysis. The findings of study are presented in a narrative format.

4.4.1. Demographic data of the participants

This section presents the demographic data of the participants. This demographic data includes age, educational level and residential area. Ten (10) participants were used for this study.

Table 4.8: Demographic data of the participants

1. Age	14 - 19 years old	1
	20- 24 years old	1
	25-34 years old	5
	> 35 years old	3
2. Educational level	Primary level	3
	High school	4
	University/collage	1
	Never went to school.	2
3. Residing at	Rural	8
	Sub-Urban	1
	Urban	1

Age

The findings revealed the majority of the participants were of young adult age of 25 years old to greater than 35 years old. The age of the participants was important in order to determine the risk of having pre-eclampsia.

Educational level

The study revealed that only three (3) participants attended primary school, four (4) only attended high school, whilst one (1) attended college and two (2) never went to school. The educational level was significant to the study because the objective of the study was to determine the knowledge of digital health which involves the use of technology systems including phones and computers to access digital health apps. Furthermore, it was also important to establish their ability to read and access the information on digital health initiatives. Willis, Tuell, and Marzilli (2020) affirmed that sociodemographic factors such as educational level are significant especially when considering the implications of technology.

Residential area

The findings revealed that nine (8) participants were from rural areas, one each from the urban area and sub-urban area. This was important to determine, as the problem statement stated that there's a knowledge gap in the utilization of digital health amongst pregnant women from a rural area. This could be probably a lack of implementation or socio-demographic factors.

4.4.2. Characteristics of the participants

Table 4.9: characteristics of participants

	YES	NO
1. This is my first pregnancy	2	8
2. I have more than 1 babies	8	2
3. I once had high blood pressure in my previous pregnancy	4	6
4. I had high blood pressure before pregnancy	0	0
5. My current pregnancy is more than 20 weeks	10	0
6. I am currently taking my high blood pressure medications	10	0
7. I have been admitted in the hospital before in my previous pregnancies for high blood pressure	8	2
8. I have never attended the clinic during my pregnancy	0	10
9. I went to the clinic for my first booking after 20 weeks of my pregnancy	3	7

The findings revealed that eight (8) participants have more than one baby and four (4) of them had Pre-Eclampsia in their previous pregnancy before. In contrast, two (2) of the participants had their first pregnancy with the six (6) of them never had Pre-Eclampsia. However all of them (10) are currently on anti-hypertensives treatment following the diagnosis of hypertension in pregnancy. In addition, eight (8) of the participants have been previously admitted to the hospital for Pre-Eclampsia, and three went for the first visit after 20 weeks.

This was important to the study to establish the participant's previous experiences with the use of digital health in previous pregnancies and whether they are knowledgeable of the condition investigated; by looking at their number of pregnancies, previous diagnosis, and current medical condition. Furthermore, to establish their source of

information with the use of digital health looking at the attendance of antenatal visits and the time of booking. This is supported by the belief that individuals who previously experienced a catastrophic event before, they are most likely to know how to deal with it if a similar event were to occur.

4.4.3. Themes and sub-themes of the study

The process of qualitative research involves emergent questions and procedures (Creswell, 2018). During the inductive process of data analysis general themes were generated, after the researcher made the interpretation and sense as well as the meaning of the data (Creswell, 2018). Themes and sub-themes reflecting the knowledge and barriers of gravid women in the utilization of digital health utilization in early detection and treatment of Pre-Eclampsia emerged. The description of these themes and sub-themes are supported by quotes from the participants. The themes and sub-themes that emerged from the study are discussed below.

Table 4.10: themes and sub-themes

THEMES	SUB-THEMES
1. Significant roles of knowledge and mode of delivery about digital health utilization in early detection and treatment of pre-eclampsia outlined	1.1. Lack of knowledge is a concern regarding the use of digital health 1.2. Enhance access to information about pre-eclampsia 1.3. Promote awareness about the availability of digital health initiatives. E.g. mom connect 1.4. Diverse information obtained from primary health care facilities such as pamphlets and magazines. 1.5. Significant others like family and friends supplement the information from PHC
2. Description on barriers for digital health utilization in early detection and treatment of pre-eclampsia	2.1. Network connectivity is challenge for accessing the digital health initiatives. 2.2. Lack of trust and validation of digital health initiatives is a concern

	<p>2.3. Poor socio-economic status impact access to smartphones</p> <p>2.4. Lack of support and implementation of available digital health initiatives.</p>
3. Strategies to improve utilization of digital health	<p>3.1. Digital health literacy</p> <p>3.2. Availability and accessibility to infrastructure</p>

THEME 1: SIGNIFICANT ROLES OF KNOWLEDGE AND MODE OF DELIVERY ABOUT DIGITAL HEALTH UTILIZATION IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA OUTLINED

WHO decreed that improvements to maternal health care services delivered require a deliberate focus on the quality of services rendered. The quality of services should involve providing services that are effective, patient centred, integrated, efficient, safe, timely and equitable. The introduction of digital health in the health system was meant to improve and strengthen the quality of maternal health care and prevent maternal mortalities and morbidities (WHO, 2020). However, the current study revealed inconsistencies in the utilization of digital health amongst pre-eclampsia women, this affects the efficient, effective, integrated, and timely quality care patients supposedly receive. The participants shared their knowledge of digital health utilization, and the following sub-themes emerged;

Table 4.11: theme related to significant roles of knowledge

Theme	Sub-themes
1. Significant roles of knowledge and mode of delivery about digital health utilization in early detection and treatment of pre-eclampsia outlined	<p>1.1. Lack of knowledge is a concern regarding the use of digital health</p> <p>1.2. Enhance access to information about pre-eclampsia</p> <p>1.3. Promote awareness about the availability of digital</p>

	<p>health initiatives. E.g. mom connect</p> <p>1.4. Diverse information obtained from primary health care facilities such as pamphlets and magazines.</p> <p>1.5. Significant others like family and friends supplement the information from PHC</p>
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Sub-theme 1.1: Lack of knowledge is a concern regarding the use of digital health

Patient-centred care involves knowledge management to improve quality care. However, the gravid women demonstrated insufficient knowledge of digital health utilization in the early detection and treatment of Pre-Eclampsia. Although the majority of participants lacked the knowledge of digital health to inform them about Pre-Eclampsia, a fair number of gravid women expressed their knowledge of digital health in early detection and treatment of pre-eclampsia. This was supported by the following quotes,

“The last pregnancy I didn’t know that I had pre-eclampsia. I experienced blurred vision. This time when I came to the clinic I found out that I have pre-eclampsia again. This time there were no signs and symptoms as before. So I googled about my baby fetal movements at every trimester. Check the estimated weight at each every trimester because last pregnancy my baby was not properly growing in the uterus, I was informed that it was due to the elevated blood pressure” (Participant 001)

In addition, another participant said that;

“I used my phone to check the signs and symptoms of high blood in pregnancy. Although I forgot some of the things. I have learnt things like that you take care of the baby.” (Participant 004)

The study revealed experiences of Pre-Eclampsia in their previous pregnancies which influenced the utilization of digital health despite that some of the participants had

significant knowledge. This was supported by Weingarten, Chen, McAdams, Yi, Hepler, and Albarracín (2016) that past life experiences or behavior often have an influence and impact on the current experiences and also have an influence on decision making. In the context of this study, it could be that based on the negative experiences that gravid women had in their previous pregnancies; they felt motivated to learn more about Pre-Eclampsia on google to avoid such experiences again. However, the study further revealed the majority of the participants lack the knowledge of digital health utilization in the early detection and treatment of pre-eclampsia. This is supported by the following quotes;

“I have never used a phone or any kinds of digital health initiatives to inform myself about my condition.” (Participant 006)

This was followed by a probing question structured like;

“Could you kindly share your reasons of not utilizing digital health?”

The participant answered and said *“It’s because I didn’t download it and I don’t even have a smart phone” (Participant 006)*

Second participant said that;

“The problem is that I don’t have a phone that am currently using. Therefore I don’t use digital health initiatives.” (Participant 002)

The probing question was asked as,

“Could you kindly share the reasons why you don’t have a phone?”

The participant answered and said;

“Eish, I don’t see the need for the use of a cell phone.” (Participant 002)

However, the study revealed that there’s a knowledge gap in the utilization of digital health in the early detection and treatment of pre-eclampsia amongst gravid women. As they also reported not having smart phones. Whilst the use of digital health doesn’t only necessarily means one should have a smart phone to use, mobile initiatives such as mom connect also assist with pre-eclampsia care and treatment. This shows a lack of knowledge amongst the participants. In this study, it could be assumed that lack of

knowledge could be associated with their level of education and residential area because factors like this limit access to information. This concurs with the results of a study conducted by Burke, Nahin and Stussman (2015) on limited knowledge as a reason for the non-use of four common complementary practices revealed that lack of knowledge is a common impediment to the use of complementary health practices and it's mostly likely as a result of lowered attained educational level and other sociodemographic factors. This aligned with the findings of a study by Ahmed, Rizvi, Rasheed, Iqbal, Bhuiya, Standing, Bloom, and Waldman (2020) that accessing information in the digital platform requires literacy, for instance accessing information from a call center (i.e. mom connect) with regards to your inquiries one is required to press specific numbers in response to questions or directions. Alternatively browsing the internet needs English literacy.

Furthermore, this could be also due to the failure of midwifery practitioner to assume their health promotion and preventive roles during practice. This was supported by the following quote;

“So far the midwifery practitioners haven’t taught me about digital health and its use in pregnancy and in informing about my condition.”(Participant 001)

Sub-theme 1.2: Enhance access to information about Pre-Eclampsia

As technology renovates the healthcare industry, it has been said that digital health has the potential to reshape traditional health care delivery. This includes the strengthening of the maternal healthcare delivery system (Wirthman, 2019). Despite the lack of knowledge amongst other gravid women some highlighted their views and knowledge on the significance of the usage of digital health initiatives to access information. The following extracts show the participant's views on the significant roles played by digital health utilization in their lives

One participant said;

“The use of digital health was informing me about the things I should eat since I had high blood pressure. Now since this is my third pregnancy am using the same information I have learned from my previous pregnancy. The time I was using mom connect, it was helpful because it used to remind me about my antenatal visits. And also the foods I should eat.” (Participant 007)

Another participant said;

“...using digital health I got to learn a lot about the symptoms of high blood pressure. I became aware of how to care for myself and my baby. I usually come across a lot of information.” (Participant 009)

This was supported by another participant by saying;

“My experience in using digital health was helpful because I was diagnosed with a high blood pressure around 26 weeks of my pregnancy. From there I was concerned about my pregnancy and started to research high blood in pregnancy. It kept me informed and I learned about the foods am supposed to eat and avoid oil foods and salty foods. It helps to check whether my baby is growing well” (Participant 008).

“Digital health guides me on the foods that am supposed to eat. Give me access to information that I never knew of before. I think the reasons my blood pressure right now because I watch what I eat.” (Participant 009).

Another participant said that;

“When I used digital health I learnt that I should take care of my baby and attended antenatal visits on time. It further helped to accept my pregnancy and learn how to care for myself and my baby since I have pre-eclampsia.” (Participant 004)

One participant said that;

“The significant thing that I have noted is that as women we won’t always have money to go to the doctor, but then the use of digital health gave access to more information about the kind of foods I am supposed to eat and what’s important such as sleeping positions and well-being of my baby.” (Participant 001).

This shows that those gravid women who used digital health had access to health information about their pregnancy and their condition. As they expressed that the use of digital health guided them and kept them informed about pre-eclampsia and caring for their babies. This was supported by a study conducted by Olu, Muneene, Bataringaya, Nahimana, Ba, Turgeon, Karamagi and Dovlo (2019) on how digital health technologies contribute to the sustainable attainment of UHC in Africa. The study reported that digital health has various benefits, this includes improved access

and quality of health care services; and improved knowledge through access to health information. Watkins, Goudge, Gómez-Olivéc and Griffiths (2018) corroborated that the use of digital health has the potential to improve access to health information.

Sub-theme 1.3: Promote awareness about the availability of digital health initiatives. E.g. mom connect

Although some of the gravid women shared their views and Knowledge on the importance and usage of digital health initiatives to access information on pre-eclampsia, however their knowledge on the availability of digital health initiatives is insufficient and limited. Most of the participants mentioned the use of the internet, mom connect and Facebook. This is supported by the following quotes;

"...So this time I used the internet to check the weight and foetal movements as well as signs of pre-eclampsia. Digital health was really helpful to me to know about my condition." (Participant 001)

A probing question was asked as follows;

Could you kindly share your knowledge on the digital health apps you used?

The participant answered and said;

"There was no apps I used instead, I googled the website pages called babies mommy and etc. you know when you go to google and search that specific content you want, it shows you variety of options. Then I'd choose flow and also mom n' baby, calendar, I visit those a lot." (Participant 001)

Another participant said;

"I only found out that I have high blood pressure around last week, so when I read on the internet I found out that it is really dangerous and I didn't know about it. The information I accessed was relevant because the signs and symptoms they mentioned I also experienced them. Some information I just googled myself from the internet after opening my file and checked what I was diagnosed with." (Participant 005)

In addition, other participants said;

“I am using mom connect and it is alright, because it guides me on the type of foods I should eat and that I should be in a clean environment. And also eat fruits, milk it could be Nkomati or fresh milk.” (Participant 003)

However only one of the participants expressed their knowledge in another different digital health app from others, even though the knowledge of other digital health initiatives is insufficient and the information provided was not of relevance to the study topic, but it shows that the participant has significant knowledge about digital health even before pregnancy and pre-eclampsia. This was supported by the following extract;

“So most of the things I had to learn from the internet... I also used a digital calendar to inform me of my menstrual cycle before pregnancy.” (Participant 008)

The study highlighted that although the participants shared their views on the use of digital health. There's limited knowledge and awareness of available digital health initiatives, as most expressed they used internet and mom connect digital platform only. Kaihlanen, Virtanen, Buchert, Safarov, Valkonen, Hietaoakka, Horhammer, Kujala, Kouvonen, and Heponiemi (2022) affirmed that most individuals are not aware of other existing digital health initiatives and their value. Olu et al (2019) concurred with Park, Young Lee, Kim, Lee, Shinn and Kim (2021) that a lack of awareness of digital health utilization is a common challenge amongst health care clients. This highlights the need for the promotion of digital health awareness through health literacy about the available digital health initiatives that can be used by gravid women during pregnancy.

Sub-theme 1.4: Diverse information obtained from primary health care facilities such as pamphlets and magazines.

Despite the lack of knowledge of digital health utilization in early detection and treatment of pre-eclampsia amongst the participants, some were shown to know about Pre-Eclampsia as they acquired the information from the alternative informational support system. This includes information from midwives and pamphlets from primary health care facilities. This was supported by the following quotes;

“The midwives taught me about digital health they even registered me to mom connect, they also taught me how I should care for myself and not to lift up heavy stuff. And that I should avoid stressful events. (Participant 003).

“I was never taught about digital health however, I was informed about what pre-eclampsia is and how to care for myself from the clinic. They also taught me I should eat healthy and drink a lot of water.”(Participant 004).

“I was only reading magazines and the pamphlets from the clinic on how to care from myself and the baby.” (Participant 006).

Although some of the participants expressed that they were taught by midwifery practitioners about Pre-Eclampsia. Others stated that they were not informed nor taught about pre-eclampsia and the utilization of digital health. If they happen to be taught about it; it's because they asked about it from the midwives. This is supported by the following quotes;

“Nurses never taught me anything about the use of the phones in pregnancy. Most of the time I have to ask them about the information so that they can tell me. That's how I learnt about mom connect, because in my first pregnancy I wasn't told about mom connect. So with this second pregnancy that's when I started to consult the internet because I didn't want to go through what I went through the first pregnancy.” (Participant 009)

“Ah, I was never taught about high blood pressure in pregnancy. I was referred to high risk clinic at general hospital.” (Participant 008)

“No, I have never been informed about digital health initiatives. Maybe it's because this is my second visit. (Participant 001)

A probing question was asked as follows;

Since this is your second pregnancy, could you kindly explain your experience in your first pregnancy about digital health?

The participant answered;

“Even on my first pregnancy when I was attending my visits, the time I got here when they detected the high blood pressure they referred me straight to the hospital. So I was attending my clinic there.” (Participant 001)

The results revealed inconsistencies in practices of health literacy in clinical practice by midwifery practitioners, as some of the participants expressed their concern about not being taught about pre-eclampsia or digital health. This was supported by Creedy, Gamble, Boorman and Allen (2021) that midwives hardly promote the practice of health literacy. Poor understanding of health literacy and inadequate health practices among midwives often lead to poor outcomes in patient’s health (Munangatire & Mareka, 2022). This shows a significant need for the emphasis on the implementation of health literacy practices amongst midwifery practitioners to improve the knowledge of gravid women with regard to their diagnosis.

Sub-theme 1.5: Significant others like family and friends supplement the information from PHC

The study revealed that the reason some of the gravid women are knowledgeable of Pre-Eclampsia is because they used alternative sources of information to keep themselves informed about pre-eclampsia. This includes the consultation of family and friends. The participants expressed the reasons they prefer consultation of friends and family than digital health; it’s because they want to avoid confusion and that they don’t really trust some of the information. This was supported by the following quotations;

“I never used digital health because at home there’s someone who has high blood pressure and been living with it for some time. So also the sisters at the clinic taught me about my condition. So I used the information from my relative with high blood pressure and the one from the nurses. I watched what I should eat and what I should avoid eating.” (Participant 010)

“So most of the things I had to learn from the internet and from my mother as well.” (Participant 008)

Another participant said;

“I usually talk to other pregnant women at the clinic about pre-eclampsia.” (Participant 008)

It was supported by a study conducted in Bangladesh on digital health and inequalities in access to health services by Ahmed et al (2020) concurred with a study that most people preferred to discuss their health care needs with their friends and family first then use digital health. The findings suggest that the reasons that participants preferred consulting family and friends over digital health it could be directly associated with a lack of trust in digital health and avoiding confusion with the load of information from digital health platforms. Park et al (2021) concurred with Ahmed et al (2020) that distrust in the accurateness and quality of health information as well as discomfort were associated with the non-utilization of digital health to access information.

THEME 2: DESCRIPTION OF BARRIERS TO DIGITAL HEALTH UTILIZATION IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA

Despite some of the participant familiarity with digital health utilization in early detection and treatment of Pre-Eclampsia, others expressed their challenges and barriers that resulted in to not using digital health as much as they like.

Table 4.12: theme related to the barriers to utilization of digital health

Themes	Sub-themes
2. The description on barriers for digital health utilization in early detection and treatment of pre-eclampsia	<p>2.1. Network connectivity is challenge for accessing the digital health initiatives.</p> <p>2.2. Lack of trust and validation of digital health initiatives is a concern</p> <p>2.3. Poor socio-economic status impact access to smartphones & network connectivity</p> <p>2.4. Lack of support and implementation of available digital health initiatives.</p>

Sub-theme 2.1: Network connectivity is a challenge for accessing digital health initiatives.

Although the participants have significant knowledge of digital health and the availability of digital health initiatives, they expressed their challenges in accessing the information they need related to their pregnancy and Pre-Eclampsia. This includes challenges such as Wi-Fi and poor network connection. This was supported by the following quotes;

“Ah, from my side I won’t lie and say I experienced a lot of difficulties because I know how to google search especially because am young so what if someone else whose old whom don’t have the knowledge to use phones and those who don’t have smart phones. They weren’t going to be able to google ...However poor network connections is also the challenge I usually face most of the time and I don’t have Wi-Fi at home, I mostly use the Wi-Fi at work access information about my pregnancy and pre-eclampsia.”(Participant 001)

This was supported by another participant who said;

“Sometimes I’d face network connectivity problems when trying to access information about my pregnancy and pre-eclampsia especially during load shedding.” (Participant 008)

The findings of the study revealed poor infrastructure is a barrier to the utilization of digital health amongst gravid women. This includes lack of access to Wi-Fi connection and poor network connections most likely to be associated with power outages as stated by the participants. Curiosso, Ting, van Ginneken and Were (2022) affirmed that access to the internet still remains a major concern in low and middle-income countries, especially in rural areas. Most people experience slow or intermittent internet and inequalities in access to electricity. Olu et al (2019) concurred with the results of the study, Curiosso et al (2022) and Holst et al (2020) that poor infrastructures such as poor network connectivity and unstable power supply influence the use of digital health.

Sub-theme 2.2: Lack of trust and validation of digital health initiatives

In contrast to the knowledge of digital health utilization in early detection and treatment of pre-eclampsia by gravid women. Some participants expressed their fears about the use of digital health information. Some mentioned a lack of trust in the information access because they don't whether such information is true and validated. This is supported by the following extracts;

"The thing is that for me is that I was never sure which website to use and to trust, because I was never taught about it at the clinic. Nowadays people can write on the about their experiences about pre-eclampsia and most of their information is not validated..." (Participant 008)

"I usually come across a lot of information, sometimes I get confused on which one to trust, especially on Facebook because a lot of women there have a lot share, so I end up not knowing whether to trust the information." (Participant 009)

The findings of the study revealed that the lack of trust and validation of digital health by midwifery practitioners to gravid women limited them to access more information related to their pregnancy on the digital health platforms. A study conducted by Ahmed et al (2020) concurred with the findings of the study that most participants don't trust the truthfulness and quality of digital health information. Instead, they prefer direct interactions with the person providing the information and advice. Kaihlanen et al (2022) and Caballero-Urbe (2018) concurred with the study that fears, lack of reliability, and lack of trust in digital health impede the use of digital health platforms.

Sub-theme 2.3: Poor socio-economic status impact access to smartphones & network connectivity

Most of the participants are from rural areas with poor socio-economic factors. Most of the participants expressed their concerns with regards to the utilization of digital health in the early detection and treatment of pre-eclampsia. The participants further stated the factors impeding them from the utilization of digital health were socio-economic mainly affordability of smartphones and data, and unemployment. This is supported by the following extracts;

"And nowadays data is expensive, even myself I usually google a lot when am at work and save data. I can say that my challenge is whenever am at home, I can't google more because I don't have enough data..." (Participant 001)

“Another challenge, data was the problem most, because am unemployed and a student I can’t afford to buy data all the time to google, still have to rely on my boyfriend and my parents...” (Participant 008)

“Sister, I don’t have a smart phone. So the information I have about the high blood pressure is because of my previous pregnancy because this registered me to what you call mom- connect. So it was informing me about the things I should eat since I had high blood pressure. Now since this is my third pregnancy I am using the same information I have learnt from my previous pregnancy.” (Participant 007)

A probing question was asked as follows;

Could you kindly elaborate more on the challenges and barriers to utilization of digital health?

The participant answered and said;

“As I have already said I don’t have a smart phone and I don’t know much about the use of cell phones and computers. My last standard 4, so am uneducated and I don’t think I even afford to buy one.” (Participant 007)

The study by Watkins et al (2018) is in agreement with the study findings that financial instability influences the utilization of digital health. Watkins et al (2018) as a result of in financial instability patients couldn’t afford airtime consequently reducing the use of digital health platforms. Moreover, the study revealed that the unaffordability of data and smartphones are hindering the use and access to digital health amongst gravid women. Goggin (2014) and Reiners, Sturm, Bouw, and Wouters (2019) affirmed that affordability is a recurrent issue in the use and access of digital health; people with low and no income tend to have limited availability and access to internet or digital health care services.

Sub-theme 2.4: Lack of support and implementation of available digital health initiatives

Most of the participants expressed that they receive no support on the use of digital health in pregnancy. Moreover, they shared that they were never taught about the available digital health initiatives. This was supported by the following quotes;

“I just googled myself from the internet after opening my file and checked what I was diagnosed with. So I didn’t receive any support from the midwives.” (Participant 005)

Another participant said;

“I have never received any support with regards to the use of digital health initiatives. They never taught me anything about digital health initiatives that may assist me with my pregnancy.” (Participant 004)

The findings revealed that there’s lack of support and poor implementation of available digital health initiatives by midwifery practitioners in clinical practice. This shows that the lack of knowledge of digital health and available digital health among gravid women could be associated with a lack of support and poor implementation by midwives; hence the gravid women lack skills and knowledge of digital health. Kaihlanen et al (2022) affirmed that weak skills are often linked to another common problem to access digital health such as inadequate experience and difficulty in finding support for digital health services use. Philippe, Sikder, Jackson, Koblanski, Liow, Pilarinos, and Vasarhelyi (2021) concurred that lack of guidance and support from practitioners is a concern in the implementation of digital health services.

THEME 3: SUGGESTIONS TO IMPROVE UTILIZATION OF DIGITAL HEALTH

The gravid women suggested improving the use of digital health. Two themes emerged; digital health literacy and availability and accessibility of digital health. The suggestions made by the gravid women were mostly related to the challenges they experienced in the utilization of digital health.

Table 4.13: Theme related to suggestions to improve digital health utilization

Theme	Sub-themes
3. Suggestions to improve utilization of digital health	3.1. Digital health literacy 3.2. Availability and accessibility to infrastructure

Sub-theme 3.1: Digital health literacy

Most of the participants indicated that midwifery practitioners never taught them about the use of digital health in pregnancy. Although few gravid women indicated that they were only taught about Pre-Eclampsia; the use of digital health in the treatment of Pre-Eclampsia was never part of the lessons. This was supported by the following quotes;

“Nurses should teach pregnant women on the use of digital health and provide us pregnant women with the information necessary for high blood pressure in pregnancy.”
(Participant 009)

“Nurses should teach pregnant women on the use of digital health and the websites that we can trust to provide relevant information.” **(Participant 008).**

The study shows that there's a lack of digital health literacy implementation in clinical practice by midwifery practitioners. This was supported by the suggestions of gravid women emphasis the need of digital health literacy. Curioso et al (2022) that lack of adult literacy and health literacy is one of the major issues hindering the implementation of digital health initiatives. Many digital health initiatives require health literacy; and for gravid women to take an active role in their healthcare they require skills and knowledge. Thus midwives should take it upon themselves to counsel and guide gravid women on the use of digital health (Busse, Nitsche, Kernebeck, Weitz, Ehlers & Bork, 2022).

Sub-theme 3.2: Availability and accessibility to infrastructure

Based on gravid women views on knowledge and barriers of the utilization of digital health in the early detection and treatment of pre-eclampsia, the participant made a few suggestions. Some of the participants that more free Wi-Fi should be added in their local areas so they will be able to access the information they need. The was supported by the following quote;

”To address this Wi-Fi and data expenses, if possible maybe free Wi-Fi station should be installed in our local areas so that we can more access to the information we need with regards to pre-eclampsia and our pregnancy. As far as I read, pre-eclampsia is

dangerous and every women diagnosed with pre-eclampsia should have access to all the information they need, because it could serve our lives.” (Participant 001)

Another participant supported by saying;“...and help with free access to the information with need online with regards to our pregnancy.” (Participant 008)

Raj (2019) and Hoque, Mazmum & Bao (2014) affirmed that poor infrastructure such as poor Wi-Fi access, computers, tablets, and electricity is a concern in the utilization of digital health. The study findings suggested that to improve accessibility to digital health by gravid women the infrastructure must be improved.

4.3. INTEGRATION OF THE QUANTITATIVE AND QUALITATIVE FINDINGS

The study adopted a convergent parallel research design to gain the complementarity views and completeness of the phenomena under study. The adopted research method enabled the researcher to enhance the credibility of the study and to evaluate how the knowledge and barriers in the utilisation of digital health by gravid women were influenced by the midwifery practitioners (McCrudden, Marchand & Schutz, 2019; Venkatesh, Brown & Sullivan, 2016). A convergent design allowed the researcher to identify the point where the findings converge, diverge and relate to each other (Creswell, 2014).

4.3.1. Procedure that guided the integration

Using a cross-case comparison mixed method analytical strategy, the researcher was able to identify inconsistencies and consistencies across the cases and create explanations for why they occur. Cross-case comparison is a mixed method analytical technique that consolidates the data of quantitative and qualitative by building holistic, internally coherent profiles that are used to test or expand upon quantitatively or qualitatively derived themes for comparison purposes (Creamer, 2018). This enabled the researcher to identify the overlapping constructs following the merging of the findings. These further produced principal conclusions of the study and principal themes were formed (Creamer, 2018).

The principal themes are presented in a joint display format whereby they were created following the cross-case comparison. The created principal themes informed the development of strategies to enhance the utilization of digital health in the early

detection and treatment of Pre-Eclampsia. The overall intent of the joint display was to provide a detailed description of atypical configurations that emerged from the perspective of the midwifery practitioners and gravid women in the utilization of digital health. The study significantly focused on the knowledge and barriers of digital health utilization in the early detection and treatment of pre-eclampsia.

4.4. INTEGRATION, INTERPRETATION AND DISCUSSION OF BOTH QUANTITATIVE AND QUALITATIVE FINDINGS

4.4.1. Knowledge and importance of digital health utilization in the management of pre-eclampsia

The quantitative findings, revealed that the midwifery practitioners have adequate knowledge of utilization of digital health in early detection and treatment of pre-eclampsia. Based on the knowledge and importance variables, 82.4% of the midwifery practitioners pointed out that digital health is the utilization of digital, mobile, and wireless technologies for health. Majority of midwifery practitioners (86.3%) reported that the purpose of digital health is to minimize maternal mortality and morbidity through active communication with gravid women using mobile initiatives such as mom connect. Most of midwifery practitioners (83.3%) admitted that the use of digital health assists them to accurately diagnose pre-eclampsia and detect early conditions such as pre-eclampsia. In contrast to the findings, the qualitative findings revealed that the majority of gravid women lack the knowledge of digital health utilization in the early detection and treatment of Pre-Eclampsia. This could be associated with the emerged sub-themes socio-economic factors such as affordability, educational level, and related factors such as lack of support and poor implementation of available digital health initiatives. Olu et al (2019) affirmed with the results of the current study, that although digital health has the potential to improve the quality of care; lack of knowledge and awareness is a common challenge in using digital health in the health care system.

The integrated findings indicated that although the midwifery practitioners are knowledgeable about the utilization of digital health, there's a gap in knowledge transmission and implementation of digital health initiatives through health education. Poor health literacy is associated with diverse negative outcomes such as less use of importance tools necessary for self-care including digital health (Nawabi, Alayli, Krebs,

Lorenz, Shukri, Bau & Stock, 2020). Midwifery practitioners should adopt a flexible approach to accommodate patients' knowledge (Downer, McMurray & Young, 2020). However, Ifeoluwa (2016) suggested that also the lack of knowledge about use of digital health could be associated with lack of skilled personnel. Therefore, there's a significant need of programmes to improve the knowledge of digital health among midwifery practitioners and gravid women.

4.4.2. Barriers related to digital health utilization

For digital health to contribute toward optimal quality care and equality of health in the South African context, the challenges hindering the implementation of digital health need to be addressed (Toivanen, Herselman, Mylloyoja & Botha, 2016). Below are the integrated barriers to the utilization of digital health in the early detection and treatment of Pre-Eclampsia.

- ***Shortage of digital and human resources***

Shortage of resources remains a global challenge in the healthcare industry. Shortage of human resources and materials hinders the provision of quality midwifery care (Mothiba, Skaal & Berggren, 2019). The quantitative study revealed midwifery practitioners face some impediments in the provision of quality care through the use of digital health. The impediments include things a such shortage of human and digital resources. 72.5% of midwifery practitioners revealed that a shortage of staff is a major problem within the place of practice. This could consequently lead them to have too much workload. This was supported by 78.4% of midwifery practitioners who pointed out that they have too much workload. Midwifery practitioners (28.4%) reported that they hardly ever cope with their workload and 21.6% reported they hardly ever manage to complete their work at the end of the day. 73.5% of the midwifery practitioners pointed out that usually there's overcrowding of patients in the facilities. This concurs with the results of a study by Lumadi and Matlala (2019) that a shortage of midwifery practitioners consequently leads to poor quality care as a result of increased workload amongst the midwives subsequently leading to burnout and low morale.

These impediments possibly contribute to the poor implementation of digital health initiatives. This was supported by a study conducted by Vousden, Lawley, Nathan, Seed, Brown, Muchengwa, Charantimath, Bellad, Gidiri, Goudar, Chapell, Sandall and

Shennan (2018) in low resource communities, aimed to reduce maternal mortalities and morbidities by implementing of a digital health device. They reported that during the implementation of the device; health care providers faced barriers such as lack of supportive supervision of device use, high staff turnover, and poor availability of resources, the device included. However, this was supported by qualitative findings of the study, which reported a lack of support and poor implementation of available digital health initiatives by midwifery practitioners. Majority of gravid women in the qualitative study reported that they received no support from the midwifery practitioners with regards to utilization and implementation of digital health. This could be that shortage of human resources and too much workload has a direct impact on the quality of care, hence the lack of support of gravid women and poor implementation of the available digital health initiatives at the facilities.

Furthermore, the integrated findings indicated that shortage of human resources and digital resources are a common barrier in the utilization of digital health amongst midwifery practitioners and gravid women. Majority of midwifery practitioners (61.8%) in the quantitative study reported that their facilities don't have electronic devices such as tablets, Wi-Fi devices or computers. This could be hindering the implementation of other available digital health interventions that require may require the excess to the internet. Whereas the qualitative study reported that poor socio-economic status impacts access to smartphones and network connectivity. The majority of the gravid women reported that they don't smartphones, data is expensive, and don't have access to Wi-Fi. This was supported by a study conducted by Watkins et al (2018) on the use of mobile health in rural areas, in South Africa. The study reported that most healthcare providers used their own phones for healthcare and bearing the costs themselves, moreover some of the healthcare providers developed informal digital health solutions in response to their work needs and lack of resources. Furthermore, the study reported that most patients reported a lack of financial ability to use digital health solutions.

- ***Power supply inconveniences impacting network connectivity***

The quantitative study pointed out that 72.5% of midwifery practitioners experience electricity problems. This was supported by the qualitative study where the gravid women reported they experience a lot of load shedding and directly impacting their

network connectivity. Midwifery practitioners (62.7%) reported poor network connections that could be the impact of power supply inconveniences network connectivity subsequently resulting in poor access to digital health initiatives by midwifery practitioners and gravid women. Similarly, a study conducted in Nigeria by Ifeoluwa (2016) on challenges in implementing digital health reported that the unavailability of power supply affects efficiency and internet accessibility. This concurred with Vodacom spokesperson and MTN SA's executive of corporate affairs said that if the power outage and back-up batteries power at the cell towers is fully depleted, problems arise batteries begin to overheat and take longer to cool down, consequently affecting the efficacy of the network connectivity (Jacobs, 2021). Currently South Africa is facing major electricity issues, currently characterized by consistent power outages or load shedding. This shows a need to create an infrastructure to make electricity and internet accessible to midwifery practitioners and gravid women for them to implement digital health (Ifeoluwa, 2016).

- ***Lack of awareness with regards to digital health utilization in early detection and treatment of Pre-Eclampsia***

The qualitative findings shown gravid women lack awareness in use of digital health utilization and most shown have not understanding of using digital health initiatives. They had to rely on alternative sources of information such as family & Friends, Pamphlets and magazines. Even though few of the gravid women revealed their knowledge of utilization of digital health; their awareness of digital health was only limited to the use of the internet and mom connect. Lack of awareness seems to be the impending factor to the use of digital health. This was supported by the quantitative findings where 74.5% reported a lack of awareness of digital health utilization. Ahmed et al (2020) affirmed that lack of awareness, discomfort and lack of understanding and skills were the core reasons for not using digital health.

The integrated findings revealed that there's a lack of awareness of digital health utilization in the early detection and treatment of pre-eclampsia. Although the midwifery practitioners know about digital health that doesn't necessarily they aware of the digital health initiatives nor know how to use them. The lack of awareness amongst midwives could be associated with the lack of policies, programmes and strategies to optimize the utilization in digital health among pregnant women within the

facilities. A study conducted by Ifeoluwa (2016) concurred with the results of the study that there's a lack of understanding of digital health as well as awareness, which affects the perceptions of digital health. Ifeoluwa (2016) further reported that the lack of awareness about the effective use of digital health could be the result of the government unwillingness to prioritize the use of digital health in rural areas. As a result there's lack or no policy supporting use of digital health in rural areas. This evidently show that the communities of low and middle incomes should familiarize themselves with digital health, so they learn the role and impact digital health in improving health.

- ***Lack of training about the use of digital health***

The quantitative findings reported that although 81.4% of midwifery practitioners received training on Pre-Eclampsia; 94.1% of midwifery practitioners received no training in the use of digital health within the facilities. The qualitative findings revealed that there's a lack of support and poor implementation of the available digital health initiatives by midwifery practitioners. This could be possible due to a lack of training amongst midwives consequently leading to the implementation of digital health initiatives. Utukuri, Souza, Deighton, Le, Osei-Boadu, Gadi, Axiaq, Aung, Agboala, Chand, Dibblin, Patel, Abedi, Hirniak, Ta, Rudd and Sethi (2022) affirmed that inequities in digital literacy amongst the HCPs have to be noted, impeding the use of digital health in clinical practice; this shows a lack of appropriate training. Curioso et al (2022) concur with Utukuri et al (2022) that the lack of trained, qualified and skilled professionals is the main barrier to digital health utilization, especially in low and middle-income countries.

The integrated findings show that there's a significant need of the development of training programs to training midwifery practitioners on the use of digital health. This was supported by a study conducted by Utukuri et al (2022), to not harm, HCPs must be sufficiently trained on the use of digital health in practice. Manyazawel, Woldeamanuel, Blumberg, Fekadu and Marconi (2021) concurred with Curioso et al (2022) and Utukuri et al (2022) that the adoption and implementation of digital health require extensive training of the HCPs; moreover, digital health implementation can further tackle the major clinical and public sector backlog further strengthening the healthcare ecosystem.

- ***Lack of digital health initiatives validation and policies***

Lack of technology validation hinders the utilization of digital health. The quantitative study revealed that 74.5% of the midwifery practitioners pointed out that lack of technology validation is a barrier to the utilization of digital health utilization amongst midwifery practitioners. This was supported by the qualitative findings which revealed a lack of digital health initiatives validation is a concern. The gravid women reported a lack of trust and confusion in the use of digital interventions such as the internet.

Furthermore, the quantitative study discovered that there's a lack of policies, programmes and strategies to optimize the utilization in digital health among pregnant women within the facilities. This was supported by Curioso et al (2022) that the lack of policies and strategies as well as evidence for scientific validity is one of the main challenges to the use of digital health. Even though the national department of health issued a National Digital Health Strategy for SA (NDHSSA) 2019-2024. No Standard Operating Protocol or policies were designed and developed to govern the practice of digital health in the management of high-risk pregnancies, such as Pre-Eclampsia.

The integrated findings revealed that there's a need of a regulatory framework and legislative to regulate the practice of digital health in clinical practice to enhance validation. This was corroborated by Cabuka (2019) in the seminar on prioritizing research and evaluation for digital health in SA; to support the development of digital health interventions there a need for formulation of a national legislative and regulatory framework for digital health. Furthermore, Cabuka (2019) further affirmed that there's a required need to develop an enhanced digital health capacity and skilled workforce for support and implementation of digital health.

Domains	Variables	Participant 1	Participant 2	Principal theme
Knowledge	knowledge and importance	<p>Quantitative results reported 83.3% digital health apps to assist midwives help in accurate diagnosing of pre-eclampsia patients.</p> <p>Qualitative results reported lack of knowledge is a concern regarding the use of digital health</p> <p><i>“The problem is that I don’t have a phone that am currently using. Therefore I don’t use digital health initiatives.”</i></p> <p><i>Inconsistencies in knowledge of digital health between midwives and gravid women</i></p>	<p>Quantitative reported 82.4% midwives use of digital health help detect early conditions such as pre-eclampsia in gravid women.</p> <p>Qualitative results reported enhance access to information about pre-eclampsia</p> <p><i>“I have never used a phone or any kinds of digital health initiatives to inform myself about my condition.”</i></p> <p><i>Inconsistencies in knowledge of digital health between midwives and gravid women</i></p>	<i>Knowledge and importance of digital health utilization in the management of pre-eclampsia</i>
Barriers	Infrastructure, system, workload and	Quantitative results reported 61.8% pointed out that the facility don’t	Quantitative results reported that there’s overcrowding in the facility (73.5%), shortage of	<i>Shortage of digital and human resources</i>

	staffing and staff development	<p>have electronic devices such as tablets, Wi-Fi or computers</p> <p>Qualitative results reported poor socio-economic status impact access to smartphones.</p> <p><i>“As I have already said I don’t have a smart phone and I don’t know much about the use of cell phones and computers. My last standard 4, so am uneducated and I don’t think I even afford to buy one.”</i></p> <p>Shortage of digital resources</p>	<p>staff (72.5%) and too much workload (78.4%)</p> <p>Qualitative results reported lack support and implementation of digital health initiatives by midwives and poor socio-economic status impact access to smartphones.</p> <p><i>“The problem is that I don’t have a phone that am currently using. Therefore I don’t use digital health initiatives.”</i></p> <p>Shortage of resources</p>	
		<p>Quantitative results reported that the midwifery practitioners experiences electricity (72.5%). Whilst the qualitative results reported network connectivity is a challenge for accessing the digital health initiatives.</p>	<p>The Quantitative results revealed that 62.7% reported that experiences poor network connectivity. Whilst qualitative results reported that network connectivity is a challenge in accessing the digital health initiatives</p>	<p>Power supply inconveniences impact network connectivity</p>

		<p><i>“Sometimes I’d face network connectivity problems when trying to access information about my pregnancy and pre-eclampsia especially during load shedding.”</i></p> <p>Power supply inconveniences</p>	<p><i>“...also network connections is also the challenge I usually face especially during load shedding.”</i></p> <p>poor network connection due power outage</p>	
		<p>The quantitative results indicated that lack of awareness is a barrier to utilization of digital health (74.5%), whilst the qualitative results revealed that most gravid women had limited awareness of digital health. As a result they had to rely on diverse sources of information. This was supported by the sub-theme; promote awareness of availability of digital health.</p> <p><i>“I was only reading magazines and the pamphlets from the clinic on</i></p>	<p>The quantitative results revealed that lack of awareness impedes use of digital health. This was supported by the limited awareness of available digital health methods such as EM guidance, 64.7% never used it. The qualitative results indicated limited awareness of available digital health initiatives. Most of the gravid women only use the internet and mom connect.</p>	<p>Lack of awareness with regards digital health utilization in early detection and treatment of pre-eclampsia</p>

		<p><i>how to care from myself and the baby.”</i></p> <p>Lack of awareness</p>	<p><i>“There was no apps I used instead, I googled the website pages called babies mommy and etc. you know when you go to google and search that specific content you want, it shows you variety of options. Then I’d choose flow and also mom n’ baby, calendar, I visit those a lot.”</i></p> <p>lack of awareness</p>	
		<p>The quantitative results revealed that 94.1% of the midwifery practitioners received no training about digital health. The qualitative results revealed that there’s lack of support and poor implementation of digital health initiatives. The lack of</p>	<p>The quantitative results revealed that 94.1% of the midwifery practitioners never received training on the authorised digital health initiative. The qualitative results revealed poor implementation</p>	<p>Lack of training about use of digital health</p>

		<p>support could be associated with lack of training amongst midwives.</p> <p><i>“...So I didn’t receive any support from the midwives.”</i></p> <p>Lack of training</p>	<p>of the available digital health initiatives by midwives.</p> <p><i>“I have never received any support with regards to the use of digital health initiatives. They never taught me anything about digital health initiatives that may assist me with my pregnancy.”</i></p> <p>Lack of training</p>	
		<p>The quantitative results reported that 74.5% midwifery practitioners pointed out that lack of validation is a barrier to digital health. Whilst the qualitative results revealed that lack of trust and validation is a major concern in use of digital health.</p> <p><i>“The thing is that for me is that I was never sure which website to use and to trust, because I was never taught about it at the clinic.”</i></p>	<p>The quantitative results reported that there’s lack of policies, protocols and strategies supporting use of digital health (54.9%). The qualitative results reported lack of trust and confusion in use of digital health.</p> <p><i>“No, I have never been informed about digital health initiatives.”</i></p>	<p>Lack of digital health initiatives validation and policies</p>

		<p><i>Lack of trust likely associated with lack of validation</i></p>	<p><i>“I usually come across a lot of information, sometimes I get confused on which one to trust...”</i></p> <p><i>Could be associated with lack of validation</i></p>	
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Table 4. 14: Joint display of the integrated findings using case-cross comparison

4.5. INTEGRATION OF FINDINGS TO THEORETICAL FRAMEWORK

In this study, a McKinsey 7s model was used to guide the study in the development of the evidence-based strategies to enhance the utilization of digital health in the early detection and treatment of Pre-Eclampsia at PHC facilities. A McKinsey 7s model is the instrument that examines and analyses an organization's design taking into consideration the seven key components namely; structure, strategy, systems, style, staff, skills, and shared values (Ravanfar 2015; Jurevicius 2013). Furthermore, one of McKinsey's 7s model uses is to assess and identify areas that may require a change in the future (Ravanfar, 2015). Primary Health Care (PHC) facilities were made the cornerstone to reaching the sustainable development goals by 2030 by the global health community (WHO, 2018). One of the sustainable development goals is to ensure healthy lives and promote wellbeing for all ages, this includes the reduction of maternal and perinatal mortalities (Statssa, 2019). In the context of the study, a convergent parallel research design was implemented to identify the knowledge gaps and barriers amongst the midwifery practitioners and gravid women in the utilization of digital health in early detection and treatment of Pre-Eclampsia at PHC facilities. This allowed the researcher to identify the areas requiring changes within the facilities and implement the change through the development of the strategies (Ravanfar, 2015).

The McKinsey 7s model components are interdependent and one of the steps when applying the model is to identify areas that are not appropriately aligned by looking at the 7s components if they are aligned to each other (Channon & Caldart 2015; Ravanfar 2015). In the context of the study three components of the model were not aligned. Inconsistences, gaps and weakness were identified in systems, staff, skills and style of the PHC facilities. The research study focused on the components that aligned with the study and were having gaps. Components aligned with the study are integrated with the findings and discussed below.

4.5.1. Systems

The integrated findings of the study identified a shortage of digital resources and human resources. The shortage of digital resources had an impact on the utilization

of digital health. There's poor infrastructure in the facilities which includes the unavailability of tablets, computers, smartphones and Wi-Fi amongst midwifery practitioners and gravid women. Furthermore, power supply inconveniences impact network connectivity. The shortage of resources and power supply inconveniences disrupts the provision of quality care. The McKinsey model clearly states that the components are interconnected; however, the results revealed a shortage of resources and power supply inconveniences which affects the system component of the model. This clearly shows that the balance within the facilities for the provision of quality care is imbalanced (Ravanfar, 2015). Therefore a change is required to address the shortage of digital resources and power supply inconveniences to restore effectiveness and balance. The attempt to resolve this is discussed in chapter 5. Strategy 2 and 3 attempt to restore balance in the facilities.

4.5.2. Staff

The integrated findings of the study indicated the midwifery practitioners were untrained in the utilization of digital health. This possibly resulted to a lack of support and poor implementation of digital health. Furthermore, besides the lack of training the findings revealed that shortage of human resources (i.e. Shortage of staff) affects the utilization of digital health. Without adequate staffing, the implementation of digital health is affected. This may be affected due to factors such as poor midwife-patient ratio and overcrowding in facilities. Therefore the productiveness and effectiveness in the provision of quality care are consequently affected. As a result, the staff component in the McKinsey model is affected requiring to make changes. Strategies 2 and 5 attempt to resolve the shortage of human resources and lack of training in the utilization of digital health respectively.

4.5.3. Skills

The findings revealed a lack of awareness of digital health and inconsistencies in knowledge and importance of this digital health utilization. This indicates incoherence amongst the components of the model due to a lack of skills among the midwifery practitioners possibly related to lack of training which affect the competence of midwifery practitioners in the utilization of digital health. Therefore to restore balance in accordance to the McKinsey model, the skills of the midwives in the utilization of digital health should be improved. Strategy 1, strategy 4 and 5 attempt to restore

balance in the skills of the midwifery practitioners focusing on knowledge, awareness, and training respectively.

4.5.4. Styles

The attitude of senior management establishes the code of conduct (Ravanfar, 2015). In the context of the study, it is the responsibility of the higher management and policymakers to ensure that validated digital health initiatives are made available to the employees and policies supporting such are also provided to the employees. However, the integrated findings identified that the lack of validation of digital health initiatives impacts the use of digital health in clinical practice. This is said to be related to a lack of policies and protocols for the use of digital health (Rambire, 2022). Therefore the attitude and practices of higher management and policymakers consequently affect the duties of midwifery practitioners in using digital health. The style component of the McKinsey model is affected, resulting in ineffectiveness in the facilities. Strategy 6 attempts to restore the balance by addressing the styles of the leaders regarding use of digital health.

4.6. CONCLUSION

The chapter focused on presenting the results and discussion of the findings separately, further merging, converging and compared the findings to each other. The findings of the study showed existence of gap in knowledge of the utilisation of digital health in the early detection and treatment of pre-eclampsia from both groups. Furthermore, the various number of barriers were indicated by the participants. Thereafter the integrated findings were discussed with literature control and integrated with the theoretical framework.

In chapter 5, the development of the strategies is explained as well as the guiding domains; and the legislative and policy framework aligning with the overall significance and aim of the study. In addition, the identified knowledge gaps and barriers of the utilization of digital health in the early detection and treatment of pre-eclampsia are used for the development of the strategies

CHAPTER 5

DEVELOPMENT OF STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN

5.1. INTRODUCTION

The preceding chapter detailed the analysis and interpretation of data from midwifery practitioners and gravid women. The results were converged, diverged and compared to each other. The empirical findings were then integrated with the McKinsey 7s model components and it was realized there were no strategies in place within the facilities to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia. The integration of the empirical findings and model components led to the construction of pilot statements which informed the development of the strategies.

This chapter focuses on the development of strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia at primary health care facilities. Lastly, this chapter will discuss the reviewed supportive legislative and policy framework; the background of strategies, the rationale of developing the strategies and the purpose and target of the strategies. Moreover, the domains of the Appraisal of Guidelines for Research and Evaluation (AGREE) were adopted in this chapter to guide the development of the strategies. AGREE is an instrument developed to determine the quality of strategies about the feasibility of the developed guidelines to practice and usability of the guidelines. AGREE on instrument comprise of domains namely, scope and purpose, stake holder involvement, the rigour of development, clarity of presentation, applicability, and editorial independence (AGREE, 2013). Figure 5.1 illustrates the process of the strategy development.

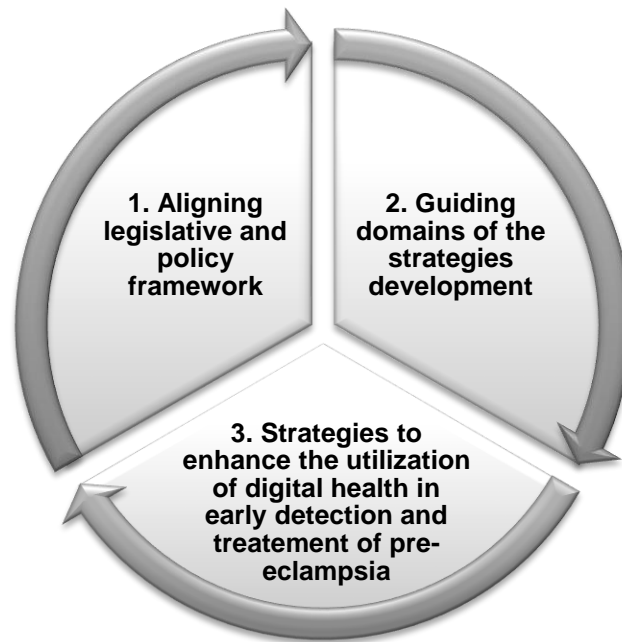


Figure 5.1. Process of strategies development

5.2. ALIGNING SUPPORTIVE LEGISLATIVE AND POLICY FRAMEWORK

The development of the strategies primarily aims to strengthen the maternal digital health systems through enhancement of digital health utilization among gravid women and midwifery practitioners. The reviewed global, SSA, and national legislative and policy framework shares a common end goal with the strategies which is the reduction of maternal morbidities and mortalities secondary to pregnancy-related complications such as pre-eclampsia (WHO, 2019). The following legislative and policy framework aligned with the strategies development.

5.2.1. Global legislative and policy framework

5.2.1.1. Sustainable Development Goals

SDGs are set visions to eradicate hunger, poverty, and disease across the globe. The SDGs were developed by the United Nations (UN) members and have 17 goals with 169 targets. However out of the 17 goals, SDG 3, “Ensure healthy lives and promote wellbeing for all at all ages” is pertinent to health and underpinned by 13 targets (WHO, 2021). The following outlined targets were pertinent to the study focusing on improvement of maternal wellbeing and quality of services focusing on accessibility to

quality services, training of healthcare professionals, and reducing maternal deaths (WHO, 2021);

- Reduction of the global maternal mortality ratio to less than 70 per 100 000 live births by 2030
- Achieve Universal Health Coverage (UHC), including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality, and affordable essential medicines and vaccines for all.
- Substantially increase health financing and the recruitment, development, training and retention of the health workforce in the developing countries, especially in the least developed countries and Small Island developing States.

5.2.1.2. *Global strategy for women and children's health*

The global strategy for women and children's health focuses on factors contributing to the failure to attain the MDGs. It set out the vital areas that require immediate action to strengthen the policy and optimize service delivery (Ki-moon, 2015). It includes the following as stated by Ki-moon (2015);

- Integrated delivery of services and life-saving interventions, so gravid women can access prevention, treatment and care whenever they need it.
- Stronger health systems with sufficient competent health workers at their core.
- Support for country-led health plans.

5.2.1.3. *Global strategy on digital health 2020-2025*

The global strategy is primarily focused on improving health for every individual by increasing the development and adoption of appropriate, accessible, affordable, scalable and sustainable person-centric digital health solutions to prevent, detect and respond to epidemics and pandemics (WHO, 2021). The global strategy objectively focuses on (WHO, 2021);

- Strengthening gender quality and health equity approaches to endorse an inclusive digital society with enhanced digital health skills.
- Development of digital health training to optimize digital health literacy

- Develop methodologies for the management of health at the population level through the utilization of digital health.

5.2.2. SSA legislative and policy framework

5.2.2.1. The Zimbabwe national maternal and neonatal health road map

This framework is primarily aimed at optimizing the maternal and neonatal health services at the institutional and program level. Furthermore, the framework prioritizes and scale up evidence-based, updated and effective strategies and activities focusing on the reduction of maternal and neonatal morbidity and mortality (Parirenyatwa, 2016). The framework aims and objectives are aligned with the context of the study with the end goal of achieving the MDG 5, “Improve maternal health”.

5.2.3. National legislative and policy framework

5.2.3.1. Strategic plan for Maternal, New-born, Child and Women’s Health (MNCWH) and nutrition in SA 2012-2016

According to the MNCWH (2015), this report focuses on prioritizing maternal, new-born, child and women’s health. Furthermore, it aims to reach larger populations at all levels of care, especially those populations who face the highest mortality rate; maternal deaths included. The MNCWHC report substantially aims to;

- To ensure access to high-quality care during antenatal, childbirth and post-delivery.
- To allocate adequate resources for patients in need.

5.2.3.2. South Africa’s national strategic plan for Campaign on Accelerated Reduction of Maternal and child Mortality in Africa (CARMMA)

The campaign focuses on the reduction of maternal deaths from pregnancy-related complications, pre-eclampsia included, as it stated on the motto itself “No women should die while giving birth”. It further aims to reduce maternal deaths through accelerated implementation of evidence-based interventions and strategies vital to improving maternal outcomes, digital health initiatives included. It aligns itself with MDG 5 (CARMMA, 2013)

5.2.3.3. South African Maternal, Perinatal and Neonatal Health (MPNH) policy

According to NDoH (2021), this policy provides an extensive framework for the provision of optimal quality and comprehensive MPNH services and informs the development of interventional programmes, guidelines and evidence-based strategies related to maternal and perinatal services in SA. The policy focuses on;

- Promote access to respectful and non-judgemental MPNH services for gravid women and neonates.
- Strengthening the health system delivery platforms
- Develop a sustainable surveillance system for maternal, perinatal and neonatal morbidity and mortality including research developments in health systems service delivery, quality improvement and innovative interventions such as digital health utilization.
- Promotion of coordinated, meaningful, multi-sectoral community engagement to enhance positive pregnancy outcomes.

5.2.3.4. National Digital Health Strategy for SA (NDHSSA) 2019-2024

The NDHSSA (2019) primary mission is to establish digital health ecosystems of people, processes and technology that support the strengthening of the health systems to enhance efficient service delivery, effective patient care and person empowerment necessary for achieving UHC. The NDHSSA (2019) prioritises the following;

- Improvement of quality patient care through digital health
- To scale up the high impact of mHealth for community-based interventions.
- Development of digital health knowledge workers for successful practice and utilization of digital health.

5.3. DEVELOPMENT OF THE STRATEGIES

5.3.1. Introduction and background of the strategies to enhance digital health utilization

Digital health is a growing branch in the health field for preventative and treatment of chronic and acute conditions that has been reported to be effective. Aranda-Jan, Mohutsiwa-Dibe and Loukanova (2014) substituted that mobile health technology is shown to be rapidly expanding also in developing countries of Africa. Moreover,

mHealth in Africa is regarded as an innovative approach to rendering health care services and has proven to be the fast-growing technological field with research opportunities including the assessment of scaling-up mHealth projects, cost-effectiveness and its impacts on the health overall system.

A narrative review in low-income countries conducted by Osei and Mashamba-Thompson (2021) corroborated that the advances in mobile technology and applications are driving the transformation in health systems delivery globally. The integration of mobile technology into current clinical services delivery is providing new channels for quality care of health services delivery (Adepoju, Albersen, Brouwere, Roosmalen & Zweekhorst, 2017).

The introduction of digital health in maternal services is also regarded as a strategic plan to minimize the maternal mortalities associated with pregnancy complications. The use of digital health in pregnancy has been associated with reduced hospitalization as a result of pregnancy-related complications. As South Africa moves towards universal health coverage (UHC) the researcher noted that the development of strategies to enhance the utilization of the digital health services within the primary health care facilities will consequently assist in achieving the reduction of MMR set to be achieved by 2030 (WHO, 2019) through the primary health care facilities. This will further achieve the sustainable development goals and millennium development goals of reduction of maternal and infant mortalities.

The developed strategies were derived from the analyzed findings of the study. The findings were from two different populations sharing their relative perspectives on knowledge and barriers of digital health utilization on pre-eclampsia. Therefore the researcher identified the discrepancies among the findings which led to the development of strategies to enhance the utilization of digital health by gravid women.

5.3.2. Rationale for development of the strategies

In contrast to the study, the findings showed limited knowledge and barriers to digital health utilization by midwifery practitioners and gravid women leading to substandard holistic quality care for pre-eclampsia women. These identified discrepancies show an essential need for the development of strategies to enhance the utilization of digital health in pre-eclampsia and to bridge the research gap of knowledge and barriers in

the utilization of digital health in pre-eclampsia further achieving standardized care and governance culture and philosophy in the provision maternal health through digital health.

5.4. GUIDING DOMAINS FOR DEVELOPMENT OF STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN

A strategy is a high-level plan to accomplish one or more goals under conditions of uncertainty. Furthermore, the strategy involves the setting of goals and a plan of action to achieve those goals (Barad, 2018; Mohammadian, 2017). In the context of health care, strategies guide how health care services are supposed to be delivered (El-Jardali & Fadlallah, 2017). In the formulation and development of strategies to enhance the utilization of digital health in early detection and treatment of Pre-Eclampsia by gravid women, the researcher adapted the domains of the Appraisal of Guidelines for Research & Evaluation II. This assisted the researcher to assess the value and quality of the strategies, and further provide the methodology for the development of the strategies (AGREE, 2013). The researcher adapted the domains of the instrument to measure the quality and value of the strategies during the development of the strategies. Table 5.1. Below illustrates how the domains of clinical guidelines development were applied in the strategies development as according to AGREE II.

Table 5.1. Guiding domains for strategy development.

DOMAINS	DESCRIPTION OF THE DOMAINS	APPLICATION TO THE STUDY
<p>Scope and purpose</p>	<p>The scope is in-depth of a subject covered in a book or programme, while purpose is referred as the reason why something is done, could be a plan to reach a target (Cambridge dictionary, 2013). However, this domain focuses on the potential impact of the strategies on society and population of the individuals. Furthermore in scope and purpose focuses on whether the overall objectives, health questions and the target group of the strategies is specifically described (AGREE II, 2013). The Scottish Intercollegiate Guideline Network 50 (SIGN 50) substantiated that this domain is concerned with the description of the purpose and the target group to which the developed strategies will apply.</p>	<p>In the context of the study, the overall purpose of the strategies is to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia by gravid women in Emalahleni local municipality, Mpumalanga province. During integration, interpretation and discussions of the results, it was revealed that gravid women lack of knowledge of digital health utilization, however, the midwifery practitioners showed significant knowledge of the utilization of digital health. An inference was that even though the midwives had knowledge they were perceived barriers leading them not teach the gravid women about digital health. For this reason intended target groups of the strategies, is the group which can potentially benefit from the strategies which is the midwifery practitioners</p>

		working at primary health care facilities and the national policy makers and stake holders.
Stake holder involvement	This domain focuses on the involvement of the relevant professional groups and target groups' views and preferences during the development. Furthermore the domain focuses on the methods used to gather the target group's views and preferences and how the gathered data was used to inform the strategies development (AGREE II, 2013). As cited by Adewale and Munano (2012), stakeholders are a group of individuals having a special interest in an organisation's work	The study is a master's level study and only focused on the development of strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia. It involved supervisors who have extensive experience in research, model constructions, and strategy development. The study was then externally reviewed by relevant professionals who have the relevant level of expertise as the supervisors, however, the strategies were not validated. In addition, a convergent parallel research approach was used in this study to gather the target group's views on the topic of the study to inform the development of the strategies.
Rigour of the development	This domain is based on the methods utilized to gather evidence and the criteria used to select the evidence. Moreover it involves the description of the	An evidence-based research approach was employed to enhance the knowledge of the prospective study by utilizing a convergent

	<p>strength and limitations of the evidence. Lastly the domain also focuses on the explicit link between the recommendations and the supporting literature; a procedure to update the strategies (AGREE II, 2013). Rigour demonstrates integrity and competence, furthermore focuses assess of the quality of development (Gill & Gill, 2020; Polit & Deck, 2015).</p>	<p>parallel methodology and narrative literature review methodology. The convergent parallel design approach strengthen the data and enhanced the validity of the study. the use of convergent parallel design ensures the gathering of context-rich data and further assists with the completeness of the study as well as assists to explain findings by both quantitative and qualitative data (Schoonenboom & Johnson, 2017). The quantitative method showed adequate knowledge of digital health, however limitation were noted such barriers in utilization of digital health. Whilst the digital shown significant limitation to rich data collection due to lack of digital health sources amongst the participants. A narrative literature methodology approach was used to gather supporting literature from the electronic bases with peer reviewed journals namely; PubMed,</p>
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		<p>google scholar, science direct, paperpile and mendeley.</p> <p>However the strategies were developed on the integrated findings and the related literature identified through the narrative literature method. Thus the strategies are more acceptable for publications because are evidence based strategies and reviewed by supervisors with extensive level of experience. A relevant theoretical framework was utilized to guide the development of the strategies. The framework helped strengthen the study by identifying inconsistencies and weakness of optimal digital health utilization from the results. The strategies were drafted from only the evidence from the population of Emalahleni local Municipality shouldn't be generalised to other regions and can be continuous updated by gathering of evidence and views of other regions on the specific topic.</p>
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<p>Clarity of presentation</p>	<p>According to AGREE II (2013) clarity of presentation is based on the specificity and unambiguous of the develop statements and that such statements can be easily identified. Mthethwa, Peu, De Waal and Yazbek (2017) corroborated that develop strategies/guidelines should be clear, understandable, simple and easy to read without ambiguity but specific.</p>	<p>The strategies were specifically for the enhancement of the utilization of digital health in early detection and treatment of pre-eclampsia. The strategies were clearly described and simplified language was used and complex terms were avoided to accommodate the targeted group of the developed strategies. Complex statement were avoided and the strategies are comprehensive, they are related to the topic of interest. In the development of the strategies, knowledgeable participants were used to informing the development of the strategies. The strategies are of relevance to the topic and they are only applicable in enhancing the utilization of digital health in the early detection and treatment of pre-eclampsia by gravid women. The integrated findings described, responsibility and performance drivers emerged in which midwifery practitioners and national policy makers and stakeholders were</p>
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		identified as the responsible individuals as they are the ones who should implement change to enhance to utilization of digital health in early detection and treatment of pre-eclampsia by gravid women.
Applicability	Applicability is based on the description of the impediments and facilitators of the strategies and how the strategies can be applied in practice and theory (AGREE II, 2013). As cited by Mthethwa (2017), it should clearly be specified who are the target groups and be simple to apply in practice. Furthermore, applicability is more focused on the relevance, acceptability, flexibility and feasibility of the developed strategies (SIGN 50, 2019).	The developed strategies were based on the identified discrepancies by the target groups, so they address the discrepancies and how are they refined to address the impending of utilizing digital health by gravid women. As a result that the strategies are of relevance to the study, consistent with the literature and scientific-based are thereof applicable to practice and theory. The strategies were developed for the enhancement of digital health utilization in early detection and treatment of pre-eclampsia by gravid women in Emalahleni local municipality, then are thereof applicable to practice within the district, shouldn't be generalised to other districts.

Editorial Independence	Editorial independence is concerned with if the views of the funding body had any influence of the strategy's content and the members of the strategies development have any competing interests (AGREE II, 2013).	The researcher was not paid for the development of the strategies, the study is part of the master's degree and required for the completion of the qualification.
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5.5. STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN

Below the developed strategies are described. Furthermore, the purpose and scope of the strategies are described in detail.

5.5.1. Scope and purpose of the strategies

5.5.1.1. Purpose of the strategies

The purpose of the development of the strategies is to enhance the utilization of digital health in the early detection and treatment of Pre-Eclampsia by gravid women in Emalahleni's Local Municipality, Mpumalanga Province. Moreover, provide midwifery practitioners with context-rich evidence-based strategies to equip and enrich them with knowledge and optimal practices of the utilization of digital health in early detection and treatment of pre-eclampsia based on the study findings:

- To enhance the level of knowledge of midwifery practitioners with regards to digital health in pre-eclampsia.
- To optimize quality care provision to pre-eclampsia women.
- To address the existing barriers of digital health utilization resulting to substandard care amongst pre-eclampsia women.
- To strengthen the maternal digital health systems in the provision of quality care.

5.5.1.2. Scope of strategies

The strategies are targeted to the following group;

- *Midwifery practitioners*

The midwifery practitioners working at the primary health care facilities will be the target of the strategies since they are the first health care providers to treat and book gravid women for antenatal care. Therefore remain essential for them to adopt such strategies since it remains their scope of practice to provide preventive measures such educate and equip gravid women with the relevant safe digital health initiatives to achieve optimal care during pregnancy.

- *National policy makers and stakeholders*

National stakeholders oversee the health needs of the population and how their needs are met as individuals. In contrast of the study, the developed strategies will enhance the utilization of digital health in early detection and treatment by gravid women. By directing the idealistic strategy interventions to national stakeholders; could bring about change on the implementation of digital health in clinical practice. To further enhance the utilization of digital health by gravid women, national stakeholders should play a significant role to ensure such activity is achieved.

5.5.2. Description of the strategies

The strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia are presented in alignment with the theoretical framework of the study. The adapted format for the strategies was outlining the model component, and guiding theme, followed by the strategy, responsibility and performance drivers and rationale. Table 5.2 shows the strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia.

STRATEGY	RESPONSIBILITY AND PERFORMANCE DRIVERS	
	Midwifery practitioners	Stakeholders and policy makers
1. prioritization of maternal digital health interventions aimed at improving the knowledge of midwifery practitioners and gravid women on the utilization of digital health to early detection and treatment of pre-eclampsia	<ul style="list-style-type: none"> • Prioritize the needs of gravid women by updating themselves with knowledge and the importance of digital in the early detection and treatment of pre-eclampsia to transmit that knowledge to gravid women. • Facilitate the knowledge of gravid women about utilization of digital health to ensure the safety and accurateness of information used by gravid women from digital health platform. • Attend workshops, seminars and training to keep themselves updated about digital health. 	<ul style="list-style-type: none"> • The political obligation that places digital health at the centre of maternal health to achieve Sustainable Development Goal 3 and Universal Health Coverage goals. • Keep midwifery practitioners informed on current knowledge with regard to digital health. • Establish communication channels that can be used by midwifery practitioners to enquire about digital health interventions. • Reinforce the vision and mission statement of implementation of digital health in clinical practice.

	<ul style="list-style-type: none"> • Provide informational support about digital health to gravid women. • Involve the designated birth companions when teaching gravid women about digital health; upon women's request. • Implement the available digital health initiatives to enhance the knowledge of gravid women. 	
Rationale	<p>The study identified knowledge inconsistencies on the use of digital health amongst midwifery practitioners and gravid women. The lack of knowledge among gravid women signals lack of support and poor implementation of available digital health initiatives by midwifery practitioners in clinical practice. The utilization of digital health has the potential to transform the healthcare system and efforts must be made to utilize digital health to its full potential. Midwifery practitioners should increasingly work towards collaboration between themselves and gravid women. Prioritize the needs of gravid women in the utilization of digital health (Busse et al., 2022; Park et al., 2021)</p>	
2. Provision of sufficient human and digital resources to ensure provision of optimal quality	<ul style="list-style-type: none"> • Keep inventory and ensure maintenance of the digital resources provided. 	<ul style="list-style-type: none"> • Provide midwifery practitioners with necessary digital resources require

<p>care to pre-eclampsia gravid women</p>	<ul style="list-style-type: none"> • Use the provided digital resources for their intended use. • The operational manager should organise in-service training to ensure that the midwifery practitioners are trained on the use of the provided digital resources. • Adhere to departmental policies and guidelines in purchasing and repairing of the digital resources. 	<p>to fully implement digital health in clinical practice.</p> <ul style="list-style-type: none"> • Employ more trained midwifery practitioner to provide optimal midwifery care through digital health. • Follow up on provided digital resources on their adequate functioning. • Provide 24/7 wireless Wi-Fi access to digital health initiatives with restricted access to non-related digital websites.
<p>Rationale</p>	<p>Shortage of digital and human resources has a great impact in the implementation of digital health in clinical practice. The study revealed that midwifery practitioners don't have any computers, tablets, and Wi-Fi access to implement digital health in practice. Moreover, the study reported a shortage of staff, overcrowding, and too much workload consequently resulting to exhaustion and burnout amongst the midwifery practitioners. For the adoption and implementation of digital health to its full capacity, there's a significant need for strengthening the capacity of the resource in the healthcare facilities (Manyazewal et al., 2021; Curioso et al., 2022).</p>	

<p>3. Development of a comprehensive plan aimed to address network connection issues following power outages</p>	<ul style="list-style-type: none"> • Educate and guide the gravid women on digital health apps that don't require a network connection to use. 	<ul style="list-style-type: none"> • Develop digital health initiatives that can be accessed offline. • Purchase high-power batteries that can sustain the cell towers for more than 24 hours. • Develop and implement more messages-orientated mobile health initiatives.
<p>Rationale</p>	<p>The findings of the study revealed power outages and poor network connections is a major concerns in the implementation of digital health. Ifeoluwa (2016) corroborated that the unavailability of constant electricity is a major challenge that doesn't only affect the healthcare sector only but also to the economy. However, this has a major impact on the implementation of digital health because during a power outage there's a possibility that digital health might not function efficiently and in some cases, infrastructures such as computers need power to function, during power outages the digital health become inaccessible.</p>	
<p>4. Improvement of the awareness measures on utilization of digital health to optimise quality care among pregnant women having pre-eclampsia</p>	<ul style="list-style-type: none"> • Midwifery practitioners must uphold ethical values and respect of the gravid women to establish a therapeutic trusting relationship between the gravid 	<ul style="list-style-type: none"> • Monitor and evaluate the practices of midwifery practitioners on the implementation of digital health. • Innovate and develop patient-centred educational guidelines on

	<p>women and midwifery practitioners to promote openness and trust</p> <ul style="list-style-type: none"> • Ensure and create informational support programmes for gravid women at the primary level to guide and inform gravid women on utilization of digital health in early detection and treatment of pre-eclampsia. • Educational support of families and communities to further promote the utilization of digital health in the early detection and treatment of pre-eclampsia. • Actively involvement and collaboration with communities through awareness campaigns to educate on the benefits of digital health in pregnancy. 	<p>the use of digital health by gravid women.</p> <ul style="list-style-type: none"> • Develop and implement national awareness strategies on use digital health. This could be done through broadcasting in TVs and radios.
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Rationale	Barriers to the utilization of digital health include a lack of awareness. The role of awareness and education in promoting the healthcare workforce should be considered vital (Ifeoluwa, 2016). The study identified there's a lack of awareness of digital health amongst gravid women and midwifery practitioners. Hence the lack of implementation of digital health by midwifery practitioners.	
5. Development of context-rich training programmes to advance the skills and competency of midwifery practitioners on the utilization of digital health	<ul style="list-style-type: none"> • Demonstrate commitment in advancing skills and knowledge in nursing informatics. • Attend seminars and workshops to advance their skills and knowledge about digital health. 	<ul style="list-style-type: none"> • Develop and Implement nursing informatics graduate programmes. • Provide and allocate a budget specific for the training of midwifery practitioners in digital health. • Monitor and evaluate the competency of midwifery practitioners in the implantation of digital health in practice following training. • Develop training centres focused on the training of the healthcare professionals in digital health.
Rationale	Lack of training is associated with a lack skills and knowledge. In relation to McKinsey 7s model, once each component is affected, imbalance results. In this study lack of skills among demonstrates incompetence in digital health utilization consequently	

	<p>affecting the care received by gravid women. The adoption and implementation to its full potential, midwives should be trained in digital health (Manyazewal et al., 2021). Therefore this clearly shows the need of training of healthcare professionals in the utilization of digital health.</p>	
<p>6. Provision of mandatory jurisdictional and regulatory framework stating the authorised digital health initiatives</p>	<ul style="list-style-type: none"> • Implement and practice within the provided policies and regulatory framework of digital health. • Implement the authorized digital health initiatives in clinical practice. • Provide feedback on the authorised digital health initiative to policymakers for review purposes 	<ul style="list-style-type: none"> • Adopt a mandatory jurisdictional and regulatory framework within which midwifery practitioners can practice and teach gravid women about the importance of the utilization of digital health in the detection and treatment of pre-eclampsia. • Adopt national and provincial quality standards that give direction of utilization of digital health within maternal health practice by health care professionals, further strengthen the maternal digital health systems. • Develop a comprehensive national digital health policies to govern digital health in practice.

		<ul style="list-style-type: none"> • Adopt and encourage access to authorised digital health environment for gravid women focusing on common complications following pregnancy. • Introduction of social media digital platform involving health professionals and gravid women focused in maternal health.
<p>Rationale</p>	<p>Lack of digital health validation and lack of policies supporting the implementation of digital health in clinical practice is one of the major challenges. The study reported that gravid women usually don't trust the information they encounter on the digital health platform. Lack of regulation and policies impact the whole health care system. Healthcare is a sensitive field involving human lives. If digital health systems are implemented, rules and proper procedures should be devised and followed to ensure the safety of the individuals (Hoque et al., 2014). A study conducted by Wit et al (2021) affirmed that midwives are open to the implementation of digital health initiatives as long they are trustworthy and scientifically study. Hence the midwives stress the need for guidelines of the utilization of the digital health initiatives. Olu et al., (2019) substantiated that digital health can contribute in the sustainable fulfillment of UHC,</p>	

	only if there's a digital health governance framework and it's implemented within the broader framework of the healthcare system.
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Table 5.2 strategies to enhance utilization of digital health

5.6. CONCLUDING ON THE STRATEGIES

The study aimed at developing strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia by gravid women in PHCs of Mpumalanga province, to further strengthen the maternal health systems of SA. As South Africa thrives on moving towards universal health coverage for better access to health care services through health care systems (Fusheini & Eyles, 2016). Digital health initiatives such as mobile health technologies were developed to improve better access to communities in low and middle-income countries.

However, lack of knowledge and necessary human and digital resources openly disturbs the quality of maternal health care services offered further leading to catastrophic maternal and perinatal outcomes. Therefore to maintain high-quality standard midwifery care, it is of consequential to facilitate proper primary interventional strategies and treatment modalities that can ensure quality care. This can be ensured through the continuum educational development of the personnel rendering health care services from primary to tertiary level and through provision of necessary digital and human resources. For SA to achieve the SDGs and MDGs is solely dependent on the proper allocations of sufficient finance for resources and educational development programs for midwifery practitioners. Also through emphasis of professional growth daily through supervised in-service training in every facility. The SSA countries suffer a great deal loss of pregnant women during perinatal, intrapartum and postpartum due to pregnancy complications such as pre-eclampsia. WHO (2019) corroborated that approximately 830 women die daily due to pregnancy complications. Therefore it is imperative to apply the developed strategies as they could effect a great deal of outcome on the maternal health care systems. Figure 5.3 shows the summarised strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia.

Strategies to enhance utilization of digital health in early detection and treatment of pre-eclampsia



1. *Prioritization of maternal digital health interventions aimed at improving the knowledge of midwifery practitioners and gravid women on the utilization of digital health to early detection and treatment of pre-eclampsia*
2. *Provision of sufficient human and digital resources to ensure provision of optimal quality care to pre-eclampsia gravid women*
3. *Development of a comprehensive plan aimed to address connection issues following power outages*
4. *Improvement of the awareness measures on utilisation of digital health to optimise quality care among pregnant women having pre-eclampsia*
5. *Development of a context-rich training programmes to advance the skills and competency of midwifery practitioners on the utilization of digital health*
6. *Provision of mandatory jurisdictive and regulatory framework stating the authorised digital health initiatives*

Figure 5.2. Summarised strategies to enhance the utilization of digital health by in early detection and treatment of pre-eclampsia by gravid women.

5.7. CONCLUSION

In this chapter, the strategies for the utilization of digital health in the early detection and treatment of pre-eclampsia by gravid women were developed. Furthermore, the strategies were developed following reviewing of the legislative and policy framework

aligning with the aim and significance of the study. The developed strategies were guided by the domains of AGREE II. In addition the developed strategies were derived from the qualitative and quantitative results of the gravid women and midwifery practitioners respectively. The following chapter will present the summaries of the findings, limitations and recommendations of the study.

CHAPTER 6

SUMMARY, RECOMMENDATIONS LIMITATIONS AND CONCLUSIONS

6.1. INTRODUCTION

This chapter focuses on summarising the overall study and further explain the limitations of the study. This includes a restatement of the research aim and objectives, as well as the achievements of the objectives. Moreover, it provides and discuss recommendations based on the study findings. In addition in this chapter, a conclusion was formulated following the recommendations based on the analysed findings of the study.

6.2. SUMMARY

In contrast to the study, a convergent parallel research design of mixed research methods was adopted. The research design allowed the researcher to collect a quantitative and qualitative data concurrently. The data was then analyzed independently then interpreted together to converge, diverge and compare the findings. The research design was appropriately suitable for the study leading the researcher to achieve the aim of the study which was:

"To develop strategies to enhance the utilization of digital health in early detection and treatment of pre-eclampsia by gravid women at primary health care facilities, Emalahleni local municipality, Mpumalanga province."

However based on the findings similarities and dissimilarities of the findings, the strategies to enhance the utilization of digital in early detection and treatment of pre-eclampsia at primary health care facilities were then formulated.

6.2.1. Quantitative strand

Restatement of the quantitative strand objectives

The objectives of the quantitative strand were to:

- Describe the knowledge and importance of utilization of digital health by midwifery practitioners at primary health care facilities.

- Identify and describe barriers to utilization of the digital health by midwifery practitioners.

Achievement of the objectives

The quantitative strand objectives were achieved using self-administered questionnaires. Before data collection, the midwifery practitioners were selecting using a simple random sampling method and adopted the fishbowl technique. A pre-test was done before the main study and incredibility and errors identified were then corrected and rectified. The questionnaire was completed in full by the midwifery practitioners. The data was then analysed using SPSS 28.0. Descriptive statistics were adopted for the analysis of the study. Validity and reliability were ensured. Thereafter the quantitative findings were then converged, diverged and compared with the qualitative findings.

The quantitative findings revealed that although midwifery practitioners know about digital health. There was number of impediments to using the digital health; this includes lack of technology validation (74.5%), poor network connections, (62.7%), lack of awareness (74.5%), and midwifery practitioners not having enough time (70.6%). The findings further reported barriers such as lack of training (94.1%), shortage of staff (72.5%), too much workload (78.4%) and electricity problems (72.5%). For this purpose, the strategies to enhance the utilization of digital health in the early detection and treatment of pre-eclampsia are of significance.

6.2.2. Qualitative strand

Restatement of the qualitative strand objectives

The objectives of the qualitative strand were to:

- Explore knowledge of gravid women on utilization of digital health.
- Identify and describe barriers on utilization of the digital health gravid women.

Achievement of the objectives

The researcher adopted the qualitative strand to achieve the study objectives of gravid women perspective. The participants were selected using purposive sampling method and sample size was determined by data saturation. The researcher conducted one

on one semi structured interviews and field notes were taken, prior to data collection pre-test was done to ensure the efficiency and effectiveness of the data collection instrument and qualitative research expert were consulted. During data analysis an open tesch coding was adopted to code the data and themes and subthemes emerged. Trustworthiness was measured using the Lincoln & Guba criteria namely; credibility, transferability, confirmability and dependability. All the collected findings from the gravid women, audio recordings, and field notes were kept on the researcher device within the reach of the researcher and supervisors only. The data was transcribed for verbatim, and an independent coder was consulted to assist with the coding and context-rich methodology of the study was done to further ensure trustworthiness. Thereafter the results were then converged, diverged and compare with the quantitative strand.

The qualitative findings revealed that there's a lack of knowledge on the utilization of digital health among pre-eclampsia women from rural areas. Most of the gravid women had to rely on alternative sources of information such as significant friends & Family and magazines. This may result from a number of barriers such as lack of digital health initiatives validation is a concern, poor socio-economic status impact access to smartphones & network connectivity, and lack of support and implementation of available digital health initiatives

6.2.3. Summary of the integrated findings

Theme 1: Knowledge and importance of digital health utilization in the management of pre-eclampsia

The integrated findings indicated inconsistencies in knowledge in the utilization of digital health among midwifery practitioners and gravid women. The study revealed that there's a lack of knowledge of digital health among gravid women; and for those who show significant knowledge of digital health, it was upon their concern and their previous experiences. This indicates a lack of implementation of digital health literacy by midwifery practitioners.

Theme 2: Shortage of digital and human resources

The integrated findings reported that the shortage of human and digital resources impedes the utilization of digital health. The midwifery practitioners reported a

shortage of staff and a lack of infrastructures such as computers, tablets, and wireless Wi-Fi. Whilst the gravid women reported not having smartphones and unaffordability of data and airtime. This indicates that poor infrastructure hinders the implementation of digital health.

Theme 3: Power supply inconveniences impacting network connectivity

The integrated findings revealed that power supply impacts network connectivity rendering some digital health initiatives inaccessible. The gravid women expressed their views that they mostly experience poor network connection problems, especially during power outages. This indicates that power outage serves as a barrier in accessing digital health initiatives.

Theme 4: Lack of awareness with regards to digital health utilization in early detection and treatment of Pre-Eclampsia

The integrated findings report a lack of awareness with regards to digital health utilization early detection and treatment of pre-eclampsia. The midwifery practitioners pointed out that they are not aware of digital health implementation. Although midwifery practitioners lack awareness of digital health, gravid women have shown limited awareness of digital health upon their concern of their well-being and pregnancy.

Theme 5: Lack of training about the use of digital health

The integrated findings revealed that there's a lack of training about the use of digital health. The midwifery practitioners pointed out that they were not trained in digital health utilization. This could be linked to the lack of support and poor implementation of available of digital health in clinical practice.

Theme 6: Lack of digital health initiatives validation and policies

The integrated findings of the study reported that there's lack of digital health initiatives and policies. The midwifery practitioners reported a lack of validation of digital health initiatives and the lack of policies and programs supporting digital health is a major concern. This could be linked to the lack of support and poor implementation of digital health. The gravid women expressed their lack of trust of some of the health information accessed in digital health.

6.3. RECOMMENDATIONS

The following recommendations are intended for midwifery practice, midwifery research and the Department Of Health.

6.3.1. Midwifery practice

Midwifery practitioners should;

- Create a safe environment for the gravid women to promote open channels of communication amongst themselves.
- Sustain an optimal and updated practice when rendering quality midwifery services
- The strategies should be made available to all primary health care facilities to promote consistent quality care.
- Standard operating procedures for the utilization of digital health in maternal services should be developed and made available at clinical practice.
- Update themselves with current knowledge such as the utilization of digital health to strengthen the maternal digital health system.
- Adhere to the provided quality standards and guidelines in optimizing the quality of life for gravid women.
- Attend perinatal and maternal mortalities review meetings to have current updates and discuss the way forward with regard to patient care.
- Make proper and efficient use of the provided materials, equipment, and resources.
- Conduct research focusing on improving the maternal health system through research.
- Apply in clinical practice the recommendations from reports such as the WHO global digital health strategy, Saving mothers and babies reports and Campaign on Accelerated Reduction of Maternal Mortality (CARMMA)

6.3.2. Midwifery education

Midwifery educators should;

- Provide learner midwives with knowledge about digital health as an emerging field

- Integrate digital health into the midwifery learning curriculum
- Emphasise the implementation of validated digital health initiatives in reduction of perinatal and maternal mortalities.

6.3.3. Midwifery research

- More research should be done focusing of more development and validation of digital health platforms to strengthen the maternal health system.
- A follow-up research study should be done to validate and evaluate the developed strategies and make the necessary changes.
- Context-rich health education programmes and frameworks should be developed to educate and inform midwifery practitioners and gravid women about the utilization of digital health.

6.3.3. Department of health

- Should prioritize the implementation of digital health utilization to further achieve UHC goal
- Enforce the use of digital health in the clinical practice by midwifery practitioners and take necessary measures to follow up
- Provide update circulars on available digital health initiatives
- Follow up on the provided budget on whether is used for what its intended for.

6.4. LIMITATIONS

The study was conducted at primary health care facilities within Emalahleni Local Municipality Of Mpumalanga Province. Therefore the findings were limited to those primary health care facilities within Emalahleni local Municipality, the findings cannot be generalized for other primary health care facilities within Mpumalanga Province or other provinces. Moreover, the findings of the study were more focused on digital health utilization for early detection and treatment of pre-eclampsia, therefore the findings cannot be generalized to other medical conditions. Due to lack of funding and time the study was only focused in a specific area of Mpumalanga province.

6.5. CONCLUSION

For South Africa to succeed in achieving the UHC goals, health care providers should adopt digital health practices in clinical practice. The implementation of digital health should be reinforced and emphasized. However, the developed strategies could play a major role in eliminating the barriers to digital health implementation and further strengthening the maternal health system. Therefore the strategies should be adapted in practice to facilitate the implementation of digital health in clinical practice. Although there are more barriers to the implementation of digital health, more research should be done to eliminate such barriers.

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ANNEXURE A: Turfloop Research Ethical Committee Certificate



University of Limpopo
Department of Research Administration and Development
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Tel: (015) 268 3935, Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE
ETHICS CLEARANCE CERTIFICATE

MEETING: 23 May 2022
PROJECT NUMBER: TREC/81/2022: PG

PROJECT:

Title: Strategies to Enhance the Utilization of Digital Health in Early Detection and Treatment of Pre-Eclampsia by Gravid Women in Emalahleni Local Municipality, Mpumalanga Province.
Researcher: MW Ngwenya
Supervisor: Mrs L Muthelo
Co-Supervisor/s: Prof TM Mothiba
School: Health Care Sciences
Degree: Master of Nursing Science

PROF D MAPOSA
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: REC-0310111-031

Note:

- i) This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.
- ii) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.
- iii) PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding solutions for Africa

ANNEXURE B: Department of health permission letter



Indwa Building, Government Boulevard, Riverside Park, Ext. 2, Mbombela, 1200, Mpumalanga Province
Private Bag X11285, Mbombela, 1200, Mpumalanga Province
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Departmental Web: Gasondhelo

UmNyango Wezeli: splilo

Enq: 013 766 3766
Ref: MF_202205_004

Research Permission Letter

Mr M Ngwenya
UNIVERSITY Rd
Polokwane, 0727

STUDY TITLE: STRATEGIES TO ENHANCE THE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN IN EMALAHLENI LOCAL MUNICIPALITY, MPUMALANGA PROVINCE

Dear Mr Ngwenya

The Provincial Department of Health Research Committee has approved your research proposal in the latest format you sent, and hereby grant you permission to conduct your research as detailed below.

- Approval Reference Number: **MP_202205_004**
- Data Collection Period: **15 June 2022 to 30 December 2022**
- Approved Data Collection Facilities: **Ackerville Clinic; Beatty Clinic; Delmas Clinic; Hlatankhale Clinic; Klapfontein Clinic; Kriel Clinic; Kwa Guga Extension 10 CHC; Louisa Clinic; Lynnville Clinic; Ogles Clinic; Phola CHC; Poly Clinic; Riet Spruit Clinic; Siphosesimbi CHC & Thubelithe Clinic.**

Kindly ensure that conditions mentioned below are adhered to, and that the study is conducted with minimal disruption and impact on our staff, and also ensure that you provide us with a soft or hard copy of the report once your research project has been completed.

Conditions:

- Researchers not allowed to make copies or take pictures of medical records.
- Kindly notify the facility manager a week BEFORE you start with data collection to ensure that conditions are conducive in the facility.
- The FINAL RESEARCH FINDINGS must be uploaded on the NHRD website.

Kind regards


DR C NELSON
MPUMALANGA PHRC CHAIRPERSON
DATE: 09/06/2022



ANNEXURE C: letter from language editor



With nurses every time

House 618 Unit B, Mankwang, Polokwane, Sovenga 0727
Email: stories@nursejourney.co.za/masenyani.mbombi@gmail.com
Cell: 0711078116

04 October 2022

To Whom It May Concern

I hereby confirm that I have proof-read the document entitled: **"Strategies to enhance the utilization of digital health in early detection and treatment of Pre-Eclampsia by gravid women in Emalahleni Local Municipality, Mpumalanga Province"** authored by **Mxolisi Welcome Ngwenya**. I provided research and language editing with suggestions that the author may or may not accept, at her discretion.

Each of us has our own unique voice as far as both spoken and written language are concerned. In my role as proofreader, I try not to let my own "written voice" overshadow the voice of the author, while at the same time attempting to ensure a readable document.

Please refer any queries to me.

IT IS NICE DOING BUSINESS WITH YOU

A handwritten signature in black ink on a light-colored background. The signature is stylized and appears to be 'Masenyani Mbombi'.

ANNEXURE D1: Consent form for midwifery practitioners

UNIVERSITY OF LIMPOPO
MIDWIFERY PRACTITIONERS INFORMED CONSENT (ENGLISH)

I hereby declare that I agree to take part of the study entitled “**Strategies to enhance utilization of digital health in early detection and treatment of pre-eclampsia by gravid women.**” I further declare that the researcher explained the study thoroughly to me in a fluent and comfortable language of my understanding and am satisfied; all my questions were addressed, and still have an opportunity to ask for clarity.

I participant the study alert and conscious, I understand that taking part is voluntary and I was not pressurized to partake the study and I can leave the study whenever I choose to leave and will not be punished nor penalized. I am consciously aware that I will not be paid to the participant the study and I was made aware that any information will be kept confidential and the information will be anonymously developed into research report that might be published and the researcher will keep me aware of progress of the study as I wish to know.

Signed at.....on2022

Participants signature..... Date.....

Researcher’s signature..... Date.....

Witness 1..... Date.....

Witness 2..... Date.....

ANNEXURE D2: Consent form for Gravid women (English)

UNIVERSITY OF LIMPOPO

GRAVID WOMEN INFORMED CONSENT (ENGLISH)

I hereby declare that I agree to take part of the study entitled “**Strategies to enhance utilization of digital health in early detection and treatment of pre-eclampsia by gravid women.**” I further declare that the researcher explained the study thoroughly to me in a fluent and comfortable language of my understanding and am satisfied; all my questions were addressed, and still have an opportunity to ask for clarity.

I participant the study alert and conscious, I understand that taking part is voluntary and I was not pressurized to partake the study and I can leave the study whenever I choose to leave and will not be punished nor penalised. I know and understand that the researcher will make sound recordings of the interview for analysis purposes. I am consciously aware that I will not be paid to the participant in the study and I was made aware that any information will be kept confidential and the information will be anonymously developed into a research report that might be published and the researcher will keep me aware of the progress of the study as I wish to know.

Signed at.....on2022

Participants signature..... Date.....

Researcher’s signature..... Date.....

Witness 1..... Date.....

Witness 2..... Date.....

ANNEXURE D3: Consent form for gravid women (Zulu)

UNIVERSITY OF LIMPOPO

GRAVID WOMEN INFORMED CONSENT (ZULU)

Ngimemezela ukuthi ngiyavuma ukuthatha ingxenye yocwaningo enesihloko esithi **“Strategies to enhance utilization of digital health in early detection and treatment of pre-eclampsia by gravid women.”**

Ngiphinde ngimemezele ukuthi umcwaningi wasichaza kahle isifundo ngolimi olushelelayo nolukhululekile lokuqonda kwami futhi wanelisekile; yonke imibuzo yami ibhekisiwe, futhi ngisenalo ithuba lokucela ukucaciseleka.

Ngibamba iqhaza isexwayiso socwaningo futhi ngiyazi, ngiyaqonda ukuthi ukubamba iqhaza kungokuzithandela futhi angizange ngicindezeleke ukuthi ngihlanganyele ocwaningweni futhi ngikwazi ukushiya isifundo noma nini lapho ngikhetha ukuhamba futhi ngeke ngijeziswe noma ngijeziswe. Ngiyazi futhi ngiyaqonda ukuthi umcwaningi uzokwenza ukuqoshwa okuzwakalayo kwengxoxo ngenhloso yokuhlaziya. Ngiyazi kahle ukuthi ngeke ngikhokhelwe umuntu obambe iqhaza ocwaningweni futhi ngaziswa ukuthi noma yiluphi ulwazi luzogcinwa luyimfihlo futhi imininingwane izokwakhiwa ngokungaziwa ibe ngumbiko wocwaningo ongashicilelwa futhi umcwaningi uzongazisa ngenqubekela phambili isifundo njengoba ngifisa ukwazi.

Isayinwe ku Ku 2022

Isiginesha yababambiqhaza Usuku

Isiginesha yomcwaningi Usuku

Ufakazi 1 Usuku

Ufakazi 2 Usuku

ANNEXURE E: Questionnaire for Midwifery practitioners

TITLE: STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA BY GRAVID WOMEN AT PRIMARY HEALTH CARE FACILITIES, EMALAHLENI LOCAL MUNICIPALITY MPUMALANGA PROVINCE

THE OBJECTIVES OF THE STUDY: to determine and describe the knowledge and importance of utilization of the digital health by midwifery practitioners

: Identify and describe the barriers of utilization of the digital health such as mom connect.

All information will be treated as confidential and the researcher undertakes not to reveal any individual information that appears in this questionnaire.

The participants are required to complete this questionnaire which is subdivided into four sections complete within 40 minutes.

NB: The participant should mark the correct of answer with **(X)** as illustrated below

EXAMPLE: What is your gender?

Male

Female **X**

SECTION A: DEMOGRAPHIC FACTORS

1. Age

21-34 years old	A
35-50 years old	B
51-65 years old	C

2. Gender

Male	A
Female	B

3. Qualification in nursing

Diploma in midwifery	A
Diploma in nursing (general, community, psychiatric and midwifery)	B
Degree in nursing (general, community, psychiatric and midwifery)	C

4. Specialty in nursing

Postgraduate diploma in primary health care	A
Masters in primary health care	B
Advanced midwifery and neonatal nursing	C
None	D

5. Work experience

Less than 1 year	A
1 year -5 years old	B
6 years old-10 years	C
≥ 10 years old	D

6. Number of midwifery practitioners in the facility

1-2	A
3-4	B
5-6	C
7-8	D
9-10	E
>10	F

7. Operational time of the facility

8 Hrs	A
24 Hrs	B

8. Number of consultation for maternal services

1	A
2	B
>3	C
None	D

SECTION B: KNOWLEDGE OF MIDWIFERY ABOUT DIGITAL HEALTH

Indicate your answer on the following statement using the given keys:

A= Disagree B= Agree

	A	B
9. Digital health is the utilization of digital, mobile, and wireless technologies for health		
10. The purpose of digital health is to minimize maternal mortality and morbidity through active communication with gravid women using apps such as mom connect		
11. digital health apps to assist midwives help in accurate diagnosing of pre-eclampsia patients		
12. Digital health help me reach an informed decision of when to refer patient to higher facility		
13. Use of digital health help detect early conditions such as pre-eclampsia in gravid women		
14. In the pandemic era digital health helps curb the spread of COVID-19		

15. Digital health provide midwives with up to date treatment for pre-eclampsia		
16. Digital health apps provide nurses with nutritional advices for pre-eclampsia women		
17. Digital health provide midwives with proper assessment guide of pre-eclampsia women		
18. Can you register a multiparity to mom connect every each pregnancy		
19. Mom connect have no effect on pre-eclampsia women		
20. I advise patient on utilization of digital health apps		
21. Digital health initiatives such as mom connect informs pre-eclampsia patient on how to care for themselves and foetus		
22. Digital health apps help identify women at risk of pre-eclampsia early		
23. I advise pre-eclamptic women to consult the internet for information about pre-eclampsia danger signs		

DIGITAL HEALTH METHODS

Please indicate how often you use the following digital health initiatives to achieve optimal maternal health and sustainable quality care, using the following keys:

A= Never **B=**Hardly ever **C=**sometimes **D=** often **E=** always

	A	B	C	D	E
24. EM guidance					
25. Mom connect					
26. EML clinical guide					
27. Nurse connect					
28. Medical Social media					

29. Digital gestational wheel					
30. Digital gestational calculator					

SECTION C: BARRIERS TO UTILIZATION OF DIGITAL HEALTH

Indicate your answer on the following statement using the given keys:

A= Disagree B= agree

C1	A	B
31. Lack of technology validation	A	B
32. Patients don't have mobile phone	A	B
33. Poor network connection in the facility	A	B
34. Patients not interested in the mHealth initiatives	A	B
35. Interferes with patient-nurse relationship	A	B
36. I find digital health unreliable	A	B
37. Most of the patients are technological illiterate	A	B
38. Lack of awareness of digital health	A	B
39. Don't have enough time to use digital health during patient consultation	A	B
40. I find digital health app difficult to use	A	B
41. The digital health doesn't covers relevant treatment to pre-eclampsia	A	B
42. I don't have a smartphone to access digital health apps	A	B
43. The facility don't have electronic devices such as tablets or computers	A	B
44. Electronic health record system not implemented in the facility	A	B
45. Digital health don't have enough information therefore I don't use it	A	B
46. Lack of policies, programmes and strategies to optimize utilization in digital health among pregnant women within the facility	A	B

47. Digital health requires more mental efforts	A	B			
48. Experience electricity problems in the area	A	B			
49. Overcrowding within facility	A	B			
C2: STAFFING AND STAFF DEVELOPMENT	A	B			
50. Shortage of staff in facility	A	B			
51. Absenteeism high in the facility	A	B			
52. Trained in digital health in past 2 years	A	B			
53. Trained about the digital health authorised app	A	B			
54. In-service training of pre-eclampsia	A	B			
55. Attendance perinatal mortality meeting	A	B			
56. Allowed to further educational level in maternal and child services and nursing informatics	A	B			
57. Poor patient midwives ratio	A	B			
58. Too much workload	A	B			
C3 : WORKLOAD A= Never B=Hardly ever C=sometimes D= often E= always	N	HE	S	O	A
59. Able to cope with workload in the facility	A	B	C	D	E
60. Staff in facility always manage to complete all the duties and patient for day	A	B	C	D	E
61. Working conditions in the unit pleasant	A	B	C	D	E

ANNEXURE F: Interview guide for gravid women

PART 1: GRAVID WOMEN INTERVIEW GUIDE

TITLE: STRATEGIES TO ENHANCE UTILIZATION OF DIGITAL HEALTH IN EARLY DETECTION AND TREATMENT OF PRE-ECLAMPSIA AT PRIMARY HEALTH CARE FACILITIES, EMALAHLENI LOCAL MUNICIPALITY MPUMALANGA PROVINCE

PART 1: DEMOGRAPHIC AND OBSTETRICAL DATA

1. Age

14-20 years old	A
21-25 years old	B
26-34 years old	D
35-50years old	E

2. Educational level

Primary level	A
High school	B
University/collage	C
Never went to school.	D

	Yes	No
3. This is my first pregnancy		
4. I have more than 2 babies		
5. I once had high blood pressure in my previous pregnancy		
6. I had high blood pressure before pregnancy		
7. My current pregnancy is more than 20 weeks		

8. I am currently taking my high blood pressure medications		
9. I have been admitted in hospital before in my previous pregnancies for high blood pressure		
10. I have never attended clinic for my pregnancy		
11. I went to clinic for my first booking after 20 weeks of my pregnancy		

PART 2: INTERVIEW GUIDE

Central question: Elaborate in-depth your knowledge of digital health use in pregnancy?

Probing questions

Briefly describe the digital health initiatives you know and their relevance to your medical conditions

What are challenges and hindrances you faced on using digital health?

Describe in details the relationship and support between you and midwifery practitioners in using digital health?

How was digital health helpful in early detection and treatment of pre-eclampsia?

Describe in details the exclusive benefits of digital health use as a pre-eclampsia patient?

ANNEXURE G: Interview transcripts with one of the participants

INTERVIEW TRANSCRIPT

NAME: PARTICIPANT NO 1

KEY

R- RESEARCHER

P- PARTICIPANT

DATE: 15 JUNE 2022

R- Hello, how are you

P- Am good and yourself

R- Am also good, as I have already introduced myself. I'm Mxolisi Ngwenya, masters' student from the University of Limpopo. As I am sitting before you, we going to talk about my research that I have already explain to you prior the recording. As I have said before my research is about the utilization digital health in pregnancy by women with pre-eclampsia. This includes the use of phones, computers, etc. So now would kindly describe your experience in details about utilization of digital health such mobile initiatives in pregnancy?

P- The current pregnancy is different from the last one, since I had pre-eclampsia before in my first pregnancy. The last pregnancy I didn't know that I had it. I experienced blurred vision. This time when I came to the clinic I found out I have it. This time there were no symptoms as before. So I googled about my baby foetal movements at each and every trimester. Check the estimated weight at each every trimester because last pregnancy my baby was growing in the uterus, I was informed that it was due to the elevated blood pressure. So this time I used the internet to check the weight and foetal movements as well as signs of pre-eclampsia. Digital health was really helpful to me to know about my condition.

R- Could you kindly share your knowledge on the digital health apps you used?

P- There was no apps I used instead, I googled the website pages called babies mommy and etc. you know when you go to google and search that specific

content you want, it shows you variety of options. Then I'd choose flow and also mom n' baby, calendar, I visit those a lot

R- Ok, I understand. Now what are the challenges you experienced when you were digital health in pregnancy?

P- None at all.

R- Describe the relationship you have with the midwives in the clinic in assisting you with use of digital health?

P- So far they haven't taught me about digital health.

R- So from your perspective could you kindly elaborate on how can we improve such?

P- Eh, we can improve it by where you encounter a case similar to mine, it's important to let that individual to know. Because with my case I wasn't informed and it was due to my own concern that I ended up googling the information. So they should inform and teach others that there are specific apps that you can download and explain more about digital health. Cause even now when we discussing it, it's something new to me. To me it's like if I didn't google it at work I wouldn't have known or if it was my first pregnancy I wouldn't have known either.

R- Mmh ohk, so I have seen you already highlighted the benefits of digital health. Could elaborate on other benefits of digital health utilization?

P- the benefits that I have noted is that as women we won't always have money to go to the doctor, but then the use of digital health gave access to more information about the kind of foods I am supposed to eat and what's important such as sleeping positions.

R- Mmhk. So this means you have never been registered for digital health initiatives such as mom connect?

P- No, I have never been informed about it. Maybe it's because this is my second visit

- P-** Since this is your second pregnancy, could you kindly explain your experience in your first pregnancy about digital health?
- P-** Even on my first pregnancy when I was attending my visits, the time I got here when they detected the high blood pressure they referred me straight to the hospital. So I was attending my clinic there.
- R-** Ohk, so you can say those are challenges you experienced, because there are many challenges you could have experienced?
- P-** Ah, from my side I won't lie and say I experienced difficulties because I know how to google search especially because am young so what if someone else whose old whom don't have the knowledge to use phones and those who don't have smart phones. They weren't going to be able to google. And nowadays data is expensive, even myself I usually google a lot when am at work and save data. I can say that my challenge is whenever am at home, I can't google more cause I don't have enough data. However poor network connections is also the challenge I usually face most of the time especially during load shedding and I don't have Wi-Fi at home, I mostly use the Wi-Fi at work access information about my pregnancy and pre-eclampsia. To address this Wi-Fi and data expenses, if possible maybe free Wi-Fi station should be installed in our local areas so that we can more access to the information we need with regards to pre-eclampsia and our pregnancy. As far as I read pre-eclampsia is dangerous and every women diagnosed with pre-eclampsia should have access to all the information they need, because it could serve our lives.
- R-** To be sure, you said you use google search, could kindly elaborate on that
- P-** Ok, you know when you go to google and search that specific content you want, it shows you variety of options. Then I'd choose flow and also mom n' baby, calendar, I visit those a lot.
- R-** Thank you very much for your time. I appreciate your contributions towards this study.
- P-** My pleasure.

