DEVELOPING AN EVIDENCE-BASED MANAGEMENT MODEL TO MITIGATE THE RISK FACTORS ASSOCIATED WITH GESTATIONAL DIABETES MELLITUS IN THE MOPANI DISTRICT OF LIMPOPO PROVINCE, SOUTH AFRICA.

by

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THESIS

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DECLARATION

I declare that “Developing an evidence-based management model to mitigate the risk factors associated with gestational diabetes mellitus in the Mopani District of Limpopo Province, South Africa” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

Ntshauba Elelwani Thelma 30 November 2023

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Full names **Date**

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DEDICATION

This one goes to Dr Phumudzo Precious Ntshauba, my twin sister, strong pillar and source of inspiration. Thank you for always being there to support me; your prayers and continuous encouragement have kept me pressing forward and abiding in the Word of God and prayer. I thank God for you, and I love you very much…. always!

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ABSTRACT

Background: A model of care for non-communicable diseases (NCDs) has been developed to combat the growing burden of diseases in low-and-middle income countries due to sedentary lifestyles and westernised diets. Resources in these countries are often constrained and it is imperative that the health and well-being of people of all ages are ensured in order to minimise adverse health outcomes, mortality and morbidity.

Purpose: This study was conducted with the aim to develop an evidence-based management model to mitigate risk factors and improve maternal and infant health outcomes associated with gestational diabetes mellitus in the Mopani district of the Limpopo province in South Africa.

Methodology: A mixed-method exploratory sequential research design was used to best address the research question. Multistage sampling was used to select the health facilities under study. During qualitative phase one, a total of 12 key informants were purposively sampled to participate, and semi-structured interviews were conducted. During quantitative phase two. A total of 386 pregnant women attending antenatal clinic visits were randomly selected to participate in the study. A questionnaire was used to collect data, while a data entry form was used to capture information from maternity casebooks. Pregnant women who were diagnosed with gestational diabetes were purposively sampled to participate in a semi-structured interview. Qualitative data was analysed using thematic analysis while quantitative data was analysed using SPSS. Furthermore, the results from both phases were integrated and interpreted.

Findings: The study has found few cases of gestational diabetes mellitus (GDM). Most pregnant women attending antenatal visits were unaware of GDM, its risk factors, complications, adverse health outcomes and treatment. A minority of pregnant women diagnosed with gestational diabetes were referred to a dietician and health education on gestational diabetes was only offered to pregnant women diagnosed with this health condition. Pregnant women who are 35 years of age and older are at risk of developing GDM. Intervention strategies to reduce modifiable risk factors were developed and

validated using Delphi method. In addition, the strategies proposed informed the model, which was validated by calculating the content validation index.

Conclusion: Awareness about gestational diabetes should be raised in communities and during antenatal clinics. This might have a positive impact on the prevalence of non-communicable diseases and assist in achieving SGD no 3 by the year 2030.

Key words: Model of care; non-communicable diseases; gestational diabetes mellitus; pregnant women; evidence-based management; Mopani district; Limpopo province

LIST OF ACRONYMS

ACRONYMS	MEANING
ADA	American Diabetes Association
AMO	Ability, Motivation and Opportunity
ANC	Antenatal Clinic
BEE	Black Economic Empowerment
BMI	Body Mass Index
CARMMA	Campaign on Accelerated Reduction of Maternal Mortality
CHBAH	Chris Hani Baragwanath Academic Hospital
CHC	Community Healthcare Centre
COPD	Chronic Obstructive Pulmonary Diseases
CPD	Continuing Professional Development
CVD	Cardiovascular diseases
CVI	Content Validation Index
DM	Diabetes Mellitus
DOTS	Directly Observed Therapy Short Course
GDM	Gestational Diabetes Mellitus
GWG	Gestational Weight Gain
HGT	Haemogluco-test
HOMA-IR	High Insulin Resistance Index
IADPSG	International Association of Diabetes and Pregnancy Study Groups
IPI	Inter-pregnancy interval
LBW	Low Birth Weight
MD	Medical Doctor
MDT	Multi-disciplinary team
MENA	Middle East and North Africa
MMR	Mixed Methods Research
MNCWH	Maternal Newborn Child and Women's Health
MNT	Medical Nutrition Therapy
MOU	Midwife and Obstetric Units
NBW	Neonatal Birth Weight

NCDs	Non-communicable diseases
NdoH	National Department of Health
NICE	National Institute for Health and Care Excellence
NRDS	Neonatal Respiratory Distress Syndrome
OGCT	Oral Glucose Challenge Test
OGTT	Oral Glucose Tolerance Test
PCOS	Polycystic Ovarian Syndrome
PE	Pre-eclampsia
PHC	Primary Healthcare Clinic
PPH	Pregnancy-induced hypertension
QIPs	Quality Improvement Plans
QUAL	Qualitative
QUAN	Quantitative
RWG	Rapid Weight Gain
SA	South Africa
SADC	Southern African Development Community
SDGs	Sustainable Development Goals
SES	Socio-economic status
SGAs	Second Generation Antipsychotics
SHBG	Sex-Hormone-Binding Protein
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TB	Tuberculosis
USA	United States of America
WHO	World Health Organisation
WINGS	Women in India with Gestational Diabetes Mellitus Strategy

DEFINITION OF CONCEPTS

Evidence-based management refers to a systematic application of the best available evidence to management decision-making, which is aimed at improving the performance of healthcare establishments (Janati et al., 2018). In the context of this study, evidence-based management will refer to the evidence employed to develop a management model in aid of the mitigation of risk factors associated with gestational diabetes mellitus.

Gestational diabetes mellitus (GDM) refers to a state of diabetes first detected during the first trimester of pregnancy that is not clearly overt diabetes (Holt & Flyvbjerg, 2023). In the context of the study, gestational diabetes mellitus will refer to the first-time diabetes diagnosis of a pregnant woman.

Health Outcomes refer to events occurring due to an intervention, which need a comprehensive assessment to determine their absence or presence (Oleske & Islam, 2019). In the context of the study, health outcomes will refer to conditions detected during pregnancy, intrapartum and postpartum for pregnant women diagnosed with GDM and neonates.

Risk factors refer to attributes, characteristics or exposures of an individual that increase the likelihood of developing a disease or injury (World Health Organisation, 2017). In the context of this study, risk factors will include a family history of diabetes, advanced maternal age, pregnancy-induced hypertension, physical inactivity; multiparity; previous delivery of a macrosomic baby, delivery of a low-birth-weight baby, and obesity,

CHAPTER ONE: ORIENTATION TO THE STUDY

1. Introduction and background

Many low- and middle-income countries are experiencing demographic, nutritional, and epidemiological transitions which have resulted in an increase in non-communicable diseases (NCDs) (Macaulay et al., 2018). Research has estimated that 15,1% of pregnancies are affected by gestational diabetes mellitus (GDM) (Li et al., 2020). GDM has become a prioritised public health issue (Alejandro et al., 2020) as it predisposes the mother and infant to developing Type 2 diabetes mellitus (DM) and obesity in the future (Sweeting et al., 2022). Moreover, gestational diabetes has become one of the leading causes of maternal and child mortality and morbidity (Li et al., 2020).

Numerous studies have been conducted on GDM, with prevalence rates varying due to different diagnostic criteria used across countries and populations (Dłuski, et al., 2022; Mazumder et al., 2022, Dias et al., 2019). The global prevalence of GDM was reported to be 14,7% based on the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria (Saedi et al., 2021). In the United States of America (USA), it was found that the prevalence of GDM has climbed to 14% and affects 25% of pregnancies (Choudhury & Rajeswari, 2021) while South-East Asia had a GDM prevalence of 24,2% (Plows et al., 2018). In Africa, the highest prevalence was reported in Tanzania, at 13,1% (Maidwell-Smith et al., 2020). Research on GDM in South Africa has been conducted in Soweto and Johannesburg amongst Black pregnant women and a prevalence of 9,1% was reported using the World Health Organisation (WHO) 2013 criteria (Macaulay et al., 2018). A research study conducted in Limpopo province, South Africa revealed a prevalence of 1,96% (Ntshauba et al., 2022).

Ideally, every pregnant woman needs to be assessed for GDM to prompt the early identification of the health conditions and interventions needed. However, this is too costly for developing countries and resource-poor settings. South Africa' public health system has adopted a selective screening approach where only women with risk factors are assessed (Macaulay et al., 2018). A high pre-pregnancy body mass index (BMI); family history of diabetes; advanced maternal age and glycosuria have been found to be associated with a higher risk of developing GDM (Grunnet et al., 2020).

GDM can result in serious complications affecting the mother and foetus (Aburezq et al., 2020). Lifestyle interventions such as diet and exercise or physical activity during the early stages of pregnancy were found to be effective in reducing the positive rate of GDM (Zakaria et al., 2023). During literature review, it was found that research on GDM in the rural context of the Limpopo province is limited. This means there is not enough data on the prevalence of GDM in the rural areas of South Africa. It is important to understand the burden of GDM in the rural context due to westernised diets, physical inactivity amongst others which have been adopted.

The priori framework for synthesis for model of care for NCDs can be used to explain the increased prevalence of GDM. Furthermore, the framework has three concepts, screening; prevention and control (Kane et al.,2017). The framework emphasises case finding. In our context, an active case finding would be expensive and as a result, the health facilities only actively screen pregnant women with risk factors of GDM. Through conducting this study, we will be able to understand which risk factors are common in our context and how we can modify the risk factors which are modifiable in order to prevent the occurrence of GDM.

Thus, the study aims to develop an evidence-based management model for the mitigation of risk factors and improve maternal and infant health outcomes associated with GDM in the Mopani district of the Limpopo province of South Africa. The objectives of the study are to determine the prevalence and risk factors of GDM and the association of socio-demographics, risk factors with maternal and infant outcomes; describe the maternal and infant outcomes associated with GDM; investigate the knowledge of pregnant women on GDM and its management; explore the perceptions of patients on management of GDM by health care providers; describe the collaboration between non-communicable disease and maternal & child health units in district health services.

Thereafter, the findings will be used to develop an evidence-based management model to mitigate and manage gestational diabetes mellitus in the Mopani district. An evidence-based integrated intervention for GDM is needed and a holistic public health approach needs to be adopted to minimise risk factors and reduce the risk of diseases. An understanding of the burden of GDM, risk factors and its adverse health outcomes in the province by the provincial officials and members of the communities will go a

long way in reducing the diabetes epidemic. This study aims to strengthen our health system, improve early warning of disease and reduce global health risks.

2. Research Problem Statement

The prevalence of GDM is increasing drastically worldwide and in South Africa, the prevalence is estimated to be 1,6 – 25,8% with selective screening/ risk-factor based approach which is commonly used as it is cost effective, but this approach has poor sensitivity and specificity (Dias et al., 2019). This means that some cases might be missed. In a study conducted amongst Black pregnant women in Soweto, the prevalence of GDM was found to be 9,1% using WHO 2013 criteria (Macaulay et al., 2018). A gap in literature which was identified was that research on GDM in the South African rural context is scant and the burden of NCDs in low-and middle-income countries is rising drastically due to epidemiological transitions. A study was conducted in Limpopo province in 2007 amongst pregnant women and the prevalence of GDM was found to be 8.8% (Mamabolo et al., 2007).

Furthermore, another study on the prevalence and associated risk factors of GDM was conducted in the Mopani district of the Limpopo province and the prevalence of GDM was 1.9% (Ntshauba et al., 2022). Moreover, the small sample size was reported to be one of the limitations of this study (Ntshauba et al., 2022). This indicates that more studies need to be conducted to contribute to the body of knowledge and it is imperative that researchers understand GDM in the rural context as individuals from developing countries are adopting sedentary lifestyles and westernised diets. Hence, GDM needs to be understood and this will assist in developing an evidence-based management model to mitigate risk factors and improve maternal and infant health outcomes associated with GDM.

3. Research question

The research question for this current study was how to develop an evidence-based management model to mitigate risk factors and improve maternal and infant health outcomes associated with GDM in the Mopani district of Limpopo province.

3.1. Research aim.

This study aimed to develop an evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with GDM in the Mopani district of the Limpopo province.

3.2. Research objectives.

The study had three phases as mixed method design was adopted. Below is a representation of the study phases with objectives:

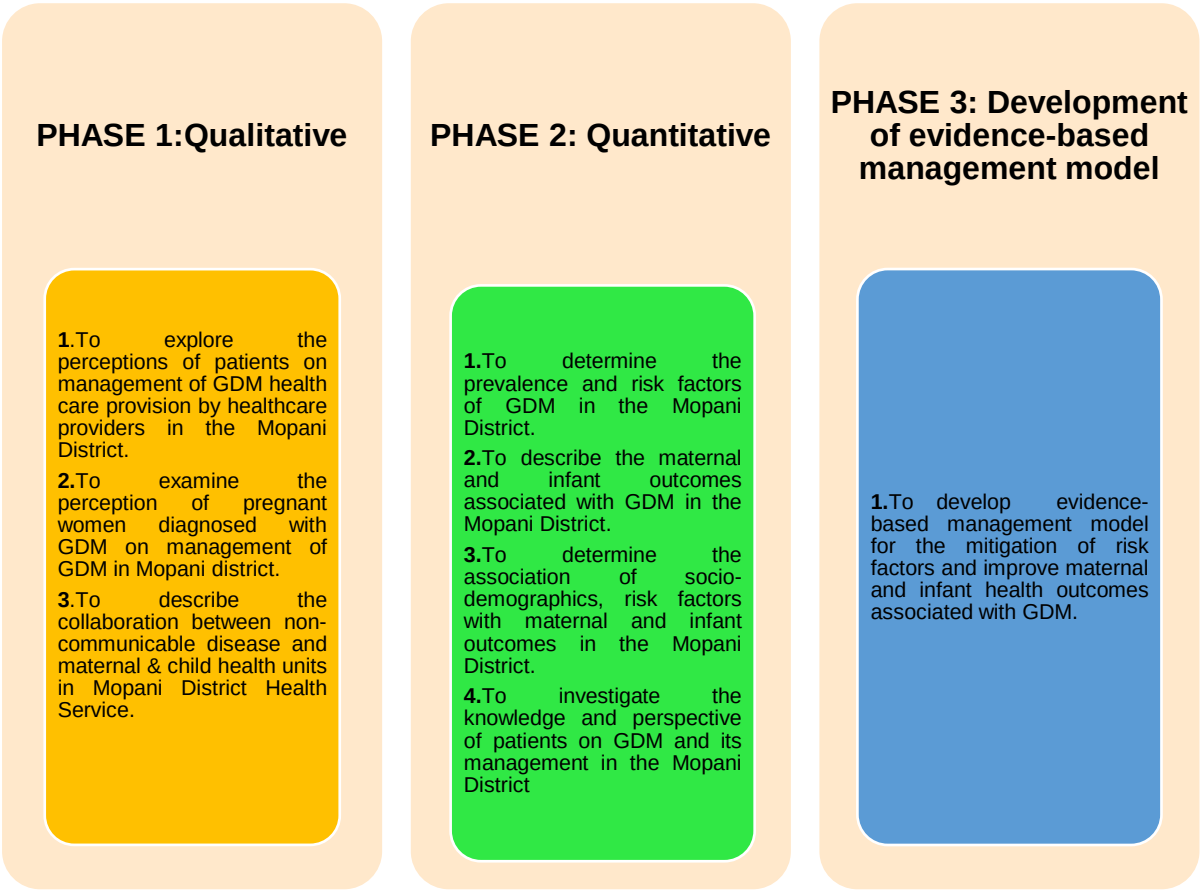


Figure 1.1: Research objectives according to the study phases.

4. Purpose of the study

The purpose of this study was to understand GDM as it exists in the rural context of the Limpopo province. In addition, developing countries are experiencing a surge in obesity among their populations as a result of sedentary lifestyles, physical inactivity, and westernised diets, which can lead to insulin resistance. Our study aimed at understanding the modifiable GDM risk factors which exist in the Mopani district, so that an evidence-based management model can be developed. Moreover, this study

also aimed to benefit health facilities in the Mopani district because the outcomes of the study will hopefully contribute to promote a good standard of practice which subsequently will improve women's health in communities and provision of quality health services. Also, this study will encourage collaboration among different sectors as outcomes of this study will be used to address both individual and population health. Through conducting this study, the researcher aimed to encourage the Limpopo Department of Health to strengthen continuous education for health practitioners through workshops, in-service trainings and other initiatives. Furthermore, this will ensure that patients are managed using evidence-based practice.

5. Research methodology

5.1. Research design.

An exploratory sequential mixed method design was used to address the research question of this study. In phase one, a qualitative study was conducted, and the findings obtained were used to inform the data collection instrument in phase two. Also, in phase two a quantitative study was conducted and in parallel, a qualitative study with pregnant women diagnosed with GDM was conducted. Thereafter, findings from both phases were integrated and used to inform the proposed evidence-based model.

5.2. Research paradigm.

Ugwu, Ekere and Onoh (2021) describe the research paradigm as a researcher's way of thinking, worldview or philosophical perspective that influences what should be studied; how it should be studied; and how the results of the study should be interpreted. The pragmatism paradigm guided this study as it allowed for GDM to be studied using various methods of inquiry to gain complete understanding. The study applied ontological (reality) and epistemological (knowledge) assumptions within an exploratory sequential mixed methods design. The research paradigm of this study will be discussed in detail in Chapter 4.

5.3. Research methodology process.

The methodology for each phase is outlined below in Table 1.1. A detailed description of the methodological process will be provided in Chapter 4.

Table 1.1: Research methodology process.

PHASES	**RESEARCH METHODOLOGY**			
	Sampling method	**Sample size**	**Data collection tool**	**Data analysis**
Phase 1: Qualitative strand	Purposive sampling was used to select key informants.	12 participants participated in the study. 5 medical doctors, 5 professional nurses and 2 Mopani district health units' managers (NCDs & Child and maternal health). Data saturation for medical doctors was reached on 5th participant while for professional nurses it was reached on 4th participant. ***Inclusion criteria:*** Doctors & nurses working with pregnant women in the maternity unit. ***Exclusion criteria:*** Doctors & nurses who were not willing to participate in the study.	Semi-structured face-to-face and telephonic interviews.	Qualitative data was analysed using thematic analysis.
Phase 2: Quantitative strand	Simple random sampling was used to select primary participants.	386 pregnant women attending antenatal clinic visits at selected study sites participated in the study.	Questionnaire and data entry form.	Quantitative data was analysed using SPSS version 29.0.0.0 (IBM SPSS Statistics, 2022).

PHASES	RESEARCH METHODOLOGY			
	Sampling method	**Sample size**	**Data collection tool**	**Data analysis**
Phase 2: Qualitative strand	Purposive sampling used to select participants.	***Inclusion criteria:*** All pregnant women attending antenatal clinic visits. ***Exclusion criteria:*** Pregnant women who were not willing to participate in the study or those who were severely ill to participate in the study and those with pre-existing diabetes mellitus. 07 pregnant women diagnosed with GDM participated. Data saturation was reached on the 5th participant. ***Inclusion criteria:*** Pregnant women diagnosed with GDM. ***Exclusion criteria:*** Pregnant women diagnosed with GDM not willing to participate in the study or those who were severely ill to participate in the study.	Semi-structured face-to-face interviews.	Qualitative data was analysed using thematic analysis.

PHASES	RESEARCH METHODOLOGY			
	Sampling method	**Sample size**	**Data collection tool**	**Data analysis**
Phase 3: Development of evidence-based management model	Purposive sampling used to select experts.	Three experts (Dietetics district coordinator, Midwifery, Medical doctor) participated for Delphi technique. Two experts validated the model.	Delphi technique survey to validate the proposed intervention strategies and make recommendations. Chapter 7 explains this in detail. Model validation survey conducted to determine the content validation index (CVI) of the model.	Content validation analysis

5.4. Reliability and Validity

Different methods were used to ensure validity and reliability of the data collection tools to ensure relevancy, appropriateness and consistency. In addition, validity and reliability will be discussed in great length in Chapter 4 of this study.

5.5. Bias

In this study, measures were taken to minimise potential biases that might result during sampling and administration of data collection tools (data collection). This will be discussed in detail in Chapter 4.

5.6. Ethical considerations

To maintain the credibility of the research community, the study adhered to the following ethical considerations: permission to conduct research, respect for persons participating in research, measures to protect participants' privacy and confidentiality, beneficence and compensation of participants. Chapter 4 provides more description of how these ethical considerations were adhered to during the research process.

6. Integration of qualitative and quantitative results

Qualitative and quantitative data were integrated to draw out new insights. In this study, visual joint display and four-step approach proposed by Skamagki et al (2022) were used to integrate and interpret the data. The four-step approach components include, creating a joint display; linking activity; establishing relationships; and interpreting and reporting. In this study, convergence; divergence and complementary were used to establish relationships between qualitative and quantitative data. Integration process and results will be discussed in detail in Chapter 6.

7. Significance of the study

This study was tailored towards sustainable development goal (SDG) no 3 which aims to ensure healthy lives and promote well-being for all at all ages. The results of this study can be used to raise community awareness on GDM as a health condition which can affect any pregnant woman. Also, health practitioners involved in management of GDM need to be capacitated through training skills programmes which can assist in strengthening management and practice, encourage adherence to relevant policies and guidelines. The results of this study have provided a foundation for future research which is imperative for the body of knowledge.

8. Outline of the thesis

The thesis is organised into eight chapters and the section below indicates details the contents of each chapter:

1. **Chapter one** includes introduction and background of the study, research problem, research aim, research question, research objectives, research methodology, chapter summary and organisation of the thesis.

2. **Chapter two** entails literature review which has been divided into sections: introduction, search strategy, Gestational diabetes mellitus as health condition, burden of GDM, impact of GDM, modifiable and non-modifiable risk factors associated with GDM, infant and maternal health outcomes associated with GDM, public health intervention on prevention and control, knowledge of pregnant women on GDM and its management, perceptions of patients on management of GDM by health care providers, evidence-based management model of GDM, health system barriers and human resources for health.

3. **Chapter three** presents the theoretical framework which guided the study.

4. **Chapter four** consists of the research methodologies used in the study.

5. **Chapter five** presents the research findings, and they were presented according to methods and data collection tools used guided by the research objectives:

   Phase one: Qualitative strand

   - Exploring the perception of patients on management of gestational diabetes mellitus healthcare provision by health care providers and collaboration between non-communicable disease and maternal & child health units.

   Phase two: Quantitative strand

   - Determining the prevalence, risk factors, maternal and infant health outcomes of GDM, and investigating knowledge and perspective of patients on GDM and its management**.**
   - Examining the perception of pregnant women diagnosed with gestational diabetes mellitus on management of GDM.

6. **Chapter six** presents integration of qualitative and quantitative results; and interpretation of results findings.

7. **Chapter seven** presents proposed intervention strategies which were guided by study findings, literature review, a priori framework for synthesis for model of care for non-communicable diseases; guideline for maternity care; ideal hospital realisation and maintenance framework manual; referral policy for South African health services and referral implementation guidelines; National Core Standards for health establishments in South Africa, validation of proposed strategies using Delphi technique; development of evidence-based management model for the mitigation of risk factors and improve maternal and infant health outcomes; model validation.

8. **Chapter eight** outlines a summary of the research findings, attainment of research objectives, recommendations to various stakeholders, the contribution of the study to the body of knowledge, the limitations of the study, and the thesis' conclusion.

8. Chapter summary

Chapter one highlighted the orientation to the study, the introduction and background, the research problem statement, research question, research aim, research objectives, the purpose of the study, research methodology process, research paradigm, reliability and validity, bias, ethical consideration, the integration of qualitative and quantitative results, the significance of the study, and an outline of the thesis. Chapter two will focus on the literature review.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter reviews the relevant sources and documentation within its scope to show what has already been done related to this topic and what is going to be done to add something to the existing pool of knowledge. A literature review is a process whereby researchers methodically explore relevant studies from various sources to help them determine whether the intended topic is worth studying and develop a feasible research problem. A review of the literature is fundamental to understanding the accumulated knowledge about the topic being reviewed (Garrard, 2022). Literature review has also been described as a way of synthesizing research findings with the aim of showing evidence and uncovering areas which needs more research to be focused on and is essential in generating theoretical frameworks and conceptual models (Snyder, 2019). In this study, a theoretical framework was used to provide structure and summarise existing knowledge into a logical manner.

Through literature review, one can understand how others have explored research problems alike and establish a trend of the topic under study to establish what is old, new as well as the gap identified by other researchers. Furthermore, literature review enables a researcher to report on the current knowledge about a topic after summarising and synthesising a variety of sources including a variety of journal articles, books, and web-based resources using the literature search in the documentation and siting of pertinent papers.

This chapter reviewed GDM; Impact of gestational diabetes; burden of GDM i.e. internationally, Africa including Southern African Development Community (SADC), South Africa, Limpopo province, and the Mopani district; risk factors associated with gestational diabetes, maternal and infant health outcomes associated with gestational diabetes; public health interventions on gestational diabetes; knowledge of pregnant women on gestational diabetes and its management; perceptions of patients on management of GDM by health care providers; evidence-based management model of gestational diabetes; healthcare system deficiencies; and human resources for health on delivery of services

2.2. Search strategy.

2.2.1. Types of sources reviewed.

Relevant publications were searched and identified, and their related articles and citations were also searched. Furthermore, additional searches were performed by reviewing relevant articles. Search engines such as PubMed, Cochrane library; Biology Medical Journal; Elsevier; Sage publications; Springer; Taylor & Francis; Wiley; Google scholar and others were comprehensively searched using key terms 'Gestational Diabetes Mellitus; 'Risk factors'; 'Prevalence'; 'Intervention'; 'health outcomes'; 'health system' and Human resource to identify relevant studies. During the process of searching for literature, subject headings and free texts were adopted.

2.3. Gestational diabetes mellitus

2.3.1. Pathophysiology, risk factors and adverse health outcomes of gestational diabetes

GDM is defined as diabetes which is first detected during pregnancy that is not overt diabetes (WHO, 2013). Furthermore, GDM is typically diagnosed between 24 to 28 weeks of gestation (Kim et al., 2019). GDM is characterised by an increase in the maternal secretion of progesterone which leads to an increase in insulin secretion and hyperinsulinemia, resulting in the foetus requiring more glucose (Sharma et al., 2022). Moreover, this condition is also characterised by insulin resistance, which can be defined as "the state in which normal concentration Insulin resistance fails to achieve an appropriate biological response downstream of the insulin receptor" (Alejandro et al., 2020). Insulin resistance occurs when the muscles, fat and liver fail to respond to insulin hormone which then causes a build-up of glucose in the blood as the glucose is not being used for energy.

It is common for a pregnant woman to experience morning sickness in the form of nausea and vomiting. Hypoglycaemia can also be a problem in the first weeks of pregnancy as much as hyperglycaemia and hypoglycaemia followed by hyperglycaemia from counter-regulatory hormones might complicate glucose control (Eichenwald et al., 2021). During pregnancy, a woman's body undergoes physical and physiological changes to meet the demands of a growing baby. Some of the changes include metabolic systems. It has been noted that during pregnancy, a pregnant woman experiences insulin resistance, which serves as a physiological adaptation to

subsidise the supply of carbohydrates to a rapidly growing foetus, which requires glucose as the main source of energy (Leoni et al., 2022).

As the pregnancy progresses, there is a drastic increase in placental, oestrogen, progesterone, leptin, cortisol, placental lactogen and placental growth hormones which promote insulin resistance (Plows et al., 2018). The insulin resistance or insulin requirements is due to increase production of abovementioned hormones that antagonises the action of insulin, and this is more common in mid-third trimester of pregnancy (Eichenwald et al., 2021). In addition, this will allow for blood glucose to increase. When the maternal β cells are unable to adapt to the metabolic changes in pregnancy, hyperglycaemia of GDM result (Alejandro et al., 2020). As the foetus feeds through the placenta, the increase in blood glucose will be transported across the placenta and this will fuel the growth of the foetus (Guadix et al., 2023). Similarly, maternal hyperglycaemia leads to foetal hyperglycaemia and foetal hyperinsulinemia which causes foetal overgrowth (Eichenwald et al., 2021).

There are several factors which influence the occurrence of gestational diabetes. These include obesity, non-Caucasian ethnicity, advanced maternal age, family history of diabetes, excessive gestational weight gain (GWG), macrosomia, cigarette smoking (Gajera et al., 2023). These concur with what Eichenwald et al (2021) highlighted that multifoetal gestation, increased BMI and strong family history of diabetes are the risk factors of GDM. Native Americans, Southeast Asians and African Americans are at more risk of developing GDM than other ethnic groups (Eichenwald et al., 2021). All these risk factors will be discussed in detail later in this literature review. Below is figure 2.1 which is a summarised graphic representation of pathophysiology and risk factors of GDM:

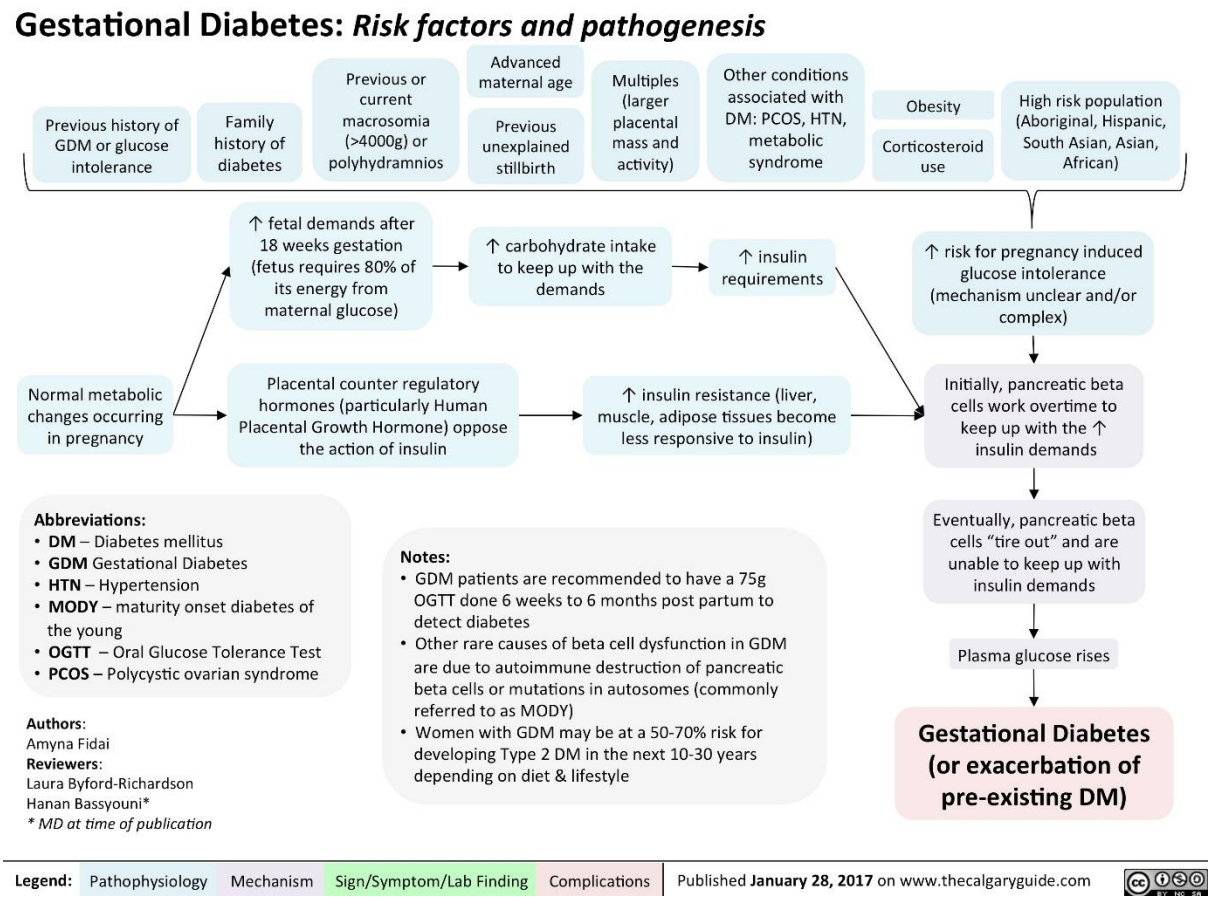


Figure 2.1: Gestational diabetes mellitus risk factors and pathogenesis. The Calgary guide to understanding disease (2022). Gestational Diabetes: Risk factors and pathogenesis | Calgary Guide (ucalgary.ca)

GDM adversely impacts the health outcome of infants and mothers. For an infant, the health outcomes are more likely to be macrosomia where their weight is ≥4kg and as a result, they are more susceptible to birth-related injuries such as shoulder dystocia (Natamba et al., 2019). Due to the infant's weight, the mother is more likely to have vaginal lacerations should she deliver naturally, postpartum haemorrhage or deliver via caesarean section.

In addition, the mother remains at increased risk of developing Type 2 DM in the long term (Natamba et al., 2019) and recurrence of GDM in subsequent pregnancies (Alejandro et al., 2020). It has been explained that GDM is a severe yet an overlooked threat to both maternal and child health (Dissassa et al.,2023) and morbidities included cardiovascular and metabolic amongst others (Christensen et al., 2022). The desire of the researcher was to explore this health condition in the context of this study.

2.4. The Burden of gestational diabetes mellitus

In this section, the global, sub-Saharan Africa (SSA), South Africa, Limpopo province and Mopani district burden of gestational diabetes mellitus were discussed.

2.4.1. The global burden of gestational diabetes mellitus

The global prevalence of GDM was estimated to range from 1%-28% and discrepancies in the prevalence amongst countries was found to be as a result of ethnicity, ethnic variation amongst different populations and inconsistent use of screening and diagnostic criteria (Al-Rifai et al., 2021). In 2017, the International Diabetes Federation estimated that the prevalence of GDM is expected to increase every year (Zhang et al., 2021). In a systematic international review study on prevalence of GDM, it was established that 9-25% of pregnancies worldwide are affected by acute and long-term complications of this health condition (Scheider et al., 2012). In the United States of America (USA), the prevalence of GDM ranges from 1% - 25% whereas South-East Asia has the highest GDM prevalence of 24.2% was reported (Li et al., 2022).

The prevalence of GDM in low-income countries is estimated to be higher than that in high-income countries. In a systematic review and meta-analysis study conducted by Nguyen et al.(2018), it was established that the GDM prevalence in low-middle-income countries was about 64% higher than in high-income countries. In contrast to this finding, a systematic literature review which was done to determine published studies on the prevalence of diabetes found that South-East Asia region had a high prevalence of hyperglycaemia of 26.6% while in the African region, the prevalence of GDM was 13.61% and sub-Saharan region, 14.28% (Muche et al., 2019). In agreement to this, in a review study, the global estimates of GDM prevalence in high-income countries was between 14.1-14.2% (Wang et al., 2022). A cross-sectional study based on secondary data from the Bangladesh Demographic and Health Survey (BDHS) 2017–2018 highlighted that the overall prevalence of GDM in Bangladesh which is a country in South Asia was estimated at 35% amongst pregnant women visiting the urban tertiary hospital (Mazumder et al., 2022). The reason for the high prevalence was that the studies used WHO 2013 criteria and it has a lower cut-off value of 5.1-6.9 mmol/l Fasting glucose plasma compared to WHO 1999 criteria which were used in previous studies (Mazumder et al., 2022).

In the past few years, the prevalence of GDM in China, which is a high-income country, has changed after they adopted new GDM diagnostic criteria. In 2011, various cities and regions in China adopted the International Association of Diabetes and Pregnancy Study Groups (IADPSG) and an upward trend in the prevalence of GDM was observed (Juan & Yang, 2020). A recent systematic review and meta-analysis study found that the prevalence of GDM in mainland China was 14.8% with a 95% confidence interval of 12.8%-16.7% (Gao et al., 2019). The increased GDM prevalence in China was a result of improvements in the economy and living standards; lifestyle changes as the country was becoming more westernised with changes in dietary patterns and physical inactivity (Juan & Yang, 2020). As such, in 2015, a 'two-child' policy was introduced in China to limit further increase in population size and this resulted in an increased incidence of high-risk pregnant women and women having a history of GDM (Juan & Yang, 2020).

As previously mentioned, the discrepancy in the prevalence of GDM worldwide is due to the diagnostic criteria used. According to a systematic review and meta-analysis study, the commonly used diagnostic criteria was WHO 1999 (33%) followed by IADPSG (28%) with WHO 1985 being the least used diagnostic criterion (Gyasi-Antwi et al., 2020). A higher prevalence of GDM was found in studies which used IADPSG diagnostic criteria, American Diabetes Association (ADA) 2012 or WHO 2013 criteria (Nguyen et al., 2018). Similarly, the use of IADPSG and WHO 2013 criteria yielded a higher prevalence of GDM compared to Carpenter and Coustan criteria: WHO 1985 criteria and WHO 2006 criteria (Natamba et al., 2019). IADPSG criteria had a lower threshold value of fasting glucose (5,1 mmol/L) and higher sensitivity for GDM detection, though over diagnosing of GDM might predispose women to psychological stress, unnecessary treatments and impaired quality of life because of associated adverse health outcomes (Gyasi-Antwi et al., 2020).

2.4.2. The burden of gestational diabetes mellitus in Sub-Saharan Africa

A systematic review, meta-analysis and meta-regression analysis study was conducted in the Middle East and North Africa (MENA) which looked at the prevalence of GDM during the period 2000-2019, demonstrated that the prevalence of GDM was 10.6% (95% CI:8.1-13.4%-98.9%) in studies which were conducted before 2009 while in studies which were conducted in or after 2010, the prevalence of GDM was 14.0%

(95% CI:12.1-16.0%, 99.3%) (Al-Rifai et al., 2021). Likewise, a cross-sectional study conducted from April 2017 to October 2017 amongst 390 pregnant women attending antenatal care clinic of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia showed a GDM prevalence of 16.9% (Nigatu et al., 2022). This shows that over the years the prevalence of GDM has steadily increased. Furthermore, the abovementioned cited studies advised that a steady increase in the prevalence of GDM was corresponding to an increase in BMI which correlates with overweight and obesity (Al-Rafai et al., 2021).

Disparities in the prevalence of GDM were observed in various sub-regions of Africa. It was reported that Central Africa had the highest prevalence of GDM at 20.4% compared to Northern Africa which had the lowest GDM prevalence of 7.6% (Muche et al., 2019). Furthermore, East-Africa had a higher prevalence of GDM than West Africa. This is observed in a longitudinal cohort study which was conducted among women of reproductive age in the West Kiang of Gambia found a lower prevalence of GDM in Nigeria (8.6%) which is one of the West African countries compared to the prevalence of GDM of 13.1% in Tanzania, one of East-Africa countries (Maidwell-Smith et al., 2020).

2.4.3. The Burden of gestational diabetes mellitus in South Africa

In a cross-sectional study which was conducted in 2012 to measure the nutrition and health status of the South African population amongst 27, 580 participants from 8,166 households, the prevalence of diabetes in pregnancy was reported to be 3% (Chola et al., 2017). With the increasing burden of diabetes, the International Diabetes Federation (IDF) estimated an increase in the prevalence of GDM in South Africa. According to the International Diabetes Federation Diabetes Atlas report on diabetes, the prevalence of GDM was estimated at 11.0% in the year 2021 (South African Diabetes Report, 2021).

In a cohort study conducted amongst 1906 Black South African women attending antenatal care visits at Chris Hani Baragwanath Academic Hospital (CHBAH) from 1 June 2013 to 30 April 2017, a prevalence of GDM of 9.1% was found after using WHO 2013 criteria (Macaulay et al., 2018). Moreover, with the same cohort study participants the prevalence of GDM after using WHO 1999 criteria was 5.6% and using

the IADPSG criteria the prevalence of women with GDM was 9.4% (Macaulay et al., 2018). From the previously mentioned study findings, we can deduce that the prevalence of GDM amongst Black South African women has progressively increased over the years.

2.4.4. The burden of gestational diabetes mellitus in Limpopo province

There is limited rigour in studies related to GDM which are conducted in Limpopo Province. In a study which was conducted in the Central region of Limpopo province amongst 262 Pedi pregnant women in the third trimester (28-36 weeks) gestational age who were attending antenatal care visits between May/August 1999 and February/April 2000, the prevalence of GDM was found to be 8.8% and diagnostic criteria used was the World Health Organisation criteria laboratory diagnosis and monitoring of diabetes mellitus (Mamabolo et al., 2007).

2.4.5. The burden of gestational diabetes mellitus in the Mopani district

There was inadequate data on the prevalence of GDM studies conducted among pregnant women in the Mopani district. However, a cross-sectional study conducted in the district to determine the prevalence of gestational diabetes and associated risk factors among pregnant women attending antenatal clinic visits, reported the GDM prevalence of 1.9% (Ntshauba et al., 2022).

2.5. The public health impact of gestational diabetes mellitus

The burden of NCDs is rising rapidly in low-income resourced countries resulting in harmful impact on the health of an individual (Kassa & Grace, 2020). The increased prevalence of GDM has raised health concerns (Li et al., 2020) and the risk for adverse health outcomes for mother and infant has drastically increased due to an increase in maternal glucose level in the second or third trimester (Muche et al., 2020). Babies born to mothers with GDM are at risk of developing Type 2 diabetes later in life, at risk of obesity, respiratory problems, endocrine problems, risk of the impaired neurodevelopmental outcome, and ophthalmic disease (Sheiner, 2020). Women with GDM are at significant risk of developing cardiovascular and metabolic diseases later in life.

GDM has been found to have stronger association with heart failure, coronary heart diseases than cerebrovascular diseases, type 2 diabetes (Mao et al., 2022) as well as renal and ophthalmic diseases (Sheiner, 2020). The NCDs which are outlined above can cause an economic strain on healthcare systems i.e. medicines and equipment, and human resources (Mucheru, 2021). For healthcare providers, this can mean burnout due to increased workload while for health facilities it will pose a great demand for resources such as medicines and equipment, finances, the need to hire more healthcare providers, etc.

2.6. The risk factors of gestational diabetes mellitus

Risk factors are defined as the attributes, characteristics, or exposures of an individual that increases the individual's chances of developing a disease or injury (WHO, 2017). GDM is associated with multiple risk factors and these risk factors are important catalysts for the development of GDM. Modifiable and non-modifiable risk factors were discussed in this current study:

2.6.1. Modifiable risk factors

Modifiable risk factors are those risk factors that can be reduced or controlled with changed behaviour (Ada's Medical Knowledge Team, 2022). In this current study, risk factors which are likely to result in GDM will be discussed. Below are the modifiable risk factors which have been identified to increase the likelihood of GDM occurrence by numerous studies:

2.6.1.1. Maternal obesity and gestational diabetes mellitus

Pregnant women are expected to gain 30% of their gestational weight in body fat during pregnancy (Alejandro et al., 2020). A study conducted by Ménard et al., (2020) has shown that obese women are at more risk of developing GDM. Maternal obesity and GDM are independently associated with adverse pregnancy outcomes (Berntorp, 2016). Obesity and overweight are on the rise especially amongst South African Black women with 68% of them aged 15 years and above being classified as obese or overweight (Macaulay et al., 2018). Pregnant women with obesity are more likely to develop complications such as increased fasting plasma glucose, insulin resistance, high plasma triglyceride and hypertension in the first antenatal care (Cheng et al.,

2021). Furthermore, these women are more prone to metabolic syndrome, premature delivery and stillbirth (Alejandro et al., 2020).

Previous studies have supported that a higher pre-pregnancy BMI is associated with an increased risk of GDM (Rahnemaei et al.,2022; Lewandowska et al., 2020; Bender et al., 2019). It was found that during pregnancy obese pregnant women were vulnerable to suffering from GDM because of strong insulin resistance (Li et al., 2020). A prospective study conducted in Taiwan which examined the BMI and clustering of metabolic risk factors in early pregnancy and risk of GDM, a positive relationship existed between obesity/overweight and risk of GDM (Yen et al., 2019). A similar finding was found in a prospective cross-sectional study which studied gestational diabetes mellitus risk related to physical activity in early pregnancy among 544 low-income women and found that the chances of developing GDM in obese or overweight pregnant women are three times more (OR=3.1, 95% CI:1.81-5.20), (do Nascimento et al., 2019).

Dietary patterns have changed in low-income areas, and this is noticeable in street vendors selling fast food i.e., kotas, vetkoeks, chips, etc. and most people purchase them as they are affordable and convenient for the road. In addition, the increasing burden of obesity in low-income communities might be caused by the consumption of a high-energy diet, decreased physical activity, and high-fat; high-sugar; high-salt, energy-dense foods (do Nascimento et al., 2019).

2.6.1.2. Previous macrosomic delivered and gestational diabetes mellitus

Having previously delivered a baby weighing 4kg or more has been shown to increase a woman's chance of developing GDM (Macaulay et al., 2018). A study has found that macrosomia in a previous non-diabetic pregnancy was associated with GDM in a subsequent pregnancy (Rottenstreich et al., 2020). This resonates with other studies which revealed that a history of macrosomia delivered is an important risk factor for gestational diabetes (Kaini et al., 2017, Sugiyama et al., 2017).

2.6.1.3. Neonatal birth weight and gestational diabetes mellitus

Association between GDM and neonatal birth weight have been studied. Neonatal birth weight (NBW) in previous pregnancies is associated with increased GDM incidence in the subsequent pregnancy (Rottenstreich et al., 2020). It is believed that a foetus with low birth weight (LBW) compensates for undernutrition in the womb by epigenetically changing the expression of genes that are involved in fat storage, energy utilisation and appetite regulation and animal studies conducted therefore suggested that undernutrition in utero is associated with a reduced β-cell number (Plows et al., 2018). In an observational cross-sectional study conducted amongst pregnant women in Saudi Arabia, a multivariate logistic regression analysis showed a significant association between GDM and neonatal birth weight of greater than 3,5kg (Abdelmola et al., 2017).

2.6.1.4. Pregnancy-induced hypertension and gestational diabetes mellitus

A study has found that pregnancy-induced hypertension (PIH) is correlated with developing GDM (Aburezq et al., 2020). Similar finding was found in a retrospective case-control study wherein gestational hypertension was found to be a risk factor for GDM (Yaping et al., 2022).

2.6.1.5. Physical inactivity and gestational diabetes mellitus

Exercise has been found to facilitate uptake of glucose into cells to be used for energy making this strategy a conductive one to prevent GDM (Woodside & Bradford, 2021). It is normal for pregnant women to gain weight during pregnancy as a result of a growing foetus, hence during antenatal care physical activity is highly recommended to minimise excessive weight gain which can have potential harmful effect on both mother and foetus. Physical activity during pregnancy was found to have positive effects on the mother and foetus (Aburezq et al., 2020). Adeoye (2022) discovered that physical activity provides potential benefits including improved insulin sensitivity and decreased cardiometabolic risk. Women who were found to be physical inactive prior to pregnancy were three times more likely to develop GDM compared to women who were physically active (Sitzberger et al., 2020).

Modern society has normalised sedentary lifestyles and westernised diets, which have resulting in high rates of obesity. A prospective case-control study conducted in two

private hospitals among pregnant women attending clinics showed that prolonged sedentary behaviour and reduced physical activity, increased the risk for GDM(Mishra & Kishore, 2018). In support of this finding, a case control study which was done to examine the modifiable risk factors of GDM, less time spent in walking; less time spent in extraneous household physical activity and not engaging in moderate intensity physical activity were significantly associated with occurrence of GDM (Ali et al., 2021).

2.6.1.6. Gestational weight gain and gestational diabetes mellitus

An increase in gestational weight gain (GWG) during early pregnancy may increase the risk of GDM regardless of pre-pregnancy BMI (Juan &Yang, 2020). However, a population-based cohort study carried out in Sweden revealed that the likelihood of GDM occurrence increases with higher early GWG in overweight women and the risk was reduced among obese women who had lower early GWG (Xu et al., 2022). Furthermore, a retrospective cohort study conducted among women with singleton pregnancies expressed that excessive GWG in the first and second trimesters might be a risk for GDM (Qi et al., 2020). Dissimilarity, Lan et al (2020) highlighted in their study that excessive GWG in the first trimester of pregnancy was associated with an increased risk of GDM than during the second trimester, regardless of pre-pregnancy BMI.

2.6.1.7. Previous history of GDM and gestational diabetes mellitus

Studies have been conducted to determine the risk of previous GDM in subsequent pregnancies. It has been reported that 50% of women with GDM will have recurrent GDM during their next pregnancy (Schwartz et al., 2018). A cohort study conducted by Zhang et al (2022) confirmed that women with history of GDM were at increased risk for recurrent GDM in a subsequent pregnancy. Similar observations were made wherein history of GDM was positively associated with maternal higher risk for GDM recurrence after first pregnancy (Wei et al., 2022). A study has estimated that GDM occurs in 30-69% of subsequent pregnancies after the first pregnancy was affected with GDM (Juan & Yang, 2020).

2.6.1.8. Polycystic Ovarian Syndrome and gestational diabetes mellitus

Polycystic ovarian syndrome (PCOS) is a common disorder which affects women of reproductive age. This health condition is known as a risk factor of GDM as the physiologic state of hyperinsulinemia insulin resistance and early abnormal insulin action deteriorate in pregnant women with PCOS (Juan & Yang, 2020). In contrast, study posits that PCOS with other comorbidities such as obesity and advanced maternal age increases the risk of GDM and the condition alone is not a risk factor of GDM (Alejandro et al., 2020). PCOS is "a heterogeneous endocrine and metabolic disorder characterised by chronic oligomenorrhea, hyperandrogenism, and insulin resistance" (Alejandro et al., 2020). The secretion of pregnancy hormones such as oestrogen, progesterone and prolactin in women with PCOS after pregnancy can increase the insulin resistance and further aggravate glucose metabolic disorders (Li et al., 2021).

It was found that insulin resistance was observed in 50% of women with PCOS and the risk of developing Type 2 DM was four times higher compared to women without PCOS (Palm et al., 2018). A cross-sectional study undertaken in Ahvaz showed that women with PCOS are at more risk of developing long-term complications such as GDM and Type 2 diabetes (Nikbakht et al.,2018). A retrospective cohort study in pregnant women in China highlighted that there is 1.5 times increased risk for GDM for women diagnosed with PCOS especially in initial stages of pregnancy (Juan & Yang, 2020). A study conducted in a tertiary hospital amongst pregnant women with PCOS in China revealed an increased incidence of GDM in patients with PCOS (Li et al., 2021). Patients with PCOS who are 30 years of age and above are more at risk of developing gestational diabetes (Li et al., 2021).

In addition, advance age; increase BMI; High Insulin resistance index (HOMA-IR); Fasting insulin (Fins); reduced Sex hormone-binding protein (SHBG); testosterone and androstenedione were found to be independent risk factors of GDM in women with PCOS (Li et al., 2021). Furthermore, the risk of GDM was found to be dependent on the woman's age and use of fertility treatment among Asian women with PCOS (Palm et al., 2018). Weight gain was also found to be a predictor of GDM in patients with PCOS (Nikbakht et al., 2018).

2.6.1.9. Psychological stress and gestational diabetes mellitus

Pregnancy is characterised by hormonal and physical changes in a woman, and this may result in psychological stress and anxiety in some women who are experiencing these changes. Furthermore, stress can produce insulin resistance. Psychosocial stress is a potentially modifiable risk factor which is common among pregnant women, particularly those diagnosed with GDM (Kubo et al., 2017). Mishra et al (2020) noted that the odds of being diagnosed with GDM were 13 times higher in women with high antenatal stress compared to those women who experienced low stress. A study has documented that prolonged exposure to psychological and environmental stress might increase the risk of GDM (Alejandro et al., 2020). A study which examined stress adaptation and its association with insulin resistance among pregnant women diagnosed with GDM revealed that elevation of stress hormones and stress adaptation disturbance are more likely to be linked with pathogenesis of GDM in pregnant women (Feng et al., 2020).

2.6.1.10. Pre-eclampsia and gestational diabetes mellitus

Pre-eclampsia (PE) has been linked to the degree of glucose intolerance (Lee et al, 2017). This concurs with the statement made by Alejandro et al (2020) who suggested that PE is also linked to hyperglycaemia, glucose intolerance and obesity. A study conducted by Lee et al (2017) has shown that a history of PE in the first pregnancy was a risk factor of GDM in successive pregnancies. However, Garmendia et al (2020) shared a different view as they found that history of pre-eclampsia in previous pregnancies was negatively associated with occurrence of GDM in subsequent pregnancies.

2.6.1.11. Medications and gestational diabetes mellitus

Antidepressant and psychotropic medications have also been shown to be the risk factors of GDM (Alejandro et al., 2020). A nested case-control study conducted in Quebec, Canada established that the overall use of antidepressants was associated with increased risk of GDM especially venlafaxine (27%) and amitriptyline (52%) (Dandjino et al., 2019). Studies which looked at the exposure to antidepressants in patients with gestational diabetes revealed the risk of diabetes increased with prolonged use of antidepressants while considering increasing (advanced) age and weight (Dandjino et al., 2019).

An evaluation study on risk of developing GDM among women treated with second generation antipsychotic medications (SGAs) found that there was no association between increased risk of GDM with exposure to SGAs during pregnancy compared to psychiatric ill women who were not exposed to SGAs (Panchaud et al., 2017). In addition, the study further found that the risk of developing GDM was the same in exposed and unexposed groups to SGAs (Panchaud et al., 2017). Conclusive evidence has not been found.

2.6.2. Non-modifiable risk factors

Non-modifiable risk factors are those attributes or characteristics in an individual that cannot be changed or adjusted as they are beyond an individual's control (Ibekwe, 2015). Discussed below are the non-modifiable risk factors of GDM.

2.6.2.1. First-degree relative with diabetes and gestational diabetes mellitus

The susceptibility to GDM increases in women with family history of diabetes particularly first-degree relatives due to genetic deficiency in insulin secretion from their first-degree relatives (Zhang et al., 2021). A study conducted in Poland highlighted that the risk of GDM for paternal diabetes was significant in lean pregnant women (Lewandowska, 2021). A family history of diabetes is a significant independent risk factor for the development of GDM (Alejandro et al., 2020) and GDM was found to have a recognised familial recognition. The development of GDM has been found to occur when there is an interaction between environmental, genetic and epigenetic factors (Ustianowski et al., 2023).

In a correlational study conducted in Huangdao, Qingdao, China, it was highlighted that the history of diabetes mellitus in first-degree relatives has a positive correlation with GDM (Wu et al., 2018). A meta-analysis study found that the odds ratio (OR) of family history for developing gestational diabetes was estimated as 3.6 (95% CI: 2.80-4.27) (Zhang et al., 2018). This indicates that a pregnant woman with a family history of diabetes has a greater likelihood of being diagnosed with GDM. A prospective cohort study conducted amongst Caucasian pregnant women found that the presence of DM in both the mother and grandmothers was associated with significant increase in the risk of GDM in pregnant women who were diagnosed with GDM and on diet

intervention (Lewandowska, 2021). Hence, screening for GDM in pregnant women with a family history of diabetes is important for early diagnosis and treatment.

2.6.2.2. Maternal age and gestational diabetes mellitus

Increasing maternal age and likelihood of developing GDM have been well documented. Pregnant women who were aged between 26 and 30 years in Assam, India were 1.7 times more likely to develop GDM compared to pregnant women aged 15-20 years (Chanda et al., 2020). The incidence of GDM has been increasing for the past few years particularly among women who are above 35 years (Vounzoulaki et al., 2020). In support of this, a study found that the incidence of GDM peaked at 35-39 years and then declined in women aged 40-50 years (Li et al., 2020). In a comprehensive study conducted in Turkey, women with GDM were significantly older than women without GDM (Canday, 2024).

A systematic review and meta-analysis study on maternal age and risk of GDM showed that for every consecutive year after 18 years, the risk of GDM increases by 7.90%, 12.74% and 6.5% in general, Asian and European populations (Alejandro et al., 2020). The increased risk of GDM with advanced maternal age may be because of decrease function of oxidative phosphorylation in mitochondria of islets cells as the function of insulin secreted by islets beta cells weakens; the ability of insulin-mediated glucose uptake declines; the older the pregnant women, the greater the mental stress which can easily make them anxious and subsequently increase blood glucose (Li et al., 2020). Likewise, women with advanced age present with reduced insulin sensitivity and pancreatic β-cell function which increase the risk of glucose and lipid metabolism abnormality during pregnancy (Juan & Yang, 2020).

2.6.2.3. Ethnicity and gestational diabetes mellitus

A study conducted in the US demonstrated that Hispanic women were at greater risk of GDM compared to non-Hispanic White and non-Hispanic Black (Gardner et al., 2022). A similar finding was reported from a study conducted by Alejandro et al., (2020) which stated that the increased risk of GDM was observed in several ethnic and racial groups which included Hispanic, African American and Asian women. Also, Liu et al (2019) discovered that Asians, Hispanics, and Arab Americans have higher risk of being diagnosed with GDM when compared with African Americans and Whites. Data

from the South African National Nutrition and Health examination survey collected across households nationally showed that non — Africans were more likely to report diabetes in pregnancy than Africans (Chola et al., 2017). Furthermore, Korean, Chinese and Filipino women were twice more likely to develop GDM than African American women (Alejandro et al., 2020). The variation amongst these populations may be attributed to diverse cultural, lifestyle and socioeconomic factors.

2.6.2.4. Socioeconomic status and gestational diabetes mellitus

Socioeconomic status (SES) refers to "social and economic factors that reflect what positions and prestige individuals or groups hold within the structure of a society, such as educational level, occupation and income" (Song et al., 2017). Women living in poverty have been found to be at a greater risk of adverse pregnancy outcomes (Ménard et al., 2020) whilst women with a higher income were found to have a decreased risk of GDM (Liu et al., 2018). In contrast to this finding, a cross-sectional study conducted amongst 272 pregnant women from Bangladesh in a Demographic Health Survey 2017-2018, observed a high risk of GDM among pregnant women residing in urban areas (Mazumder et al., 2022). According to Alejandro et al (2020), a study in Finland stated that there was an inverse relationship between socioeconomic status and GDM.

2.6.2.5. Education level and gestational diabetes mellitus

Education level has an impact on women's nutrition knowledge during pregnancy (Gezimu et al., 2022). Hence, the education level of pregnant women presenting at health institutions must be understood and taken into consideration when providing nutrition knowledge to ensure the health and well-being of the mother and baby. There is insufficient evidence-based information about the association between GDM and education though education has a favourable impact on women's health conditions (Lin et al., 2016). A similar finding was shared by Laine et al (2018), who observed no association between educational attainment and GDM. This finding is consistent with the finding of the meta-analysis study which found that maternal educational level was not significantly associated with the development of GDM (Wang et al., 2021).

However, a retrospective cohort and case-control study conducted among Taiwanese pregnant women results established that women with lower levels of education were

more at risk of developing GDM than women with higher levels of education (Lin et al., 2016). On contrary to the above study findings, a study conducted in rural areas of India among pregnant women of gestational age 24-28 weeks demonstrated that women who passed 10th class (Odds ratio 1.58%; CI: 1.05 — 2.37) had a significantly increased likelihood of developing GDM (Chanda et al.,2020). The differences in these study findings indicate that there is a need for further research on the association between education and GDM.

2.6.2.6. Gravidity & Parity and gestational diabetes mellitus

Gravidity is the number of times the woman has been pregnant. The "effect of gravidity on the risk of GDM has been associated with increasing age as well since an increased number of pregnancies is observed in women with advanced maternal age" (Alejandro et al., 2020, p. 4). The higher number of pregnancies has been found to be an independent risk factor of GDM and the association between GDM and the number of pregnancies was common in women who are above 30 years of age or those with pre-pregnancy BMI of <24 kg/m² (Liu et al., 2020). This indicates that a higher number of pregnancies has been found to have a significant contribution to the occurrence of GDM after a statistical model was used to determine the relationship. In contrast, a meta-analysis study which was conducted on factors associated with GDM found that being a primigravida was associated with a reduced probability of developing GDM (Zhang et al., 2021). However, elderly primigravida remains a high-risk pregnancy as the likelihood of developing PIH, anomalies, and preterm labour are high, and the incidences of perinatal mortality are increased.

Parity is the number of times a woman has given birth. Increasing gravidity and parity may denote an additional risk factor for GDM (Alejandro et al., 2020). Women in the Middle East and North Africa (MENA) region are said to be hampered by risk factors related to GDM such as being overweight and high parity (Al-Rifai et al., 2021). A study conducted established that Black, white and Southeast Asian women with parity of ≥3 live births increased the risk of GDM (Liu et al., 2020). Similarly, a study found that multiparity was associated with the risk of developing GDM (Wagan et al., 2021). In a cross-sectional study conducted on singleton pregnancies among Jordanian pregnant women, the risk of GDM increased with an increase in gravidity and parity (Basha et al., 2018). Furthermore, multiparous and multigravida women have been found to be

more likely to develop GDM than primigravida and nulliparous women (Basha et al., 2018). Likewise, a retrospective study conducted in Saudi Arabia which showed that parity was associated with GDM, and it was noted that GDM was significantly higher in multigravida (Abualhamael et al., 2019).

2.7. Maternal health outcomes associated with gestational diabetes mellitus.

GDM is detrimental to women's health as they are not only subjected to preeclampsia (a disorder characterised by hypertension and proteinuria), gestational hypertension, polyhydramnios, premature rupture of membrane and caesarean section but also are at a higher risk of developing Type 2 DM and cardiovascular diseases (Li et al., 2020). Equally, the other adverse health outcomes which pregnant women with GDM might suffer from include gestational hypertension, preeclampsia and cardiovascular diseases (Zhang et al., 2021). GDM has been found to damage endothelial cells which can cause vascular destruction associated with hypertension (Alejandro et al., 2020).

The risk of developing type 2 DM after delivery was found to be 17 times higher in the first five years after delivery (Vounzoulaki et al., 2020). Likewise, there is a 10% risk of developing DM after delivery in women with GDM (Chanda et al., 2020). This type 2 DM risk occurs in women who continue to experience prolonged insulin resistance even after delivery. Moreover, pregnant women with GDM are also at risk of induction of labour; premature rupture of membranes, antepartum haemorrhage, and postpartum haemorrhage (Muche et al., 2020). Women with GDM had higher risk of caesarean section delivery (Bidhendi Yarandi et al., 2021). Women who develop GDM in previous pregnancies can continue to experience a recurrence of GDM in subsequent pregnancies (Alejandro et al., 2020).

2.8. Infant health outcomes associated with gestational diabetes mellitus.

A study which was conducted in China found that the incidence of shoulder dystocia foetal distress, macrosomia, small for dates infants due to preterm birth was higher compared to those pregnant women who had normal blood glucose (Zhuang et al., 2020). Comparable findings were also found in a prospective cohort study conducted in Ethiopia by Muche et al (2020) whereby it was observed that neonates who were exposed to GDM are at increased risk of macrosomia, large for gestational age, preterm birth and poor Apgar score. Complications associated with GDM on the infant

can be short term and long term. Saravanan et al (2020) summarised the short-term complications as stillbirth, neonatal death, preterm birth, congenital malformation, cardiomyopathy, birth trauma, hypoglycaemia, hyperbilirubinemia and long term complications were summarised as childhood obesity, metabolic syndrome, high blood pressure, autism spectrum disorder, possible attention deficit disorder, earlier onset of cardiovascular diseases.

Likewise, a study which was a field-based cross-sectional in nature conducted in rural areas of India revealed that there is evidence which suggests that children who are born from mothers with GDM are nearly four to eight times more likely to develop diabetes compared with their siblings who were born from the same mother with no GDM (Chanda et al., 2020). Other neonatal complications include asphyxia, kernicterus, neonatal respiratory distress syndrome (NRDS) and birth trauma such as brachial plexus injury (Alejandro et al., 2020).

2.9. Public health intervention on Gestational diabetes mellitus prevention and control

The modifiable risk factors of GDM can be addressed through preventative interventions to prevent the occurrence of GDM and reduce the incidence of GDM. Through targeting the modifiable risk factors, the risk of GDM can be prevented in subsequent pregnancies (Egan et al., 2021). Intervention strategies aimed at reducing risk factors associated with GDM at high-risk pregnant women and improving maternal and infant health outcomes in pregnant women diagnosed GDM have been widely studied (Akalpler & Bagriacik, 2023; Mclntyre et al., 2020; Wang et al., 2022). Additionally, these approaches are not used in isolation but rather used in conjunction with each other.

2.9.1. Lifestyle & exercise intervention

Lifestyle interventions such as “diet and physical exercise are effective and first-line preventative strategies for GDM prevention and intervention” (Juan & Yang, 2020). A study conducted in China showed that dietary, western medication, and combined interventions were the most effective interventions (Xu et al.,2017). Lifestyle interventions which are inclusive of dietary modification, daily exercise and weight

management in women at high risk of GDM were associated with reduced risk of GDM and adverse maternal outcomes (Lin et al., 2020).

Exercise has been found to be a potential strategy to prevent GDM (Woodside & Bradford, 2021). Similar sentiments were found in a meta-analysis study which showed that exercise intervention during pregnancy can provide a protective effect for high-risk women to prevent GDM (Tsironikos et al., 2022). Women with GDM who engaged in exercise for ≥60 minutes per day had a lower percentage of abnormal plasma glucose (Wang et al., 2021). In addition, this indicates that exercise plays a role in glycaemic index control. It can be argued that exercise is a form of physical activity or that physical activity is part of exercise. ACOG committee Opinion (2020) explains that exercise is a physical activity which consists of planned ,structured, and repetitive body movements to improve physical fitness. Physical activity has been found to help prevent GDM as it improves glycaemic control, insulin resistance and pre-pregnancy weight gain (Galliano et al., 2019). According to (Sitzberger et al., 2020), physical activity before pregnancy can decrease the risk of developing GDM and cardiovascular risk factors during pregnancy. Hence, maintaining a healthy or lower weight prior to pregnancy is critical.

According to Mierzyński et al (2021), certain nutritional factors such as fibre, low consumption of processed meat and red meat, and mediterranean diet may have some benefits in preventing GDM. Mediterranean diet is a diet that is high in fruits and vegetables, legumes, bread, olive oil, fish, cereals, and limited animal products (Zhang et al., 2021). A prospective birth cohort study amongst Chinese pregnant women showed that a diet which has high vegetables, fruits and rice intake is associated with a lower risk of GDM (Juan & Yang, 2020). In agreement with findings of abovementioned study, a systematic and meta-analysis study revealed that women who followed a diet which was low in sugar and carbohydrates were less likely to be diagnosed with GDM (Sampathkumar et al., 2023).

2.9.2. Screening

Early identification of risk groups is a crucial step in preventing GDM and its subsequent consequences (Zaman et al., 2018). A study conducted amongst pregnant Chinese women in Beijing proposed that screening and early identification of this

possible risk factor in pregnant women would be a helpful and cost-effective way in which the planning of maternal health services could be undertaken, providing high-quality prenatal care to women who may develop GDM (Carroll et al., 2018).

It is imperative to detect diabetes in pregnancy early to start treatment promptly and optimise the outcome of pregnancy (Benham et al., 2023). In contrast, early identification of risk factors which precipitates the occurrence of GDM is important as this can assist in taking preventative measures to avoid developing GDM and adverse perinatal health outcomes (Juan & Yang, 2020). In South Africa, the common screening method is risk factor-based selective (Adam & Reeder, 2017). Few countries screen all pregnant women for GDM Universally whereas other countries test for GDM based on the risks identified (Alejandro et al., 2020).

There are two common screening and diagnostic practices which are commonly used, and these include one-step and two-step approaches. The one-step approach encompasses a 2-hour oral glucose tolerance test. With this form of approach, screening and diagnosis can be done in a single visit. However, women must fast before screening and be available for a 2-hour visit (Hillier et al., 2021). The two-step approach “includes an initial non-fasting 1-hour glucose challenge test, which is logistically simpler for women and can easily be performed as part of a scheduled prenatal visit; most women do not require further screening” (Hillier et al., 2021, p. 896). Moreover, 20% of women who underwent two-step approach screening are found to have elevated blood glucose levels and therefore they must return for a 3-hour fasting diagnostic oral glucose tolerance test (Hillier et al., 2021). According to Alejandro et al (2020), a further 100 Oral Glucose Challenge Test (OGCT) is administered a few days later to confirm the results if the blood glucose level is >7mmo/dl. One step approach is the one being used currently in the South African context.

The two approaches have their strengths and weaknesses. The strengths of the one-step approach are that this approach is easy to follow; patients find the approach easy to adhere to; mild GDM cases are detected which then lessens the complications (Alejandro et al., 2020). Similarly, a one-step approach was found to identify women with milder hyperglycaemia as having GDM and even though a linear relationship

between maternal hyperglycaemia and maternal and perinatal outcomes, the effects of identifying and treating milder cases of GDM on these outcomes are unknown (Hillier et al., 2021).in addition, there is no need for The strengths of using a two-step approach include fewer false positive results and avoiding Oral Glucose Tolerance Test (OGTT) in 75% of women (Alejandro et al., 2020). The weaknesses of the two-step approach are, patients are less compliant; require patients to visit the health facility twice; cause a delay in starting treatment for those who have already tested positive and lastly cases are more likely to be missed as confirmatory diagnostic test still needs to be done (Alejandro et al., 2020).

2.9.3. Policies and guidelines

There are policies and guidelines as well as maternal health programmes which have been directed to reduce maternal and child mortality rates. The policies and guidelines used in South Africa include the National Health Care Act of 2003 (National Department of Health, 2003); a White paper for the transformation of the health system which emphasises access to maternal, child and women's health services (National Department of Health, 1997) and National guidelines for maternity care in South Africa (National Department of Health, 2016). The maternal health programmes which have been tailored towards improving women's health care are the Campaign on Accelerated Reduction of Maternal Mortality; Newborn and child mortality (CARMMA) (African Union, 2020) and the Department of Health Strategic Plan for maternal, newborn, child and women's health (MNCWH) and Nutrition 2012-2016 (National Department of Health, 2011).

South Africa is a country with limited resources and thus women are selectively screened for GDM based on the presence of risk factors (Muhwava et al., 2018). The national and provincial guidelines such as the National guidelines for maternity care in South Africa; National Institute for Health and Care Excellence (NICE) guideline; WHO criteria and the provincial Western Cape 'Diabetes in Pregnancy' guidelines have been adopted to screen, diagnose and manage GDM (Adam & Rheeder, 2017). In addition, the National Department of Health has adopted a selective risk-factor screening based on the presence of risk factors which include obesity (BMI>30kg/m^2), repeated glycosuria, previous GDM, age >40 years, family history of diabetes (first-degree

relatives) (Muhwava et al., 2018) and currently, National guidelines for maternity care in South Africa is widely used across South Africa (Ntshauba et al., 2022).

Table 2.1. National and provincial guidelines used to screen and diagnose GDM.

GUIDELINES	SCREENING TEST	DIAGNOSTIC CRITERIA – BLOOD GLUCOSE LEVEL THRESHOLD
	NATIONAL GUIDELINES	
1.National guidelines for maternity care in South Africa [1]	-All pregnant with risk factors for diabetes in pregnancy should be screened at 1st antenatal visit and again at 28 weeks if initial screen was negative. -oral glucose 75g, glucose reading of ≥7.8 mmol/L is a positive test. Patient should come back fasted on another day. -Alternatively, the patient can bring their own breakfast to the clinic instead of glucose load.	-Fasting blood glucose level of ≥5.6 mmol/L or a two-hour value of ≥7.8 mmol/L indicates gestational diabetes.
2.National Institute for Health and Care Excellence (NICE) guideline [2,3]	-Assess GDM using risk factors at booking appointment and test women with these risk factors: 1.BMI above 30kg/m². 2.Previous macrosomic baby weighing 4.5kg or more. 3.Previous gestational diabetes. 4.Family history of diabetes (first-degree relative with diabetes). 5.an ethnicity with a high prevalence of diabetes. -Testing: -75-g 2-hour oral glucose tolerance test (OGTT) as soon as possible after booking and further 75-g 2-hour OGTT at 24-28 weeks if results of first OGTT are normal.	-1-step 75 g 2 h OGTT FPG _5.6 mmol/L 2 h plasma glucose level of _7.8 mmol/L or more.
3.WHO 2013 criteria [3, *]	-75g 2h OGTT	1-step 75 g 2 h OGTT FPG _5.1 mmol/L 1 h _10.0 mmol/L 2 h _8.6 mmol/L *2-hour post 75-g oral glucose load ≥8.5-11mmol/L or (153–199 mg/dL) following a 75 g oral glucose dose Fasting plasma glucose: 5.1–6.9 mmol/L or (92–125) mg/dL

		One-hour plasma glucose: 10.0 mmol/L or 180 mg/dL following a 75 g oral glucose load.
	PROVINCIAL GUIDELINES	
4.Provincial Western Cape 'Diabetes in Pregnancy' guideline [4]	- Urine test – if 1+ glucose or more on diagnostic strips; do a random blood glucose test. - Following patients must be screened with glucose profile (with 75g Oral Glucose Tolerance Test) before 28 weeks' even if urinary diagnostic strips remain negative for glucose: 1.Previous GDM (do OGTT when booking) 2.Unexplained intra-uterine death in previous pregnancy. 3.Previous macrosomic baby >4,5kg. 4.Body Mass Index at booking>40kg/m². 5.Maternal age >40 years. 6.Family history of diabetes (first-degree relative with diabetes). 7.Family origin with a high prevalence of diabetes (Asiatic) 8.Acanthosis nigricans. 9.polycystic ovarian syndrome.	*<8 mmol/L is normal: Repeat the test every time there is 1+ or more glucose on the strips. *≥8 but <11 mmol/L, the patient must return to the clinic the next morning for fasting blood glucose test. *≥11 mmol/L refer to nearest specialist high-risk clinic (within 1 day). **Interpretation of the 75 g OGTT (WHO definition):** *GDM: Fasting value >5,5 or 2-hour value ≥7,8 mmol/L -If fasting still ≥6 mmol/L and/or 2-hour value ≥8 mmol/L, refer patient to high risk. - ≥8 mmol/L refer to nearest specialist/high risk clinic within 1 day. In rural area, start treatment and make appointment at nearest outreach clinic.

1. National Department of Health. (2016). *Guidelines for Maternity Care in South Africa: A manual for clinics, community health centres and district hospitals*.

2. National Institute for Health and Care Excellence. 2015. NICE guideline — Diabetes in Pregnancy: management from preconception to the postnatal period. United Kingdom

2;3. Dias, S., Pheiffer, C., Rheeder, P., & Adam, S. (2019). Screening and diagnosis of gestational diabetes mellitus in South Africa: What we know so far. *South African Medical Journal,* 109(7),457-462

3* Olumodeji, A.M., Okere, R.A., Adebara, I.O., Ajani, G.O., Adewara, O.E., Ghazali, S.M., & Olumodeji, U.O. (2020). Implementing the 2013 WHO diagnostic criteria for gestational diabetes mellitus in a Rural Nigerian Population. *Pan African Medical Journal,* 36(208),1-8.

3. Mazumder, T., Akter, E., Rahman, S.M., Islam, M.T., & Talukder, M.R. (2022). Prevalence and Risk Factors of Gestational Diabetes Mellitus in Bangladesh: Findings from Demographic Health Survey 2017–2018. *International Journal of Environmental Research and Public Health,* 19 (2583); 1-10.

4. Provincial Government of the Western Cape. Diabetes in Pregnancy: Guideline for the management of diabetes and its complications from pre-conception to the postnatal period. Government printers: Pretoria.

2.10. Knowledge of pregnant women on gestational diabetes mellitus and its management

Knowledge is an essential component of health literacy (Liu et al., 2020). Health literacy refers to a person's competence in assessing , understanding, evaluating, and applying health information in order to make sound decisions (Stormacq et al., 2020). It has been shown that inadequate knowledge about the disease leads to poor health outcomes (Bhavadharini et al., 2017). Education was found to have a strong impact on health literacy (Vamos et al., 2020). Pregnant women with primary education had the least knowledge about GDM, compared to pregnant women who attended secondary school and above, as these ones were four times more likely to have satisfactory knowledge about GDM (Dissassa et al., 2023). Socioeconomic status does seem to influence an increased prevalence of GDM. In a suburban area of Beijing, it was found that the women lacked knowledge on how to maintain a well-balanced diet and healthy lifestyle (Juan & Yang, 2020). This might be attributed to the diet and lifestyle patterns of individuals living in suburban areas.

A study conducted in Saudi Arabia found that pregnant women had no GDM-related knowledge and were not aware of such knowledge although a high prevalence of pregnancy and GDM was reported in the area (Alharthi et al., 2018). Significant number of pregnant women were aware of GDM, its risk factors, complications, and how to prevent or manage it (Byakwaga et al., 2021). In addition, Women had poor awareness and knowledge of GDM because of poor health education on GDM provided during prenatal care (Byakwaga et al., 2021). Starting diet control promptly can reduce adverse outcomes of pregnancy. The participants in the study which was conducted in the rural community in Bangladesh perceived that physical exercise was not possible for a pregnant woman as they consider GDM to be more problematic (Biswas et al., 2020).

2.11. Perceptions of patients on management of gestational diabetes by health care providers

In a qualitative study conducted in South India by Sahu et al (2021), it was found that household responsibilities which made women to neglect their own wellbeing, underestimation of GDM, challenges with monitoring sugar levels at home and

skipping of GDM were barriers which have been identified to influence self-management of GDM by pregnant women diagnosed with GDM. According to Healthcare practitioners who participated in an interview in a qualitative study expressed that there was a low patient engagement in health care due to other women citing that they didn't think the treatment they were provided with was strictly necessary and not honouring their follow-up appointments because of their busy lives (Yee et al., 2020).

Healthcare practitioners expressed that blood glucose monitoring, medication administration, time and pain were barriers to adherence to GDM treatment (Lucas et al., 2022). Health education on GDM proved to be overwhelming to other pregnant women diagnosed with GDM. A qualitative study revealed that other pregnant women were educationally overwhelmed which was attributed to women's low health literacy and they struggled to understand their diagnosis and treatment plan (Yee et al., 2020). Other women found to be overwhelmed with their GDM diagnosis which had an impact on self-management (McCloskey et al., 2019).

2.12. Evidence-based management model of GDM

A Women in India with Gestational Diabetes Mellitus Strategy (WINGS 4) model was developed in India to respond to gaps which were identified in GDM care prevalent in low-resource settings and its first line of treatment is Medical Nutrition Therapy (MNT) (Kayal et al., 2016). According to Wilkinson et al (2019), MNT is a prime intervention for managing blood glucose levels in patients with GDM and can improve blood glucose levels significantly thus reducing the need for insulin. The model was developed using established clinical guidelines and piloted to ensure that it is culturally appropriate and feasible (Kayal et al., 2016).

The WINGS 4 model focuses on the diagnosis, management and follow-up of women with GDM throughout their pregnancy (Kayal et al., 2016). Below is a graphical representation of WINGS 4 model:

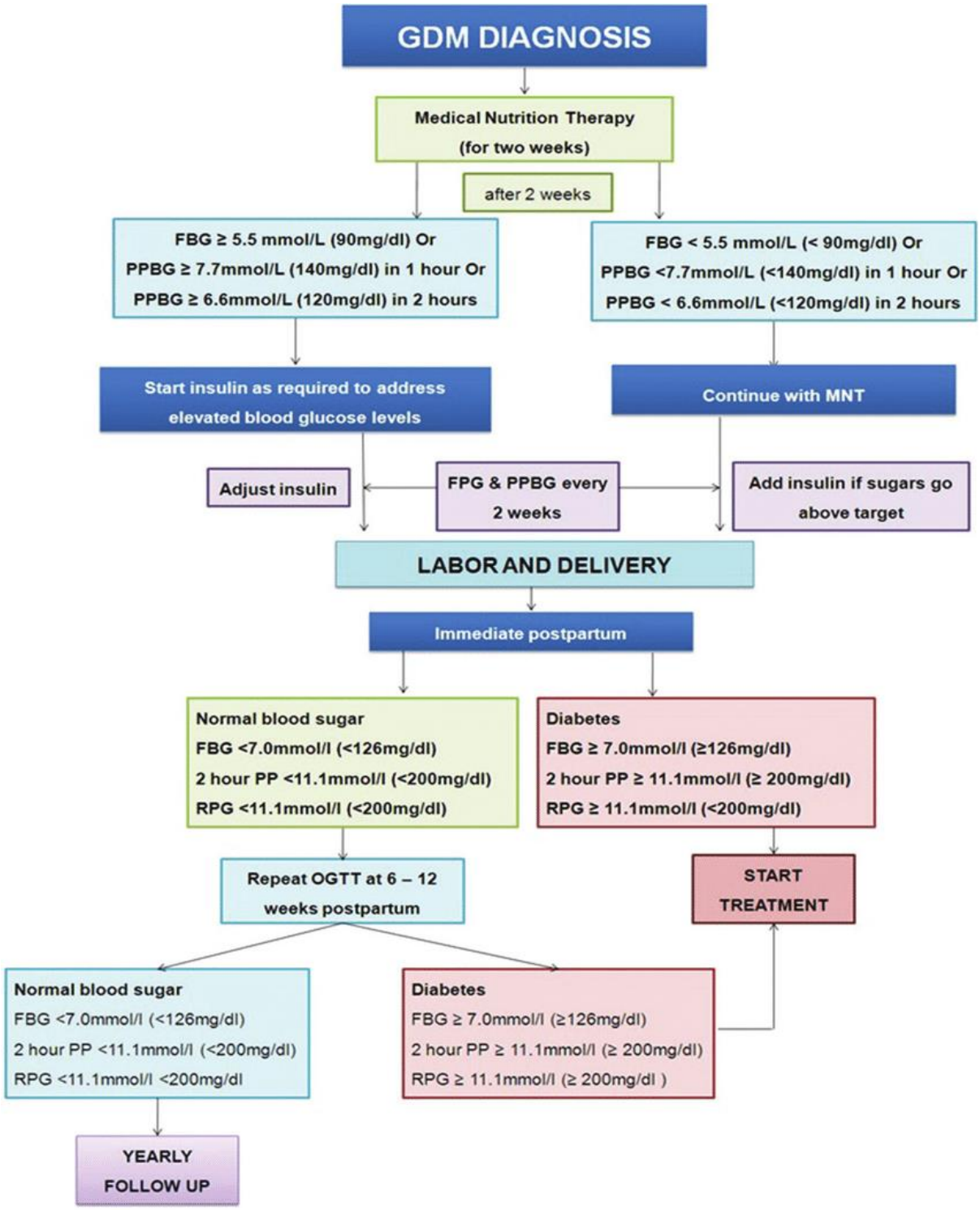


Figure 2.2. Women in India with Gestational Diabetes Mellitus Strategy (WINGS) management protocol for gestational diabetes mellitus (Kayal et al., 2016).

The graphical representation of the WINGS model of treatment of GDM shows what necessary steps are meant to be taken after a woman has been diagnosed with GDM. The model suggests that pregnant women with GDM must be started on MNT for 2 weeks to lower their blood glucose level (Kayal et al., 2016).

Figure 2.3: Framework for the development of WINGS GDM model of care (Kayal et al., 2016).

A peer literature review of studies conducted in SSA argues that the disease-system diagonal approach can be used to improve access, quality and safety of diabetes care programs while supporting other chronic illnesses (Mercer et al., 2019). Moreover, they proposed using six World Health Organisation (WHO) health system building blocks as a framework to design a diagonal approach which will focus on strengthening the health system and integration to implement and scale quality diabetes care (Mercer et al., 2019). In addition, the integration element is integrating the vertical and horizontal approaches to health.

The vertical approach is defined as disease specific (Univ.Heidelberg Organisation, 2023) and this approach was found to be used in LMIC settings as it is cost-effective to provide immediate response and management to the disease (Mercer et al., 2019). Regarding horizontal approach, it “promotes health services that strengthen infrastructure and functions of the entire health system” (Mercer et al., 2019).

2.12. Health system barriers

South Africa currently faces multiple burdens of disease, with HIV/AIDS epidemic overlapping with a high burden of tuberculosis, high maternal and child mortality, high

levels of violence and injuries and a growing burden of non-communicable diseases (diabetes, cardiovascular diseases, chronic respiratory conditions and cancer) (Maphumulo & Bhengu, 2019). A critical review study revealed numerous quality improvement programmes which had been initiated, adapted, modified, and tested but failed to produce the required level of quality service delivery (Maphumulo & Bhengu, 2019). Malakaone et al (2020) identified in their study that fragmentation of services, staff shortages and financial problems were the common health system challenges experienced in Free State, SA. A systematic review which examined barriers to screening, diagnosis and management of GDM revealed that shortage of health providers, inadequate knowledge and skills, and limited opportunities for in-service training were the health system-related barriers affecting GDM management (Hinneh et al., 2022).

In addition, this finding corresponds to findings of a study conducted by Maphumulo and Bhengu (2019) who discovered that a shortage of human resources, a shortage of resources in medicine and equipment, and prolonged waiting times, are health systems barriers affecting the provision of health services. The public health facilities problems in South Africa are no different from those of other countries. In India, challenges such as difficult terrain, poor health infrastructure and shortage of medical doctors at peripheral public health facilities resulted in inadequate implementation of various government health programmes (Chanda et al., 2020).

2.13. Human resources for Health

It is common for most people in our country to experience prolonged waiting times to be seen by a health practitioner in our clinics and hospitals. This can be attributed to the shortage of staff. Health workers are people who significantly contribute to establishing, restoring and maintaining our health. A scoping review of 332 peer-reviewed articles which looked at human resource for health-related challenges identified the following challenges: insufficient and inequitable distribution of health workers and heavy workload, poor retention and absenteeism, poor work environment , limited and poor supervision, low morale, motivation, attitude and job satisfaction, structural and contextual barriers, etc (Bolan et al., 2021). Health workers are all people who are primarily engaged in actions with the primary intent of enhancing health (Mohanty et al., 2019).

Studies have found that Africa has less than one health worker per 1000 population compared to 10 per 1000 in Europe (Maphumulo & Bhengu, 2019). In a study conducted by Mothiba et al (2019), midwives in Limpopo province expressed that they experienced overcrowding of women in maternity units which led to provision of substandard care. Provision of in-service training for health practitioners was found to be a challenge. Study conducted in rural Bangladesh among healthcare providers and pregnant women. A qualitative study was conducted at Regional Hospitals in Limpopo Province to explore the in-service training needs of nurses implementing the nursing process. The study found that there was no in-service training for professional nurses on the nursing process due to lack of support from management (Mutshatshi et al., 2022). In addition, this can impact on knowledge and skills of the health practitioners. According to Biswas et al (2020), health managers were found to lack in-depth knowledge of GDM and that there was no structured protocol or guideline in a qualitative.

2.14. Conclusion

This chapter discussed the overview of GDM, its prevalence, modifiable and non-modifiable risk factors, maternal and infant health outcomes, public health intervention and the Evidence-based management model of GDM from the reviewed literature. The following chapter precisely focuses on the theoretical framework underpinning this study.

CHAPTER THREE: THEORETICAL FRAMEWORK

3.1. Introduction

The previous chapter was a literature review with a special focus on risk factors, health outcomes on mother and infant, and public health intervention as well as evidence-based management practices, with emphasis on gestational diabetes mellitus as obtained from multiple studies worldwide and locally. The current chapter focused on the theoretical framework which supported this study. Theoretical framework has been described as a foundational review of theories that serves as a roadmap for developing arguments as the researcher engages in literature review and during the research process (George, 2023). It should be noted that the theoretical framework supports the rationale of the study, the problem statement, research questions as well as the significance of the study. As such, Crawford (2020) emphasised that theoretical framework is an element of conceptual framework that positions the relationships explored in the study within the context of developing or testing formal theories.

This current study used existing theory to provide foundation for the study and assess the existing concepts with the aim of developing a model. It is important to note that the use of theoretical framework provides the researcher with the guide for what to look for in a data collected, make connections between elements observed in data, serve as lens through which the researcher focus on data and observe meanings within data and increase transferability of findings or external validity and generalisability of results (Crawford, 2020). In context of this study, a priori framework for synthesis framework for model of care for non-communicable diseases provided a philosophical grounding for the phenomena under study. Ability, motivation and opportunity (AMO) theory and Multidisciplinary team (MDT) Model were used to address the limitations of the framework underpinning the study.

3.2. Theoretical framework

3.2.1. A priori framework for synthesising a model of care for non-communicable diseases

Wagner et al (1996) first developed the model of care for chronic care in response to the re-organising of primary care and the implementation of critical elements that allowed the model to proactively respond to patients with chronic conditions. In 1990s,

the World Health Organisation endorsed TB case management strategy known as Directly Observed Therapy, Short Course (DOTS) (Zimmer et al., 2021) and used it for scaling up HIV care, later the strategy was conceptualised for the management of non-communicable diseases (Kane et al., 2017). Further, this was later followed by development of a priori framework for synthesising a model of care for non-communicable diseases which was developed by the abovementioned conceptual models of care for NCDs in low-and middle-income countries for primary care interventions specifically on cardiovascular diseases (CVD), DM, and respiratory diseases such as chronic obstructive pulmonary diseases (COPD) and asthma (Kane et al., 2017).

The priori framework for a model of care is centred around three concepts: screening, prevention and control. The goal of these concepts is to improve the provision of quality health services which result in improving patient outcomes. The previous models of care were designed to be used on an individual level in primary health care settings. Furthermore, the priori framework for synthesising a model of care was designed as a public health approach focusing on organised monitoring and evaluating patient outcomes, standardised quality care and systematic follow-up (Kane et al., 2017). That is, the framework has been designed to inform population-based interventions for NCDs.

Moreover, the model had limitations, it failed to capture the themes: “staff competence”, “dedicated NCD staff”, “review criteria”, and “communication with MD/specialist”, however they were revised and added to the priori model to create a synthesised evidence-based NCD model of care through utilising inductive and deductive approaches (Kane et al., 2017). The theme “” training staff” was slightly changed to “train and retrain staff” and theme adherence was revised to “adherence to medication” and “adherence to follow-up appointments” for them to be consistent with the primary data of studies reviewed (Kane et al., 2017). A model of care “overarching design for the provision of a particular type of health care service” designed for displaced populations during humanitarian care was designed based on previous frameworks and existing models of care including the priori synthesis model of care (Schmid et al., 2022).

3.2.2. A priori synthesis model of care concepts

As previously mentioned, the priori framework has three priori concepts which are screening, prevention and control. During the conceptualisation of this model, it was found that most of the interventions from the reviewed primary studies were on the concept of control (Kane et al., 2017). Figure 3.1 below represents the priori synthesis of model of care concepts:

A priori concepts	New concepts	A priori themes	Revised and new themes
Screening		Case finding	
Prevention		Modify risk factors	
Control	Quality improvement		Review criteria
			Staff competence
	Health systems	Essential medicines	
		Essential diagnostics	
		Systematic monitoring and evaluation	
		Decentralized care	
	Decision support	Standardized treatment	Adherence to medications
		Standardized diagnosis	Adherence to follow-up
		Standardized referral pathway	Communication with MD/specialist
		Standardized follow-up appointments	
	Human Resources	Task-shifting/Multidisciplinary clinic	Train and retrain staff
			Dedicated NCD staff

Figure 3.1: A priori synthesis model of care for NCDs. Source: Kane, J., Landes, M., Carroll, C., Noel, A., and Sodhi, S. (2017). A systematic review of primary care models for non-communicable disease interventions in Sub-Saharan Africa. *BMC Family Practice* ,*18*,46.

3.2.2.1. Screening

In this concept, passive case finding was advocated for as it was a cost-effective approach in SSA (Kane et al., 2017). Active case finding was found to be expensive, labour intensive, and required more resources which makes this approach not ideal in low-and middle-income settings. Furthermore, this approach was found to be ideal in patients who come to health facilities presenting with symptoms already.

3.2.2.2. Prevention

This concept highlights strategies on reducing modifiable risk factors of NCDs and this included counselling and education. Education strategy was found to be effective in one of the studies reviewed as it was done frequently (Kane et al., 2017). In the context of this study, the prevention concept affects the infant and maternal health outcomes, while their quality of life also create an economic burden of NCDs in the country.

3.2.2.3. Control

Control concept aims at quality NCDs interventions which improves patients' outcomes. This concept was categorised into quality improvement, health systems, decision support and human resources (Kane et al., 2017). The main goal of this concept was provision of quality of care which must meet minimal standards of quality care.

3.3. Triangulation of models

To enhance the priori synthesis an eclectic model that combines AMO theory was used including the MDT model.

3.3.1. Ability, motivation and opportunity (AMO) theory

The components of this theory are work-system elements which form employee characteristics and result in an organisation achieving its mandate (Bos-Nehles et al., 2013). The ability component emphasises the practices and policies that human resource department (HR) undertake to ensure that employees gain skills, knowledge and become competent in their work area as well as perform their work duties with minimal supervision (Yahya et al., 2017). Motivation component outlines strategies which HR implements to motivate the health workers, and the last component, opportunity which focuses on engaging employees through providing opportunities (Yahya et al., 2017). In addition, this relates to skills training opportunities. This framework was used to understand some of the data findings from qualitative phase one which were from nurses and doctors.

3.3.2. Multidisciplinary team (MDT) Model

To address the "communication with Medical doctor (MD)/Specialist" concern, the researcher used multidisciplinary team care, an approach through which appropriate and comprehensive treatment is provided to improve quality of life (Taberna et al., 2020). MDT model refers to "developing a standardised, individualised, continuous and the most reasonable treatment plan for a particular disease, which is through the regular, timely, and address meetings and relying on a multidisciplinary expert team and multidisciplinary collaborative discussions" (Zhong et al., 2020). It was crucial for the researcher to adopt this model to understand collaboration among health professionals when managing GDM.

3.4. Application of the framework in the study

3.4.1. Screening

This concept was vital in the study as it assisted in determining the number of GDM cases among pregnant women attending Antenatal clinic (ANC) visits in the Mopani district health facilities as well as case finding approach used. Data was collected in the form of questionnaires and the reviewing of medical records from pregnant women and unstructured interviews with doctors, nurses and pregnant women diagnosed with GDM. Furthermore, data related to associated risk factors of GDM as discussed in the literature review chapter was explored, along with the association of these risk factors with socio-demographic characteristics during data analysis.

3.4.2. Prevention

This concept relates to qualitative objectives of the study, which are to explore the perceptions of patients on management of gestational diabetes by health care providers; and examine the perception of pregnant women diagnosed with gestational diabetes mellitus on management of gestational diabetes mellitus. This provided an understanding of the management of GDM in the Mopani district as well as health system barriers affecting the management.

3.4.3. Control

The control concept was critical in this study as it allowed the researcher to understand provision of obstetric health care services, collaboration between various health providers/ stakeholders, detection, and management of GDM in the district. The categories of control concept were discussed below:

3.4.3.1. Quality improvement

Competency amongst health care workers needs to be prioritised and evaluation of competency is critical to identify gaps in knowledge. According to Soares et al (2019), competency in health care and professionals is the foundation of high-quality care and services. Furthermore, health professionals need competencies, skills, knowledge, attitude and self-efficacy to execute their work (Guerrero et al., 2024). It is important to note that health professionals need to be competent to meet the minimal standards of quality health care. Thus, during qualitative phase one of this study, competency and experience of nurses and doctors, as well as review criteria to evaluate

interventions by nurses, doctors, hospital/clinic managers and district managers were explored and discussed in chapter five, results section.

3.4.3.2. Health systems

Essential medication, diagnostics technologies, systematic monitoring and evaluation and decentralised care is needed for an efficient and effective health system. Medications are important for treatment of diseases and there should be availability of them. There is a need to establish the availability of medications in health facilities as they are critical in the management of diseases. Moreover, the researcher had to establish which diagnostic technologies are utilised, competency in operating the technologies to diagnose GDM. In this study, the health system factors were explored in qualitative phase one and two and outlined in detail in chapter five.

3.4.3.3. Decision support

Referring of patients to an appropriate level of care is important for provision of quality clinical care. Thus, communication between primary health care clinics, district, regional and tertiary hospitals to enhance patient management need to be ensured. A clear understanding on how patients are referred from one level of health facility, what procedures are followed, and follow-ups is needed. There is a need to have a standardised follow-up with patients and compliance of follow-ups need to be ensured.

In this study, decision support was addressed during qualitative phase one wherein the researcher sought to understand management of GDM, that is health practitioners involved in the management. Also, qualitative phase two of this study also addressed decision support. Collaboration of health professionals in the management of GDM might positively affect the infant and maternal outcomes in pregnant women diagnosed with GDM. Standardisation of diagnosis and treatment was found to help ensure quality of standards for clinical care (Kane et al., 2017). Data relating to diagnostic criteria and tools were assessed and discussed in discussion chapter seven.

3.4.3.4. Human resources

Human resources are the foundation of a functioning health care system. A health care system consists of groups, institutions, and resources that provide health care services to meet the needs of the target population. A well-performing health workforce

has adequate numbers of trained staff who are distributed fairly across sections/departments in a health facility. Given the shortage of health workforces such as nurses, doctors, etc. task-shifting was thought to be necessary to NCD care (Kane et al., 2017). The number of nurses and doctors working in the maternity unit, , and the challenges of managing GDM were assessed and interpreted in chapter five.

3.5. Conclusion

The current chapter has described the theoretical framework of the study. The researcher used the priori synthesis framework for model of care to explain screening, prevention and control of GDM in the Mopani district. This model had its own limitations which were addressed by triangulation of models such as AMO theory and MDT model. The chosen model was used to synthesize qualitative and quantitative data in chapter five of the study. The next chapter addresses the methodology section of the study.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1. Introduction

Research methodology is described as an overall approach to research that is interrelated with the paradigm, theoretical framework, literature and ethical principles (Nguyen, 2019). The same sentiments are shared by Okesina (2020) who explains research methodology as a wide term which encompasses research philosophical approach, design, method and procedures used to investigate data gathering, participants' selection, instruments use, data analysis as well as assumptions and limitations for the study – how they are mitigated. Research methodology is one of the components of the research paradigm which answers the question of how the researcher went about finding the answer to the research question.

According to Kamal (2019), the fundamental question related to methodology is How can the researcher go about trying to know what can be known about reality?. It is the process of acquiring knowledge about the phenomena under study. This chapter outlines the research method, research paradigm, research design, sampling, population, sample size, data collection, measuring instruments, inclusion and exclusion criteria, data analysis, validity and reliability, trustworthiness, and ethical considerations in this study. A research paradigm which informed the research method and research design was chosen to meet the objectives of this study.

4.2. Research paradigm.

Research paradigm refers to researchers' underlying philosophical views regarding the truth and reality in general as well as the research issue in particular (Dawadi et al., 2021). Ugwu et al (2021) went further to describe the research paradigm as a researcher's way of thinking, worldview or philosophical perspective that influences what should be studied; how it should be studied; and how the results of the study should be interpreted. Likewise, the intention and motivation for research are made known. A research paradigm was adopted in this study to conceptualise the researcher's beliefs about the nature of knowledge and select methods which are appropriate to address research questions (Allemang et al., 2021). The research paradigm chosen for this study as a worldview was pragmatism, which is defined as a paradigm which accommodates mixed methods and is therefore applicable to both quantitative and qualitative methods (Makombe, 2017).

The rationale for choosing the pragmatism paradigm in this study was that it allowed for quantitative and qualitative data to be collected and integrated into a single study. The paradigm is grounded on using the best methods to explore real-world problems, use various sources of data and knowledge to answer research questions, and recognise the importance of the physical; psychological; and social worlds i.e., culture, language, institutions and subjective thoughts (Allemang et al., 2021). Not only does pragmatism use different sources of data to explore real-world problems, but also provides an action-orientated framework for research where the researcher seeks to address practical issues emanating from communities by means of relevant methods for answering the research question (Hothersall, 2019).

Moreover, this study has complied with these characteristics of pragmatism because knowledge is both constructed and based on the reality of the world we live in and experience. That is, knowledge about GDM in the Mopani District can be known through understanding the epidemiological transitions in local communities and healthcare professionals (nurses and doctors) and participants' perspectives as well as knowledge of this health condition. Table 4.1 below illustrates the philosophical assumptions that informed the methodological approach, design and methods of data collection and analysis of this study:

Table 4.1: Philosophical assumptions and methodological approach

Ontology	Epistemology	Paradigm	Approach	Design	Methods
One reality and multiple perceptions	Double-faced knowledge	Pragmatism	Mixed method	Exploratory sequential	Semi-structured interviews, Questionnaires, thematic analysis & SPSS.

Adapted from: Ugwu, C. I., Ekere, J. N., & Onoh, C. (2021). Research paradigms and methodological choices in the research process. *Journal of Applied Information Science and Technology*, *14*(2), 116-124.

4.2.1. Ontological assumptions

Ontology refers to the study of the nature of existence or reality and provides an understanding of the things that constitute reality, while reality is what there is to study (Ugwu et al., 2021). Maarouf (2019) argues that only one reality exists in a particular context and changing a context changes reality and the "existence of multiple contexts means the existence of multiple realities". Realities are personal, social, economic and cultural factors that exist out there that can explain the epidemiological transitions occurring in developing countries which is resulting in an increased burden of non-communicable diseases (CVD, DM, etc). Moreover, realities are perceived differently by humans or social actors (Maarouf, 2019).

In this study, the researcher adopted one reality view and used a qualitative approach to examine participants' perceptions about GDM in the Mopani district as the researcher believes that different people can have different views about that in the real world. This allowed for a deep understanding of the context generating the reality and assisted the researcher in developing variables to be measured in the quantitative phase. Qualitative results were confirmed with quantitative research because it provided a simplified view of reality.

4.2.2. Epistemological assumptions

Epistemology refers to how we know the truth or reality, or what counts as knowledge (Nguyen, 2019). A similar view was expressed by Kamal (2019) who explained Epistemology as a process by which the investigator comes to know the truth and reality, and the relationship between the inquirer and the inquired. Maarouf (2019) assert that epistemology point of view directly flows from ontological point of view, hence epistemological position is conceptualised as double-faced knowledge which refers "to any type of knowledge that can be seen as observable or unobservable based on the ontological position of the researcher not on the nature of knowledge itself".

Similar statement was made by Kamal (2019) who stated that epistemological assumptions are informed by ontological assumptions. There are different ways of knowing about GDM in the Mopani district. In this study, the researcher used a qualitative research method to gain unobservable knowledge and a quantitative

research method to gain observable knowledge. Unstructured interviews were used to address unobservable variables such as participants' perceptions and perspective; while a questionnaire was used to address observable knowledge such as prevalence, risk factors, knowledge and this source of knowledge limited participants' responses to a certain number of structured answers to be able to measure it. Knowledge was gained from district health managers, doctors, nurses as well as pregnant women diagnosed with GDM considering their knowledge about GDM, experience and actions. Through administering questionnaires to pregnant women, interviewing health practitioners, and women diagnosed with GDM, the researcher was able to acquire knowledge about GDM in the Mopani district. Validation of this knowledge came through interaction with the study participants and experts.

4.2.3. Research methodological approach.

4.2.3.1. Research approach.

Research approach is a plan and procedure for research that outlines the steps and detailed methods of data collection, analysis, and interpretation (Creswell & Creswell, , 2022). Our study adopted a mixed method research (MMR) approach which is defined as an approach whereby both qualitative and quantitative approaches are combined based on the purpose of the study and nature of research question (Taherdoost, 2022). In this study, MMR was used to examine different aspects of the research problem and gain complete understanding.

4.2.3.2. Research design.

The research design refers to a framework aligning the research problem with research questions (Zhang & Ramos, 2023). Exploratory sequential design is a type of study design wherein the quantitative phase of data collection and analysis follows the qualitative phase of data collection and analysis (Shiyanbola et al.,2021). Exploratory sequential design was used to assist the researcher in first gaining an insight into the research problem through using a qualitative approach and the themes which emerged from qualitative data were used to inform the development of a quantitative data collection instrument to further explore the research problem.

4.2.3.3. Method of data collection and analysis

Qualitative and quantitative methodology were used in a sequential manner in this study. The data collection methods used in this study were unstructured interviews and a questionnaire. Furthermore, data generated was analysed using thematic analysis and SPSS version no 29.0.0.0 (IBM SPSS Statistics, 2022).

4.3. Research method.

Research Methods refers to how data is collected, analysed and generalisation or representations drawn from the data (Okesina, 2020). The conventional research method used in this study was mixed methods. A mixed-method approach to research is an approach wherein the researcher integrates methods of collecting or analysing data from the quantitative and qualitative approaches/methods in a single study. The researcher chooses the quantitative approach to respond to questions requiring evaluation, explanation and numerical data while the qualitative approach chooses questions requiring exploration and textual data (Ugwu et al., 2021).

Additionally, MMR approach provides rich insights and a comprehensive understanding of the research phenomena, data sets from quantitative and qualitative produces greater confidence in findings and broader application in the conclusion, providing additional insight into various components of the phenomena which might help in generating fundamental theories, and triangulate data which is essential for validating results and inferences than what a single research approach can do (Dawadi et al., 2021). In addition, Maarouf (2019) outlines that triangulation enriches and strengthens research findings by using different methods of data collection and analysis to study the same phenomena. The MMR approach also provides opportunities to study contextual factors such as culture, beliefs, and perceptions qualitatively and develop quantitative measures (Shiyanbola et al., 2021). The disadvantage of using a mixed method approach is that it requires time, effort, funding and researcher skills and experience (Maarouf, 2019).

4.4. Research design.

The research design has been described as a way of translating a research problem into data for analysis in order to provide relevant answers to a research question (Asenhabi, 2019). As previously explained, an exploratory sequential MMR was

chosen and this design enabled the researcher to explore the GDM concept, before validating it which allows for greater versatility in ascertaining original ideas offered by the qualitative approach (Gogo & Musonda, 2022).

The exploratory sequential design was chosen as it allowed the researcher to gain an in-depth understanding of GDM in the Mopani district and understand the views of the participants. After the data has been analysed, the information was used to build into the second phase – quantitative wherein an appropriate instrument which best fits the sample under study and has variables that need to go into the second phase was constructed. Furthermore, data from both phases were integrated to guide the content of an evidence-based management model which was relevant to the context under study. The design allows for new ideas to be discovered and understands why people act the way they do and most importantly enables the researcher to get a complete representation of the research phenomena. The design has been described as a method that offers more robust validity as it can resolve unresolved issues and develop as well as extend ideas based on such findings (Heesen et al., 2019).

Earlier on it was mentioned that with exploratory sequential design, qualitative approach precedes quantitative approach. Qualitative approach is an approach which uses an inductive approach to building new knowledge aimed at generating meaning; while quantitative approach, it values scope, statistical description, numerical values and generalizability of study outcomes (Leavy,2022).

4.5. Research setting.

A research setting is a place where research data is to be collected from (Koswara, 2022). The study was conducted in the Mopani district of the Limpopo province in South Africa. The Mopani District municipality is one of the 5 districts in Limpopo and is situated in the North-eastern part of the Limpopo Province, 70 km and 50 km from Polokwane (the main City of the Limpopo Province), along provincial roads R81 and R71, respectively.

The district spans a total area of 2 001 100 ha (20 011 km^2), inclusive of a portion of Kruger National Park from Olifants to Tshingwedzi camps or Lepelle to Tshingwedzi rivers. There are 16 urban areas (towns and townships), 354 villages (rural

settlements) and a total of 125 Wards. The population of the Mopani District Municipality has Vatsonga and Northern Sotho (Ba-Pedi) speaking people as dominant ethnic groups (StatsSA, 2011).

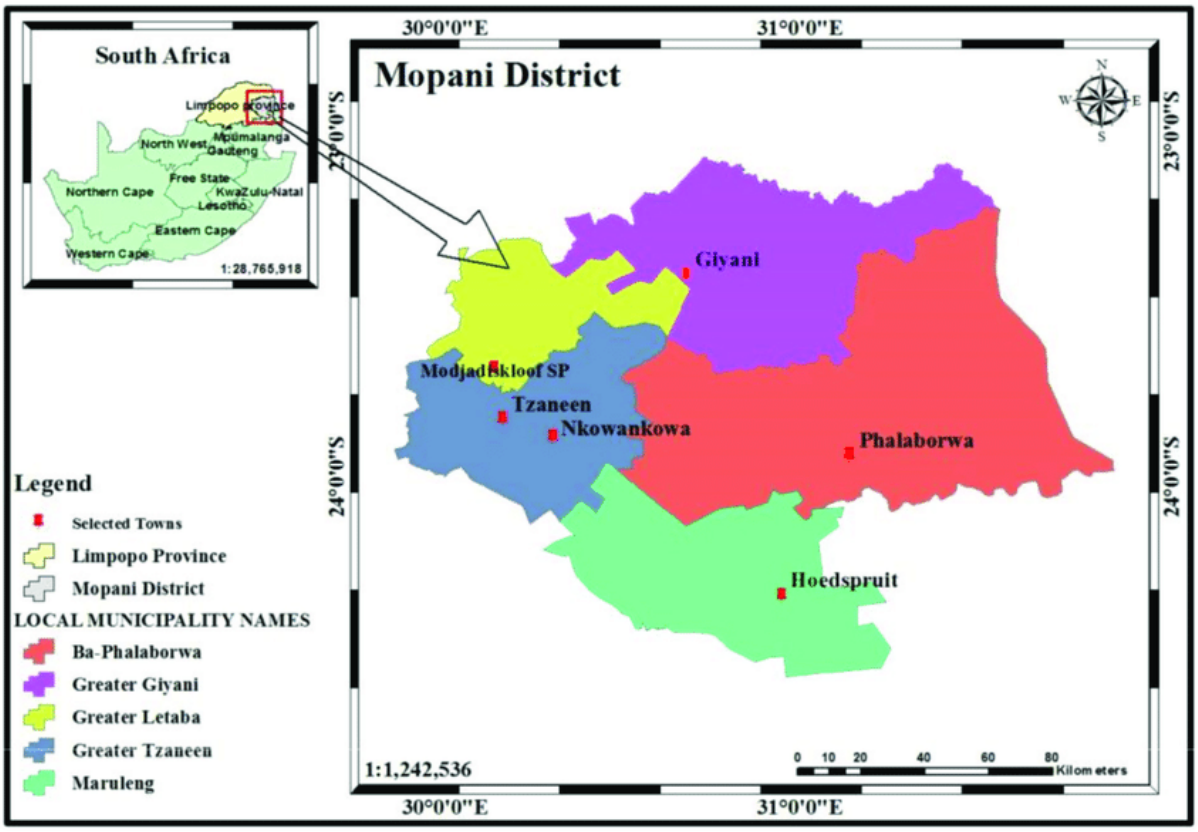


Figure 4.1: Mopani District Municipality map, source: Authors' Field Data, 2019

Different levels of care in the Mopani district are provided by the Department of Health, this includes Primary Health Care (PHC), Community Healthcare Centre (CHC), District Hospital and Regional Hospital. Below is the representation of levels of care:

Primary healthcare level (PHC)

- Functions only on weekdays during working hours.
- Services offered includes chronic diseases, child health, family planning.
- Provides antenatal care for low and intermediate risk women including point of care blood and urine testing; postnatal follow-up; immediate management of obstetric and neonatal emergencies.

Refers patients identified with risk factors for pregnancy complications to District Hospital.

Community healthcare level (CHC)

- Provides 24-hour comprehensive health service with obstetric unit run by midwives.
- Other services offered includes emergency care, minor ailments, chronic diseases and promotive services.
- Provides low-to intermediate-risk antenatal care basic emergency obstetric care signal functions: magnesium sulphate, intravenous antibiotics, oxytocic, vacuum delivery, removal of retained placenta, manual vacuum aspiration, neonatal resuscitation, 24-hour labour and delivery service for low-risk women, comprehensive contraceptive care.

Refer patients with problems to District Hospital.

District Hospital level

- services provided at district hospitals includes trauma and emergency care, in-patient and out-patient visits, paediatric and obstetric care.
- Provides antenatal care for high-risk women, antenatal ultrasound service, treatment of pregnancy problems, 24-hour labour and delivery service including caesarean delivery, regional and general anaesthesia, essential special investigations, postnatal care and postoperative care, contraceptive services, etc.

Referral & supervision centre for PHCs and CHCs in district, has visiting specialist Obstetricians.

Regional Hospital level

- Offers services at a general specialist level, receive referrals from district hospitals, and they serve as a platform for training and research.
- frequently offer the functions of district hospitals and are the base specialist health facility for clinics and community health centres in their defined geographical area.
- Manages severely ill pregnant women.
- Specialist supervision of care of pregnant women.

Figure 4.2: Levels of care; source: Department of Health. (2016). Guidelines for Maternity Care in South Africa: A manual for clinics, community health centres and district hospitals.

4.5.1. Selection of health facilities

The four research sites in this study (4 PHCs, 1 CHC, 1 district hospital, 1 regional hospital) were sampled from the entire Mopani district with its geographic and demographic diversity. In this study, multistage sampling was used to sample the study settings. Multistage sampling divides large population into smaller groups which assist in ensuring that the sampling process is practical (Yarahmadi, 2020). In this study, multistage sampling enabled the researcher to select health facilities in different levels of care in the Mopani district as it was impossible to study every pregnant woman attending ANC in all the Mopani district health facilities.

There are three stages in multistage sampling:

Stage 1: Choosing a sample frame considering the population of interest.

In this study, cluster sampling was used to group health facilities in the Mopani district into clusters. Cluster sampling refers to a sampling method where the researcher divides the entire group into groups or clusters (Simkus, 2022) and this method was cost and time effective.

Stage 2: The health facilities in the Mopani district are clustered into four groups, which are regional hospital; district hospital; CHCs and PHCs. There is 1 regional hospital; 6 district hospitals; 8 community health centres of which 2 in Greater Giyani, 1 Greater Letaba, 4 Greater Tzaneen, 1 Ba-Phalaborwa and 96 primary healthcare clinics of which 28 in Greater Giyani, 20 Greater Letaba, 31 in Greater Tzaneen, 9 in Ba-Phalaborwa and 11 in Maruleng (Department of cooperative governance and traditional affairs, 2020).

Stage 3: Simple random sampling of research settings was used. Simple random sampling refers to a method of selecting a sample from a population wherein every member in a population has an equal chance of being selected (Makwana et al., 2023). This was achieved through sampling the study sites without replacement, meaning that a health facility could only be selected once. To illustrate, a bowl containing names of health facilities in the Mopani district was set up and randomly selected one health facility at a time to include in research settings. Once a paper was drawn out, it was

set aside rather than putting it back into the bowl. Below is a diagram of health facilities in the Mopani District which were chosen as study setting for this current research (figure 4.3):

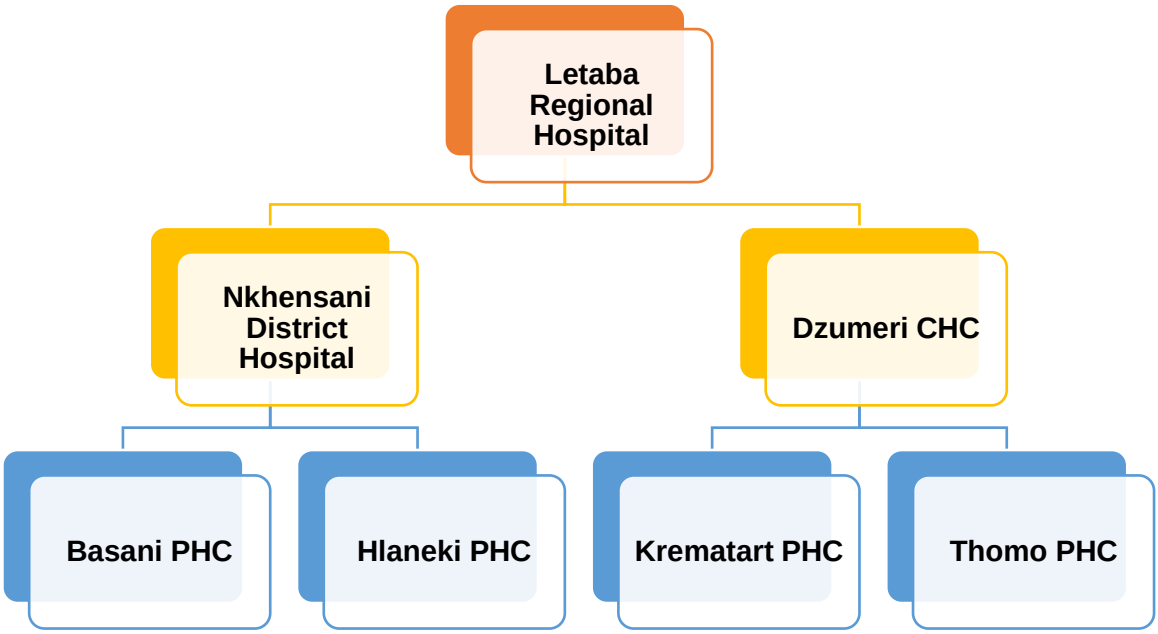


Figure 4.3: Mopani district health facilities under study.

The current study is an extension of previous study done by the researcher during her Master's programme. It was established in the previous study that the sample size was small, and few (3) study sites were selected.

4.6. Sampling of participants

Sampling is the process of selecting a sample from the population (Shukla, 2020). The sampling process is essential as the researcher does not have sufficient time and resources to study the entire population. In addition, sampling gives more accurate and faster results than studying an entire population (Bhardwaj, 2019). The main disadvantage of sampling is that it introduces a chance of bias (Bhardwaj, 2019). Bias is the deviation from the truth, and the minimisation of bias in this study was explained in the data collection section. In this section, the population, sampling, ethical issues related to sampling and sample for each research phase were described.

4.6.1. Phase 1 – Qualitative approach

4.6.1.1. Population

A population refers to a group of people on which the research findings are to be applied (Shukla, 2020). Furthermore, the group has variable characteristics which are under study and for which the research findings can be generalised. The population of the study during phase 1 included the district manager for child and maternal health services; the district manager for NCDs and health practitioners (nurses and doctors) who provide services to pregnant women.

4.6.1.2. Sampling

Purposive sampling was used to sample key informants during phase 1. The sample of the study in this non-probability sampling technique was selected according to the purpose of the study (Bhardwaj, 2019). According to Scholtz (2021), purposive sampling refers to "the most effective use of limited resources by selecting information-rich cases". The child and maternal health district manager, the NCDs district manager, and nurses and doctors were found to be the best respondents for this study as they were selected with the expectation that they will provide unique and rich information of value to the study.

The strengths of this sampling technique are obtaining real-time results as participants have appropriate knowledge, understanding the subject well as well as producing desired results as the researcher directly communicates with participants (Bhardwaj, 2019). In addition, this technique is time- and cost-effective. Purposive sampling is one of the types of non-probability sampling where a sample is selected based on characteristics of the population and objective of the study (Crossman, 2020).

4.6.1.2.1. Inclusion criteria

Key informants — Health providers (Nurses & Doctors) who work with pregnant women at selected study sites as well as district managers for child & maternal health, and non-communicable diseases.

4.6.1.2.2. Exclusion criteria

In this study, health care providers (Nurses & Doctors) who were not willing to participate.

4.6.1.3. Ethical issues related to sampling.

Selection bias is often introduced when researchers select from a population of interest or recruitment of participants, and this is more likely to threaten validity of research as study population is not representative of target population (Nikolopoulou, 2023).In addition, this can make generalisation of research findings to the entire population to be difficult.

4.6.1.4. Sample

Sample size in qualitative research is determined by data saturation, not by statistical power analysis (Guest et al., 2020). Saturation refers to "the point in data collection when no additional insights or issues are identified and data begin to repeat so that further data collection is redundant, signifying that an adequate sample size is reached" (Hennink & Kaiser, 2022). In this study, data saturation was assessed when there was no new information emerging during the interviews with participants. For doctors, data saturation was reached on the 5th participant; for professional nurses data saturation was reached on the 4th participant; and for pregnant women diagnosed with GDM, data saturation was reached on the 5th participant. In this study, five (5) professional nurses, (5) doctors, (7) pregnant women diagnosed with gestational diabetes mellitus; NCDs district manager and child and maternal health district manager were recruited to participate in the study. Key informants who participated in an interview telephonically signed the consent electronically while others who engaged in face-to-face interview including primary participants i.e. pregnant women diagnosed with GDM signed the consent manually.

4.6.2. Phase 2 – Quantitative approach

A cross-sectional descriptive study design was used to get a 'snapshot' of information on pregnant women attending ANC visits. Moreover, this design allowed the researcher to collect information on participants at a single point in time.

4.6.2.1. Population

The population in this study referred to pregnant women attending antenatal clinic visits at primary health care; community health care centres and hospitals which were chosen as research settings.

4.6.2.2. Sampling

Pregnant women were sampled using probability sampling technique which emphasises that every individual has an equal chance of being selected with the aim of producing results that are representative of the entire population (McCombes, 2023). The sampling technique used in the study was Simple random sampling. In Simple random sampling, “the members of the sample are selected randomly and purely by chance” (Bhardwaj, 2019). The strengths of this sampling technique include, the sample being representative of the population which allows the researcher to make generalisations from the results of the sample to the population; while the major weakness of this technique is that if the sample is not representative of the population, sampling error can occur (Sharma, 2017).

A random sampling procedure was chosen as it maximised external validity and optimised the sample size. To randomly sample the participants, a lottery method/envelope was used where each pregnant woman was assigned a unique number, i.e., 1 or 2, and the numbers were placed in a bowl and thoroughly mixed, and the researcher picked number 2 from the bowl. Thereafter, pregnant women who picked the number which had been picked by the researcher were then selected to participate in the study.

4.6.2.2.1. Inclusion criteria

Inclusion criteria is defined as key features of the target population that the researcher will use to answer the research question (Patico & Ferreira, 2018). In this study, the inclusion criteria included all pregnant women attending ANC at the selected study sites.

4.6.2.2.2. Exclusion criteria

Exclusion criteria are potential study participants who don’t meet the inclusion criteria and they might be having potential features that might interfere with outcome of the study (Patico & Ferreira, 2018). Women who were pregnant but were not willing to participate in the study and those diagnosed with DM did not form part of the study.

4.6.2.3. Ethical issues related to sampling.

With simple random sampling, the sample chosen needs to be representative of the population to minimise the occurrence of sampling error.

4.6.2.4. Sample

Shukla (2020) defines a sample as a part of the population that represents it completely. In this study, the sample size was determined as follows:

Sample size determination is an act of choosing the number of observers to include in a statistical sample (Kaur, 2021). The sample size in this study was estimated using Cochran's formula for dichotomous variables. Since the GDM prevalence in the Greater Giyani Area (1.96%). The sample size was calculated as follows:

$$n = \frac{\left(Z\ 1-\frac{n}{2}\right)^2 pq}{d^2}$$

$$= \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2}$$

$$=385$$

Were,

n is the sample size

Z is the 95% confidence interval

p is estimated proportion of the population which has the attribute in question (0,5)

d is the sampling error (5%)

A 10% was added to the sample size, i.e., 385 + 10% of 385 = **424**. The addition of 10% to the sample size allowed for a non-response rate among the participants in instances where, for example, the participants provided incomplete information on the questionnaire, refused to complete the questionnaire, or withdraw from participating in the study. The response rate refers to the number of eligible participants in the sample (Booker et al., 2021).

The sample size for a health facility was calculated using sample weight multiplied by the total number of women in all facilities by the sample weight (424). Thereafter, the sample size was distributed proportionally to the size of the facility (Table 4.2).

Table 4.2: Sample size for health facilities.

	N (population)	n (sample)
Letaba regional hospital	500	119
Nkhensani district hospital	450	107
Dzumeri CHC	160	38
Basani PHC	250	60
Hlaneki PHC	110	26
Krematart PHC	170	40
Thomo PHC	140	33
Total	**1780**	**424**

4.6.2.5. Qualitative strand within Quantitative approach of Phase 2

For pregnant women diagnosed with GDM, they were purposively sampled to participate in a semi-structured interview with an objective of examining their perception on the management of GDM. In addition, the nature of the study was explained to participants, and they were provided with a study information letter. After having understood the nature of the study, they signed the consent form prior to continuing with the interview.

4.6.3. Phase 3 – Development of evidence-based management model of GDM

4.6.3.1. Population

A multi-disciplinary team comprised of individuals responsible for the management and prevention of GDM.

4.6.3.2. Sampling

Purposive sampling was used to select participants and those who were eligible formed part of the study.

4.6.3.3. Ethical issues related to sampling.

The ethical issue related to the chosen sampling method is the generalisation or external validity. This means that generalisation is only possible to the defined population by the sample selection criteria and those in the population who have the characteristics of the sample studied (Andrade, 2021).

4.6.3.4. Sample

The sample in this phase included doctors and nurses working with pregnant women, dietician, child and maternal health district managers, and non-communicable diseases district managers.

4.7. Data collection

Data collection is a process of gathering, measuring and analysing data to find solutions to research problems and answer research questions. This section details the data collection approach and method used in the study, the data collection instruments and how data was collected in this study.

4.7.1. Data collection approach and method

In this study, data was collected from various multiple sources. Table 4.3 below shows the data collection methods which were undertaken in the study:

Table 4.3: Multiple sources of data

DATA SOURCE	DATA METHOD	ANALYSIS DATA
1. Primary participants: **1.1. Pregnant women attending ANC visits.**	Questionnaire adapted from Michigan Diabetes Research & Training Centre DCP 2.0 (Quantitative approach). This tool will be refined after phase one of Qualitative. Semi-structured interview with pregnant women diagnosed with gestational diabetes mellitus.	Descriptive field notes & Questionnaire Audio-tape transcripts.
2. Key Informants **2.1. Health practitioners (Nurses & Doctors)**	Semi-structured interview guide with closed and open-ended questions. (Qualitative approach)	Audio-tape transcripts.

2.2. District managers (child & maternal health; NCDs)	Semi-structured interview guide with closed and opened questions. (Qualitative approach)	Audio-tape transcripts.
3. Documents (WHO criteria 2013; National guidelines for maternity care in SA; policies & standard of practices; statistics)	Reading documents; records. (Qualitative approach)	Texts from relevant documents; records.

4.7.2. Development and testing of the data collection instrument.

A questionnaire with open and closed-ended questions adapted from Michigan Diabetes Research & Training Centre DCP 2.0 (The University of Michigan, 1998); and Elamurugan & Arounassalame (2016) were used to collect data (Annexure A). Other questions from the questionnaire and data entry form (Annexure C) were adapted from a study conducted in India by Varghese et al, 2012 on *the prevalence, Risk factors, and Maternal and Foetal outcomes in Gestational Diabetes Mellitus*. After the completion of phase 1 Qualitative data analysis, the questionnaire was amended based on the qualitative findings.

The questionnaire was translated into the local language from English to Xitsonga (Annexure B). The questionnaire was piloted to ensure content validity, which is the questions asked are relevant to the aim and objectives of the study. A semi-structured interview guide for key informants was developed with questions relevant to research objectives (Annexure D, E). Research supervisors verified the developed interview guide to ensure the reliability of the instrument.

4.7.3. Characteristics of the data collection instruments.

4.7.3.1. Questionnaire

A questionnaire is a data collection tool which has been adapted from Michigan Diabetes Research & Training Centre DCP 2.0; and Elamurugan and Arounassalame (2016). The use of a questionnaire allows the researcher to generate specific data relevant to their research and offers insights that might otherwise be unavailable. In addition, questionnaires allow for many respondents to be reached; represents a larger population; allows for comparisons; generates quantifiable, standardised, and empirical; and is anonymous which ensures the confidentiality of participants.

4.7.3.2. Semi-structured interview guide

The semi-structured interview guide consisted of open-ended questions on main topics, the burden of GDM; risk factors; maternal and infant health outcomes; current interventions by the district. As the interview progressed, questions were added. The strength of this tool is that it is flexible; although the interview is led by the researcher, the direction of the interview can change as the interview progresses. Interviews "give the most direct and straightforward approach to gathering detailed and rich data regarding a particular phenomenon" (Barrett & Twycross, 2018).

4.7.4. Data collection process

Data collection is a systematic process of gathering data from different sources of data to answer the research question. Below is a graphical representation of the process which was followed in this study:

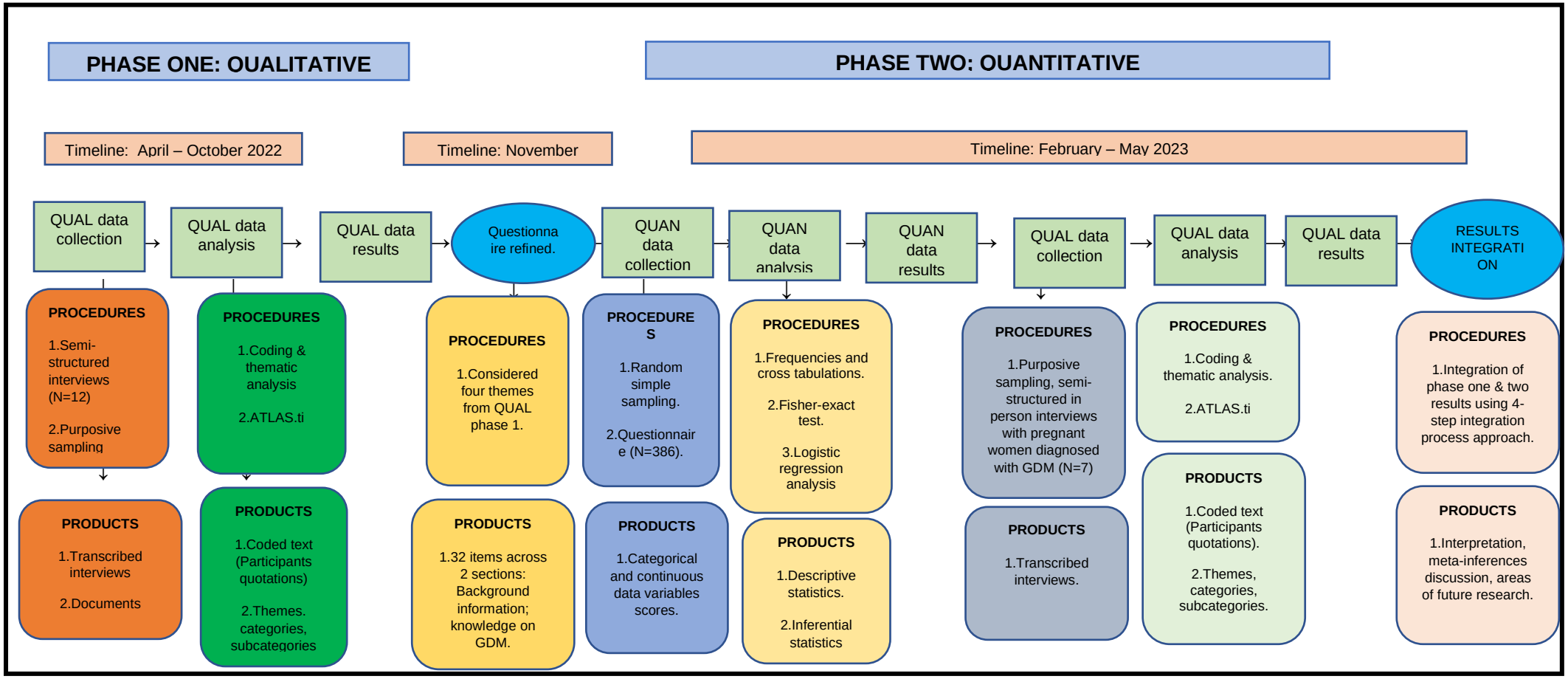


Figure 4.4: Exploratory sequential mixed methods research design. Adapted from Berman, E.A. 2017. An Exploratory Sequential Mixed Methods Approach to understanding Researchers' data management practices at UVM: Findings from the Quantitative Phase. *Journal of eScience Librarianship* 6(1): e1098

For the Qualitative phase of this study, a semi-structured interview guide was developed to gain an in-depth understanding of GDM in the Mopani district. The interview guide focused on questions related to the prevalence of GDM; common risk factors; screening & diagnosis; treatment; awareness; infant & maternal health outcomes associated with GDM; district interventions, etc. Data collected was analysed using thematic analysis and this was outlined in detail in chapter five. The themes were used to refine the quantitative data collection tool to further explore the research problem.

The second phase of this research was guided by a questionnaire which was completed by 386 pregnant women who were attending ANC and were randomly sampled to participate in the study. In parallel, 14 pregnant women who were diagnosed with GDM were then recruited for an interview with the aim of gaining their perspective on management of GDM. Only seven patients agreed to an interview. In addition, interviews were conducted in Xitsonga and English. Thereafter, quantitative and qualitative data were analysed, this was described in detail in chapter five. The integration of qualitative and quantitative data is the one that defines mixed method research and highlights its value. In this study, firstly occurred at design level wherein qualitative phase one results were used to build quantitative phase two design. Secondly, integration also occurred during the interpretation stage where qualitative data from phase one and quantitative data from phase two were connected using joint display and through a four-step integration process approach.

4.7.5. Ethical considerations related to data collection.

The following ethics were taken into consideration during data collection:

i. Participants completed informed consent to participate in the study after the researcher explained the study's aim and purpose; how data will be collected; how data will be stored; and who will have access to the data.
ii. To maintain anonymity and confidentiality, participants were not required to divulge their names or information which could reveal their identity. Data was stored in secured places and only researchers and supervisors had access.

iii. Participants' right to autonomy was respected by informing them that should they wish to withdraw from the study at any time, their decision will be respected.

iv. The study had no known risks which could expose the participants to harm.

v. Primary participants had an equal chance of being selected to be part of the study. Hence, the ethical principle of justice was upheld.

4.8. Data analysis

Data analysis is an ongoing process during research and involves analysing participant information by using analysis guidelines or software tools.

4.8.1. Qualitative phase 1 data analysis

To uncover emerging themes, patterns, concepts, insights, thematic analysis was used. Thematic analysis is an analytic method for identifying, analysing and reporting patterns within the data (Mihas, 2023).The researcher followed the following Qualitative data analysis steps:

4.8.1.1. Becoming familiar with the data

The researcher transcribed the interview recordings verbatim and listened several times to ensure data is captured correctly.

4.8.1.2. Coding data

Data were coded using ATLAS.ti software version 23.3 (Atlas.ti Scientific Software Development, 2023). To identify, analyse and document themes in a data set. This was done with the assistance of a qualified qualitative data analyst.

4.8.1.3. Interpretation of data and conclusion

During the interpretation of data, participants' direct statements 'segment of meanings in a text – codes' were used to support the theme generated and conclusions were made. Chapter Five which details the research findings of the study highlights the interpretation and conclusion of the qualitative data.

4.8.2. Quantitative phase 2 data analysis

Data was captured in a Microsoft Excel spreadsheet, and then transferred to SPSS version no 29.0.0.0. for analysis. Assistance in analysing the results was sought from a qualified statistician. Categorical variables were presented as percentages and

frequencies. Likewise, the comparison of categorical variables was done using a Chi-Squared test and P-value of <0.05 was considered significant. The association between variables was assessed using the fisher-exact test, and risk factors using logistic regression analysis.

4.9. Integration of qualitative and quantitative data

Joint displays which are visual displays are used in mixed method research to integrate qualitative and quantitative data during data collection, analysis and interpretation (McCrudden et al., 2021). The joint display is a way of integrating data through bringing data together through a visual means to draw out new insights beyond the information gained from separate quantitative and qualitative results (Fetters & Tajima, 2022). In this study, the qualitative and quantitative data were integrated and interpreted using a four-step approach, creating a joint display, linking activity, establishing relationships, and interpreting and reporting (Skamagki et al., 2022).

4.10. Internal and External validity of the study

Validity refers to “how well the results among the study participants represent true findings among similar individuals outside the study” (Patino & Ferreira, 2018). Validity encompasses internal and external validity. Internal validity reflects the extent to which the study’s methodology can provide unbiased findings (Frampton et al., 2022). With regards to external validity, it relates to the extent to which inferences drawn from the study sample can be applied to the broader population (Findley et al., 2021).

4.10.1. Reliability and validity of quantitative data

4.10.1.1. Validity

To increase internal validity, the researcher ensured that the research was carefully planned with detailed research methodology, adequate recruitment strategies were identified as well as data collection and data analysis. Questionnaire was piloted to identify misleading questions, spelling and grammatical errors which can potentially introduce bias into the study. Regarding external validity, simple random sampling was used to ensure that the sample is representative of the population which can therefore allow for the

results of the study to be generalised to the population from which the sample was drawn (Andrade, 2018).

4.10.1.2. Reliability

Reliability is about truthfulness in the data obtained (Ahmed & Ishtiaq, 2021). A pilot study was done to ensure reliability. A reliability test was used to check the internal consistency findings.

4.10.2. Trustworthiness of the qualitative data

The validity of qualitative research is measured through trustworthiness and the strategies include credibility, transferability, confirmability and dependability (Riazi et al., 2023).

4.10.2.1. Credibility

Credibility reflects internal validity and focuses on whether the researcher has demonstrated a certain level of confidence in the findings of the phenomenon under study (Lemons & Hayes, 2020). To ensure credibility, member checking; peer debriefing; prolonged engagement and triangulation were used (Stenfors et al., 2020). For member checking, emerging findings of the study were taken back to participants for the interpretation of the data, and for the participants to correct the data should there be errors.

Peer debriefing was implemented by allowing the supervisors to check the data as a way of ensuring that the analysed data aligns with the study's aim and objectives and assistance from a statistician and qualitative data analysis expert was sought. Prolonged engagement is very important for data saturation. The researcher stayed long in the field collecting data to ensure that an in-depth understanding was gained as well as building trust with research participants.

Triangulation involves the use of multiple sources of data and in this study, an opportunity was seized to examine the relevant documents referred to by the key informants (health practitioners & two district unit managers) which shed more light on the phenomenon under study. Triangulation assisted in identifying inconsistencies in research findings that can be useful in gaining a deep

insightful understanding of the phenomenon under study (Lemons & Hayes, 2020). Different questions were asked and different sources of collecting data were used.

4.10.2.2. Transferability

Transferability refers to the extent to which the research findings can be applied to other contexts or other participants (Lemons & Hayes, 2020). In other words, applying the findings to the wider population. A thick description strategy was used to ensure transferability. The strategy entails describing in detail the participants, what transpired and the setting. The researcher provided sufficient contextual information about the study sites and participants to enable the findings to be applied in other contexts and studies.

4.10.2.3. Dependability

Dependability refers to reliability in Quantitative research and emphasises that research findings must be distinctive to a specific time, place, and consistency of explanations across data (Lemons & Hayes, 2020). Dependability implies the stability of findings over time, in similar contexts and with participants. To ensure dependability, the research method process was detailed and thoroughly followed, and this enabled readers to develop a thorough understanding of the processes followed and their effectiveness. Moreover, this relates to the audit trail strategy. The researcher ensured that there was consistency across different aspects of the research process by detailing the research methodology for the qualitative and quantitative phases.

4.10.2.4. Confirmability

The concept of Confirmability “addresses whether the interpretations and findings are from the participants’ lived experiences and do not include the researcher’s biases” (Lemons & Hayes, 2020). To achieve conformability, an audit trail was used by ensuring that all changes and aspects of the research that deviated from the research protocol are documented. According to Frey (2018), the researcher should utilise useful techniques such as triangulation of the data to reduce bias.

The researcher ensured that the findings are accurate and relevant, and meaning can be drawn through consulting research supervisors and experts in the field. Diagrams were used to demonstrate the Audit trail. The researcher was aware that there might be shortcomings in the methods used during the study and how biases might affect the study were identified and minimisation of such biases. The data reflected the voice of participants by using direct quotations of codes.

4.11. Minimising potential bias in the study

Bias refers to any deviation from the truth in data collection, data analysis and interpretation which can cause incorrect conclusions (Florczak, 2022). In this current study, participants were randomly selected to ensure that all participants who meet the study's inclusion criteria are selected to participate in the study. In the quantitative approach, attention bias was minimised by ensuring that participants were given detailed information letters regarding the study to ensure that they understood what the study was about before consenting.

In the qualitative approach, the researcher should only exhibit the bias necessary to enhance the research and when answering research questions; this is referred to as the necessary bias principle (Maarouf, 2019). The researcher had a pre-understanding of GDM, which formed the basis of both the qualitative and quantitative methods and directed the choice of research question and variables. Having this pre-understanding enriched the qualitative research by aiding the researcher to add more insights, discover more sides of this phenomena and necessary to meet the research requirements. This form of bias is not acceptable; hence the researcher did not direct the research findings in a predetermined way. Triangulation of data also assisted in minimising bias in data.

4.12. Ethical considerations

4.12.1. Permission to conduct the study.

To ensure ethical consideration in this study, permission to conduct the study was sought from the Turfloop Research Ethics Committee (TREC) under the University of Limpopo and was approved (Annexure X). Permission to conduct study was also sought from the Department of Health Provincial through applying online and a

registration number was therefore provided. Thereafter, the Department issued an approval letter (Annexure Y, Z). After permission had been granted, permission to conduct the study was then requested from the Mopani District Health Services, where an approval letter was issued (Annexure Aa). In addition, permission to conduct the study had to be obtained from the hospitals, CHC and PHCs which were selected as study sites before data collection commences (Annexures F-I).

4.12.2. Respect for persons participating in the study.

This principle emphasises that research participants are and should be treated as autonomous and participants with reduced autonomy due to youth, mental disabilities or illness should receive additional protection. In this study, participants were given a choice to choose whether to participate in the study or not. For those who choose to participate, an information letter regarding the study was provided in the participant's comprehensible language.

The information letter outlined the purpose of the study, research procedures risks and anticipated benefits (Annexures J, K, N, O, R, S, T, U). Thereafter, informed consent was provided for participants to sign to ensure that they understood the nature of the research and agreed to participate (H, I, L, M, P, R, S, V, W). For participants who were under the age of 18 years of age, their parents had to give consent and then they were also required to sign an assent form. Most importantly, participation was voluntary, and should the participant want to withdraw from the study, they were free to do so at any time for any reason.

4.12.3. Measures to protect participant's privacy and confidentiality.

To ensure the confidentiality of the information gathered from the participants, a storage system i.e., hard drive, compact disc and file for hard copies was implemented and information was stored in a manner that the participant's identity was not revealed. Only the researcher and supervisors had access to the research data.

4.12.4. Beneficence

The benefit of participating in the study can be to the participant or community. Research findings will be to the provincial health department, the Mopani district and study sites to ensure that they benefit from the outcomes of this study. Research

should not harm the participants participating in the study in any way. Risks might be associated with physical harm, psychological distress, and damaging participants' finances. In this study, there were no foreseeable risks associated with participation as no samples such as blood were drawn from the participants. Furthermore, data was only collected when pregnant women attended antenatal visits to reduce participants' travel costs, while for key informants the researcher visited the study sites and other interviews were conducted telephonically due to some of key informants' work commitments.

4.12.5. Justice

The principle of justice emphasises fairness in the distribution of research benefits. Compensation relates to money given to participants for participating in the research study that acknowledges their time and effort. In this study, all participants were not compensated i.e., monetary for participating in the study. Instead, they were thanked verbally for their participation. Furthermore, all participants were treated fairly, and no certain number of participants were subjected to high-risk prospects.

4.13. Conclusion

This chapter discussed how participants in this study were sampled, which measuring instruments were used and their characteristics, the process of collecting data, data management, minimisation of potential biases as well as ethical considerations which are important for research validity as well as protection of the rights of research participants. The next chapter focused on the presentation of research findings.

CHAPTER FIVE: RESEARCH FINDINGS

5.1. INTRODUCTION

This chapter presents the study results three phases based on the methods used in data collection guided by the study objectives as follows:

- **Phase I: Qualitative focusing on:**
    1. To explore the perceptions of patients on management of gestational diabetes health care provision by healthcare providers in the Mopani District.
    2. To examine the perception of pregnant women diagnosed with gestational diabetes mellitus on management of gestational diabetes mellitus in the Mopani district.
    3. To describe the collaboration between non-communicable disease and maternal and child health units in the Mopani District Health Service.

- **Phase II: Quantitative focusing on:**

    1. To determine the prevalence and risk factors of gestational diabetes in the Mopani District.
    2. To describe the maternal and infant outcomes associated with gestational diabetes mellitus in the Mopani District.
    3. To determine the association of socio-demographics, risk factors with maternal and infant outcomes in the Mopani District.
    4. To investigate the knowledge and perspective of patients on gestational diabetes and its management in the Mopani District

Phase III: Integration of qualitative and quantitative results

1.To develop an evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with GDM in the Mopani district of the Limpopo province in South Africa.

In this chapter, qualitative results from phase I were presented first followed by quantitative results from phase II. Furthermore, in phase II pregnant women who were

found to have been diagnosed with GDM were interviewed and their qualitative data were presented after phase II quantitative data.

5.2 QUALITATIVE PHASE I

Exploring the perception of patients on management of gestational diabetes mellitus healthcare provision by health care providers and collaboration between non-communicable disease and maternal & child health units.

5.2.1. Introduction

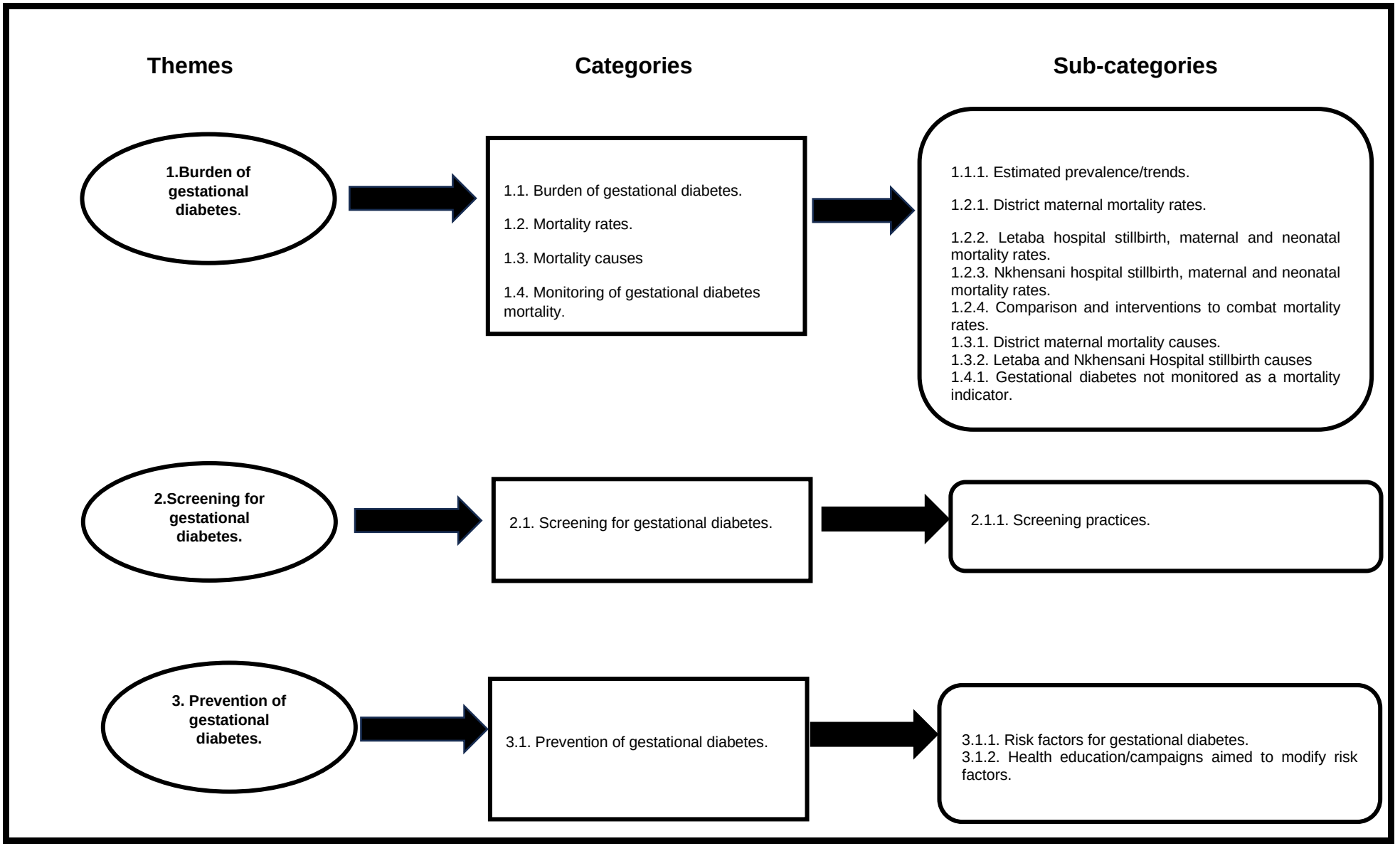
This section outlines the qualitative findings for phase 1 of exploratory mixed method design and purposive sampling was used to sample the participants. The data was collected from nurses (Five) and doctors (Five) providing health care to pregnant women and the Mopani district health managers (two) i.e., NCDs and maternal & child health managers. Unstructured interviews were conducted by the researcher and thereafter, interviews were transcribed verbatim. Thematic analysis was done using ATLAS.ti statistical software version 23.3 whereby themes, categories and sub-categories were identified. Data was presented in table format and direct quotations.

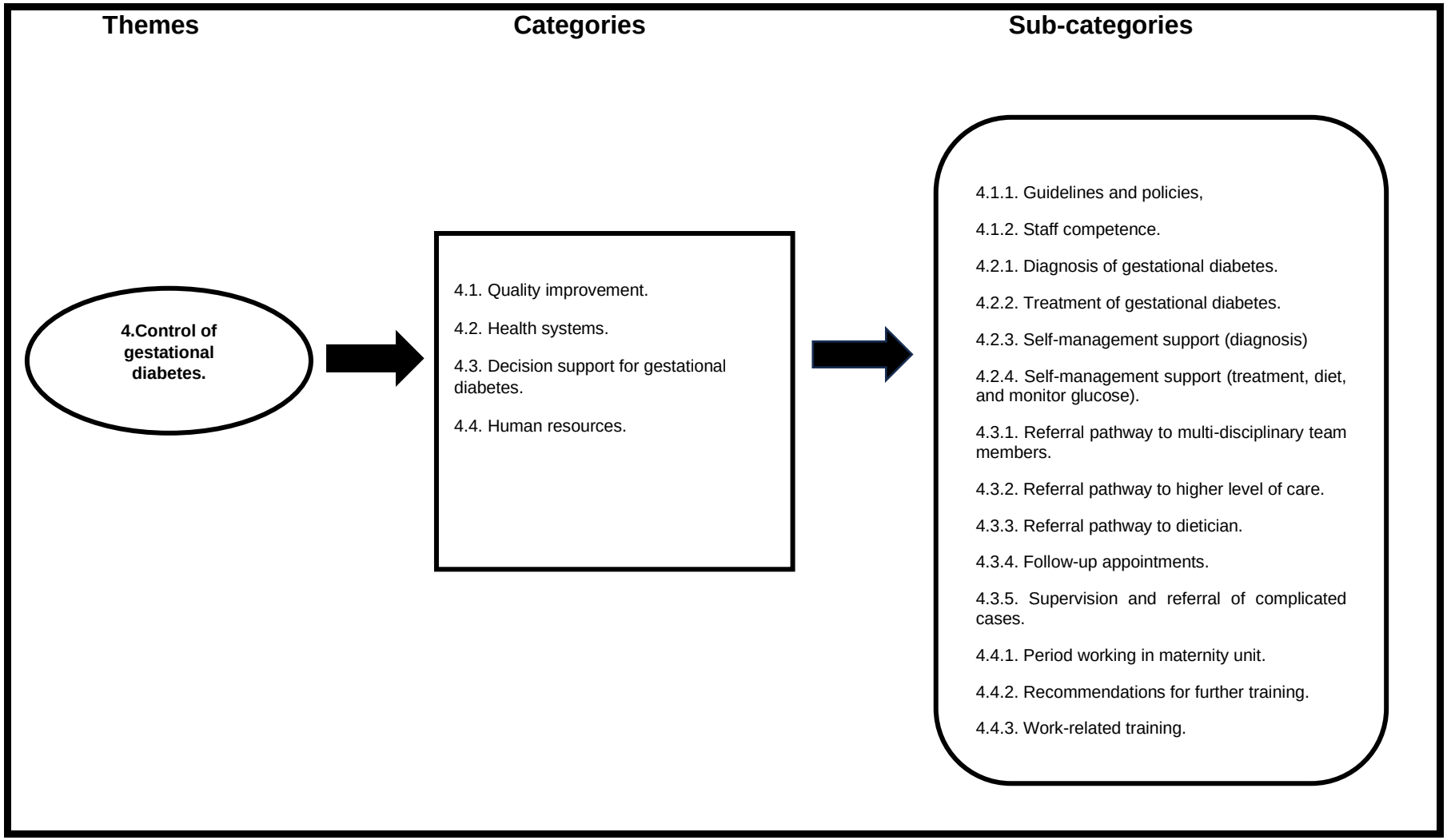
5.2.2. Data management and analysis

Data was collected using semi-structured interviews to explore perceptions of healthcare providers and ascertain the collaboration between NCDs and maternal & child health units in the health district. After data has been captured through recording, interviews were transcribed verbatim and stored in hard and soft drives. Thematic analysis was done, and codes were grouped into sub-categories, sub-categories were grouped into categories which resulted in the emergence of themes which are participants' accounts characterising perceptions and/or experiences which the researcher saw as relevant to answer the research question.

5.2.3. Research results.

From the qualitative analysis, six themes, 13 categories and 36 sub-categories emerged from the data collected through thematic analysis as outlined in figure 5.1 below. Thirty-three (33) codes were identified and from the 33 grouped codes, 312 quotations were identified. These themes describe GDM in the Mopani district.


Themes
Categories
Sub-categories
1.Burden of gestational diabetes.
1.1. Burden of gestational diabetes.
1.2. Mortality rates.
1.3. Mortality causes
1.4. Monitoring of gestational diabetes mortality.
1.1.1. Estimated prevalence/trends.
1.2.1. District maternal mortality rates.
1.2.2. Letaba hospital stillbirth, maternal and neonatal mortality rates.
1.2.3. Nkhensani hospital stillbirth, maternal and neonatal mortality rates.
1.2.4. Comparison and interventions to combat mortality rates.
1.3.1. District maternal mortality causes.
1.3.2. Letaba and Nkhensani Hospital stillbirth causes
1.4.1. Gestational diabetes not monitored as a mortality indicator.
2.Screening for gestational diabetes.
2.1. Screening for gestational diabetes.
2.1.1. Screening practices.
3. Prevention of gestational diabetes.
3.1. Prevention of gestational diabetes.
3.1.1. Risk factors for gestational diabetes.
3.1.2. Health education/campaigns aimed to modify risk factors.


Themes
Categories
Sub-categories
4.Control of gestational diabetes.
4.1. Quality improvement.
4.2. Health systems.
4.3. Decision support for gestational diabetes.
4.4. Human resources.
4.1.1. Guidelines and policies,
4.1.2. Staff competence.
4.2.1. Diagnosis of gestational diabetes.
4.2.2. Treatment of gestational diabetes.
4.2.3. Self-management support (diagnosis)
4.2.4. Self-management support (treatment, diet, and monitor glucose).
4.3.1. Referral pathway to multi-disciplinary team members.
4.3.2. Referral pathway to higher level of care.
4.3.3. Referral pathway to dietician.
4.3.4. Follow-up appointments.
4.3.5. Supervision and referral of complicated cases.
4.4.1. Period working in maternity unit.
4.4.2. Recommendations for further training.
4.4.3. Work-related training.

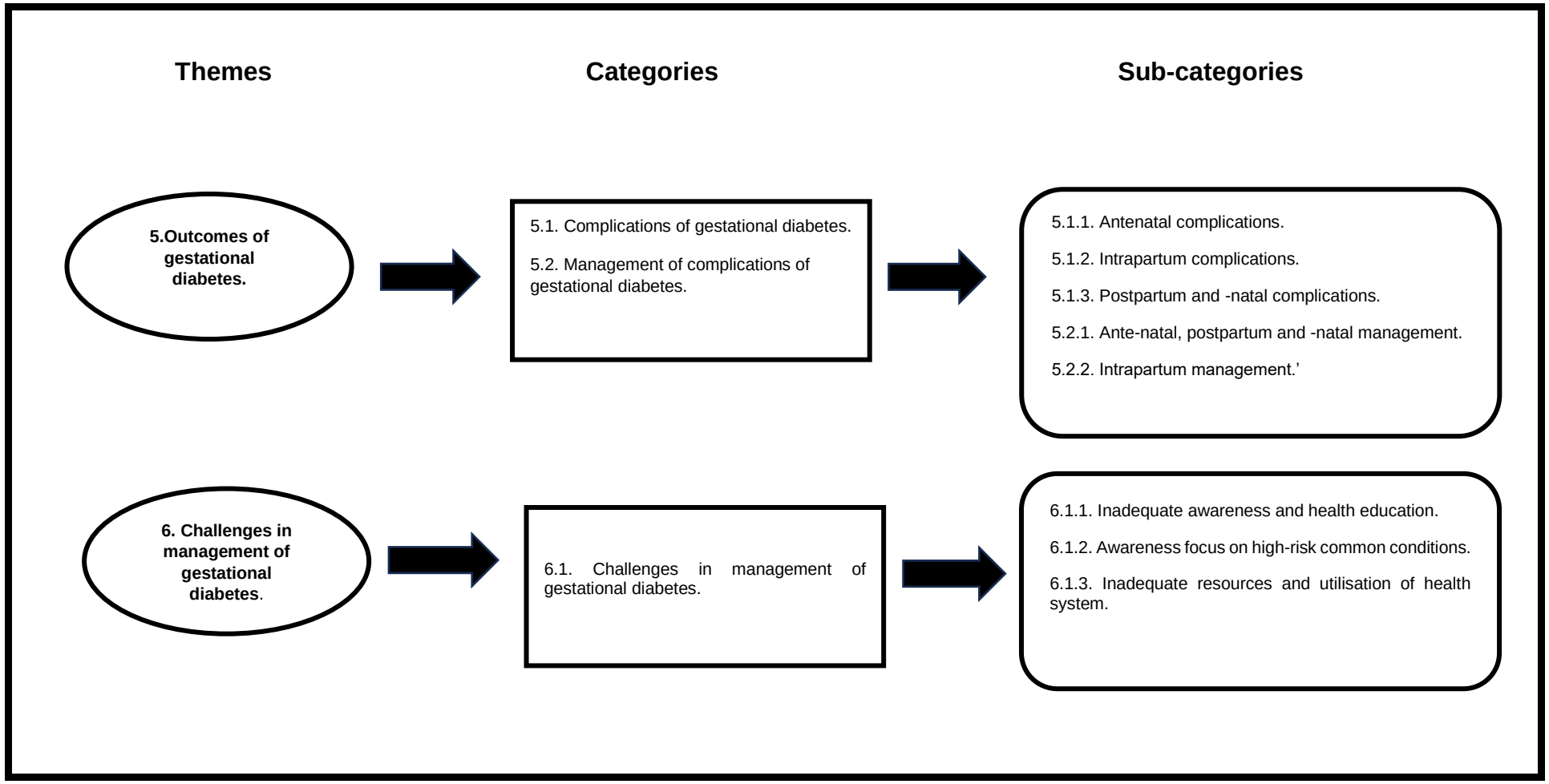


Figure 5.1: Thematic analysis –Themes, categories, sub-categories.

THEME 1 – BURDEN OF GESTATIONAL DIABETES

The theme 'burden of gestational diabetes' expresses the prevalence of gestational diabetes in the Mopani district. Doctors and professional nurses explained that there were few cases of gestational diabetes diagnosed or even reported in the health facilities. The neonatal mortality rate was to be gradually decreasing over the last five (05) years with common causes being unexplained uterine foetal death, labour related intrapartum hypoxia, cord around the neck, extreme prematurity, abruptio placentae, never initiated antenatal clinic and congenital abnormalities. Child and Maternal Health district manager expressed that there is no indicator for GDM in the DHIS system. Hence, there is no monitoring of this health condition. While the NCDs district manager indicated that they only have an indicator for screening not on the prevalence.

The theme was supported by the following categories:

Burden of gestational diabetes

Most professional nurses and doctors working with pregnant women reported few cases of GDM in public health facilities in the Mopani district.

Quotations

"I have seen many, I have seen more than 10 cases".

[District hospital doctor 1]

"During my rotation I think I saw, there were quite a number of cases. Maybe I can say less than 10 patients per month. But the ones we have diagnosed were less than 5. Most of them are usually pre-existing diabetes on treatment".

[District hospital doctor 3]

"Last year we identified one case".

[Primary healthcare professional nurse 3]

Over the years the prevalence of GDM has been noted to be increasing due to increase in knowledge and experiences gained by the health practitioners working in the obstetric unit.

Quotations

"It's increasing in a way that now we get more consultants or when we are furthering our studies, we get to know more, now we are always ready, we investigate more when we see a patient with a risk factor. Unlike before, we were not investigating them. Maybe it was due to lack of knowledge or maybe it was due to lack of supervision. But now we are seeing more that we are helping, we discover by just doing the oral glucose tolerance test (OGTT) we investigate them, or we do Hb1Ac. Those are the ones that we come across, now we are seeing more because we are investigating".

[Regional Hospital Doctor 1]

Mortality rates

It was ascertained during the interview with the child and maternal health district manager that the maternal and neonatal mortality rate was high.

Quotations

"The mortality rate in the hospitals is above the targets".

[Child and Maternal Health District manager]

Measures have been put in place by the district to combat the increase in maternal and neonatal mortality rate.

Quotations

"We have got monthly perinatal reviews in our hospitals (combination of hospital doctors and PHC nurses) and the CEO & Clinical manager must be there to facilitate; we have also established the issue of Esmoes; and the clinical audits of records".

[Child and Maternal Health District manager]

Mortality causes

As the stillbirth rate was reported to the above target in hospitals, causes for those deaths occurred before and during labour.

Quotations

"The top causes for those stillbirths, it was delayed in seeking medical help during labour; unexplained uttering foetal death; labour related

intrapartum hypoxia; cord around the neck; extreme prematurity; abruptio placentae; never initiated ANC and congenital abnormalities".

[Child and Maternal Health District manager]

Monitoring of gestational diabetes mortality

Monitoring of GDM is not being done in the district as a result of not having the indicator of gestational diabetes in the District Information Health System (DHIS) system. Thus, this makes it challenging to determine the extent of the burden of GDM in the district.

Quotations

"We are not monitoring that indicator. It's not on the DHIS system".

[Child and Maternal Health District manager]

"I don't know why the indicator is not on the DHIS because these indicators are from above, the national office. We are just told to monitor these ones".

[Child and Maternal Health District Manager]

THEME 2 – SCREENING FOR GESTATIONAL DIABETES

The theme 'Screening for gestational diabetes' was part of the practices done by professional nurses and doctors when screening for GDM in women attending ANC.

This theme was supported by the following category:

Screening practice for gestational diabetes

This category was supported by the sub-category 'screening practices. During the interview with the professional nurses and doctors at various levels of health facilities, there were similarities with regards to how the screen for GDM. Mostly they looked for symptoms and pregnant women who are at risk of developing GDM.

Quotations

"If the patient is not showing any signs we don't screen. If the patient present with signs, it is then that we screen and do HGT. After that if you have protein in the urine we refer".

[District Hospital Professional nurse]

"……we screen the ones who come with symptoms. You find that they are saying they have dry mouths, but the sugar is normal, then we investigate those ones".

[Regional Doctor 1]

On the contrary, other professional nurses emphasised that all pregnant women were being screened for GDM.

Quotations

"At booking, every woman who comes for booking we take blood glucose, we check blood glucose level and if the subsequent visit the woman would present with anything that we think is related to gestational diabetes, then we will repeat it. Every pregnant woman will have her baseline blood glucose level checked at booking".

[Primary Healthcare professional nurse 1]

"At booking all women are supposed to be screened for diabetes by checking their urine for sugar and blood glucose and especially the high parity and the obese women even all the subsequent visits urine is being checked and those that their sugar is high they are referred to the hospital to attend high risk clinic".

[Regional Hospital professional nurse]

On the other hand, pregnant women who are at risk were screened without failure.

Quotations

"So firstly, we ask on the booking form, there is where we have to ask whether there is family history of diabetes at home, whether she is on May treatment of diabetes. And then we ask the signs, does she sweat a lot even when it's not hot, does she have excessive thirst, hunger. If there is yes to those, then we rapidly go test".

[Primary Healthcare Professional nurse 2]

"We look at risk factors like advanced maternal age, family history, and bad obstetric history. I think most of our patients have obstetric history

like they have had multiple second or third trimester miscarriages or previous high macrosomia baby or baby with congenital anomalies. So, we usually look at that because we can't afford to screen everyone, you just pick and choose your patients".

[Regional Hospital Doctor 2]

"So just recently implemented in less than 2 months I think, we started with the OGTT test at around 24 weeks of gestation. So, you select your patients because on the risk factors is advanced maternal age and high BMI but not really, that the screening…those are the ones we do OGTT for or any patient who had abnormal random glucose at one point maybe they have not yet been diagnosed with diabetes, we do OGTT for them".

[Regional Hospital Doctor 2]

THEME 3 – PREVENTION OF GESTATIONAL DIABETES

The theme 'prevention of gestational diabetes' articulates professional nurses and doctors' knowledge on GDM. Furthermore, they highlighted the risk factors which influence the occurrence of this health condition and reflected on the inadequacy in their health educational programmes.

This theme was supported by the category:

Prevention of gestational diabetes

The category was supported by the following sub-categories:

Risk factors for gestational diabetes.

The common non-modifiable risk factors which were mostly emphasised by the professional nurses and doctors were advanced maternal age, family history of diabetes and history of delivering a macrosomia baby. Regarding modifiable risk factors, obesity, unexplained stillborn births in previous pregnancy and obstetric history.

Quotations

"Family history, previous gestational diabetes which contributes to the occurrence of gestational diabetes in subsequent pregnancies…that's all I know".

[District Hospital professional nurse]

"Yes, she said her father was diabetic though he is no longer around".

[Primary Healthcare professional nurse 2]

"So, the common one in our setting we see patients that have family history of diabetes, some had unexplained stillborn in previous pregnancy but was not diagnosed. Those are the ones. We see the ones that deliver big babies, they came when labour starts but were not investigated. Or the ones with advanced maternal age who are more than 40 years or 37 years old. So those are the most common ones that we see or the ones who are obese".

[Regional Hospital Doctor 1]

"Advanced maternal age, that's the number one and then patients with family history of diabetes, I would say previous history of gestational diabetes, high BMI but mostly the advanced maternal age and previous history of diabetes are the most common ones".

[Regional Hospital Doctor 2]

Health education/campaigns aimed to modify risk factors.

The participants described that continuous health education was being offered to the pregnant women along with continuous campaigns for prevention of chronic illnesses. However, it emerged from the interviews that GDM was rarely focused on during ANC health education.

Quotations

"..., most of the cases in high risk, those who come earlier we give health talk. Not only for diabetes, even the hypertension, that's if the patient is having this medical condition, what type of complications do we expect from the mother and the importance of coming to clinic and hospital. And also letting them know that those who are at home should go and check themselves whether they are having the condition or not".

[District Hospital Doctor 2]

"During ANC booking, they need to be given health talks at the clinic. Health education can help a lot".

[District Hospital professional nurse]

"For a woman who previously had gestational diabetes, we do tell them that there is a possibility of gestational diabetes recurring so she should be prepared that she might have it again".

[District Hospital professional nurse]

"On the district level we are running continuous campaigns for prevention of chronic diseases. In terms of diabetes specifically, we have got a very effective dietician. There is a team of dietician who is based here in the district, they will also go out and do campaigns, do BMIs and all those things, and advise people on nutrition".

[Non-communicable diseases district manager]

It emerged during the interview that different stakeholders collaborated during health educational campaigns.

Quotations

"When we run our campaigns we collaborate with other stakeholders, in this sense we invite businesspeople to come and be part of our campaigns. We are involved in what is called School Health programme, so we involve the Department of Health. We involve all the other departments. For example, last week we had a campaign wherein the Department of Agriculture had their own health day where they invited the Department of Health to grace their occasion".

[Non-communicable diseases district manager]

"The only place we could say we are collaborating is because we are under one roof. So, if I am planning a campaign, they will be there. They will know that we are planning a campaign, and they will go in with what they need to say in the campaign….".

[Non-communicable diseases district manager]

GDM was described as a rare condition which was rarely focused on during antenatal classes.

Quotations

"I think it's an eye opener, that while we educate them on other conditions, we should also include gestational diabetes. Maybe it's because it's rare that we have this condition that we never consider including it while we teach them about other conditions that are familiar during pregnancy".

[Primary Healthcare professional nurse]

"…everything is changing. Those things which we saw was rare before, they are now prevalent……. Things are changing. They have to be aware like when I see somethings like this, I need to report, by just educating them about the importance of giving us urine when they come for ANC classes, the urine testing, it would make a difference that they will be willing to do it so that they know that they are investigating something serious".

[Community Health centre professional nurse]

THEME 4 – CONTROL OF GESTATIONAL DIABETES

The theme 'control of gestational diabetes' describes the elements which ensures that the services provided at the health facilities are efficient.

This theme was supported by the following categories:

Quality improvement

It emerged from the interview that the professional nurses and doctors relied on policies and guidelines when providing care to pregnant women. The policies and guidelines differed from one level of health institution to the other.

Quotations

"Maternity guideline, it's a national guideline…that's the only guideline I know".

[District Hospital Doctor 1]

"There is maternity guideline 2016. We also incorporate the teachings from consultants/specialists".

[District Hospital Doctor 3]

"We also have protocols that are signed by the doctors in the maternity. We use them in conjunction with maternity guideline".

[Primary Healthcare professional nurse 1]

"With gestational diabetes, we use the Apogee or the Royal College of Obstetrics and Gynaecology (RCOG) guidelines. It also depends on the consultants that you are working with at the time. Some consultants prefer the Americans ones, and some prefer the RCOG ones. South African guidelines are not clear when it comes to managing gestational diabetes, so most of our consultants prefers those other ones but it's also a mixture, it also depends on situations".

[Regional Hospital Doctor 2]

"Mostly we refer to obstetric guideline in Limpopo or because now they are not there official, its either you refer to Cronje book that we read, or the consultant will be there. It's either they do a management of where they have been trained, or what they are comfortable with. They use regime from Steve Biko, Groote Schuur in Cape Town, then we use that. That's what we use or from the Maternity guideline even though everything is modified depending on the hospital that side".

[Regional Hospital Doctor 1]

From the interviews conducted, there were some professional nurses and doctors who prioritise that they ought to be competent in their practice after they have identified gaps in knowledge. Furthermore, it emerged that some senior doctors were reluctant to manage maternity cases. While, for others they didn't have any further training.

Quotations

"I have a Diploma in Obstetrics".

[Regional Hospital Doctor 1]

"No, I just have midwifery. Basic midwifery".

[Primary Healthcare professional nurse 1]

"I have speciality in Midwifery which I obtained in 1999".

[Regional Hospital professional nurse]

"It's a bit difficult for the district because a lot of our districts don't have seniors so it's quite difficult. One problem I have noted is that our maternity in the districts is not being managed by senior. The seniors run away from maternity and leave community service doctors, most of them don't know how to manage maternity".

[Regional Hospital Doctor 2]

For others, there was no further training done to improve their skills.

Quotations

"Apart from the training we did in obstetrics emergencies when I was still doing my internship in 2017, no I don't have further training".

[District Hospital Doctor 3]

Health system

All the health facilities in this study reported conducting urine dipstick, HGT, random blood plasma, fasting glucose, oral glucose tolerance test (OGTT) as means of diagnosing gestational diabetes.

Quotations

"Fasting glucose we do sometimes especially in our inpatients. So, if we admit them if the HGT is high, we admit them and tell them from 22h00 you must not eat anything and in the morning before they eat, we collect bloods".

[District Hospital Doctor 3]

"…. She was diagnosed at the clinic after urine analysis-the blood sugar was high".

[District Hospital professional nurse]

"If we investigate, it's either we take bloods, do HbA1C, or you do OGTT just to investigate".

[Regional Hospital Doctor 1]

It emerged from the interviews that there were discrepancies in management of GDM. Variety of treatments were provided to patients.

Quotations

"It depends on….it depends, it's the same as the other diabetes. It depends if it's young one we just give insulin".

[District Hospital Doctor 1]

"We give them oral hypoglycaemic agents".

[District Hospital Doctor 2]

"We used to give them insulin but now we don't. we believe that the old practice was that if you had diabetes before pregnancy or newly diagnosed, you supposed to be on insulin treatment. But currently not because of other developing studies, it has been shown that if we put the patient on oral metformin, they do well provide that the blood glucose is maintained".

[District Hospital Doctor 3]

"But because we never put them on injectable for gestational DM straight away, we start them on orals we don't usually worry about hypoglycaemia, we usually worry about hyperglycaemia and possible complications".

[Regional Hospital Doctor 2]

"We used to check their blood sugar 4 hourly; some brought their injections while others were on metformin. Their glucose was well controlled. Their diets were that of diabetic patient. Their food didn't have sugar, and this included tea".

[District Hospital professional nurse]

"With our gestational diabetes, we give them metformin and Glucophage. It depends on how high the sugar is, or it depend on the people. Here we tend to start them at 850 mg three times a day, then if it's not working that's when now we admit them if their sugar is still very high. We admit them, we do what we call glucose profile. With glucose profile we sat that you are in the hospital, they must take your sugar before you eat in the morning, 30 minutes again before you eat any meal, 2 hours after you ate your breakfast, lunch, or supper. Then we get them glucose profile, then we start them on injectable. Our injectable is either we start them on unltraphide, the short acting insulin, we give them ultraphrane which is the intermediate or we go to protaphane which is long acting. We start them on that depending again on their weight. It's either we give them two thirds in the morning, the other third evening calculating using their weight on the doses we give".

[Regional Hospital Doctor 1]

As part of the health education during ANC, pregnant women who were diagnosed with GDM received education on the health condition and how to take care of themselves.

Quotations

"We usually educate them on how the gestational diabetes is going to affect the pregnancy, the growth of the baby and also their weight as well as they have to do follow up".

[District Hospital Doctor 3]

"Mostly for us what we do is that we might be suspecting before the results even comes out. When the results come out, we counsel them and now that we've picked up the sugar has been high or any investigations that we did are showing us that you have gestational diabetes, the next step is you will be seen by a dietician who will tell you about the food to eat and not to eat. Again, from our side, now you've become a high risk meaning that we must see you almost every 2 weeks in our clinic. Again, the other thing is just adherence at home, they must

watch what they eat. They must be compliant with their treatment either they are on injections or oral agents".

[Regional Hospital Doctor 1]

As part of support provided to pregnant women diagnosed with GDM by professional nurses and doctors; information on treatment, diet and monitoring of glucose was provided to ensure successful self-management.

Quotations

"We give education on diet. Most are referred to a dietician. We teach them to monitor foetal movement and complying with treatment which they are given".

[District Hospital professional nurse]

"A lot of patients' experience metal taste with metformin and what not. The simple, most common complications that patients are worried about, they are not worried about the renal effects, they're worried about what things they will experience once they start taking metformin. Some patients stop taking it because they don't like the side effects. So, you try to advise them to say if there are any changes, they must come back to you, and this is how we are going to monitor them".

[Regional Hospital Doctor 2]

"Some I do advise to even check their blood sugar at the nearest clinic".

[Regional Hospital Professional nurse]

Decision support for gestational diabetes

It emerged from the interviews that multi-disciplinary approach was used when managing pregnant women with GDM.

Quotations

"Usually, we refer her to the doctor at high risk. I've never had a case where I had to refer to a social worker, I've never had such a case".

[Primary Healthcare Professional nurse 2]

"Then again because you know that diabetes has to do with food, then the social workers must come and explore if the patient can afford the food that they are being told to eat knowing that things are expensive, if they are saying that you must be on diabetic diet its very expensive because every time you are eating. Then the social worker must come. Also, the psychologist mostly for them is a shock now that they have to start injecting. Again, they have to go for ophthalmologist consult for eye test. Again, we have to consult a physician to come and explore the complications that the patient can develop".

[Regional Hospital Doctor 1]

"The management is team approach. A dietician, social worker to check the social condition of the woman if she will manage the diet that is needed; the fridge to keep the insulin if she is on injectable, we also need a physician that should also see the woman because after delivery the physician must take over so it's a co-management. They will only go to occupational therapy when they have mobility issues. Otherwise, the major ones are the dietician, physician, obstetrician, midwife. And maybe the psychologist because some are being affected to a point of not coping, that is individual not routine".

[Regional Hospital professional nurse]

During interview, it was found that in an event wherein the woman requires or would require specialised care, they were referred to a next level of care for further management.

Quotations

"When we have the gestational diabetes patient, we book them with Letaba hospital, and they attend the high risk from Letaba at gestational age of 36 weeks and then we send them that side for delivery".

[District Hospital Doctor 2]

"They are managed at the hospital. Once we diagnosed them, they are taken to high-risk clinic where they will attend their antenatal clinics there and deliver at the hospital".

[Community Health centre Professional nurse]

"Gestational diabetes is not managed at district level because the baby will need a paediatrics consult when they are born".

[Regional Hospital Doctor 2]

Across all interviews with professional nurses and doctors working in maternity unit, after the woman has been diagnosed with GDM or has delivered, they were referred to a dietician immediately. However, in other health facilities, a dietician was not accessible.

Quotations

"We work with dieticians because they have a big role in this case as they have to educate our patients on what to eat".

[District Hospital Doctor 3]

"When it comes to managing it is through lifestyle. We try not to give a lot of dietary information because I feel like most of us feel that we are not qualified enough to give dietary information. For us we just encourage them to listen to what the dieticians are saying".

[Regional Hospital Doctor 2]

"No, she came around February, but it was just a surprised because we didn't know she will come. Last year we didn't have, 2020 we did not have, before covid they used to come every month once a month so we would book patients for them. But since covid, they have not been coming".

[Primary Healthcare professional nurse 2]

It was reported during the interview that after the woman has delivered, she and the baby would be given follow-up appointment dates for continuation of care. For patients who were being seen at the district hospital, they were sent to clinics for follow-ups while those who were being seen at regional hospital, they do their follow-ups in district hospital.

Quotations

"…. After delivery we send patients back to the clinics to do postnatal check-ups there unless if there is a complication then the clinic will send the patient back to the hospital".

[District Hospital Doctor 2]

"The mother comes for a follow-up after a month for blood glucose monitoring. With the baby, we just ask how the baby is doing at home. Are they suckling well, eating well, it there is nothing we don't really do formal investigations".

[District Hospital Doctor 3]

"The baby and mother would come after 3 days or within 3-6 days for check-up, so we don't usually follow them up that much. The doctor would have made an appointment with this mother that must come on this side for follow-ups".

[Community Health centre professional nurse]

"They go to their hospitals. What we do when we discharge them, there is a discharge summary letter which we write addressing doctors at district hospitals for patients to do follow-ups in their hospitals that side. What we've realised again is that having doctors that refer most of them are more comfortable treating diabetes when the patient is not pregnant than when they are not pregnant. So, we refer them that side and they will continue with treatment in their hospital'.

[Regional Hospital Doctor 1]

The research established that there was supervision in maternity unit and referrals of complicated cases were made. Furthermore, there were challenges experienced by district hospital doctors when referring patients to regional hospital for further management.

Quotations

"There is an overall supervisor, usually am alone but she is always there in the clinic. In case I need help with something, she will be there to assist".

[Primary Healthcare professional nurse 2]

"I have 2 consultants. 1 general obstetrics/gynae and 1 gynae oncology".

[Regional Hospital Doctor 2]

"it's not easy because you have to convince the other doctor who doesn't even see the patient. And even if the patient is in serious condition, they don't accept it because they are afraid of maternal death. The protocols states that we must start with regional hospital and if we fail, we go to tertiary hospital. If we fail there, we involve the clinical managers so they will be the ones who are dealing with the case".

[District Hospital Doctor 2]

Human resources

It emerged from the interview that doctors and professional nurses had different experiences regarding how long they have been working in maternity unit. In other institutions, they work on rotational basis.

Quotations

"Since 2005, though we rotate but most of the time I'm working in maternity".

[Community Health centre professional nurse]

"For about 10 years now".

[Primary Healthcare professional nurse 2]

"I worked there for almost four months".

[District Hospital Doctor 3]

"I have been working there for 20 years".

[Regional Hospital professional nurse]

"Since 2016, u think 6 years and some few months if am not mistaken".

[Regional Hospital Doctor 1]

It was a common consensus among the professional nurses and doctors that further training is important when working in maternity unit as management is constantly challenging as a result of emerging information.

Quotations

"I think it's very important considering that we do have a lot of maternal mortality and morbidity, so if we can have the right training it will assist in reducing those and also improving the outcome of your neonatal or babies".

[District Hospital Doctor 3]

"It's very important to go to training workshop because things keep changing every day, so we always have to keep updating ourselves. And we can only do that through trainings".

[Primary Healthcare professional nurse 2]

In-service trainings and workshops were found to be conducted in most health facilities. For other health facilities, it was not the case.

Quotations

"The only things we have are in-service trainings, workshops, no other further trainings except those ones".

[Community Health centre professional nurse]

"…. At hospital level, its meetings, morning meetings and then ESMOES especially for the newly employed".

[Regional Hospital professional nurse]

"No, there is nothing happening. But I remember, a district specialist used to come in our institution and teach but that was in 2019. He only came once in 2019".

[District Hospital Doctor 3]

THEME 5 – OUTCOMES OF GESTATIONAL DIABETES

The theme ‘outcomes of gestational diabetes’ relate to the maternal and infant health outcomes that are associated with GDM. During the interview, it was found that there were complications which were found during ANC visits, during labour and post-delivery. Management of such complications was also highlighted.

The theme was supported by the following categories:

Complications of gestational diabetes

Quotations

“That’s why we end up having patients by the end of 36 weeks of gestational age, there is no heartbeat on the baby, and they have IFD because that prolong uncontrolled hyperglycaemia does affect the foetus”.

[District Hospital Doctor 3]

“The reason we take them out at around 38 weeks is because we know that the placenta tends to grow out quicker with diabetics and hypertensive around 38 weeks the placenta tends to be too old to support the big baby and that’s where most of the babies die inside”.

[Regional Hospital Doctor 2]

“They can have difficulties in delivering, have IFD, shoulder dystocia”.

[District Hospital Doctor 1]

“With the babies, it’s usually the baby is too big, so you end up with a Caesarean section”.

[Regional Hospital Doctor 1]

“For the woman because of that hyperglycaemia, they gain weight a lot so it puts them at risk of anaesthesia because in that kind of patients we suspect that the baby might be big, then we know that the patient has to go for an operation”.

[District Hospital Doctor 3]

"After delivery if the baby is out what we mostly fear is that most of the babies become hypoglycaemic, and most of them have respiratory distress because mostly diabetic babies their lungs are not matured like normal babies. So those are the things or expectant death of the baby. You find that they are delivered, they are with their mother the sugar goes down, the mother doesn't notify the health care worker or doesn't say anything. Or the mother has delivered via caesarean section, and they are struggling to breastfeed, or the milk is not coming out, they don't say anything for a top out milk and then the baby dies".

[Regional Hospital Doctor 1]

"The baby has some cardiac problems which you will see after they've been delivered…".

[Regional Hospital Doctor 2]

Management of complications of gestational diabetes

It emerged from the interview that the complications associated with GDM were managed by MDT. This meant that the mothers and babies were referred based on their specific needs at that time.

Quotations

"Then in our mothers what we do mostly is we, they are offered psychology consult after delivery and if they have more complications, they end up with acute kidney failure and we bring our physician to come and help with the management. It's just a multi-disciplinary approach mostly in our women because we want our physician to be there, we want our dietician to be there, our social workers to be there and the psychologist. With other things if there are renal problems which we can't manage in our institution, we ask Polokwane, the renal team to send patients to them so they can help us with renal problems".

[Regional Hospital Doctor 1]

"……there are consultants who are interested in paediatrics, so they are the ones who see all babies either the sugar is down, they top up with milk

or the admit them in their unit and start investigating more if they keep having complications".

[Regional Hospital Doctor 1]

It was highlighted that during intrapartum, caesarean section was performed to minimised adverse health outcomes on mother and baby.

Quotations

"For big babies most of the time we end up with caesarean section unless if she is well controlled, you are going to induce at around 8 months. If the baby is not too big, she can deliver but if around 38 weeks and 36 weeks and the baby is too big you can't induce. You have to take out the baby via caesarean section".

[Regional Hospital Doctor 2]

Measures to prevent complications were taken by nurses and doctors. In addition, the pregnant women themselves are also educated on how to manage themselves at home to minimise complications.

Quotations

"Then the other way is for the mother to monitor the baby if the baby is playing which can be difficult especially if they have a lot of lacquer because of diabetes, but it's for them to monitor how the baby is playing, if there is any change, they you admit the patient and take the baby out".

[Regional Hospital Doctor 2]

"The other thing is the importance of getting it controlled because it has a danger on the baby especially, it might not be too dangerous on her but on the baby if the sugar is not controlled the baby might be affected".

[Regional Hospital professional nurse]

THEME 6 – CHALLENGES IN MANAGEMENT OF GESTATIONAL DIABETES

The theme 'challenges in management of gestational diabetes' is connected to health system barriers which affect the provision of health services.

The theme was supported by the following category:

Challenges in management of gestational diabetes

It was found in the study that the majority of pregnant women were not aware about GDM as there was no education provided to them by professional nurses and doctors. The women who are become aware are the ones who at some point during ANC get investigated for it after presenting with symptoms.

Quotations

"There is no education".

[District Hospital Doctor 1]

"They are not aware because it's a rare thing and we even forgot to tell them about it. It's a rare thing, we just forget to talk about it or maybe giving health education in the mornings, we forget".

[Community Health centre professional nurse]

"…The ones we are checking are becoming more aware. Other patients, we are lacking when it comes to both the hospital and our bigger clinic 'High risk'. Like the information is not enough".

[Regional Hospital Doctor 1]

Therefore, health education in ANC mainly focused on high-risk common conditions which therefore contributes to poor awareness of GDM amongst pregnant women.

Quotations

"But gestational diabetes is poorly understood, or we don't just invest much on it. We usually focus more on hypertensive disorders in pregnancy. I can say we don't actually screen patients for it unless they are having symptoms".

[District Hospital Doctor 3]

"We educate them on any topics like hypertension in pregnancy, STIs, Foetal movements monitoring. Breastfeeding, infant feeding…family planning….".

[Community Healthcare centre professional nurse]

"The main thing here is that the focus is still, the chronic diseases are overshadowed by HIV/AIDS, Covid-19, those things are the ones that get more prominence than chronic diseases. I can tell you now that I was looking at the annual performance plan for the province and on that annual performance plan, we don't have a single indicator on chronic diseases. This tells you that the province is not monitoring what the districts are doing in terms of chronic diseases. Now, that's a problem on its own".

[Non communicable diseases district manager]

"So, I think also because the complications of diabetes are not always as tragic as hypertension and HIV. They so tend to focus on those things that are affecting the community more like more common in the community which is hypertension and HIV".

[Regional Hospital Doctor 2]

It emerged from the interviews that inadequate resources and utilisation of health system contributed to challenges in management of GDM. It was expressed that there was overcrowding, limited physical space, high number of patients and malfunctioning equipment affected the services which were being rendered.

Quotations

"The high risk here has high number of patients, so we start with health talk. When we start with the clinic, we start pushing the queue so patients must go home earlier, and the space is limited".

[District Hospital Doctor 2]

"It's a problem because there is no privacy and at the end you become tired seeing unnecessary conditions then we end up missing the serious ones".

[District Hospital Doctor 2]

"Unavailability of resources. I think that's one of the biggest contributing factors. Also, the issue of overcrowding, the number of patients we see is just too much. So usually, we just do basic vitals like blood pressure,

temperature, pulse. Sometimes we find that the scale is broken and so if you were to do thorough vitals in each patient if we are having 75 patients on that day, it's going to take more time. In most of the time we are just basically pushing the queue making sure that everyone who comes are attended to".

[District Hospital Doctor 3]

"…. That's a difficult part because there is no area for them to be together and be taught. It's such many patients that you are seeing at high-risk day. We don't have space for them. Most of them in the clinics we share the same clinic with medical patients, psychiatric patients, with paediatrics. You find that your patients are sitting outside, they are just coming in small numbers, and they just come to the consultation room".

[Regional Hospital Doctor 2]

"Because gestational diabetes am not sure if its due to knowledge as a staff, we don't go much into it".

[Regional Hospital Doctor 1]

5.2.4. Overview of research findings

The findings of the study showed that there were few cases of GDM reported and monitoring of GDM was not done as there is no indicator for GDM in the DHIS system. The study found that tests were only done in pregnant women presenting with signs and symptoms. Furthermore, all pregnant women were screened for GDM through urine dipstick analysis during ANC visits and interview during ANC booking. Heath education on GDM was only provided to pregnant women diagnosed with GDM as it was a challenge to educate everyone as result of infrastructure, human resource challenges in hospitals and clinics. It emerged from the study that district health units collaborate in health educational campaigns.

However, they rarely focus on GDM. When providing treatment to pregnant women, doctors and nurses were found to use policies and guidelines as references and these varied depending on level of care (PHC, CHC, district hospital and regional hospital) and training. Multi-disciplinary approach was used when managing pregnant women

diagnosed with GDM. With regards to GDM treatment approaches, medications were prescribed; dietary treatment was provided as well as self-management approaches to be followed a home. To minimise complications associated with GDM, caesarean section as mode of delivery was scheduled before the woman reaches 40 weeks of gestational age. Inadequate to no training was provided to doctors and nurses by the clinics and hospitals.

5.2.5. Conclusion

The results of qualitative phase I of exploratory mixed method were presented and interpreted. The following section of this chapter will focus on presenting phase II results findings.

5.3. PHASE 2 QUANTITATIVE RESEARCH FINDINGS

Determining the prevalence, risk factors, maternal and infant health outcomes of GDM, and investigating knowledge and perspective of patients on GDM and its management.

5.3.1. Introduction

This chapter presents the findings of the descriptive quantitative design, which is the second phase of exploratory mixed methods. The objectives of quantitative design in this study were to determine the prevalence and risk factors of GDM, describe the maternal and infant outcomes associated with GDM, determine the association of socio-demographics and risk factors with maternal and infant outcomes, and investigate the knowledge of pregnant women on GDM and its management.

The quantitative data was collected from the pregnant women. Data was collected using a questionnaire, and findings were categorised into socio-demographic characteristics representing the profile of pregnant women and variables attributed to the occurrence of GDM. Data was collected from 386 pregnant women attending antenatal clinic visits in various levels of care health facilities, i.e., regional hospital, district hospital, community health centres and primary health care across the Mopani district. The data was captured and analysed using SPSS version no 29.0.0.0. Frequency tables, percentages, fisher-exact tests, and univariate and multivariate logistic regression analysis were used to analyse data.

5.3.2. Data management and analysis

The researcher captured data collected from pregnant women during ANC visits in a book register and later in a Microsoft Excel spreadsheet. The questionnaires completed by the pregnant women in conjunction with informed consent forms were stored in lever arch files. SPSS version no 29.0.0.0. was used to analyse data and interpret using frequencies and percentages. The association between variables was assessed using the fisher-exact test, and risk factors using logistic regression analysis.

5.3.3. Research results.

5.3.3.1. Socio-demographic factors

A total of 424 pregnant women were asked to participate in the study, of which 386 participated. Most (79%) pregnant women attended their 1st ANC visit after 8 weeks

of gestation (Figure 6.1). About 44.3% of pregnant women their current gestational age (GA) was at 24-34 weeks.

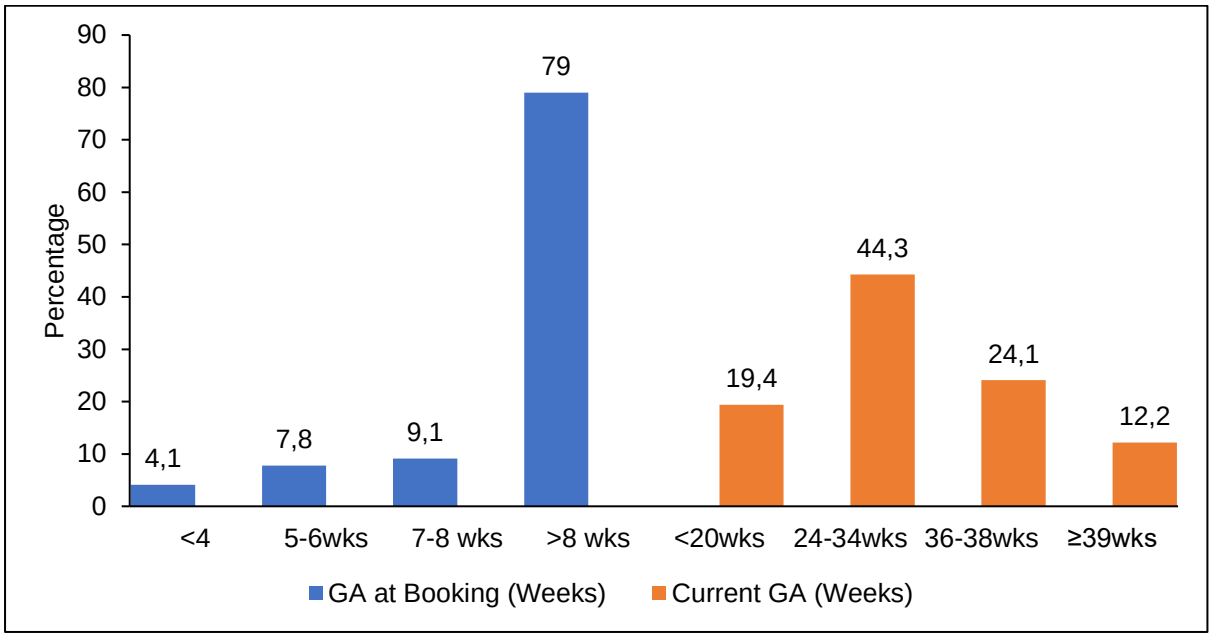


Figure 5.2: Pregnant women's gestational age.

Table 5.1 shows the socio-demographic characteristics of pregnant women participating in this study. Most of the pregnant women (24.9%) were in the age group 30-34 years. Fifty-three per cent (53.4%) of the women were unmarried, while 73.8% had secondary education. This study's unemployment rate was very high, as 80.6% of pregnant women were not working.

Forty-two per cent (41.7%) of the pregnant women were obese (>30 kg/m²), and most of the women have been pregnant at least two times (26.2%), while 30.8% of the women have given birth to more than one child. A high proportion (81.6%) of pregnant women have never had a miscarriage before, and 82.6% have no family history of diabetes.

Table 5.1: Socio-demographic information of pregnant women participants

	No	(%)
Age (years)		
15-19	52	13.5
20-24	64	16.6
25-29	84	21.8
30-34	96	24.9
35-39	60	15.5
>40	30	7.8
Marital status		
Single	206	53.4
Married	171	44.3
Divorced	3	0.8
Widowed	5	1.3
Educational level		
None	10	2.6
Primary	19	4.9
Secondary	285	73.8
Tertiary	72	18.7
Employment		
Employed	74	19.2
Unemployed	311	80.6
Body Mass Index		
Underweight (<18.5 kg/m²)	4	1.0
Normal weight (18.5-25 kg/m²)	101	26.2
Overweight (25-30 kg/m²)	119	30.8
Obese (>30 kg/m²)	161	41.7
Gravidity (No of times a woman has been pregnant)		
One	90	23.3
Two	101	26.2
Three or more	195	50.5
Parity (No of times a woman has given birth)		
Zero	104	26.9
One	119	30.8
Two	84	21.8
Three or more	79	20.5
Miscarriage		
None	315	81.6
One	57	14.8
Two	8	2.0
Three or more	6	1.6
Family history of diabetes		
History of Diabetes	67	17.4
No history of diabetes	319	82.6

5.3.3.2. Prevalence and risk factors of gestational diabetes

The prevalence of GDM was 3.6% (n = 14). A univariate logistic regression model shows pregnant women aged 35 years and older had a higher risk of developing GDM than those aged 30 and younger (OR: 2.31; 95% CI: 0.72-7.37, p<0.2, **Table 5.2**).

The result of the multivariable logistic regression model also confirmed this relationship but was not statistically significant (OR: 1.72; 95% CI: 0.51-5.74, p>0.05). The other factor significantly associated with GDM in the univariate logistic regression model was married pregnant women (OR: 2.33; 95% CI: 00.76-7.09, p<0.2), but in the multivariable logistic regression model, the finding was not statistically significant (OR: 2.04; 95% CI: 0.64-6.49, p>0.05).

Table 5.2. Association between demographic and clinical characteristics with risk of GDM

	Univariate Logistics Regression		Multivariate Logistics Regression	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age (years)				
<30	Ref		Ref	
30-34	0.68(0.14-3.47)	0.651	0.57(0.11-2.94)	0.501
35+	2.31(0.72-7.37)	0.157	1.72(0.51-5.74)	0.381
Marital status				
Unmarried	Ref		Ref	
Married	2.33(0.76-7.09)	0.135	2.04(0.64-6.49)	0.226
Educational level				
None/Primary/ Secondary	Ref			
Tertiary	0.72(0.16-3.29)	0.670		
Employment				
Employed	Ref			
Unemployed	2.82(0.44-18.07)	0.274		
Body Mass Index				
Under/Normal weight (<25 kg/m²)	Ref			
Overweight/ Obese (>25 kg/m²)	2.31(0.51-10.48)	0.279		
Had a family history of diabetes				
Yes	Ref		Ref	
No	0.6(0.12-1.11)	0.076	0.41(0.13-1.28)	0.126
Parity				
0	Ref			
1	1.17(0.26-5.36)	0.839		
2+	1.51(0.38-5.98)	0.557		

The association between demographics and GDM is shown in Table 5.3. Pregnant women in the age groups <25 years were significantly less likely to present with GDM than the other age groups (p<0.05). There was no statistically significant association between GDM and marital status, educational level, employment status, BMI, family history of diabetes and parity (p>0.05). Pregnant women between the ages 25-29

years, married, had secondary education but unemployed, obese, with a family history of diabetes and had given birth to 2 children or more were more likely to present with

	N	Gestational Diabetes Mellitus		p-value
		Yes GDM	No GDM	
Age (years)				
<25	116	0(0)	116(100)	0.005
25-29	84	6(7.1)	78(92.9)	
30-34	96	2(2.1)	94(97.9)	
35+	90	6(6.7)	84(93.3)	
Marital status				
Single	206	5(2.4)	201(97.6)	0.412
Married	171	9(5.3)	162(94.7)	
Divorced/ Widowed	9	0(0)	9(100)	
Educational level				
None	10	0(0)	10(100	0.916
Primary	19	0(0)	19(100	
Secondary	285	12(4.2)	273(95.8	
Tertiary	72	2(2.8)	70(97.2)	
Employment				
Employed	74	1(1.4)	73(98.7)	0.486
Unemployed	312	13(4.2)	299(95.8)	
Body Mass Index				
Underweight (<18.5 kg/m²)	4	0(0)	4(100.0)	0.386
Normal weight (18.5-25 kg/m²)	101	2(2.0)	99(98.0)	
Overweight (25-30 kg/m²)	119	3(2.5)	116(97.5)	
Obese (>30 kg/m²)	161	9(5.6)	152(94.4)	
Had a family history of diabetes				
Yes	67	5(7.5)	62(92.5)	0.065
No	319	9(2.8)	310(97.2)	
Parity				
0	104	3(2.9)	101(97.1)	0.888
1	119	4(3.4)	115(96.6)	
2+	163	7(4.3)	156(95.7)	

GDM than their counterparts. **Table 5.3:** Association between Demographics and GDM.

5.3.3.3. Maternal and infant outcomes associated with gestational diabetes mellitus.

Table 5.4: Distribution of the pregnant women diagnosed with GDM according to complications associated with the pregnancy.

Complication associated with pregnancy	Number of pregnant women	Percentage (%)
None	3	21.43
Previous caesarean section	2	14.29
Previous IUD	2	14.29
Bad obstetric history (obese, Advanced maternal age, PIH, etc)	6	42.86
No foetal movements	1	7.14

As shown in Table 5.4, four women (28.4%) were found with previous caesarean section and previous IUD, 6 (42.86%) with bad obstetric history and 1 (7.14%) with no foetal movements. All pregnant women were booked for caesarean section delivery. The Infant outcomes were not recorded as the pregnant women were not followed until delivery.

5.3.3.4. Knowledge of patients on gestational diabetes and its management

Most pregnant women (84.7%) were unaware of Gestational Diabetes Mellitus, while only 15.3% were aware (Figure 5.2.). For those mindful of GDM (n=59), various sources of information identified are shown in Table 5.6.

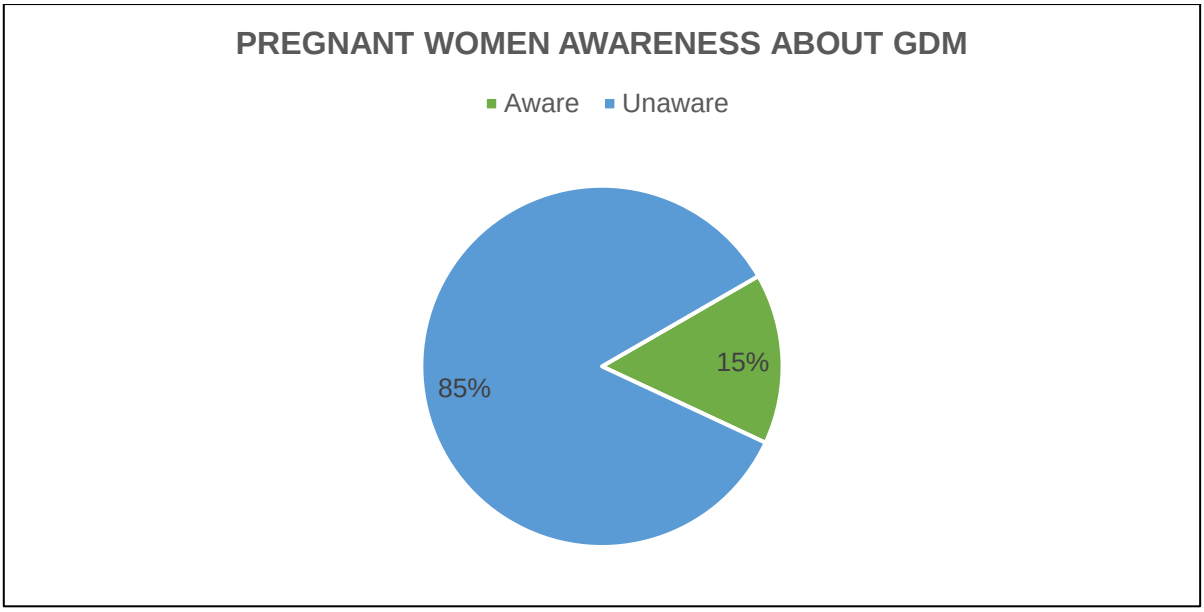


Figure 5.3: Awareness of pregnant women about Gestational Diabetes Mellitus

Most pregnant women (69.5%) heard about GDM from healthcare workers while consulting at a clinic or hospital, and 18.6% heard about this condition from a family member who either was diagnosed or knew of someone with diabetes mellitus. In table 5.5, about 8.5% of pregnant women knew about GDM from media (TV, Radio, Newspaper, Pamphlet, Online), with few (0.5%) having heard about GDM in school when learning Life sciences/Biology.

Table 5.5: Sources of information for pregnant women who have heard about GDM.

	No	%
Health worker	41	69,5
Family	11	18,6
Media	5	8,5
School	2	3,4
Total	59	100,0

Table 5.6 below presents pregnant women's knowledge and awareness of GDM and its management. When questioned about GDM occurring for the first time in pregnancy, 65.8% of the pregnant women reported that GDM could not occur for the first time in pregnancy, while 34.2% of pregnant women had different views as they said it's possible that GDM could happen for the first time in pregnancy. Most pregnant women (66%) didn't consider family history as a risk factor of GDM compared to 34% pregnant

women who reported that diabetes is a familial health condition; hence those with family history can be diagnosed with GDM during pregnancy.

When pregnant women were asked if obesity before pregnancy is a risk factor for GDM, most (72.3%) reported that obesity was not a risk factor for GDM, with only 27.7% reporting obesity as a risk factor. The study found that a high proportion of pregnant women (75.4%) reported that previous history of GDM was not a risk factor for GDM compared to the low proportion of pregnant women (24.6%) who agreed that GDM could reoccur in subsequent pregnancies.

When asked if rapid weight gain (RWG) during pregnancy is a risk factor for GDM, 78.2% of the pregnant women felt that RWG is not a risk factor compared to 21.8% of pregnant women who expressed that RWG can influence the occurrence of GDM. Most women (69.2%) in this study highlighted that they had never heard about blood test after glucose load to test for GDM meanwhile 30.8% of women were aware of this diagnostic method of GDM.

Table 5.6: Pregnant women's knowledge regarding what they think are risk factors that contribute to GDM and long-term consequences of GDM in children & mothers.

Pregnant women's knowledge on risk factors contributing to GDM and long-term consequences in children & mothers.	**Yes (%)**	**No (%)**
A. Know the occurrence of GDM	34.2	65.8
B. Known family history as a risk factor	34	66
C. Obesity before pregnancy as a risk factor of GDM	27.7	72.3
D. Previous GDM as risk factor of GDM	24.6	75.4
E. Rapid weight gain as a risk factor of GDM	21.8	78.2
F. Awareness about blood test after glucose load to test for gestational diabetes mellitus.	30.8	69.2
G. Necessity of testing for GDM during pregnancy	82	18
H. Even diet, exercises and insulin can be used to treat GDM	62.7	37
I. GDM resolves after pregnancy	15	85
J. GDM pose a risk on the baby if untreated	60.4	39.6
K. Mothers with GDM are at risk of developing Type 2 DM in future	27	73

Amongst pregnant women who participated in this study, 82% believed it necessary to test for GDM during pregnancy. However, 18% of pregnant women answered that it is not essential for a woman to be tested for GDM during pregnancy. The study findings showed that most pregnant women (62.7%) were aware that even diet, exercise, and insulin could treat GDM compared to (37%) who were not aware. Furthermore, it is of note that there were pregnant women (0.3%) who didn't give their response when asked about this question.

A high number of pregnant women (85%) in this study reported that GDM does not resolve after pregnancy. Only a small number of pregnant women (15%) agreed that GDM resolves after pregnancy. More women (60%) agreed that not treating GDM poses a risk to the baby, whereas few women (40%) reported that the baby is not at risk even if GDM was not treated. Amongst pregnant women, 73% reported that mothers who had GDM in pregnancy were not at risk of developing Type 2 DM in future, with only 27% believing that GDM could lead to Type 2 DM.

5.3.4. Conclusion

In this chapter, the study's quantitative findings were presented and interpreted. The next section of phase II will focus on qualitative wherein the results obtained from pregnant women diagnosed with GDM will be presented.

5.4. PHASE 2 QUALITATIVE RESEARCH FINDINGS

The perception of pregnant women diagnosed with gestational diabetes mellitus on management of GDM.

5.4.1. Introduction

This section presents the qualitative purposive design findings for pregnant women diagnosed with GDM. The data was collected concurrently with administration of questionnaires to pregnant women attending ANC visits. Data was collected using a semi-structured interview and later transcribed verbatim to capture the pregnant women's perception of management of GDM. Fourteen (14) pregnant women diagnosed with GDM were recruited to participate in the study, with only seven (7) agreeing to participate. Xitsonga and English were used during the interviews. The data was analysed using thematic analysis wherein themes and categories were identified. No sub-categories emerged during analysis. Furthermore, table and direct quotations were used to support the researcher claims and giving the study participants a voice in the outcome of the study while contributing to credibility and transparency of the research.

5.4.2. Data management and analysis.

Data was collected using semi-structured interviews to further explore the phenomena of GDM amongst pregnant women diagnosed with GDM. Thereafter, interviews were transcribed verbatim, and transcripts were stored in a hard drive. Thematic analysis method was used wherein codes which are the segments of meanings were extracted from paragraphs. Codes were then grouped together to categories, and from the categories a theme was identified.

5.4.3. Research results.

Figure 5.8. below outlines the themes and categories for the pregnant women diagnosed with GDM summarising their perceptions. Three (3) themes, challenges in self-management of gestational diabetes; health system support for gestational diabetes; decision support for gestational diabetes and five (5) categories, adaptation challenges; no self-management challenges; self-management support (diet and exercise); self-management support (treatment and monitor blood glucose); and referral to dietician were identified.

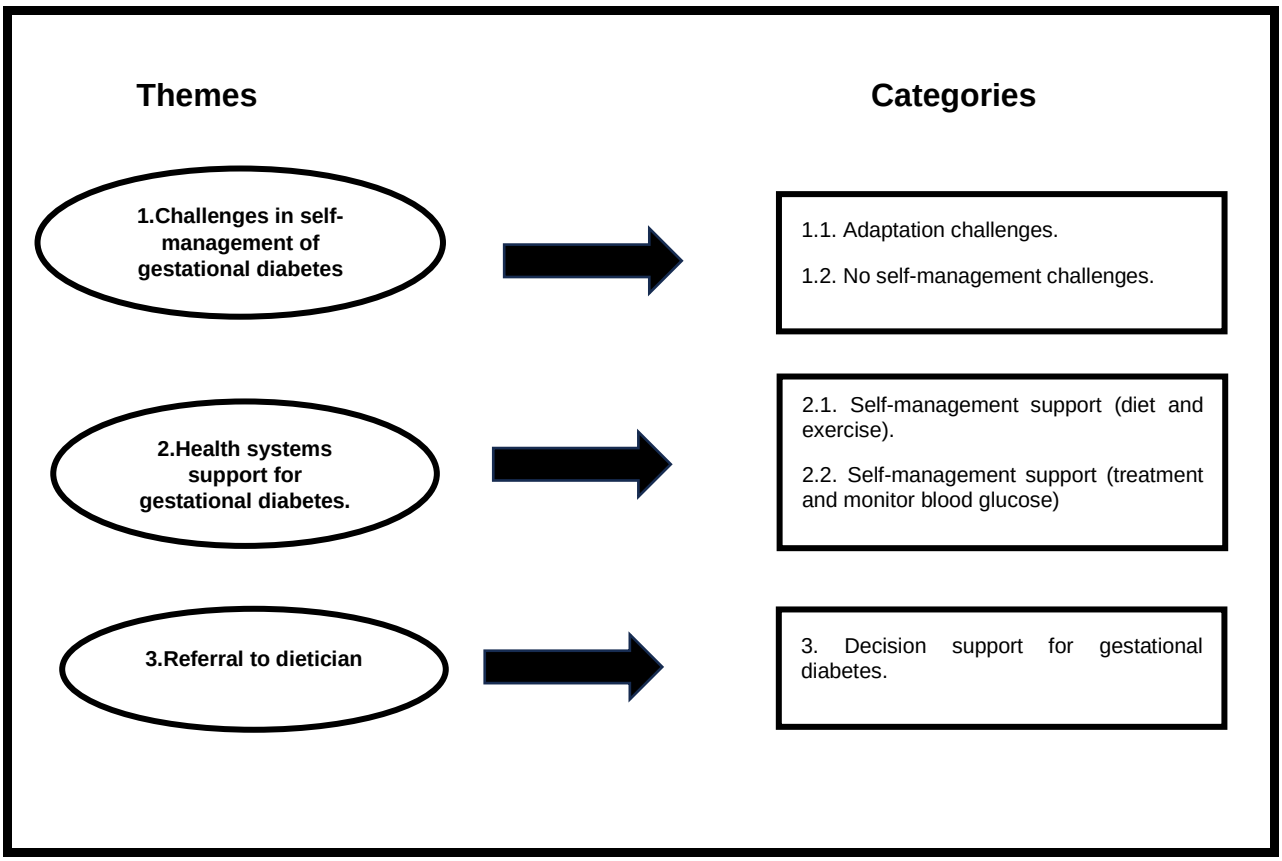


Figure 5.4: Thematic analysis – Themes, Categories.

THEME 1: CHALLENGES IN SELF-MANAGEMENT OF GESTATIONAL DIABETES MELLITUS

The theme was supported by the categories, adaptation challenges and no self-management challenges. The study findings revealed that they had to adapt their lifestyles after being diagnosed with GDM.

Quotations

> *"This condition has just been discovered recently when I was 28 weeks pregnant. At first it was difficult for me because I haven't adjusted to the fact that I have diabetes and I have to eat like this".*
>
> *[GDM Patient NK 62]*

"It's not easy but I have to tell myself that for me and my babies to be safe, I have to do what I'm being told. It's not easy to get some of the food I'm supposed to eat but I do try".

[GDM Patient NK70]

Other pregnant women expressed that they didn't experience any challenges when they were managing GDM at home as they are following the health education they received whilst attending ANC visits and for some, they were only recently diagnosed.

"So far nothing, as the medication I'm taking is treating me well".

[GDM Patient LH 29]

THEME 2: HEALTH SYSTEM SUPPORT FOR GESTATIONAL DIABETES MELLITUS

The theme was supported by the categories; Self-management support (diet and exercise) and self-management support (treatment and monitor blood glucose). As part of self-care management, health education related to diet and exercise was provided to the pregnant women by dieticians, doctors, and nurses during ANC visits.

Quotations

"I was told to change my diet and exercise".

[GDM Patient LH44]

"The dietician told me I must eat a meal like pap, it shouldn't exceed the size of my hand. I must eat less salt, less sugar in everything. But if I am hungry maybe an hour or 2 hours before my meal, I must have a snack to avoid my sugar level from dropping down to a level wherein it can hurt me".

[GDM Patient NK62]

However, some of the pregnant women expressed that they were not provided with any form of health education related to management of GDM after being diagnosed.

"I was not told anything. I eat the way I used to eat before I got pregnant."

[GDM Patient NK70].

Our findings showed that pregnant women who were on injectable treatment were given blood glucose monitoring while pregnant women who were not on injectables were not provided with blood glucose monitoring.

> *"(…...) before breakfast, I need to check my sugar level, and wait for 30 minutes before I administer an injection (actrapid and protaphane). I have to wait 30 minutes before I eat, after 30 minutes I would eat and wait for 2 hours before checking if my sugar level is back to normal".*
>
> *[GDM Patient NK62]*

> *"The nurses showed me how to test myself as well as injecting myself when it is time to take treatment".*
>
> *[GDM Patient LH45]*

> *"I'm taking metformin. Initially I was taking 850 mg, when I came back, they change it to 500 mg and I used to feel dizzy after taking it and when I complained about it, they changed it back to 850 mg".*
>
> *[GDM Patient NK76]*

> *"The treatment is easily accessible and always available".*
>
> *[GDM Patient NK62]*

THEME 3: DECISION SUPPORT FOR GESTATIONAL DIABETES

There was inconsistency in referring pregnant women diagnosed with GDM to a Dietician for management. Majority of them stated that they are only being seen by the nurses and doctors and not being referred to a dietician. For those who were referred to a dietician, they were previously admitted at some point during their pregnancy.

Quotations

"I am only seeing the doctor and nurse. I have not been referred to any other practitioner".

[GDM Patient LH29]

"(..)was referred before I was discharged. They told me to first go to a dietician to explain to me which diet plan I must follow".

[GDM Patient NK62]

"In Johannesburg where I was admitted, they referred me to a dietician, and they told me about the diet I must follow and gave me a pamphlet".

[GDM Patient NK70]

5.4.4. Overview of research findings

Our findings showed that management of GDM presents with its own challenges amongst pregnant women diagnosed with GDM. Majority of them had to change their lifestyle such as eating habits while others didn't encounter any challenges as they managed this condition at home. Treatment provided to the women varied as others were put on injectables and provided with blood glucose monitoring devices to monitor their sugar levels after a meal. In addition, for those put on oral tablets they were advised to eat healthy and exercise. However, this didn't apply to some pregnant women who expressed that they were not informed of any diet changes. The study further found that pregnant women diagnosed with GDM who were seen by a dietician were the ones admitted in the hospital.

5.4.5. Conclusion

The study clearly shows that the management of GDM in pregnant women diagnosed with GDM is not consistent. The results of the second section of phase II of this study were presented and interpreted. The next chapter will focus on integrating the study findings and discussion.

CHAPTER 6: INTEGRATION OF QUALITATIVE AND QUANTITATIVE FINDINGS AND INTERPRETATION OF RESEARCH FINDINGS

6.1. Introduction

In this chapter, the qualitative and quantitative findings were integrated using the merging method and the reporting of findings was done through visual joint display. A four-step approach was used to guide the interpretation and integration of findings and it includes creating a joint display, linking activity, establishing relationships, and interpreting and reporting (Skamagki et al., 2022). Data was presented in tables, direct quotations, percentages, graphs. Theoretical framework was used to organise the themes. The integration of research findings is followed by discussion in relation to the study objectives.

6.2. Data management and analysis

Qualitative data obtained from nurses, doctors, NCDs unit district health manager, maternal & child health unit district manager, and women diagnosed with GDM was collected using unstructured interviews. In addition, data was captured using recording and later transcribed verbatim and analysed using thematic analysis where themes emerged. Quantitative data was obtained from pregnant women during ANC visits in selected health facilities across the Mopani district. Questionnaires were used to collect data and information was captured in a data collection register. Thereafter, data was captured in Microsoft Excel spreadsheet and analysed using SPSS version no 29.0.0.0. program whereby association between variables was assessed using fisher-exact test, and risk factors using logistic regression analysis. Information from both datasets was stored in hard drive and arch files.

6.3. Results

6.3.1. Integration process

Integration was done using a four-step approach: creating a joint display, linking activity, establishing relationships, and interpreting and reporting. Graphs and tables were used to support the comprehensive description and illustration of the integration process.

6.3.1.1. Step 1: Creating a joint display.

A joint display was used to organise findings of qualitative and quantitative findings in a logical manner. The researcher was able to identify the links between two phases and looked for patterns. In the table 6.1 provided below, qualitative themes for phase I were displayed in the first column of the theme-by-statistics joint display and used as overall concepts for both phases. The other twelve (12) columns are the quantitative variables with illustrative quotes and statistical results. The qualitative results from phase II were integrated with qualitative results from phase I using a merging approach.

Table 6.1: Themes of Phase 1-by-statistics visual joint display

Themes	Variable-**Age**	Variable-**Employment**	Variable-**Marital status**	Variable-**Body Mass Index**	Variable –**Education level**	Variable-**Gravidity**	Variable-**Parity**	Variable-**Miscarriage**	Variable-**Diagnosis**	Variable-**Complications**	Variable –**Family history of diabetes**	Variable –**Awareness & Knowledge of GDM**
Theme 1: Burden of gestational diabetes.				.					**Illustrative quotes:** *"…. Maybe I can say less than 10 patients per month. But the ones we have diagnosed were less than 5. Most of them are usually pre-existing diabetes on treatment" [District hospital doctor 3].* *"Last year we identified one case" [Primary healthcare professional nurse 3].* *"……...now we are seeing more because we are investigating" [Regional*			

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
									Hospital Doctor 1] *"it's not that common that we get, the thing is that we are not investigating our women properly" (Regional district doctor 1).* **Statistical results:** N (14/386) = 3.6%.			
Theme 2: Screening for gestational diabetes.									**Illustrative quotes:** *"…During bookings we screen them" (Primary healthcare professional nurse 2"* *"If they (nurses) do the urine dipstick and then there happen to be glucose trace in the urine, that's where we*			**Illustrative quotes:** **Statistical results:** 82%(N=317/386) reports it is necessary to test for GDM while 18%(N=69/386) thinks it's unnecessary.

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
									will request the HGT to be done" (District Doctor 3) **Statistical results:** OGTT, HGT, Urine analysis.			
Theme 3: Prevention of gestational diabetes.	**Illustrative quotes:** "*Most patients with GDM they are between 25-35 years of age" (District Doctor 1)* *"Some of them come with advanced maternal age but we cannot really tell that its (gestational diabetes) due to advanced*	**Statistical results:** 80.6% (N=311/386) were unemployed. **Statistical results:** Employment status not significantly associated with GDM (*P=0.486*).	**Statistical results:** 53.4%(N=206/386) were unmarried. **Statistical results:** Married pregnant women were significantly associated with developing GDM in univariate logistic regression model (*OR: 2.33; 95% CI: 00.76;7.09, p<0.2*), but in the multivariable	**Illustrative quotes:** *"…. Major cause of this would be the lifestyle of the people who get affected by diabetes…" (non-communicable disease district health manager"* **Statistical results:** 41.7% (N=161/386) were obese **Illustrative quotes:** *"I would say previous*	**Statistical results:** 73.8%(N=285/386) had secondary education. **Statistical results:** Educational level not significantly associated with GDM (*P=0.916*).	**Statistical results:** 26.2%(N=101/386) have been pregnant for at least two times.	**Statistical results:** 30.8%(N=119/386) have given birth to more than one child. **Statistical results:** Parity not significantly associated with GDM (*P=0.888*).	**Statistical results:** 81.6% (N=315/386) never had miscarriage.			**Illustrative quotes:** **Statistical results:** 82.6% (N=319/386) had no family history of diabetes. **Illustrative quotes:** *"Mostly they are not having the family history" (District Doctor 1)* **Statistical results:** Family hx of diabetes not significantly	**Illustrative quotes:** "*I explain the risk of gestational diabetes and what she must do. Maybe diet" (District Hospital Dr 1).* **Statistical results:** From 15.3% (N=59/386) who were aware of GDM, 69.5% (N=41/59) heard about GDM from Health worker.

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
	maternal age" (District Doctor 2) **Statistical results:** Pregnant women <25 years were less likely to present with GDM(*P<0.05*). Pregnant women aged 35 years and older had a higher risk of developing GDM than those aged 30 and younger (*OR: 2.31; 95% CI: 0.72;7.37, p<0.2*) but was not statistically significant (*OR: 1.72; 95% CI:*		logistic regression model, the finding was not statistically significant (*OR: 2.04; 95% CI: 0.64;6.49, p>0.05*). Marital status not significantly associated with GDM(*P=0.412*).	*history of gestational diabetes, high BMI but mostly the advanced maternal age and previous history of diabetes are the most common ones" (Regional Hospital Dr 2)* **Statistical results:** BMI not significantly associated with GDM (*P=0.386*). 27.7%(N=107/386) thinks obesity before pregnancy is a risk factor of GDM while 72.3%(N=279/386) doesn't think so.						associated with GDM(*P=0.065*). 34%(N=131/386) reported family history of diabetes as risk factor of GDM while 66%(N=255/386) disagreed.	

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
	0.51;5.74, p>0.05) with multivariable logistic regression model.			21.8%(N=84/386) believes rapid weight gain is risk factor of GDM whereas 78.2% (302/386) doesn't believe so.								
Theme 4: Control of gestational diabetes.												**Illustrative quotes:** *"They must take their prescribed medications" (District Doctor 2)* *"We give education on diet" (District Hospital professional nurse.)* *"…. Lifestyle modification related to diets, weight reduction if the woman is overweight …." (Primary healthcare professional nurse 1).*

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
												"Here they do HGT and also take random blood plasma" (District Doctor 1). **Statistical results:** 62.7%(N=242/386) reported even diet, exercise & insulin can treat GDM. 37%(N=143/386) doesn't think even diet, exercise & insulin can treat GDM. 30.8%(N=119/386) think after glucose load, blood test is needed to test for GDM.

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
												69.2%(N=267/386) doesn't think after glucose load, blood test is needed to test for GDM.
Theme 5: Outcomes of gestational diabetes										**Illustrative quotes:** **"***We take them out at around 38 weeks because placenta tends to grow quicker with diabetics" (Regional hospital Dr 2)* *"Majority its foetal death…." (Regional Hospital professional nurse).* **Statistical results:** Previous IUD		**Illustrative quotes:** *"The baby might be very big and experience some problems during delivery" (Community health centre professional nurse)* **Statistical results:** 60.4%(N=233/386) thinks GDM pose a risk on the baby if untreated with 39.6%(N=153/386) doesn't think so.

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
										(14.29%, N=2/14). Previous C-section (14.29%, N=2/14). Bad obstetric Hx (42.8%, N=6/14). No foetal movements (7.14%, N=1/14). None (21.43%, N=3/14).		27%(N=104/386) reports mothers with GDM are at risk of developing Type 2 diabetes while 73%(N=282/386) doesn't think mothers with GDM are at risk. 15%(N=58/386) reported GDM resolves after pregnancy while 85%(N=328/386) doesn't think so.
Theme 6: Challenges in management of gestational diabetes.												**Illustrative results:** *"There is no education" (District hospital Dr 1).* *"They are not aware because it's a rare thing and we even*

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
												forgot to tell them about it" (Community health centre professional nurse). *"The issue of overcrowding, the number of patients we see is just too much…. Most of the time we are basically just pushing the queue making sure that everyone who comes are attended to" (District Hospital Dr 3).* **Statistical results:** 34.2%(N=132/386) does know GDM can occur for the 1st time in pregnancy while 65.8%(N=254/386)

Themes	Variable- **Age**	Variable- **Employment**	Variable- **Marital status**	Variable- **Body Mass Index**	Variable – **Education level**	Variable- **Gravidity**	Variable- **Parity**	Variable- **Miscarriage**	Variable- **Diagnosis**	Variable- **Complications**	Variable – **Family history of diabetes**	Variable – **Awareness & Knowledge of GDM**
												doesn't know it can occur for 1st time during pregnancy. 84.7%(N=327/386) unaware of GDM. 15.3%(N=59/386) aware of GDM. For those who have heard about GDM, 69.5% (N=41/59) heard from health worker; 18.6% (N=11/59) from family; 8.5% (N=5/59) from media; and 3,4%(N=2/59) from school.

6.3.1.2. Step 2: Linking activity.

The next step of integration process was to establish linkages between the quantitative findings and qualitative findings. Merging integration was used to reveal areas of similarities and contrast.

6.3.1.3. Step 3: Establishing relationships.

To establish relationships between qualitative and quantitative data, the researcher looked for inconsistencies, alignments, or conflicting findings. In addition, this enhanced interpretations. Convergence, complementary, expansion and divergence were used to structure the interpretation of the 'fit' between the findings.

6.3.1.4. Step 4: Interpreting and reporting

Table 6.2 shows the distribution of participants from the qualitative and quantitative designs of the study.

Table 6.2. Number of participants in the study

Qualitative Results	Quantitative Results	Merged Results
Doctors N= 5 **Nurses N= 5** **Mopani District health managers N= 2** **Pregnant women diagnosed with GDM N= 7**	Pregnant women N= 386	Participants= 405(qualitative 19 + quantitative 386)
Total= 19 (12+7)	Total= 386	Total participants: N= 405(10 health practitioners + 2 mopani district health managers + 386 pregnant women + 7 pregnant women diagnosed with gestational diabetes)

A total of five nurses and five doctors across primary healthcare clinics, community healthcare centre, district hospital, and regional hospital; two Mopani district health managers (NCDs and child & maternal health); seven pregnant women diagnosed with GDM (14 were recruited, only seven agreed) were recruited and agreed for an interview. A total of 425 pregnant women were recruited to participate in the study, and only 386 pregnant women (n=386; 91%) agreed to participate. Thereafter, 386 questionnaires were distributed to pregnant women and (n=386;100%) were completed and returned. Our Findings from the participants were interpreted and reported concurrently for comparison and contrasting.

6.3.1.4.1. Socio-demographics characteristics of pregnant women

Table 6.3: Socio-demographics of pregnant women

Variable	Quantitative	Qualitative	Merged Results
Age	Minority: >40 years Majority: 30-34 years	Minority:30-34 years Majority: 25-29 years &35-39 years	Minority: 30-34 years Majority: 25-29 years &35-39 years
Marital status	Married: n=206;53.4% Unmarried=171;44.3%	Married: n=5; 71.43% Unmarried: n=2; 28.57%	Married: n=211;52.09% (211/405) Unmarried: n=173; 42.72% (173/405)
Educational level	No education: n=10; 2.6% Primary: n=19; 4.9% Secondary: n=285; 73.8% Tertiary: n= 72; 18.7%	No education: n=0; 0% Primary: n=0; 0% Secondary: n= 6; 85.7% Tertiary: n=1; 14.29%	Secondary: n=291;71.85% (291/405) Tertiary: n=73; 18.02% (73/405)
Employment	Employed: n=74; 19.2% Unemployed: n=311; 80.6%	Employed: n=1; 14.29% Unemployed: n=6; 85.7%	Employed: n=75;18.52% (75/405) Unemployed: n= 317; 78.27% (317/405)
Body Mass Index	Underweight (<18.5 kg/m²): n=4; 1% Normal weight (18.5-25 kg/m²): n=101; 26.2% Overweight(25-30kg/m²): n= 119; 30.8% Obese (>30 kg/m²): n=161; 41.7%	Underweight (<18.5 kg/m²): n= 2;28.57% Normal weight (18.5-25 kg/m²): n= 0; 0% Overweight(25-30kg/m²): n=0; 0% Obese (>30 kg/m²): n= 5;71.43%	Underweight (<18.5 kg/m²): n=6;1.48% (6/405) Obese (>30 kg/m²): n=166; 40.99% (166/405)
Parity	Zero: n=104; 26.9% One: n=119; 30.7% Two: n=84; 21.7% Three or more: n=79; 20.4%	Zero: n= 1; 14.29% One: n=3; 42.86% Two: n=0; 0% Three or more: n= 3; 42.86%	Zero: n=105;25.93% (105/405) One: n=122; 30.12% (122/405) Three or more: n= 82; 20.25% 982/405)

Gravidity	One: n=90; 23.3% Two: n=101; 26.2% Three or more: n=195; 50.5%	One: n= 1; 14.29% Two: n= 0; 0% Three or more: n= 6; 85.71%	One: n=91; 22.47% (91/405) Three or more: n=201; 49.63% (201/405)
Miscarriage	None: n=315; 81.6% One: n=57; 14.8% Two: n=8; 2.1% Three or more: n=6; 1.6%	None: n= 3; 42.86% One: n= 3; 42.86% Two: n= 1; 14.29% Three or more: n=0; 0%	None: n=318; 78.52% (318/405) One: n= 60; 14.81% (60/405) Two: n=9; 2.22% (9/405)
Family history of diabetes	Family history of diabetes: n= 67; 17.4% No family history of diabetes: n= 319; 82.6%	Family history of diabetes: n= 2; 28.57% No family history of diabetes: n=5; 71.43%	Family history of diabetes: n= 69; 17.04% (69/405) No family history of diabetes: n=324; 80% (324/405)

******Quantitative –* *All pregnant women* ******Qualitative –* *pregnant women diagnosed with GDM*

8. *Age*

Our findings showed there was a difference between minority and majority age groups of pregnant women in quantitative and qualitative study designs as the merged analysis revealed that minority age group of pregnant women was 30-34 years, while the majority age group was 25-29 years and 35-39 years respectively. Age difference could have been attributed to the fact that the pregnant women in quantitative study design were recruited using random sampling, whereas in the qualitative component pregnant women were recruited using purposive sampling.

2. Marital status

Majority of pregnant women were unmarried in this study and this finding was consistent in both quantitative and qualitative study designs. This could be attributed to the fact that most pregnant women in this study had secondary education i.e., likely that some pregnant women were still attending secondary school while others were secondary school dropouts.

8. *Educational level*

Secondary education was the highest education level for pregnant women not diagnosed with GDM and those diagnosed with the health condition from both quantitative and qualitative study designs. Minority of pregnant women in both quantitative and qualitative components had tertiary education.

8. *Employment*

Majority of pregnant women were unemployed in both quantitative and qualitative study design. Only a small proportion of women were employed.

8. *Body Mass Index (BMI)*

Most pregnant women in this study were obese (BMI>30kg/m^2) and only few were found to be underweight (<18.5 kg/m^2). On the other hand, there were no pregnant women in normal (18.5-25 kg/m^2) and overweight (25-30 kg/m^2) BMI scale amongst pregnant women diagnosed with GDM. This might be attributed to the fact that the majority of them were in their second and third trimester where considerable weight gain is expected.

6.Parity

Our findings demonstrated that the majority of pregnant women had given birth to one child, and this finding was consistent in both study designs. The study found consistent results in pregnant women who had given birth to three or more children in both study designs. Most of the pregnant women who had not given birth were in the quantitative design, with qualitative design being the least. The significant difference could be because of sample size and sampling method.

7.Gravidity

High proportion of pregnant women had been pregnant three times or more and this finding was consistent in both study designs. Only a small proportion of them were primigravida and this finding was consistent.

8.Miscarriage

Our study revealed that the majority of pregnant women in both study designs had never had miscarriages before, small percentage of pregnant women had miscarried once or twice, and this finding was consistent in both study designs.

9.Family history of diabetes

Our study found that most pregnant women in both study design had no family history of diabetes. On the other hand, those with a family history of diabetes were few.

6.3.1.4.2. Prevalence/burden of gestational diabetes mellitus

In the qualitative design, unstructured interviews were used to obtain information from doctors, nurses, Mopani district health managers about the burden of GDM; while questionnaires were used for pregnant women to obtain information from them to determine those diagnosed with GDM for the quantitative design. Table 6.4 shows the results from both study designs, interpretation, and meta inferences of findings in relation to burden of GDM.

Table 6.4: Qualitative and Quantitative results on the burden of gestational diabetes

	Qualitative Results	**Quantitative Results**	**Meta inferences and Interpretation**
Burden of gestational diabetes mellitus	Most professional nurses and doctors working with pregnant women reported few cases of GDM in public health facilities in Mopani district.	GDM diagnosis: N (14/386) = 3.6%.	Area of **convergence** as the qualitative results are supported by participants' quotations wherein participants expressed that they see few cases of GDM, and that this health condition is not common is supported by quantitative results which yielded small percentage of pregnant women diagnosed with GDM.

The study showed adequate qualitative and quantitative data which are indicative of the occurrence of GDM. In quantitative study design, the prevalence of GDM amongst pregnant women attending ANC visits was 3.6% (n=14) which was corroborated by doctors and nurses in Theme 1: "Burden of gestational diabetes". Doctors and nurses confirmed that there are few cases of GDM and now the cases that they are diagnosing have increased compared to previous years while in other primary healthcare clinics there were no cases of GDM.

In our study, the prevalence of GDM was 3.6%. The prevalence of GDM amongst married pregnant women was 64.3% (nine pregnant women), unmarried was 28.6% (four pregnant women); employed pregnant women was 7.1% (one pregnant woman), unemployed (92.9%). The prevalence of GDM among pregnant women with secondary education was 78.6% (11 pregnant women), those with tertiary education was 21.4% (three pregnant women); pregnant women with healthy weight was 14.3% (two pregnant women), overweight was 21.4% (three pregnant women), obese was 64.3% (nine pregnant women).

With regards to gravidity, the prevalence of GDM in pregnant women with 1 child was 14.3% (2 pregnant women), 2 children was 7.14% (one pregnant women), three or more children was 78.6% (11 pregnant women); prevalence of GDM among pregnant women who had never been pregnant before was 14.3% (two pregnant women), had one pregnancy was 35.7% (five pregnant women), had been pregnant twice was 14.3% (two pregnant women), had three or more pregnancies was 35.7% (five pregnant women). Lastly, the prevalence rate of GDM in pregnant women who never had miscarriages before was 64.3% (nine pregnant women), in those who had one miscarriage the rate was 21.4% (three pregnant women), and in those who had two miscarriages the rate was 14.3% (two pregnant women). In overall, the prevalence of GDM in this study was high among pregnant women who were married, unemployed, had secondary education, obese, had three or more pregnancies, had given birth to one, three or more children, and had no miscarriages.

The prevalence of our study was lower than the prevalence of GDM of 8.8% in study conducted amongst pregnant women who were in their third trimester attending antenatal care visits at their local clinics (Mamabolo et al., 2007); 9,1 %, in Soweto amongst black South African women recruited from Chris Hani Baragwanath Academic Hospital in Johannesburg (Macaulay et al., 2018). Likewise, the prevalence of this study was lower than in St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia which had the prevalence of 16,9% (Nigatu et al., 2022)13.1% in Tanzania and 8.6% in Nigeria (Maidwell-Smith et al., 2020). It was further observed that the prevalence of GDM in this study was higher than the findings of 1,9% in the Mopani district in the Limpopo province (Ntshauba et al., 2022), 3% in a cross-

sectional study conducted in 2012, South Africa (Chola et al., 2017), 2.9% in Western Kenya (Pastakia et al., 2017).

The difference in prevalence of GDM in our current study and other studies might be attributed to sample size, diagnostic criteria, population characteristics and screening strategies used (Li et al., 2020). Interestingly, it emerged from the qualitative study design of this current study that monitoring of GDM is not done as there is no indicator in the DHIS system. This is an area that needs further research to be conducted to assess the following if whether such a monitoring indicator existed, would it have an impact on the prevalence of GDM? The strength of using MMR in this study was that it provided in-depth understanding of the GDM occurrence and allowed the research problem to be investigated in different angles using different approaches. The first objective of this study which was to determine the prevalence of GDM has been met.

6.3.1.4.3. Risk factors of gestational diabetes

This section addresses qualitative and quantitative results in relation to risk factors associated with GDM. Table 6.5. compared the qualitative and quantitative results and made meta-inferences and interpretations.

Table 6.5: Merged results for risk factors associated with gestational diabetes.

	Qualitative results	Quantitative results	Meta-inferences and Interpretation
Risk factors for gestational diabetes	The common non-modifiable risk factors which were mostly emphasised by the professional nurses and doctors were advanced maternal age, family history of diabetes and history of delivering a macrosomia baby. Regarding modifiable risk factors, obesity, unexplained stillborn births in previous pregnancy and obstetric history	Pregnant women <25 years were less likely to present with GDM(*P<0.05*). Educational level, parity, family history of diabetes, employment status was not statistically associated with GDM (P>0.05).	Area of **'convergence'** as in the qualitative design the participants expressed that advanced maternal age was one of the risk factors of GDM and this finding was supported by finding of quantitative design as it was showed that pregnant women over age of 35 years and older are at risk of developing GDM. However, an area of **'divergence'** was identified wherein the above statistical findings were found to be insignificant, thus creating conflicting interpretation. An area of **'complementary'** as in the qualitative study design, family history

	Qualitative results	Quantitative results	Meta-inferences and Interpretation
			was identified as one of risk factors which is found among pregnant women diagnosed with GDM. However, in quantitative design, it was not statistically significant. Other non-modifiable risk factors (education, employment, marital status, etc) and modifiable (parity, gravidity, miscarriage, PIH, etc) were not highlighted by nurses and doctors because GDM cases are few.
Health education/campaigns aimed to modify risk factors	Continuous health education was being offered to the pregnant women as well as continuous campaigns for prevention of chronic illnesses. However, it emerged from the interviews that gestational diabetes mellitus was rarely focused on during ANC health education and educational campaigns facilitated at the district. Furthermore, the same sentiments were shared by pregnant women diagnosed with GDM whereby those who were once admitted in early stages of pregnancy received health education.	84.7%(N=327/386) unaware of GDM and 15.3%(N=59/386) aware of GDM.	An area of **'convergence'** as doctors and nurses reflected that pregnant women are unaware of GDM because continuous health education are not focused on GDM but other health conditions. Furthermore, those who are aware of GDM, have been diagnosed with the condition or know of someone living with diabetes. Qualitative quotes support this as it emerged, overcrowding; high number of patients; infrastructure limitations are causative factors of lack of health education in relation to GDM.

In our study, pregnant women in the age groups <25 years were significantly less likely to present with GDM than the other age groups ($p<0.05$). There was no statistically significant association between GDM and marital status, educational level, employment status, BMI, family history of diabetes and parity ($p>0.05$). The results however were not supported by qualitative findings. Pregnant women between the ages 25-29 years, married, had secondary education but unemployed, obese, with a family history of diabetes and had given birth to 2 children or more were more likely to present with GDM than their counterparts. The quantitative findings were supported by qualitative Theme 3: "Prevention of gestational diabetes" with categories; risk factors of gestational diabetes, and health education/campaigns aimed to modify risk

factors. Our Qualitative findings revealed that family history of diabetes, advanced maternal age, high BMI, and previous history of diabetes were the common risk factors. Furthermore, the abovementioned qualitative findings only supported the two risk factors identified in quantitative design: obesity and family history of diabetes. Results from both qualitative and quantitative design reveal that health education was not provided unless the pregnant woman has GDM.

Our results from regression model showed that there was no significant relationship between GDM and marital status, educational level, employment status, BMI, family history of diabetes and parity as the p-value is greater than the significance level ($p \geq 0.05$), as a result we do not the null hypothesis, we accept it. Instead, this suggests that the findings of this study showed insufficient evidence to suggest an association between marital status; educational level; employment status; BMI; family history of diabetes; parity and GDM. It was observed in a study conducted in Saudi Arabia that primigravida, nulligravida, multigravida, age, working status, place of living, family history of diabetes, BMI, hypertension were not significantly associated with GDM (Abualhamael et al., 2019). Economic status and level of education were not associated with risk of developing GDM (Mantzorou et al., 2023).

Our study findings mentioned above were not consistent with the study findings of a prospective case-control study which was conducted in coastal Karnataka where maternal and paternal history of diabetes mellitus, age, multiparity, age (25-29 years) was strongly associated with occurrence of GDM (Mishra et al., 2020); likelihood of developing GDM increased firmly with age ≥30 years, BMI from pre-pregnancy to 15-20 gestational age, history of DM (Li et al., 2020). Likewise, in a prospective population-based study conducted in Ahvaz city, the study showed a significant relationship with previous GDM, maternal age, high BMI before pregnancy, positive family history of diabetes; and risk of GDM (Zamana et al., 2018).

Previous history of GDM, macrosomia, congenital anomalies, BMI ≥25 kg/m², pregnancy-induced hypertension, family history of diabetes, history of abortion, age ≥25 kg/m², multiparity and history of preterm delivery were strongly associated with

GDM in a systematic review and meta-analysis study conducted in Asia (Lee et al., 2018).

Our study also found that pregnant women in the age group ≤ 25 years were less likely to present with GDM compared to pregnant women in other age groups. In support of this study, a cross sectional study conducted in Siriraj Hospital found the risk of developing GDM in women who were ≤ 25 years was significantly less than women who were >25-29 years (Sirirat et al., 2022). It was further observed in another study that women who were aged > 25 years were more likely to present with GDM (Mishra et al., 2020). The difference in these study findings might have been due to research design, sample size, ethnic groups studied and research setting.

6.3.1.4.4. Maternal and infant health outcomes associated with GDM.

This section addresses the findings in relation to maternal and infant health outcomes associated with GDM. Table 6.6 shows both qualitative and quantitative results and their interpretations.

Table 6.6: Merged results for maternal and infant health outcomes associated with GDM.

	Qualitative Results	Quantitative Results	Meta-inferences & Interpretations
Complications of gestational diabetes.	Doctors and nurses expressed complications associated with GDM can arise during antenatal, intrapartum, postpartum and post-natal.	7.14% (n=1) pregnant women experienced no foetal movement.	The merged results are **complementary** and supports that GDM is associated with adverse health outcomes on baby. The only outcome on the mother was that they were booked for c-section to minimise intrapartum complications.
Management of complications of gestational diabetes.	Complications were managed during ante-natal, delivery and after delivery. In case where the baby experience adverse outcomes, post-natal management would be implemented. Moreover, pregnant women diagnosed with GDM were given self-management health education to prevent complications from occurring.	The women were put on treatment, either metformin or insulin injectable. 28.57%(n=2) of pregnant women indicated they were once admitted and were referred to a dietician.	Results from both study designs corroborate **"complementary'** and showed that management of GDM requires multi-disciplinary approach. Not every pregnant woman diagnosed was referred to a dietician and this indicates that the referral system needs to be strengthened as they are the only profession who can provide in-depth and sufficient information on diet.

The quantitative results were supported by the Theme 5: Outcomes of gestational diabetes which was supported by two categories: complications of gestational diabetes, and management of complications of gestational diabetes. There was one pregnant woman who presented with no foetal movements and qualitative results complemented this quantitative finding by indicating that there are outcomes which can occur during antenatal. The qualitative and quantitative results indicated that management of complications of gestational diabetes requires a multi-disciplinary team to minimise adverse health outcomes. The study found that multi-disciplinary teams were not effective, particularly collaborating with dieticians during management. Furthermore, the study found that the nurses were the ones providing education related to diet and lifestyle modifications.

6.3.1.4.5. Association of socio-demographics, risk factors, with maternal and infant health outcomes

This section outlines the qualitative and quantitative findings of association of socio-demographics, risk factors, with maternal and infant health outcomes. Table 6.7 shows both qualitative and quantitative results and their meta-inferences & interpretations.

Table 6.7: Merged results on association of socio-demographic, risk factors, with maternal and infant health outcomes.

	Qualitative Results	**Quantitative Results**	**Meta-inferences & Interpretation**
Association between socio-demographic, risk factors with maternal and infant health outcomes.	Majority of pregnant women diagnosed with GDM were in the age groups 25-29 years & 35-39 years and married.	Pregnant women aged 35 years and older had a higher risk of developing GDM than those aged 30 and younger (*OR: 2.31; 95% CI: 0.72-7.37, p<0.2*) but was not statistically significant (*OR: 1.72; 95% CI: 0.51-5.74, p>0.05*) with multivariable logistic regression model. 7.14%(n=1) pregnant women presented with infant complication.	The results from qualitative and quantitative design completement each other.

Our findings revealed there was no association between socio-demographics, risk factors, with infant and maternal outcomes. This can be attributed to the fact that pregnant women diagnosed with GDM were not followed up until they delivered. Hence, more infant and maternal outcomes couldn't be determined. Follow up study

on pregnant women who were diagnosed with GDM and have delivered would assist in determining the maternal and infant health outcomes.

The other finding in our study was that pregnant women diagnosed with GDM had been booked for caesarean section delivery before the end of 39 weeks of gestational age at the regional hospital where specialised care is provided. In a qualitative study conducted among policy makers, clinicians and managers in Johannesburg and Cape Town, South Africa, it was found that women with GDM were referred to secondary or tertiary hospitals to attend their remaining ANC as well as delivery (Muhwava et al., 2018). Likewise, in another population-based retrospective cohort study conducted in Missouri, women had a scheduled delivery at 37 – 39 weeks of gestation as the risk of neonatal death and adverse neonatal outcomes were minimal (Harper et al., 2020).

In another systematic review study, it was highlighted that the risk of neonatal mortality and morbidity is increased at 36 and 37 weeks of gestation but low at 38, 39 and 40 weeks of gestation (Papalia et al., 2022). Overall, timing of delivery for a woman whose pregnancy is complicated with diabetes depends on level of glycaemic control, foetal lung maturity Bishop score, and presence of complications; thus, the risk and benefits to both mother and baby need to be balanced (Li et al., 2023; Metcalfe et al., 2019).

6.3.1.4.6. Knowledge and perspective of pregnant women on GDM and its management, & perceptions of patients on management of GDM by health care providers.

This section addresses pregnant women's responses in relation to their knowledge and perspective on GDM and its management, as well as health care providers' perception of pregnant women on GDM management. Theme, category, and subcategories that emerged are shown in Table 6.8, compared with qualitative and quantitative results, and meta-inferences and interpretations were made.

Table 6.8 depicts merged results of qualitative and quantitative study designs regarding knowledge and perspective of pregnant women on GDM and health care providers perceptions of pregnant women on GDM.

	Qualitative Results	Quantitative results	Meta-inferences & Interpretation
Challenges in management of gestational diabetes.	Inadequate awareness and health education. Awareness focus on high-risk common conditions. Inadequate resources and utilisation in health system.	34.2%(N=132/386) does know GDM can occur for the 1st time in pregnancy while 65.8%(N=254/386) doesn't know it can occur for 1st time during pregnancy. 62.7%(N=242/386) reported even diet, exercise & insulin can treat GDM. 37%(N=143/386) doesn't think even diet, exercise & insulin can treat GDM. 82%(N=317/386) reports it is necessary to test for GDM while 18%(N=69/386) thinks it's unnecessary 60.4%(N=233/386) thinks GDM pose a risk on the baby if untreated with 39.6%(N=153/386) doesn't think so. 27%(N=104/386) reports mothers with GDM are at risk of developing Type 2 diabetes while 73%(N=282/386) doesn't think mothers with GDM are at risk.	Results from both qualitative and quantitative study designs are evidence that no education on GDM is being offered to pregnant woman unless she is diagnosed with it. Health education on GDM during ANC visits need to be provided and frequent to enhance pregnant women's knowledge in GDM and its management.

The sub-categories that emerged from the category 'challenges in management of gestational diabetes' include inadequate awareness and health education, awareness focus on high-risk common conditions and inadequate resources and utilisation in the healthcare system. The study revealed that no health awareness on GDM is being provided to pregnant women attending ANC visits. Health education was only being provided to those diagnosed with the condition.

Our study showed that health education on GDM was only provided to pregnant women diagnosed with GDM. Further, knowledge on GDM, its risk factors,

screening, complications, and management was not sufficient amongst pregnant women who were aware of this health condition. Our finding concurs with the study conducted at Kawempe National Referral Hospital, Uganda which reported that only a small proportion (31%) of pregnant women were aware about GDM, its risk factors and adverse health outcomes (Byakwaga et al., 2021).

Similarly, in a cross-sectional study done by Msollo et al (2021) in Arusha city of Tanzania, it was found that 10.7% of pregnant women were aware about the existence of GDM, 30% of pregnant women knew the risk factors associated with GDM and potential adverse health outcomes on the mother and baby. In another study conducted in Western Turkey, the knowledge of GDM amongst pregnant women was very poor (Aypar Akbağ & Aluş Tokat, 2021). In another study, a qualitative study conducted in Tangail district situated in Bangladesh, it emerged that 78.7% of the women were not familiar with the term gestational diabetes mellitus (Biswas et al., 2020).

It was further observed in a cross-sectional study done in SRM Medical College Hospital and Research Centre that 51.5% of pregnant women had good knowledge, followed by 34% of pregnant with fair knowledge and lastly 14.5% had poor knowledge (Prabhu et al., 2021). Likewise, 40% of pregnant women diagnosed with GDM understood the condition in a descriptive cross-sectional study conducted in Dharan, Nepal (Kuwar et al., 2020). The level of awareness about GDM amongst pregnant women might be due to study setting (urban/semi-urban, rural), educational level, occupation, ANC educational programme, limited health practitioners in clinic/hospital, being diagnosed with GDM (Aypar Akbağ & Aluş Tokat, 2021 et al., 2021; Prabhu et al., 2021; Kuwar et al., 2020).

During interviews with pregnant women diagnosed with GDM, some of them expressed that they've never received any health education on the condition and self-management measures. The pregnant women responses were supported by doctors and nurses who expressed that there is no education being provided as GDM is a rare condition and overcrowding and high number of patients they see during ANC visits leaves no room to focus on education. Therefore, it is paramount that health facilities facilitate clinical teachings, increase human resource as well as

providing clinics with obstetric equipment that advanced midwives can use. This is more likely to reduce the influx of pregnant women in hospitals.

Our study found that from those pregnant women who were aware of GDM, the majority of them heard about this condition from a health worker i.e., doctor, nurse. In addition, studies which have been done on pregnant women's knowledge on GDM did not have sufficient data to support this study's finding. It was observed in a study conducted in Nigeria that pregnant women who knew about GDM did not receive the information from a health care worker (Offomiyor & Rehal ,2023). Our study findings were different from the findings of a study conducted by Prabhu et al (2021) who expressed that most pregnant women who were aware of GDM knew this information from relatives and friends. A study conducted in Tanzania amongst pregnant women showed education level was the contributing factor of awareness of GDM (Msollo et al., 2021).

During a review of the relevant documents, it was found that the National Department of Health (NdoH) does provide health education on Diabetes through printed material i.e., flyers and posters. Moreover, on the 14$^{th\ of}$ November 2023, World Diabetes Day was celebrated to draw people's attention to the rapid increase in cases of diabetes and increase access to diabetes education with the aim of improving the lives of people living with diabetes (Dutta, 2023). On the 15$^{th\ of}$ November 2023, the University of Pretoria held the 2023 Diabetes Summit whereby the theme was Translating Policies into Reality. In essence, what each individual, patients living with diabetes, communities, government, diabetes alliances can do to combat rising prevalence of GDM. The World Diabetes Day in 2017 was geared towards women's right to a healthy future as high blood glucose in pregnancy increases the risk to health for both mother and child, and risk of diabetes for the child in future (World Health Organisation, 2017). This shows that measures are being done to optimise diabetes outcomes, prevent diabetes, increase affordable and equitable access to care and education.

Our study has noted health system barriers which impacted on the pregnant women's knowledge and awareness on GDM. During ANC visits, there is a structured health education programme conducted by professional nurses as

pregnant women wait to be attended to. Further, our study revealed there was no facilitation of health education on GDM. However, GDM health education was done during consultation only if the pregnant woman was diagnosed with GDM due to time constraints, increased number of patients to be seen, understaffing, limited physical space. In support of our finding, a qualitative study conducted among pregnant women patients and healthcare providers in Barnes Jewish Hospital in St, Louis a tertiary centre, discovered that long waiting appointment time, understaffing, short consultation time which prevented in-depth health education, fragmented care were some of the health systems barriers to screening and prevention of diabetes after pregnancy complicated by GDM (Sinha et al., 2022).

Likewise, a shortage of healthcare providers; inadequate knowledge and skills and inadequate in-service training emerged as barriers to management of hyperglycaemia during pregnancy in a systematic review study (Hinneh et al., 2022). Similarly, it was found in a qualitative study conducted in public hospitals of South India that delay visits to hospital, long waiting period, unavailability of resources, lack of standardised protocols, poor follow-up visits, inadequate supportive oversight and shortage of staff were some of barriers to screening and management of GDM (Sahu et al., 2021). Likewise, crowded clinics and lack of privacy affected the effectiveness of some of the services provided (Mutabazi et al., 2022). These health systems barriers ultimately affect health providers' ability to provide GDM health education to pregnant women attending ANC visits.

In our study, the health facilities had standardised protocols, and support was provided by medical doctors and specialists during meetings and outreach. Differences in these findings can be because of study settings i.e., tertiary hospitals/clinics as higher level of care centres often have high number of patients requiring to be attended to by the doctor; nature of the study, and limited space where patients are seen.

6.3.1.4.6. Perception of pregnant women diagnosed with GDM on management.

Our study findings revealed that the majority of pregnant women diagnosed with GDM reported that they had to change their eating habits at home as part of

managing this health condition while the minority had not changed their eating habits as they had insufficient to no knowledge. It was observed in systematic review study that women who had insufficient knowledge on how to cope and manage GDM at home felt not confident (Pham et al., 2022).

In our study, minority of the pregnant women diagnosed with GDM had negative experience related to diet wherein they had poor access to healthy food as prescribed by dietician because of being unemployed. It was observed in a cohort study conducted amongst women diagnosed with gestational diabetes in Chris Hani Baragwanath Academic Hospital (CHBAH) in Soweto, Johannesburg, South Africa, the women expressed that adapting to eating habits was very challenging as It was part of the treatment but accepted the new eating plan as it assisted in controlling blood sugar levels (Norris et al., 2020).

In a systematic review study conducted on pregnant women diagnosed with GDM experience on care, it was established that the women's experience on diet and medication was positive and negative (Pham et al., 2022). In a qualitative study, the women were anxious concerning the management of GDM as they view that diet needed to be controlled to avoid its effects on foetal development (Su et al., 2021). Moreover, a negative experience with their diet might be attributed to not having access to healthy food due to low socioeconomic status. In our study, only one pregnant woman had a negative experience with medication prescribed because of the side-effects and the dosage had to be changed. Moreover, the others had positive experience as they did not experience side effects and medication was easily accessible in the clinics/hospitals. It was observed in other studies that prescribed medications were viewed as a positive experience by pregnant women (Pham et al., 2022).

It emerged from our study that pregnant women who were on insulin were issued with a Haemogluco test (HGT) device by the specialised hospital where they would monitor blood glucose level before and after meals. In addition, positive experiences were expressed as education was provided first on the utilisation of the device by doctors and nurses before they were sent home. Furthermore, our study findings were different from a systematic review study conducted by Pham et al (2022) where

they identified more studies wherein pregnant women had negative experience as they felt they were overly criticised as health providers wanted to achieve good clinical outcomes (Parsons et al., 2018; cited in Pham et al., 2022).

The variation of findings is due to data collection method (most studies used focus groups), study design, and external factors i.e., time. In this study, the majority of them did not have enough time for an interview as they were in the waiting room to enter the consultation room while others were anxious not to miss their turn. In addition, another attribute was that most women had little knowledge on GDM and management.

6.3.1.4.7. Collaboration in the management of gestational diabetes mellitus.

In our study, it was found that there was collaboration between health professionals in the management of GDM. Furthermore, referral of pregnant women diagnosed with GDM to a dietician was not consistent as those who were once referred were admitted at some point during pregnancy. It was observed in a mixed method study conducted in Grooter Schuur hospital and other health facilities in Western Cape, South Africa that “counselling sessions” were routinely scheduled for pregnant women diagnosed with GDM regarding lifestyle intervention and management of GDM though health system barriers decreased the effectiveness of the program (Mutabazi et al., 2022). The guideline for maternity care which is being used as a reference in the management of GDM in most health facilities in the Mopani district stipulates that once a pregnant woman has been diagnosed with GDM, she must receive lifestyle modification education and dietary advice, and thereafter referred to a dietician. Moreover, this was not consistent in all cases diagnosed in this current study.

In our study, we found that pregnant women diagnosed with GDM were referred to a regional hospital which has specialised care to continue with their ANC visits till delivery with the aim of monitoring the mother and baby, investigations to rule out adverse outcomes. Furthermore, this study found that adequate medical information on the pregnant woman was provided to the receiving health practitioner during the referral process. Similarly, pregnant women diagnosed with GDM were referred from clinics to Midwife and Obstetric Units (MOU) to tertiary hospital where they would

receive comprehensive care such as investigations for other health problems which goes beyond GDM, lifestyle change and dietary interventions (Mutabazi et al., 2022).

In a qualitative study conducted among different health professionals including endocrinologists; obstetricians; general practitioners; dieticians; midwives and diabetes nurses, collaboration among the specified health professionals was disorganised due to ambiguous responsibilities in sharing of information between health professionals especially when women diagnosed with GDM had to be transferred to another setting (Timm et al., 2021). Our study revealed during interviews with health practitioners, it emerged that before a pregnant woman is referred, telephonic consultation first occurs between health practitioners wherein a case is presented and discussed. According to Sina et al (2020, p. 4), “communication between clinicians is essential and referral pathways must be established to allow women to be stepped up or down in a timely and streamlined fashion”. We found that health practitioners were cognisant of the referral pathway system.

Our study has found that after the pregnant woman diagnosed with GDM has delivered from a regional hospital, they are referred to a district hospital with a discharge summary for follow-up on mother and baby. In addition, our study findings were different from the findings of a study conducted by Mutabazi et al (2022) where it emerged that there was no consistency with referring women to clinics from hospitals for follow up postnatal care and that follow-up care tends to focus more on the baby.

6.4. Conclusion

In this chapter, the researcher integrated qualitative and quantitative data and drew meaningful conclusions. In this study, it emerged that the prevalence of GDM is low and possible risk factors were noted. Few cases of GDM were reported in health institutions in the Mopani district, hence health education and promotion were rarely done on this conditions which indirectly impact pregnant women’s awareness and knowledge as the majority of them were not aware of GDM and had poor knowledge. Therefore, there is a need to develop an evidence-based model to address GDM

among pregnant women which will need to be linked to intervention strategies which will assist in the implementation process. The next chapter will focus on intervention strategies of this study.

CHAPTER SEVEN: DEVELOPMENT OF INTERVENTION STRATEGIES

Phase III: Developing an evidence-based management model to mitigate risk factors and improve maternal and infant health outcomes associated with GDM in the Mopani district.

7.1. Introduction

The previous chapter focused on the discussion of integrated qualitative and quantitative findings. The current chapter will focus on developing strategies to mitigate risk factors associated with gestational diabetes mellitus and compliance to existing intervention guidelines. Further, a rationale for developing intervention strategies was provided as well as description of what influenced the development of such intervention strategies.

7.2. Rationale for developing intervention strategies.

The intervention strategies were developed with the aim of promoting realisation of the Sustainable Development Goal (SDG) no 3 which focuses on ensuring healthy lives and promoting well-being for all at all ages (World Health Organisation, 2015). The objectives of SGD no 3 which are relevant to this study are to:

i. Reduce the global maternal mortality ratio to less than 70per 100,000 live births,
ii. End preventable death of newborns and children below age of 5 years,
iii. Reduce by one third premature mortality from non-communicable diseases through prevention and treatment, promote mental health and well-being by the end of 2030.

It is pivotal that intervention strategies be developed to improve the performance of health systems in providing care to pregnant women during and after pregnancy, and during delivery (Camara et al., 2021).

7.3. Development of intervention strategies.

The intervention strategies were developed in reference to the current study findings, literature review, A Priori Framework for Synthesis for Model of Care for Non-communicable diseases (2017), The Guideline for Maternity Care (2016), Ideal Hospital Realisation and Maintenance Framework Manual (2022), Referral policy for South African Health Services and Referral Implementation Guidelines (2020), and National Core Standards for Health Standards for Health Establishments in South Africa (2011).

7.4. Proposed intervention strategies.

The strategies were adapted from four step process i.e., strategy goal, justification, responsibility and performance drivers outlined by Muthelo (2022) and Rogers' Diffusion of Innovative Theory (Rogers et al., 2014) strategies which are:

i. Compatibility: refers to the extent to which the idea or innovation fits current values, experience and needs.
ii. Trialability: refers to the degree in which the innovation can be experimented on before being adopted.
iii. Observability: refers to the degree to which results of the innovation are visible to the adopters.

Strategy 1: Community awareness about GDM

1. *Strategy goal*

   To create awareness regarding GDM, its risk factors, associated maternal and infant adverse health outcomes, and treatment among pregnant and non-pregnant women.

2. *Justification*

   The proposed strategy emanated from the current study finding where there was poor knowledge and awareness of GDM amongst pregnant women attending ANC in selected the Mopani district health institutions. It is important for pregnant women attending ANC and non-pregnant women to understand GDM, its risk factors, adverse maternal & infant health outcomes and treatment. This is to mitigate the modifiable risk factors which mostly influence the occurrence of GDM. When both pregnant and non-pregnant women are aware of GDM, its risk factors, complications and treatment method, they can take preventative measures which will reduce their chances of presenting with modifiable risk factors. Awareness in both health institutions and communities is critical as masses of women can be reached.

3. *Responsibility*

   The strategy can be facilitated by doctors, nurses and community health workers.

4. *Performance drivers*

- Design and review a health promotion and education program that is relevant to the Mopani district context.
- Outline program objectives and set targets.
- Involve doctors, nurses and community health workers with experience and skills in Obstetrics and Gynaecology.
- Strengthen community actions by involving community radio stations and community liaison officers.
- Printing health education materials.
- Designing strong health promotion guidelines in education sessions during ANC.

5. *Compatibility*

   The issue of awareness campaign is not a foreign concept in the context of the Mopani district. There are existing health educational programmes on community radio stations being presented by doctors during the week in the evening.

6. *Trialability*

   The main strength for this strategy is that already the resources are available, and these include human resources such as doctors, nurses, allied health professionals as well as community radio stations. A possible limitation might be that doctors, nurses might feel like their workload is increased, which might affect their morale. No budgeting and other equipment will be needed; hence this strategy can be easily tested.

7. *Observability*

   The results of this strategy can be determined by knowledge gained by the community during answer and question time after radio presentation. Also, during ANC, pregnant women who know this health education can be encouraged to educate others with assistance from professional nurses before ANC begins.

Strategy 2: Reinforcing standard of practice

1. *Strategy goal*

To reinforce and monitor management of GDM in accordance with guidelines and policies within six months.

2. *Justification*

   The current study revealed that among pregnant women diagnosed with GDM, the majority had poor knowledge of this health condition, and few were not informed on lifestyle modification and self-management measures as they were provided with insufficient information by attending doctors and nurses during ANC. The Guideline for maternity care (2016) outlines that on the initial management of GDM, the woman should immediately receive advice on lifestyle modifications including smoking cessation and moderate exercise as well as dietary advice and then be referred to a dietician. This strategy will ensure that pregnant women with GDM have sufficient information on self-management techniques to manage the health condition themselves at home and avoid some avoidable complications. Also, they will gain knowledge on postpartum Type 2 DM risk, improvement in diet and physical activity.

3. *Responsibility*

   Doctors and nurses working in the maternity unit.

4. *Performance drivers.*

   - Conducting clinical audits.
   - National Core Standard and Ideal Hospital assessments specifically quality care items where a patient is interviewed by an assessor.
   - Displaying of standard of practice or treatment guideline in consultation rooms.

5. *Compatibility*

   Already patients are receiving inadequate information on GDM because of time, overcrowding and limited working space. Further, pregnant women are being referred to a dietician when admitted in hospital. Enhancing referrals to dieticians during ANC visits can be more beneficial.

6. *Trialability*

   The strategy does not require time and resources as there are already dieticians in hospitals. In the Greater Giyani area of the Mopani district,

dieticians who were placed in PHC and CHCs facilities were moved to district hospitals. Hence, the availability of dieticians is sufficient.

7. *Observability*

   The effectiveness of this strategy can be determined by the number of referrals made to a dietician after being diagnosed with GDM, as well as auditing of clinical notes.

Strategy 3: Adoption of Ideal Hospital Facilities and Infrastructure domain in accordance with Ideal Hospital Realisation and Maintenance Framework

1. *Strategy goal*

   To adopt Ideal Hospital Realisation and Maintenance Framework to improve health service delivery and patient experiences.

2. *Justification*

   This strategy was developed based on the current study finding that the hospitals and clinics were overcrowded and had inadequate working space. Overcrowding can have an impact on staff morale, less time spent per patient, can increase interruptions during consultations and most likely to cause burnout among healthcare professionals. According to Ideal Hospital Realisation and Maintenance Framework Manual (2022), hospital space should accommodate all service and support areas, that is it is essential to monitor if the physical space of the health institution is adequate and functional for the hospital workload.

3. *Responsibility*

   Hospital Chief executive officer/ clinic manager, district manager, hospital board and Department of Health.

4. *Performance drivers*

   - To advocate for temporary structures to be used as extension consultation rooms for maternity units.
   - Providing funding for upgrade of infrastructure.
   - Engage with communities, stakeholders such as Black Economic Empowerment (BEE) to invest in upgrading of hospitals.

5. *Compatibility*

Ideal Hospital assessments are being conducted in the Mopani district PHCs, CHCs and Hospitals to determine their compliance to set standards. After assessments, Quality Improvements Plans (QIPs) are developed and presented in MDT meetings and activities conducted to meet the set standards.

6. *Trialability*

   To implement this strategy, human resource and training on assessment of Ideal Hospital will be required. No budgeting is required.

7. *Observability*

   The results of this strategy can be evaluated by assessing if the hospital is meeting the vitals and extreme scores.

Strategy 4: Strengthening interdepartmental referral system.

1. *Strategy goal*

To strengthen the interdepartmental referral system for patients diagnosed with gestational diabetes mellitus.

2. *Justification*

The strengthening of the interdepartmental referral system was developed based on the minority of pregnant women diagnosed with GDM being referred to a dietician only when they were admitted in the hospital and those who have never been admitted were not referred to a dietician. According to the Referral Policy for South African Health Services and Referral Implementation Guidelines (2020), there are internal referrals between different disciplines within the same hospital and as such, verbal or internally developed referral forms must be provided to the practitioner about the referral. Also, the Guideline for maternity care (2016) points out that during initial management of GDM, referral to a dietician must be made. Collaboration between health practitioners involved in the management of GDM can have the potential to improve patient care, health outcomes and overall improve quality of care.

3. *Responsibility*

   Doctors.

4. *Performance drivers*

- Number of referrals to a dietician where the pregnant woman with GDM was attending ANC.
- Number of referrals to a dietician where the pregnant woman with GDM was admitted.
- Clinical audits of patient files.
- Referral protocol when managing gestational diabetes mellitus.

5. *Compatibility*

   Health facilities in the Mopani district currently have a referral policy which indicates when to refer a patient inter-departmentally or to another level of care for management. Hence, this strategy will not be new to clinics and hospitals.

6. *Trialability*

   This strategy requires referral forms and can easily be piloted without requiring extensive resources.

7. *Observability*

   The positive results of this strategy can be determined by evaluating the number of pregnant women diagnosed with GDM attending ANC vs those referred to a dietician. Also, we can check the dietetics departments statistics particularly on days where ANC is conducted in the Maternity Unit to check if the number referred from ANC corresponds to the number seen by OPD Dietetics.

Strategy 5: Providing training programs on gestational diabetes mellitus.

1. *Strategy goal*

To conduct a training skills programme on gestational diabetes mellitus to health practitioners involved in the management.

2. *Justification*

This strategy was developed based on the current study finding that there are no training workshops conducted by the hospitals/clinics on GDM. A systematic review conducted in Africa showed that insufficient knowledge on GDM, management and insufficient training on relevant skills for GDM compared to health conditions such as HIV, Malaria were described as health system-related barriers experienced by health professionals (Hinneh et al.,

2022). The National Core Standards for Health Establishments in South Africa (2011) emphasise that there need to be a comprehensive programme for staff training and continuing professional development (CPD) in place.

Currently, the hospitals have CPD meetings on a weekly basis where health practitioners present on topics and discussions take place thereafter. The development of this strategy will assist the PHCs, CHCs and district hospitals in management of GDM. Currently, in hospitals they have perinatal and maternal mortality and morbidity meetings where nurses from PHCs and CHCs are invited to attend in hospitals to discuss cases with the aim of teaching them skills on management of the health condition under discussion.

The program will ensure that doctors especially from district hospitals and nurses have sufficient skills and knowledge on GDM with regards to understanding risk factors, screening and diagnosis, complications and treatment. Also, the program will have to be facilitated by a health practitioner with a speciality, advanced skills and experience to ensure that the information that is being shared is up to date. This strategy will enhance coordination and transition of care.

3. *Responsibility*

Speciality doctors and medical officers.

4. *Performance drivers*

- Assessing the knowledge of trained nurses and medical doctors to screen, diagnose, treat and manage complications.
- Reinforce outreach services of specialised doctors to district hospitals to capacitate medical doctors with current knowledge and skills and in turn the medical doctors will train nurses in hospital, PHCs and CHCs.
- Trainings conducted in the form of visual presentation, demonstration and practical.
- Design online learning modules for doctors and nurses.

5. *Compatibility*

   The strategy is compatible as already hospitals and clinics conduct training programs or workshops to enhance practitioner's work

competence. A training program on gestational diabetes mellitus can be easily adopted.

6. *Trialability*

   More time will be required to implement this strategy as doctors, nurses, and other relevant stakeholders will have to meet and discuss operational strategies, activities, resources required, space and costs. Existing training programs can be used to benchmark this strategy.

7. *Observability*

   The effectiveness of this strategy can be determined by assessing the knowledge gained by doctors and nurses on screening, diagnostics, risk factors, complications and treatment.

Strategy 6: Intersectoral collaboration.

1. *Strategy goal*

To promote collaboration between the Department of Health, other departments and stakeholders.

2. *Justification*

This strategy was developed after the current study revealed that there was collaboration between the child and maternal health district unit and non-communicable disease district unit. This strategy will ensure that resources, competences and expertise are shared, as well as building positive long-term relationships amongst various stakeholders.

3. *Responsibility*

District health units' managers, clinical managers, nursing managers, Obstetrics and Gynaecology specialists.

4. *Performance drivers*

   - To conduct workshops and district meetings to understand roles and priorities of different district units.
   - Coordination of prevention strategies between district health units. managers, clinical managers, nursing managers and specialists.

5. *Compatibility*

   Intersectoral collaboration already exists in the Mopani district. For example, public hospitals work closely with communities by conducting

Imbizo to determine community needs and evaluate the effectiveness of hospital or clinic programs in improve health outcomes of individuals in the community.

6. *Trialability*

   Collaboration of different departments will require adequate and comprehensive planning as responsibilities and roles need to be outlined as well as memorandum of understanding to achieve mutual understanding of the partnership, as well as what each department or stakeholder can achieve or what their intentions are.

7. *Observability*

7.5. The positive results of this strategy can be determined by observing if there is coordination between various units within the Mopani district health and with other departments, sectors in implementation of programs related to gestational diabetes mellitus.

Validation of intervention strategies

To validate the proposed intervention strategies, Delphi technique method was used. According to Humphrey-Murto et al (2020), Delphi technique is a systematic process used for developing and gathering consensus. In this current study, the technique was used to make decisions regarding the proposed intervention strategies together with recruited experts. This method was appropriate to use in this study as the experts were dispersed and to minimise unnecessary dominance among experts as they were of various ranks within the Department of Health. The following Delphi method process was followed in this study:

7.5.1 Development of Delphi Survey.

The questions from the survey were developed based on study findings, management guidelines and policies, sustainable development goal no 3, standard of practice and experts' knowledge. The survey criteria selected for inclusion were goal and management practice, context of strategies, explanation of strategies and evidence to support the strategies. These criteria were vital as they assess the relevance of intervention strategies in response to the study findings. The survey had two sections with section one

focusing on experts' background information. In addition, section two focused on gathering experts' input on proposed intervention strategies. Also, there were four criteria, and 10 questions and experts were required to provide an input of yes or no and give a comment should they wish to do so (Annexure Ac).

7.5.2 Selection of experts

Different experts from different fields within the health sector were recruited to participate in this validation process because of their variety in knowledge, skills and expertise. The experts were purposively sampled and recruited telephonically, and the call information was recorded on phone call log disposition (Annexure Ab). In this study, eight experts were recruited to participate; only three of them agreed to participate after being told the nature of the study validation process. Thereafter, an email with attached consent form and survey was sent to the experts for completion (Annexure Ac).

The three experts were the Mopani district dietetics coordinator, professional nurse and medical officer. The Mopani district dietetics coordinator holds a Master's degree in dietetics with 32 years of experience, the professional nurse working as midwifery holds a BSc degree in nursing with 9 years of experience, and medical officer who holds a diploma in obstetrics and gynaecology with 8 years of experience. The experts were identified as practitioners with lived experience of working with pregnant women in the maternity unit.

7.5.3 Identify convergence of opinion.

Two rounds have been planned in this Delphi validation process. After the first round, a summary of full group responses per question was provided to the experts. The second round was not done as there was a significant attrition of experts due to work commitments.

7.5.4. Report of results

7.5.4.1 Goal and practice.

The response to these questions i.e., one to three in these criteria were based on the examination of strategy goals when compared with DGM management guidelines and SDG no 3. All three experts agreed that the proposed intervention strategies were relevant to the existing management guidelines and policies. All three experts made no further comments or recommendations (Table 7.1 to 7.3., question one to three).

7.5.4.2 Context of the strategies.

The experts had to rate how well suited are the proposed strategies to the context given the study findings and if they can be transferred to the study setting. Experts had to respond to questions four to six. All experts agreed that the intervention strategies were suited and can be transferred to the context of this study. Expert 1 made the following comments under question 5 (Table 7.1 to 7.3., question four to six).

Quotation:

"They are well suited considering the availability of human resources, maternal and child health programs and infrastructure" [Expert 1].

7.5.4.3 Explanation of the strategies.

In this criterion, the experts had to respond to the questions seven and eight based on their judgement about the explanations of the strategies. That is, respond to whether the strategies are consistent with study findings and explanation of strategies is sufficient. All experts agreed that the strategies were consistent with study findings and explanation provided was sufficient (Table 7.1 to 7.3, question seven and eight).

7.6. Evidence to support the strategies.

In response to this criterion, experts had to rate the strategies based on the evidence of study findings, existing literature, management

guidelines, referrals guidelines, NCS guidelines, Ideal Hospital framework and SDG 3. All experts agreed that there is evidence to support the strategies and expert 1 made the following recommendations (Table 7.1 to 7.3, question 9 and 10):

Quotation:

"Also, there is an office of health care standards compliance checklist and disease specific protocols" [Expert 1].

Table 7.1. Rating of strategies during Delphi round Expert 1**.**

No	Criteria	Yes(X)	No(X)	Comments
	Goal and management practice: Response to these questions need to be based on examination of strategy goals in comparison with GDM management guidelines & Sustainable development goals.			
1.	Are the strategy goals in line with Sustainable Development Goal no 3 objectives?	X		
2.	Are the strategy goals in line with GDM management guidelines?	X		
3.	Do the strategies have the potential to reduce maternal mortality, prevent deaths of newborns and reduce premature mortality from non-communicable diseases?	X		
	Context of strategies: Response to these questions must be based on how well strategies might be transferred in the context of this study.			
4.	Is the intended context of strategies consistent with SDG no	X		

	3 and GDM management guidelines?			
5.	How well suited are the strategies given the findings of the study?	X		They are well suited considering the availability of human resources, maternal and child health programs and infrastructure
6.	Do all proposed strategies fit within the context of producing good maternal and infant health outcomes, improving quality of health provided to pregnant women with GDM?	X		
	Explanation of strategies: Response to these questions must be based on expert's judgement about explanation concerning practice			
7.	Are the explanation of the strategies sufficient to be used in improving provision of quality health & services?	X		
8.	Is the explanation of strategies consistent with study findings?	X		
	Evidence to support the strategies: Response to these questions need to be based on the evidence of study findings, existing literature, management guidelines, referrals guidelines, NCS guidelines, Ideal Hospital Framework, SDG no 3.			
9.	Is there evidence to support the proposed strategies?	X		Also, there is office of health care standards compliance checklist and disease specific protocols

10.	Is there relevant information about corresponding guidelines provided?	X		Also, there is office of health care standards compliance checklist and disease specific protocols

Table 7.2. Rating of strategies during Delphi round Expert 2

No	Criteria	Yes(X)	No(X)	Comments
	Goal and management practice: Response to these questions need to be based on examination of strategy goals in comparison with GDM management guidelines & Sustainable development goals.			
1.	Are the strategy goals in line with Sustainable Development Goal no 3 objectives?	X		
2.	Are the strategy goals in line with GDM management guidelines?	X		
3.	Do the strategies have the potential to reduce maternal mortality, prevent deaths of newborns and reduce premature mortality from non-communicable diseases?	X		
	Context of strategies: Response to these questions must be based on how well strategies might be transferred in the context of this study.			
4.	Is the intended context of strategies consistent with SDG no 3 and GDM management guidelines?	X		

5.	How well suited are the strategies given the findings of the study?	X		
6.	Do all proposed strategies fit within the context of producing good maternal and infant health outcomes, improving quality of health provided to pregnant women with GDM?	X		
	Explanation of strategies: Response to these questions must be based on expert's judgement about explanation concerning practice			
7.	Are the explanation of the strategies sufficient to be used in improving provision of quality health & services?	X		
8.	Is the explanation of strategies consistent with study findings?	X		
	Evidence to support the strategies: Response to these questions need to be based on the evidence of study findings, existing literature, management guidelines, referrals guidelines, NCS guidelines, Ideal Hospital Framework, SDG no 3.			
9.	Is there evidence to support the proposed strategies?	X		
10.	Is there relevant information about corresponding guidelines provided?	X		

8.5. Rating of strategies during Delphi round Expert 3.

No	Criteria	Yes(X)	No(X)	Comments
	Goal and management practice: Response to these questions need to be based on examination of strategy goals in comparison with GDM management guidelines & Sustainable development goals.			
1.	Are the strategy goals in line with Sustainable Development Goal no 3 objectives?	X		
2.	Are the strategy goals in line with GDM management guidelines?	X		
3.	Do the strategies have the potential to reduce maternal mortality, prevent deaths of newborns and reduce premature mortality from non-communicable diseases?	X		
	Context of strategies: Response to these questions must be based on how well strategies might be transferred in the context of this study.			
4.	Is the intended context of strategies consistent with SDG no 3 and GDM management guidelines?	X		
5.	How well suited are the strategies given the findings of the study?	X		
6.	Do all proposed strategies fit within the context of producing good maternal and infant health outcomes, improving quality of health provided to pregnant women with GDM?	X		

	Explanation of strategies: Response to these questions must be based on expert's judgement about explanation concerning practice			
7.	Are the explanation of the strategies sufficient to be used in improving provision of quality health & services?	X		
8.	Is the explanation of strategies consistent with study findings?	X		
	Evidence to support the strategies: Response to these questions need to be based on the evidence of study findings, existing literature, management guidelines, referrals guidelines, NCS guidelines, Ideal Hospital Framework, SDG no 3.			
9.	Is there evidence to support the proposed strategies?	X		
10.	Is there relevant information about corresponding guidelines provided?	X		

7.7. Logic model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with gestational diabetes mellitus.

The logic model which was developed in this study was based on the proposed intervention strategies from phase III. The strategies were proposed with the aim of mitigating risk factors, particularly modifiable ones, and the improvement of maternal and infant health outcomes associated with gestational diabetes mellitus. Below is logic model presented in figure 7.1. The main activities were drawn from inputs which are the proposed intervention strategies. In addition, this model focuses on

health promotion and education; coordination of resources, expertise, competencies by different stakeholders; providing training to nurses, doctors and dieticians; referring patients diagnosed with GDM to dieticians and referencing GDM management guidelines during practice.

The outputs from main activities are awareness of GDM by pregnant and non-pregnant women in the community; establishing community needs, evaluating effectiveness and efficacy of existing programs; trained nurses, doctors and dieticians; all pregnant women with GDM receiving dietetics intervention; and compliance to management guidelines. The outputs produce the outcomes, and, in this study, the immediate outcomes were knowledge of GDM among women in the community is increased; improved stakeholder engagement in health systems intervention; increased quality of GDM management; increased knowledge about lifestyle and behaviour modification; improved communication and care coordination of services, as well as enhancement of evidence-based management practice.

The immediate outcomes produced intermediate outcomes which are lifestyle modification, reduction of modifiable risk factors associated with GDM, and improvement of maternal and infant health outcomes. These intermediate outcomes led to impact of interventions which are the objectives of SDG no 3. Further, reduction of premature mortality from NCD, reduction of maternal deaths and ending preventable deaths of newborns and children under 5 years will be assessed as impact of proposed interventions.

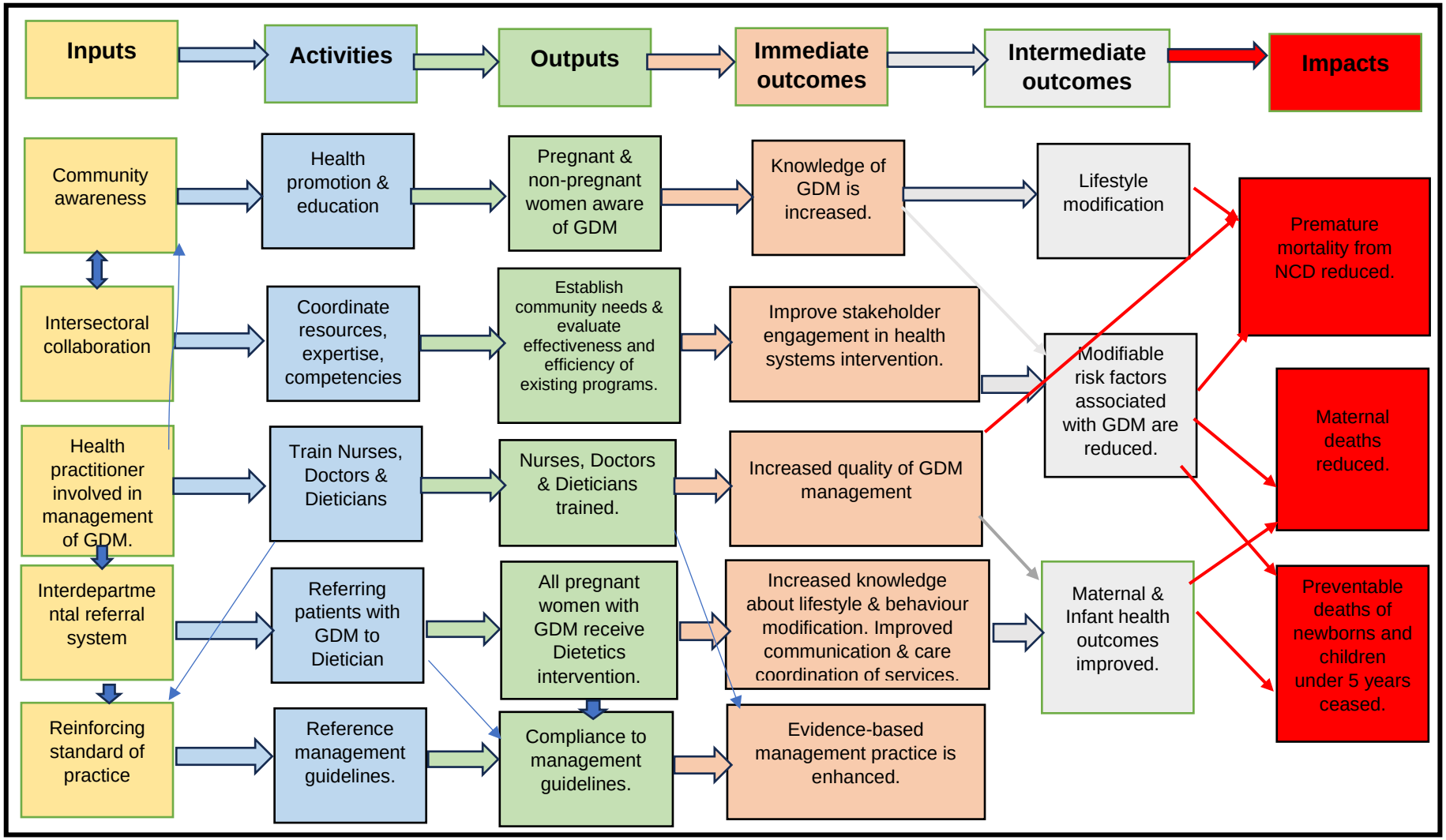

Inputs
Activities
Outputs
Immediate outcomes
Intermediate outcomes
Impacts
Community awareness
Health promotion & education
Pregnant & non-pregnant women aware of GDM
Knowledge of GDM is increased.
Lifestyle modification
Premature mortality from NCD reduced.
Intersectoral collaboration
Coordinate resources, expertise, competencies
Establish community needs & evaluate effectiveness and efficiency of existing programs.
Improve stakeholder engagement in health systems intervention.
Modifiable risk factors associated with GDM are reduced.
Maternal deaths reduced.
Health practitioner involved in management of GDM.
Train Nurses, Doctors & Dieticians
Nurses, Doctors & Dieticians trained.
Increased quality of GDM management
Interdepartmental referral system
Referring patients with GDM to Dietician
All pregnant women with GDM receive Dietetics intervention.
Increased knowledge about lifestyle & behaviour modification. Improved communication & care coordination of services.
Maternal & Infant health outcomes improved.
Preventable deaths of newborns and children under 5 years ceased.
Reinforcing standard of practice
Reference management guidelines.
Compliance to management guidelines.
Evidence-based management practice is enhanced.

Figure 7.1: Logic model to mitigate risk factors and improve maternal and infant health outcomes associated with gestational diabetes mellitus. Evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with GDM.

The model depicted below in Figure 7.2 was developed based on the findings of this study. Furthermore, this model consists of three phases which are pre-pregnancy, pregnancy and postpartum.

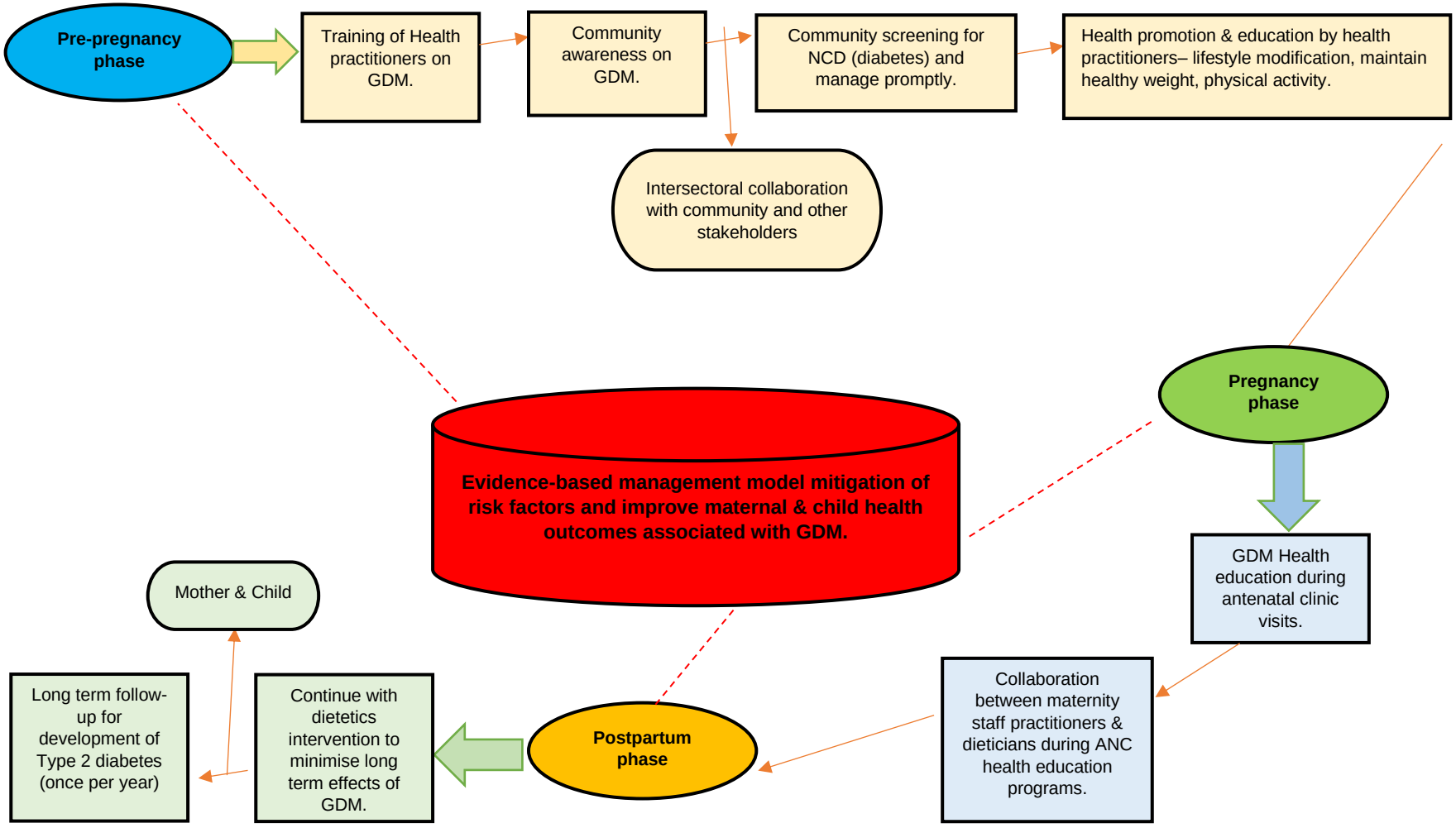


Figure 7.2. Evidence-based management model

7.7.1. Pre-pregnancy phase

This phase requires health practitioners involved in management of GDM to have necessary skills, training and expertise. Health practitioners involved in management of GDM can collaborate with different stakeholders to ensure that gestational diabetes mellitus is known in the community and that everyone is aware of it. Community awareness can be done through different platforms including radio health talks which already exists in the Mopani district, pamphlets/posters and campaigns. This will particularly be more beneficial to pregnant and non-pregnant women in the community as through this initiative, they can be able to know symptoms, risk factors, complications and management of GDM. Community can be screened during community campaigns for NCDs particularly diabetes can be done for early identification of the disease and start management promptly.

By doing so, we will be implementing a 90-60-50 cascading approach which has been adopted by the National Department of Health in 2022 with the aim of improving early detection and treatment of diabetes and hypertension (University of Pretoria Diabetes Summit, 2023). Furthermore, the adopted approach aims to ensure that 90% of all people who are over 18 years will know whether they have increased blood pressure of blood glucose; 60% of people diagnosed with hypertension or diabetes will receive intervention; and 50% of people who are receiving intervention will be controlled (University of Pretoria Diabetes Summit, 2023). This shows that intersectoral collaboration and multifactorial approach are needed to achieve these set targets. Furthermore, they can be informed about lifestyle modifications such as physical activity, nutrition as these assists in maintain healthy weight which is important before conception. In this way, strategy 1: community awareness; strategy 5: providing training programs on GDM; and strategy 6: intersectional collaboration will ensure that SDG no 3 objective which focuses on reducing premature mortality from NCDs is achieved.

7.7.2. Pregnancy phase

The aim of this phase is to strengthen the standard of practice by referring to relevant policies and guidelines. Case finding of GDM is important and thus, it is imperative that pregnant women with risk factors be screened and diagnosed for GDM as outlined in

the Guidelines for Maternity care (2016) and other guidelines. Universal screening for GDM can be beneficial to all pregnant women attending ANC as undetected GDM or late diagnosis cases can be avoided. However, this method can be costly in our context. As per guideline, all pregnant women diagnosed with GDM need to be referred to a dietician. This can be achieved by strategy of interdepartmental referral system where referral forms to dietician can be completed during ANC and in case where a patient is admitted. By doing so, pregnant women with GDM can become aware of lifestyle and behaviour modification they need to make and adhere to as this will reduce occurrence of complications associated with GDM.

What can be done to reduce risk factors associated with GDM is to include GDM as one of the health conditions to be focused on during health education programs which are conducted before ANC begins. In addition, collaboration with dieticians during ANC health education programs can be beneficial to the pregnant women as they can be educated on healthy eating and maintaining health weight during pregnancy. Furthermore, dieticians can conduct screenings and provide treatment to those who need dietary intervention. Strategy 2: Reinforcing standard of practice will ensure that quality care is provided which ultimately will produce good maternal and infant health outcomes and strategy 4: Strengthening interdepartmental referral system. Further, objectives of SDG no 3 can then be achieved.

7.7.3. Post-pregnancy phase

Postpartum care is important and long-term follow-ups for both the mother and child needs to be scheduled and monitored as pregnant women with GDM are at risk of developing Type 2 DM. Screening for Type 2 DM, weight control, physical activity and healthy eating are essential preventative measures. Further, this applies to both the mother and child as studies have showed that babies born to mothers with GDM are at risk of developing DM and other metabolic disorders which are risk factors of GDM. Also, both mother and child can be seen by dieticians as outpatients for dietary control intervention to minimise long term effects of GDM.

7.8. Validation of an evidence-based management model for the mitigation of risk factors associated with GDM and the improvement of maternal and infant health outcomes.

Model validation determines how accurate the developed model is as a representation of real-life problems (Yin & McKay, 2018). In this study, model validation was done to identify, improve errors; ensure relevance (appropriateness), representativeness and accuracy of the model. Content validation technique was used to validate the model. Content validation is a systematic process which ensures the "extent of a measurement tool represents the measured construct, and it is considered as essential evidence to support the measurement tool" (Yusoff, 2018). Content validation procedure with six steps as outlined by Yusoff (2018) was followed:

7.8.1. Preparing content validation form

A content validation form was prepared for the experts to utilised when providing their expert input on the model (Annexure Ae). The form had clear instructions which the experts were able to comprehend and follow through. In addition, the validation form had 3 domains with 13 items which experts had to rate for degree of relevance.

7.8.2. Selecting a review panel of experts

The number of experts were purposively selected to review and critique the developed model were three but only two responded. Prior to collection of data, informed consent was sought from the experts (Annexure Ad). Anonymity and confidentiality were maintained by not revealing their identities.

7.8.3. Conducting content validation

Step three includes step 4 (reviewing domain and items) and step 5 (providing score on each item). The content validation was conducted using non-contact approach wherein the validation form was sent to experts through email (online) and clear information and instructions were indicated on the form (Annexure Ad and Ae). furthermore, experts were required to review domains and items, provide a score for each item, and give a comment. Experts' comments were used to refine the domain and its items. For scoring, experts had to rate the degree of relevance of the domain's item, 1=the item is not relevant to the

measured domain; 2=the item is somewhat relevant to the measured domain; 3=the item is quite relevant to the measured domain; 4=the item is highly relevant to the measured domain. Thereafter, the experts were required to submit their responses after having rated all the items through an email.

7.8.4. Calculating Content Validation Index (CVI)

The following are the definitions of CVI indices indicated in table 7.4 as recommended by various authors:

Table 7.4: Definitions and formulas of CVI indices

The CVI indices	Definition	Formula
I-CVI (item-level content validity index).	The proportion of content experts giving item a relevance rating of 3 or 4.	**I-CVI**= (agreed item divided by number of expert).
S-CVI/Ave (scale-level content validity index based on the average method).	The average of the I-CVI scores for all items on the scale or the average of proportion relevance judged by all experts. The proportion relevant is the average of relevance rating by individual expert.	**S-CVI/Ave**= (sum of I-CVI scores) divided by (number of items) **OR** (sum of proportion relevance rating) divided by (number of expert).
S-CVI/UA (scale-level content validity index based on the universal agreement method).	The proportion of items on the scale that achieve a relevance scale of 3 or 4 by all experts. Universal agreement (UA) score is given as 1 when item achieved 100% experts in agreement, otherwise the UA score is given as 0.	**S-CVI/UA**= (sum of UA scores) divided by (number of item).

Yusoff, M.S.B. (2019). ABC of Content Validation and Content Validity Index Calculation. *Education in Medicine Journal*, 11. 49-54. http://dx.doi.org/10.21315/eimj2019.11.2.6.

According to Yussoff (2019), the relevance scale of 3 or 4 need to be recorded as 1, and the relevance scale of 1 or 2 need to be recorded as 0 before calculating the CVI. Below is table 7.5 depicting the relevance rating scores on item scale by two experts:

Table 7.5: The relevance ratings on the item scale by two experts

	Expert 1	**Expert 2**		**Experts in Agreement**	**I-CVI**	**(Universal Agreement) UA**
Item						
Q1	1	1		2	1	1
Q2	1	1		2	1	1
Q3	1	1		2	1	1
Q4	1	1		2	1	1

	Expert 1	Expert 2		Experts in Agreement	I-CVI	(Universal Agreement) UA
Q5	1	1		2	1	1
Q6	1	1		2	1	1
Q7	1	0		1	0.5	0
Q8	0	1		1	0.5	0
Q9	1	1		2	1	1
Q10	1	1		2	1	1
Q11	1	1		2	1	1
Q12	1	1		1	1	1
Q13	1	1		2	1	1
				S-CVI/Ave	**0.92**	
Proportion relevance	0.92	0.92		**S-CVI/UA**		**0.85**
Average proportion of items judged as relevance across the two experts (S-CVI/Ave based on proportion relevance)			**0.92**			

Yusoff, M.S.B. (2019). ABC of Content Validation and Content Validity Index Calculation. *Education in Medicine Journal*, 11. 49-54. http://dx.doi.org/10.21315/eimj2019.11.2.6.

The **expert in agreement** values were calculated by obtaining the total sum of relevant rating score provided by the experts i.e., Q1(1+1) =2, Q2 (1+1) =2……. Q7 (1+0) =1. The **Universal agreement (UA) score** was obtained by assigning score '1'if both experts provided the same relevance rating, that is 100% is achieved by experts in agreement. Further, a score of '0' was used if not all experts provided the relevance rating score of 1. The **I-CVI score** was achieved by dividing the expert in agreement score for a particular item by number of experts. For instance, Q3 (2/2=1); Q12 (1/2=0.5). The **S-CVI/Ave** was based on I-CVI whereby the average of I-CVI across all items divided by total number of items [(1+1+1+1+1+1+0.5+0.5+1+1+1+1+1)/13] is equal to 0.92.

The **S-CVI/Ave score** based on the proportion relevance, the average of proportion of scores across experts, [(0.92+0.92) / 2] equals to 0.92. The **S-CVI/UA score** was achieved by finding the average of UA scores across all items divided by the total number of items [(1+1+1+1+1+1+0+0+1+1+1+1+1/13] is equal to 0.85.

According to Davis (1992), the acceptable cut-off score of CVI value among two experts should be at least 0.80. Based on the calculation of CVI on this study, the I-CVI (0.92), S-CVI/Ave (0.92) and S-CVI/UA (0.85) meet the satisfactory level. Hence, the model has achieved the satisfactory level of content validity.

7.9. Conclusion

Prior to developing an evidence-based model, intervention strategies had to be proposed as they will assist in informing the model to ensure that it is relevant and appropriate to the context. Intervention strategies were proposed and validated using a Delphi technique approach. Moreover, the findings from the Delphi method informed the development of an evidence-based management model for mitigation of risk factors associated with GDM. To validate the developed model, model validation was done by two experts in the field and CVI was calculated, and it was found that the model met the satisfactory level as —-CVI score was above 0.80 as Davis (1992) proposed the acceptable cut-off value of CVI to be at least 0.80 among two experts. The next chapter will focus on summary, recommendations and limitations of the study.

CHAPTER 8: SUMMARY, RECOMMENDATIONS, LIMITATIONS, AND CONCLUSION

8.1. Introduction

This chapter summarise the study findings and developed model in relation to study objectives, research question and research problem statement. Further, the chapter discusses whether research objectives have been met or not. Thereafter, recommendations, relevance of the study, limitations of the study, contribution of the study to the existing body of knowledge, and conclusions were outlined drawn from study findings, evidence-based model generated, theoretical framework and literature review.

8.2. Gestational diabetes mellitus and associated risk factors.

Prior to developing an evidence-based management model of GDM, we needed to understand GDM phenomena as it occurs in the Mopani district, Limpopo Province. The study showed an increased prevalence of GDM of 3.6% in the Mopani district when compared to a study which was previously conducted in the Greater Giyani area, the Mopani district with a prevalence of 1.9%. During phase one of this study, it emerged from the interviews with nurses and doctors who are involved in management of obstetrics cases that GDM was a scare health condition but recently more cases are being identified compared to previous years. In this current study, pregnant women aged 35 years and older had a higher risk of developing GDM than those who were 30 years and younger though this finding was not statistically significant in multivariable logistic regression model.

There was no significant association between GDM and marital status, employment status, BMI, family history of diabetes, educational level and parity. It is worth noting that pregnant women who were of ages between 25-29 years old, married, with secondary education but unemployed, obese, had family history of diabetes and have given birth to two children or more were most likely to present with GDM. Hence, these risk factors mentioned above are critical to be addressed to ensure that we mitigate modifiable risk factors associated with GDM which will ultimately reduce the occurrence of GDM.

8.3. Study research objectives.

This section discusses research objectives which were achieved during the research process and focuses on how they were achieved according to different phases of the study.

8.3.1. Phase one: Qualitative approach

The aim of phase one of this study which undertook a qualitative approach was to explore GDM in depth with the aim of understanding and to have rich data. Qualitative research objectives were studied by purposively sampling nurses and doctors working in maternity unit and semi-structured interview with open-and-closed ended questions was used to gather data. The study findings were presented in themes and sub-themes in chapter five and were also used to develop data collection tool for phase two. The first objective was to explore the perceptions of patients on management of GDM by health care providers.

In addition, participants were asked if pregnant women attending antenatal care were aware of GDM and its causes, management. The findings of this objective were presented by theme six with one category and three sub-categories. Overall, this objective was achieved. The second objective was to describe the collaboration between NCD, and maternal and child health units in the Mopani health district. The findings of this objective were presented by theme three supported by one category and two sub-categories. It emerged in this study that there is poor coordination between the two district health units. In addition, this objective was achieved.

8.3.2. Phase two: Quantitative approach

As previously highlighted, the findings from phase one informed variables to measure in phase two. It is worth noting that there was a small section of qualitative approach as pregnant women who had been diagnosed with GDM were interviewed to examine the perception of pregnant women diagnosed with GDM on management. The quantitative objectives were studied cross-sectionally using a questionnaire as data collection method to collect data from 386 pregnant women who were attending antenatal clinic visits in selected health facilities. Further, the findings which emerged were presented in percentages, tables and graphs. The first objective was to determine

the risk factors associated with GDM. The objective was achieved through administrating a questionnaire to pregnant women and descriptive and regression analysis were done to determine prevalence and associated risk factors. Moreover, data was presented in tables.

The second objective was to describe the maternal and infant health outcomes associated with GDM. This objective was partially achieved as pregnant women who had GDM were not followed-up till delivery. The third objective was to determine the association between socio-demographics, risk factors with maternal and infant health outcomes. This objective was achieved as association was determined using fisher-exact test. The fourth objective was to investigate knowledge and perspective of patients on GDM. In addition, the objective was achieved, and findings were presented in graphs and tables.

With regards to qualitative aspect of phase two with an objective which aim to examine the perception of pregnant women diagnosed with GDM on management, the objective was achieve through conducting semi-structured interviews with seven participants and findings were presented in themes, categories and sub-categories. The findings of both qualitative and quantitative strands were integrated and interpreted. This informed Phase three of this study.

8.3.3. Phase three: Developing an evidence-based model to mitigate risk factors and improve maternal and infant health outcomes associated with GDM.

The objective of phase three was to develop an evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with GDM. Phase three entailed development of intervention strategies, validation of strategies, development of evidence-based model based on intervention strategies and validation of the model developed. In addition, Delphi technique was used to validate intervention strategies and the model was validated by using content validation. Intervention strategies were informed by study findings, literature review, theoretical framework which guided the study, guidelines and policies for maternity care, referrals, ideal hospital and health standards. Furthermore, these intervention strategies were guided by a seven-step approach adapted from Muthelo (2022) and Diffusion of innovative theory (Rogers et al., 2014). The seven-step

approach encompassed of strategy goal; justification; responsibility; performance drivers; compatibility; trialability and observability.

These intervention strategies were developed with an overall aim of achieving SDG no 3 which focuses on ensuring healthy lives and promoting well-being for all at all ages. Also, the SDG no 3 objectives – reducing maternal mortality, ending preventable deaths of newborns and children below 5 years, and reducing one third of premature mortality from NCDs. The proposed intervention strategies were community awareness about GDM, reinforcing standard of practice, adoption of Ideal Hospital facilities and Infrastructure domain in accordance with Ideal Hospitalisation and Maintenance Framework, strengthening interdepartmental referral system, providing training programs on gestational diabetes mellitus, and intersectoral strategies. More detailed information on these intervention strategies were described in chapter seven of this current study.

To ensure that the intervention strategies are relevant and appropriate, Delphi technique was used wherein experts in the field were invited to give their input. The experts included one obstetrics medical specialist, the Mopani district dietetics coordinator, and one primary health care clinic manager. Informed consent was obtained from the experts after having explained the validation process and nature of the study. Moreover, a validation survey was provided to the experts, and they had to rate and comment on goal and management practice, context of strategies, explanation of strategies, and evidence to support the strategies (Muthelo, 2022). The validation process was explained in detail in chapter seven of this study.

An evidence-based management model was therefore developed from intervention strategies. The model had three phases which are pre-pregnancy phase, pregnancy phase and post-pregnancy phase. Within each phase, there were interventions which can be facilitated with the aim of mitigating risk factors associated with GDM. Also, a detailed explanation of the model was provided in chapter seven of this study. The developed model had to be validated for relevance and representativeness. Hence, content validation was done wherein experts were selected to provide their input on the model through completing a validation form. Furthermore, the form had three domains with 13 items which experts had to rate the degree of relevance of the outlined

items. Thereafter, CVI was calculated. An in-depth content validation process was highlighted in chapter seven of this study.

8.4. Recommendations to enhance awareness and management of GDM.

8.4.1. Introduction

This section highlights the recommendations to management and practice, education and training, policy, and future research. Furthermore, the recommendations are based on study findings, proposed evidence-based model.

8.4.2. Recommendations to management and practice

According to the National Patients' Rights Charter, every patient has the right to all information regarding their illnesses and treatment involved (Patients' Rights Charter, 1999). Therefore, the study recommends that all pregnant women diagnosed with GDM need to be provided with health information related to their condition and its management. Due to shortage of staff, overcrowding and increase number of pregnant women waiting to be seen, this does affect the time that the doctor/nurse spent with the patient which result in insufficient health education or no health education at all. Therefore, it is recommended that educational materials on the condition and treatment particularly diet-related be provided which will supplement the information they received during ANC. This will assist the pregnant with GDM to be cognisant of their lifestyle and improve their awareness on this health condition.

8.4.3. Recommendations for education and training

It is recommended that continuous professional development program on GDM be provided to all health practitioners involved in the management. This can be achieved by health institutions scheduling training skills workshops to enhance skills development, work competence and this will ensure that the practice is evidence-based and up to date. A wide range of learning platforms which includes e-learning, contact learning can be used.

8.4.4. Recommendations for policy

For every pregnant woman diagnosed with GDM whether during ANC or when admitted, they need to be referred to a dietetics department as dieticians are part of health practitioners involved in management of GDM as outlined in Maternity care

guideline (2016) which is commonly used across health institutions in Limpopo province. In overall, this will strengthen the standard of practice and adherence to policy.

8.4.5. Recommendations for future research

It is recommended that future research should focus on the implementation of the evidence-based model which was developed. Further, a case control or cohort study can be conducted to assist in identifying maternal and infant adverse health outcomes associated with GDM.

8.5. Contribution of the study to the existing body of knowledge

The current study attempted to address gaps which were identified in literature review, and this includes limited research on gestational diabetes mellitus in the rural context of the Limpopo province, limited literature on model for mitigating risk factors associated with gestational diabetes in Limpopo rural context and rising burden of NCDs in low-and-middle-income countries due to epidemiological transitions. In addressing the identified gaps, several important contributions were made:

8.5.1. Theory contribution

The theoretical framework lens for this current study was a priori framework for synthesising a model of care for NCDs. The framework was developed from the model of care for chronic care which primarily focuses on responding to the needs of people with chronic conditions (Wagner et al., 1996) and it aims to inform population-based interventions for NCDs (Kane et al., 2017) as previously the model of care was developed to address individual needs (Davidson et al., 2006). Furthermore, the framework was found to improve the provision of quality health services which in turn improve patient outcomes when focusing on three essential priori concepts which are screening, prevention and control (Kane et al., 2017).

Based on the three priori concepts of a priori framework for synthesising a model of care for NCDs, the current study intended to develop an evidence-based management model for the mitigation of risk factors and the improve maternal and infant outcomes associated with GDM. This was achieved by determining the prevalence and risk factors of GDM; describing the maternal and infant outcomes associated with GDM;

determining the association of socio-demographics, risk factors with maternal and infant outcomes; investigating the knowledge and perspective of patients on GDM and its management; exploring the perception of pregnant women diagnosed with GDM on management; and describing the collaboration between NCDs and maternal & child health units. In doing so, it adds to model of care theory development by integrating the priori framework for synthesis with AMO theory and MDT model.

The aforesaid integration assisted in addressing how we can mitigate the risk factors associated with GDM during pre-pregnancy phase, pregnancy phase and post-pregnancy phase. This study shifted the focus to practical ways to reduce or mitigate modifiable risk factors associated with GDM and this led to development of the model based on identified problems which emerged during data collection. The current study was the first study to implement a priori framework for synthesising a model of care for NCDs in South African Rural context. This study showed that this theoretical framework can be applied in practice.

8.5.2. Methodological contribution

No previous studies have studied this phenomenon or research area using mixed method research approach. In addition, qualitative or quantitative research approaches were used to study GDM in previous studies. The current research adopted an exploratory sequential mixed method research approach which allowed for the research phenomena to be understood in depth first during the exploratory phase. Furthermore, utilisation of both qualitative and quantitative approaches allowed for the data to be analysed differently and contributed to a deeper analysis which contributed greatly to body of knowledge. Using this approach gave multiple insights into the research phenomena.

8.5.3. Research area as a contribution to the body of knowledge.

Gestational diabetes mellitus has not been widely researched in Limpopo province. The first study which was conducted by Mamabolo et al (2007) which focused on the prevalence of GDM and effect of weight on measures on insulin secretion and insulin resistance in third trimester. The second study was conducted by Ntshauba et al (2022) which focused on prevalence and associated risk factors of GDM. Hence, this current study was significant.

8.5.4. Emergence of NCDs as contribution to the body of knowledge

Emergence and increase prevalence of NCDs have been studied widely. This current study focused on diabetes as one of the prevalent NCDs in rural areas. Being able to study this research area in a rural context of Limpopo province has contributed to building literature on the subject matter hence, this was a significant contribution to the body of knowledge.

8.5.5. Contribution to the field of Public Health

The development of an evidence-based management model for the mitigation of risk factors associated with GDM ensures that GDM intervention is focused on at a population level (all women in communities) than individual level (pregnant women diagnosed with GDM). Thus, contributing towards Public Health field.

8.6. Limitations of the study

Below are the limitations noted in this study:

i. The study was conducted during antenatal visits in facilities which were often overcrowded, with increased noise levels and shortage of staff. The number of pregnant women to be attended to was high, particularly in regional hospitals, district hospitals and CHCs. In addition, some pregnant women were reluctant to participate in the study as they did not want to miss their turn to enter the consultation room. Others had been queuing for a long period of time, which resulted in fatigue.
ii. The proposed evidence-based model was not implemented due to time constraints. Hence, an implementation study needs to be conducted on the model to determine its effectiveness.
iii. The second round of Delphi technique was not conducted because of loss to follow-up with the experts.
iv. The response rate for content validation of the developed model was low as the majority of experts had work commitments.

8.7. Conclusion

This research study aimed to develop an evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with gestational diabetes mellitus (GDM) in the Mopani district of the Limpopo province in South Africa.

The study undertook an exploratory sequential mixed methods design to address the aim. Based on a qualitative and quantitative analysis, it can be concluded that GDM prevalence is rising and that the majority of pregnant women attending ANC are not aware of GDM, its risk factors, complications and management, and this includes pregnant women diagnosed with GDM.

The results of this study indicate that there is a need to promote GDM health education, which will bring about awareness in rural and urban communities. Such an intervention will require intersectoral collaboration. Furthermore, the standard of practice needs to be strengthened through the enhancement of an interdepartmental referral system and a multidisciplinary approach.

Adopting a mixed methods design provided advantageous in this study as it allowed for GDM to be explored in-depth in order to gain a detailed understanding of this health condition as it occurs in the Mopani district of the Limpopo province. The findings which emerged during the exploratory phase provided helpful insights and allowed for the quantitative data collection instruments to be adapted to address further insights which arose during the exploratory phase.

To further explore the implication of these study findings, future research may address the maternal and infant health outcomes associated with GDM in the form of a prospective cohort study or case-control study. Furthermore, future studies may implement the evidence-based management model for the mitigation of risk factors associated with GDM to determine its effectiveness and build on existing knowledge.

The Department of Health and other health institutions in the province should plan training skills programmes specifically on GDM to enhance health practitioners' knowledge, skills and competencies. Awareness on GDM as a non-communicable disease (NCD) should be raised, which will encourage testing and follow-up and assist in the long-term improvement of population health.

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10.Annexures

Annexure A: Questionnaire (English)

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The aim of the study is to investigate the prevalence, risk factors, maternal and infant outcomes of women with gestational diabetes mellitus in Mopani District. The study is being conducted through the University of Limpopo. There are 20 questions in this questionnaire. The questionnaire might take you 15 – 20 minutes to complete. For questions with alternative options, indicate by crossing (x) in the box. For questions with blank spaces, please provide an answer in writing.

A. BACKGROUND INFORMATION

Q1 What is your age: ☐ Years

Q2 What is your home language?

Tshivenda	Xitsonga	
Sepedi	English	
Sesotho	Other (specify)	

Q3 What is your marital status?

Single	Divorced
Married	Widowed

Q4 What is your ethnic origin/race?

Black	White
Indian	Coloured

Q5 How many people live with you ☐

Q6 What is your level of education?

None	Primary
Secondary	Tertiary

Q7 Are you working?

Yes	No

Q8	If not employed, what is your source of income?	
Q9	Where do you live?	

Q10	When did you start attending antenatal clinic visits?	≤4 Weeks	7-8 Weeks
		5-6 Weeks	>8 Weeks
Q11	Which medical condition are you diagnosed with during this pregnancy? (Specify date)		
Q12	Have you been pregnant before?	Yes	No
Q13	Were you diagnosed with gestational diabetes mellitus in your previous pregnancy?	Yes	No
Q14	Is there anyone in your family i.e., Parents, siblings, close relatives who have diabetes?	Yes	No
Q15	Have you experienced past pregnancy complications before?	Yes	No
Q16	If yes, what were they?		

Q17	What is your	Weight		Kg
		Height		M
Q18	What treatment are you receiving for your medical condition?			

B. KNOWLEDGE ON GESTATIONAL DIABETES MELLITUS

In this section, you can cross (X) your chosen answer.

B.1. Knowledge about gestational diabetes and its risk factors

Knowledge about gestational diabetes and its risk factors	Yes (X)	No (X)
1. Have you heard about diabetes mellitus?		
2. Can diabetes occur for the first time in pregnancy?		
3. Is family history of diabetes a risk factor for diabetes in pregnancy?		
4. Is pre-pregnancy obesity a risk factor for diabetes in pregnancy?		
5. Is diabetes in previous pregnancy a risk factor for diabetes in pregnancy?		
6. Is rapid weight gain in pregnancy a risk factor for diabetes in pregnancy?		

B.2. Awareness about screening and treatment of gestational diabetes

Awareness about screening and treatment of gestational diabetes	Yes (X)	No (X)
7. Have you heard about Blood test for diabetes after glucose load?		
8. Is testing for diabetes in pregnancy is necessary?		
9. Even diet and exercises can treat GDM		
10. Insulin or drugs are required to treat GDM		

B.3. Awareness about gestational diabetes consequences

Awareness about gestational diabetes consequences	Yes (X)	No (X)
11. Does GDM disappear after pregnancy?		
12. Is baby at risk if GDM is not treated?		
13. Mothers with GDM are at risk of developing diabetes		

Thank you for your participation.

Annexure B: Questionnaire (Xitsonga)

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Xikongomelo xa ndzavisigo lowu iku kumisisa nhlayo, nxungweto, mbuyelo ka ku biha e mihrini na vana eka va xisati lava nga ni vuvabyi bya chukele eka va yimani e Greater Giyani, Mopani District, Limpopo province. Ndzavisiso wu endliwa na Univhesiti ya Limpopo. Kuna swi vutiso swa 18 ena papilla leri. Ku hlamula swivutiso swiga teka 15-20 wa ti minetse. Swivutiso leswinga nyikiwa ti nhlamulo to hlaya, kombisa hi xixambani (X) endzeni ka bokisi. Swivutiso leswinga na ndzhawu yo hlamulela ka yona, mi komberiwa ku tsala nhlamulo.

Siku ro velekiwa			

Q1 Mi na malembe ma nghani? | | Wa malembe

Q2 Hi rihi ririmi ra le kaya?

Tshivenda	Xitsonga	
Sepedi	Xilungu	
Sesotho	Other (specify)	

Q3 Xa mi tekiwile?

Ani tekiwangi	Hi thalanili
Ni tekiwili	Ni lovele hi nuna / nsati

Q4 Xa mi rixukamuni?

Muntima	Mulungu
Indiya	Khaladi

Q5 Ni tshama miri vangani kaya?

Q6 Xana mi dyondze ku fika kwihi?

Ku hava	Xikolo xa le hansi
Xikolo xa le henhla	Xikolo xa le univhesithi

Q7 Xana ma tirha?

Ina	E-e

Q8 Xana loko minga tirhi, mi tihanyisa hi yini?

Q9 Mi tshama kwi?

Q10 Mi sungule rini ku ya eka tliliniki ya vu yimani?

≤4 Weeks	7-8 Weeks
5-6 Weeks	>8 Weeks

Q11 Mi switivile riwi leswaka una ma byavi eka vuyimana? (vulani siku)

Q12 Mi thsame ma va muyimani khale?

Ina	E-e

Q13 Xana mi kumeke uri na vuvabyi bya chukele ra va yimani lowu a wu tikile?

Ina	E-e

Q14 Xana kuna loyi angina vuvabyi bya chukele e kaya (ku ngava vatswari, vamakwano, maxana ya le kusuhi?

Ina	E-e

Q15 Mi tshama mivana xiphoqo eka vuyimani hebyi minga handzo?

Ina	E-e

Q16 Loko swikona, mi nga swi vulana?

Q17 Xana i yini

Ntiko		Kg
Ku leya		M

Q18 Xana mi kuma vutshunguri bya njhani?

B. VUTIVI MAYELANA NA VUVABYI BYA CHUKELE

Vutivi mayelana na Vuvabyi bya chukele eka vayimani

Eka xiphemu lexi, u ng vekela xihambani eka nhlamulo leyi uyi hlawuleke

B1. Vutivi mayelana na Vuvabyi bya chukele eka vayimani na leswi nga byi vangaku/xungwetaku ku byi vanga.

Vutivi mayelana na Vuvabyi bya chukele eka vayimani na leswi nga byi vangaku/xungwetaku ku byi vanga	**Ina (X)**	**E-e (X)**
1.Xana u tshame u twa hita vuvabyi va chukela eka vayimani?		
2.Xana vuvabyi bya chukele byinga vangeka ro sungula loko munhu ari muyimani?		
3.Xana kuva kuri na vuvabyi bya chukele e mutini swinga vangela vuvabyi bya chukele ka muyimani?		
4.Xana kuva munhu a nyuhwerile swinga vangela chukela eka muyimani?		
5.Xana vuvabyi bya chukele lebyinga va kona ka vuyimani lebyi nga hundza byinga vangela vuvabyi bya chukela ka muyimani?		
6.Xana ku tlakuka ka xihatla ka weyiti ka muyimana swinga vangela vuvabyi bya chukele ka muyimani		

B.2.Vutivi bya ku hlahluva na ku tshungula vuvabyi bya chukela ka vayimani.

Vutivi bya ku hlahluva na ku tshungula vuvabyi bya chukela ka vayimani.	**Ina (X)**	**E-e (X)**
7.Xana u tsahme u twa hita ku cheka chukele hiku kamberiwa ka ngati?		
8.Xana swina nkoka ku kamberiwa chukela eka muyimani?		
9.Madyelo na vuti olori na swona swinga tshungula vuvabyi va chukele ra vayimani.		

10.Insulin kumbe mirhi ya dingeka eka ku tshungula vuvabyi bya chukele ra vayimani		

B.3. Vutivi eka hakelo ra chukele

Vutivi eka hakelo ra chukele	**Ina (X)**	**E-e (X)**
11.Xana Vuvabyi bya chukele ra vayimani bya nyamalala endzaku ka vuyimani/ku chucheka?		
12.Xana nwa I leka khombo loko vuvabyi bya vuyimani byinga tshungutiwi?		
13.Va manana lava vangana vuvabyi bya chukele ra vayimani va leka khombo eka ku kuma vuvabyi bya chukele?		

Hi khensa matiriselo a nwina

Annexure C: Data entry form

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Participant's medical records will be reviewed, and the following data will be extracted from the file using the data entry form outlined below:

ID	Age	Gestational age	Weight (kg)	Height (m)	Past obstetric history	Test/s conducted to diagnose medical condition in pregnancy	Test result	Complications	Treatment received

Annexure D: Interview guides (English)

1.Unstructured interview questions for key informant/secondary participants: Health practitioners (Doctors & Nurses)

a. Questions related to work experience.

- how long have you been working in maternity unit?
- Do you have further training in obstetrics?
- What are your thoughts on employees receiving further training in obstetrics?
- Are you working under supervision?
    - If No, why are you not being supervised (*for junior practitioners*)?

b. Questions related to prevalence of GDM.

How would you describe the burden of gestational diabetes in your area?

Probing question:

- How many cases do you see in your facility?

c. Question related to common risk factors of GDM.

Do you mind sharing some of the common predisposing factors to gestational diabetes in your community?

Probing question:

Common risk factors in your area?

d. Question related to screening & diagnosis of GDM.

How do you screen for GDM?

How would you describe the information that you provide to a patient suspected with gestational diabetes?

How do you diagnose GDM?

Probing question:

How reliable is this method?

Do you mind sharing the information you would include to communicate the diagnosis with the woman?

e. Questions related to treatment of GDM.

Once the patient is diagnosed with gestational diabetes what are some of the self-care information should this woman consider coping with the disease.

What treatment do you offer to pregnant women with gestational diabetes in your institution?

Probing question:

- How do you collaborate with other health practitioners in managing gestational diabetes?
- Which policy documents or guidelines do you refer to when treating gestational diabetes?

f. Questions related to awareness of GDM.

Once the patient is diagnosed with gestational diabetes what are some of the self-care information should this woman consider coping with the disease.

In your opinion do you mind sharing the information you give to any woman who plan to be pregnant on gestational diabetes

What is the level of patients' awareness on gestational diabetes?

Probing question:

Do you think patients know about gestational diabetes, the causes?

g. Questions related to infant and maternal health outcomes associated with GDM.

- Which complications on the mother and baby do you encounter in your institution for a woman diagnosed with gestational diabetes?
- Do you mind sharing how you manage these complications?

2. Unstructured interview key informant: Non-communicable disease district manager

Do you mind sharing what is the burden of non-communicable disease in Mopani district?

What is the burden of gestational diabetes in Mopani district?

Probing question:

- How many cases have been identified in the past 5 years?

Do you mind sharing what are the predisposing factors of gestational diabetes which are common in Mopani district?

Which interventions are tailored towards gestational diabetes in the district?

Probing question:

- Do you mind sharing who are the stakeholders involved in intervention/s?
- Do you mind sharing what is the role of the stakeholders you have identified?

3. Unstructured interview key informant: Child & maternal health district manager

Do you mind sharing what is the perinatal, early neonatal, maternal mortality rate in the district?

What is the perinatal, early neonatal, maternal mortality rate as result of gestational diabetes?

Do you mind sharing what are the common risk factors gestational diabetes in the district?

What are the common adverse health outcomes on foetus/ neonate of pregnant women with gestational diabetes?

What are the common adverse health outcomes on woman diagnosed with gestational diabetes in the district?

In your opinion, how responsive or quick the health facilities in the district are in responding to adverse health outcomes?

Probing question:

- Referral system – is it effective and efficient? do the baby and mother get referred on time?

Do you mind sharing which interventions are directed towards the neonate and mother affected by gestational diabetes?

Do you mind sharing the collaboration which your unit has in addressing child & maternal adverse health outcomes associated with gestational diabetes? Are you collaborating with other stakeholders to address foetus/neonate health outcomes?

4.Unstructured interview guide on management of GDM: Pregnant women diagnosed with gestational diabetes mellitus

What are your thoughts about the treatment of gestational diabetes mellitus you currently on?

Annexure E: Interview guides (Xitsonga)

1. Nkambelo wa swilaveko xivutiso eka va nghenelela va xikhiya (muongori)

a. Swivutiso mayelana na ntokoko wa ntirho.

- Xana ina nkarhi wo leha ku fika kwin u tirha eka Unit ya Vayimani.
- Xana u kumile vuleteri bya le henhla eka ku beburisa?
- Xana ma titwele ya wena mayelana na ku leteriwa ka va thoriwa hi kwihi?
- Xana u tirha e hansi ka vulereli?
    - Loko swingari tano, hiko kwalaho ka yini unga leteriwi ()

b. Swivutiso mayelana na xiyimo xa chukele

Xana unga hlamusela njhani mayelana na ntshikelelo wa vuvabyi bya chukele eka vayimani e ndzhawini yaka nwina?

Xivutiso xo lavisisa:

- Kuna vayimani vangani vanga na vuvabyi lebyi eke tliliniki/xibedlele lexi?

c.Swivutiso mayelana na lexi tolovelekeke xivangelo xa chukele

Xana awuna xi phiqho ku avelana hi swivangelo leswi tivekaka swa vuvabyi bya chukela eka vayimani eka ndhawu yaka nwina?

Xivutiso xo lavisisa:

Hiswihi swilo leswi vekaka vayimana eka khombo leri eka ndzhawu yaka nwina?

d. Swivutiso mayelana na malangutisele a chukele

Xana u hlahluva njhani vuvabyi bya chukele eka vayimani?

Xana ungahi kombisa njhani hita vuxokoxoko lebyi u nyikaka muvabyi loyi anga muehleketeleriwa eka vuvabyi bya chukele ra vuyimani?

Xana u byi kuma njhani vuvabyi bya chukele ra vuyimani?

Xivutiso xo lavisisa:

Xana Ndlela ya wena yo lavisisa vuvabyi lebyi yi tshembeka ku fika kwini?

Xana awuna xiphiquo ku avelana hi vuxokoxoko bya ma tiviselo ya mbyuyelo ya vulavisisi eka vuvabyi lebyi eka vavasati?

e. Swivitiso mayelana na matsungule a chukele

Loko se muvabyi a kumeke ari na vuvabyi bya chukele ra vuyimani, I yini lawa nwansati loyi a faneleke a ma tekela e nhlonkweni ku kuva anga tshikeleleki hi vuvabyi?

Xana hi tihi ti Ndlela taku ku tshungula leti ungati nyikaku wansati loyi anga kumeke ari na vuvabyi bya chukele ra vuyimani eka tliliniki/xibedlele xa wena?

Xituviso xo lavisisa:

- Xana unga tirhisana njhani na vatirhi kulorhi va rihanyu ku lawula kumbe ku tshungula vuvabyi bya chukele ra vuyimani?
- Hi tihi ti pholisi kumbe ti guideline leti unga ti nangutisaku loko u tshungula vuvabyi bya chukele ra vuyimani?

f. Swivutiso mayelana na vutivi bya chukele

Loko se muvabyi a kumeke ari na vuvabyi bya chukele ra vuyimani, hi byihi vuxokoxoko bya kuti hlayisa lebyi nwasanti loyi a faneleke kubyi tekela e nhlokweni ku hunguta ntshikelelo?

Hikuya hi wena, awuna xi phiquo ku avelana vuxokoxoko lebyi u byi nyikaku nwansati loyi a kunguhataku kuva muyimani mayelana na vuvabyi bya chukele ra vuyimani?

Xana vavabyi van a vutivi ku fika kwini hi mayelana na vuvabyi bya chukela ra vuyimani?

Xivutiso xo lavisisa:

Xana u anakanya leswaku vavabyi vana vutivi hi vuvabyi bya chukele ra vuyimani, swivangelelo swa kona?

g. Swivutiso mayelana na switandhaku eka vavasati na vana swi fambelana na chukele.

- Xana switandhaku eka manana na nwana leswi u hlanganaku na swona eke tliniki/xibedlele xa wena eka vavasati lava kumekaka vari na vuvabyi bya chukele ra vuyimani hi swihi?
- Awuna xi phiqo ku ndzi avela ma tshungulelelo/malawulelo ya wena ya switandzhaku leswi?

2. Nkambelo wa swilaveko xivutiso eka va nghenelela va xikhiya: Murhangeri wa mavabyi a nga serelekiko

Xana awuna xiphiqo nakuni avela ntshikelelo was vuvabyi lebyinga tluleleku e xifundzheni ntsongo xa Mopani?

Xana ntshikelelo was vuvabyi bya chukele ra vuyimani wu njhani e xifundzheni ntsongo xa Mopani?

Xivutiso xo lavisisa:

- Xana I nhlayo ya njhani ya vanhu lava vangana kumeka vari na vuvabyi lebyi eka nthlanu wa malembe lawa yanga hundza?

Xana awuna xiphiqo kuni avela hita swilo leswi vekaka vanhu eka khombo ra vuvabyi bya chukele ra vuyimani, leswi talaku ku kumeka eka xifundzha ntsongo xa Mopani?

Xana hi tihi tindlela taku nghenelela let inga endleriwa vuvabyi bya chukele ra vuyimani?

Xivutiso xo lavisisa:

- Awuna xi phiqo ku ndzi avela leswaku hi swihi swirho swinwani pfunetaku eka ku nghenelela loku?
- Xana hi xihi xiphemu lexi tlangiwaku hi swirho leswi ungaswi hlamusela?

3. Nkambelo wa swilaveko xivutiso eka va nghenelela va xikhiya: Murhangeri wa mavabyi a nga serelekiko: Murhangeri wa vana na vomanana eka xifundzha

Awuna xiphiqo kundzi avela hita perinatal, early neonatal, martenal mortality rate eka xifundzha ntsongo?

Xana perinatal, early neonatal, maternal mortality rate leyi vangiwaka hi vuvabyi bya chukele ra vuyimani?

Xana awuna xiphiqo kuni avela hita swilo leswi vekaka vanhu eka khombo ra vuvabyi bya chukele ra vuyimani, leswi talaku ku kumeka eka xifundzha ntsongo?

Xana hi swihi swita ndzhaku swoka swingari kahle eka nwana loyi oka angase tswariwa kumbe loyi anga haku tswariwa hi wansati loyi angana vuvabyi bya chukele ra vuyimani

Xana hi swihi swita ndzhaku swoka swingari kahle eka wansati loyi angana vuvabyi bya chukele ra vuyimani

Hi kuya hi wena, ti ndzhawu ta vutshunguri ti hatlisa ku fika kwin langutisisa switanzhaku leswi swoka swingari kahle?

Xivutiso xo lavisisa:

- Ku hundzisela e mahlweni- xana swi tirha kahle ku fika kwini? Xana nwana na manana va hundziseriwa e mahlweni hi nkarhi?

Xana awuna xiphiqo ku ndzi avela tihi tindlela taku nghenelela leti tinga endleriwa vana na vamanana lava vanga khumbeka hi vuvabyi bya chukele ra vuyimani?

Xana awuna xiphiqo ku ndzi avela hita ntirhisano wa Unit ya wena ku ahlula switandhzaku swoka swingari kahlwe eka leswi fambisanaka na vuvabyi bya chukele ra vuyimani?

4. Nkambelo wa swilaveko xivutiso swo fambelana na matsungulele a chukele: vavasati va vuyimani vo khomiwaho hi chukele.

Xana matitwele ya wena mayelana na matshungulelo bya wena bya vuvabyi bya chukele ra vuyimani hi wahi?

Annexure F: Information letter for health institution CEO/manager (English)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear CEO/Manager

Thank you for taking the time to read this information letter. I am a postgraduate Student from the University of Limpopo conducting a research study which focuses on focuses on the "Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in Mopani District of Limpopo Province, South Africa".

There is an increased prevalence of GDM, and this medical condition can place the life of both the mother and infant at risk especially when it is poorly managed. GDM is associated with health risks which can result in mortality and morbidity of both the mother and infant. The study wishes to inform interventions and policies which can be planned to reduce the prevalence of GDM in the country and subsequently reduce infant & maternal mortality.

Information will be collected using questionnaire and data entry form to capture information from the participant's medical records. To ensure confidentiality, information gathered will be stored in a storage system which is only accessible to the researcher and research supervisor. There will be no direct harm and rewards to participants and participants can withdraw from the study at any time.

Thank you for considering this request. Please find the consent form attached for you to complete. Ethical approval has been obtained from the Faculty of Health Sciences Human Research Ethics Committee of the University of Limpopo (HREC Reference number……...).

Please forward any question or concern you may have regarding this research to the contact details provided below.

Student researcher:

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Research supervisor:

Prof Maimela E eric.maimela@ul.ac.za

Annexure G: Information letter for health institution CEO/manager (Xitsonga)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Eka Murhangeri

Ndzi khensa kuva u teka nkarhi u hlaya papila leri ra vuxokoxoko. Ndzi xichudeni xa ti dyondzo ta le henhla ta Yunivhesity ya Limpopo loyi a endlaku vulavisisi mayelana na "Ku endla model leyi ngana vumboni bya ndzavisiso yaku lawula vu vabyi bya chukele na leswi xungetaku ku byi vanga eka vayimani, na mbuyelo wa rihanyo eka vayimani na vana lavahaku tswariwaku eka Xifundhza ntsongo xa Mopani, e hansi ka Xifundhza xa Limpopo, e Afrika Dzhonga.

Kuna ntlakuko ka tinhlayo ya vuvabyi bya chukele eka vayimani na vuvabyi byinwani lebyi vekaka vutomi bya manana na nwana loyi ahaku tswariwaku e ndhozini loko by inga lawuriwi hi Ndlela ley faneleke. Vuvabyi bya chukele eke vayimani byi fambisana na nxungweto ka rihanyo lowu nga vangaka rifu na vuvabyi byinwani byo xungweta rifu. Ndzavisiso; pwu wu tsakela ku kumisisa swi ntshuxo na pholisi leswi ngata endla kuri kuva na ku hunguteka ka ti nhlayo ta vuvabyi bya chukele ka vayimani switlhela hunguta rifu eka vana na vayimani.

Vuxokoxoko byita hlengeletiwa hiku tirhisa papilla ra swivutiso na papilla ro nghenisa vuxokoxoko ku suka eka ti fayile ta rihanyo ta vanhu lavangata nghenelela aka ndzavisiso. Ku tiyisisa leswaku vuxokoxoko bya vanhu la byi hlayisekili, byita tumbetiwa eka ndhawu yaku vuhlayiseki hiku tirhisa "system", laha kungata pfumeleriwa ntsena mulavisisi na muleteri wa yena ku fikelela. Akungevi na ku vaviseka kumbe mbuyelo eka lavangata nghenelela ndzavisisio lowu, naswona vata pfumeleriwa ku ti humesa nkari wihi kumbe wihi ekandzavisiso.

Ndza khensa kuva u tekela e nhlokweni xikombelo lexi. Kuma papilla ro nyika mpfumelelo leswaku uri tata. Papila ra mpfumelelo ri kumekili ku suka eka Faculty ya Health Sciences Human Research Ethics Committee ya Yunivhesithi ya Limpopo (HREC Reference number.....)

U komberiwa ku kongomisa swivutiso na swi swilelo mayelana na vulavisisi lebyi eka vuxokoxoko lebyi nga vekiwa laha hansi.

Xichudeni xa ndzavisiso

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Muleteri wa ndzavisisio

Prof Maimela E eric.maimela@ul.ac.za

Annexure H: Consent form for health institution CEO/manager (English)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear CEO/Manager

By signing this form, I am allowing the researcher to conduct her research study in this institution.

I…… (Surname &Initials) …… (Rank) hereby consent for the research study to be conducted in this institution.

Thank you,

Place: ……

Signed: ……. **Date**: …….

Researcher: ……... **Signed**: ……

Annexure I: Consent form for health institution CEO/manager (Xitsonga)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Eka Murhangeri

Hiku sayina papilla leri, ndzi nyika mpfumelelo eka mulavisisi ku endla vulavisisi eka xibedlele/tliliniki leyi

Mina.....(Xivongo na ti inixiyali) .....(Xiyimo xale ntirweni)

Income

Ndzhawu.....

Sayina……. Siku……

Mulavisisi..... Sayina……...

Annexure J: Information letter for the participant above 18 years (English)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear Participant

Thank you for taking the time to read this information letter. I am a postgraduate student from the University of Limpopo, conducting a research study which focuses on focuses on the "Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in Mopani District of Limpopo Province, South Africa".

There is an increased prevalence of GDM, and this medical condition can place the life of both the mother and infant at risk especially when it is poorly managed. The study wishes to inform interventions and policies which can be planned to reduce the prevalence of GDM in the country and subsequently reduce infant & maternal mortality and morbidity.

The researcher requests your participation in this research. Information will be collected using questionnaire and data entry form to capture information from the participant's medical records. To ensure confidentiality, information gathered will be stored in a storage system which is only accessible to the researcher and research supervisor. There will be no direct harm and rewards to you, and you can withdraw from the study at any time.

Thank you for considering this request. Please find the consent form attached for you to complete. Ethical approval has been obtained from the Faculty of Health Sciences Human Research Ethics Committee of the University of Limpopo (HREC Reference number…….).

Please forward any question or concern you may have regarding this research to the contact details provided below.

Student researcher:

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Research supervisor:

Prof Maimela E eric.maimela@ul.ac.za

Annexure K: Information letter for the participant above 18 years (Xitsonga)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Ku nghenelela eka ndzavisiso

Ndzi khensa kuva u teka nkarhi u hlaya papila leri ra vuxokoxoko. Ndzi xichudeni xa ti dyondzo ta le henhla ta Yunivhesity ya Limpopo loyi a endlaku vulavisisi mayelana na "Ku endla model leyi ngana vumboni bya ndzavisiso yaku lawula vu vabyi bya chukele na leswi xungetaku ku byi vanga eka vayimani, na mbuyelo wa rihanyo eka vayimani na vana lavahaku tswariwaku eka Xifundhza ntsongo xa Mopani, e hansi ka Xifundhza xa Limpopo, e Afrika Dzhonga.

Kuna ntlakuko ka tinhlayo ya vuvabyi bya chukele eka vayimani na vuvabyi byinwani lebyi vekaka vutomi bya manana na nwana loyi ahaku tswariwaku e ndhozini loko by inga lawuriwi hi Ndlela ley faneleke. Vuvabyi bya chukele eke vayimani byi fambisana na nxungweto ka rihanyo lowu nga vangaka rifu na vuvabyi byinwani byo xungweta rifu. Ndzavisiso; pwu wu tsakela ku kumisisa swi ntshuxo na pholisi leswi ngata endla kuri kuva na ku hunguteka ka ti nhlayo ta vuvabyi bya chukele ka vayimani switlhela hunguta rifu eka vana na vayimani.

Vuxokoxoko byita hlengeletiwa hiku tirhisa papilla ra swivutiso na papilla ro nghenisa vuxokoxoko ku suka eka ti fayile ta rihanyo ta vanhu lavangata nghenelela aka ndzavisiso. Ku tiyisisa leswaku vuxokoxoko bya vanhu la byi hlayisekili, byita tumbetiwa eka ndhawu yaku vuhlayiseki hiku tirhisa "system", laha kungata pfumeleriwa ntsena mulavisisi na muleteri wa yena ku fikelela. Akungevi na ku vaviseka kumbe mbuyelo eka wena naswona wa pfumeleriwa ku ti humesa nkari wihi kumbe wihi ekandzavisiso.

Ndza khensa kuva u tekela e nhlokweni xikombelo lexi. Kuma papilla ro nyika mpfumelelo leswaku uri tata. Papila ra mpfumelelo ri kumekili ku suka eka Faculty ya Health Sciences Human Research Ethics Committee ya Yunivhesithi ya Limpopo (HREC Reference number.....)

U komberiwa ku kongomisa swivutiso na swi swilelo mayelana na vulavisisi lebyi eka vuxokoxoko lebyi nga vekiwa laha hansi.

Xichudeni xa ndzavisiso

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Muleteri wa ndzavisisio

Prof Maimela E eric.maimela@ul.ac.za

Annexure L: Consent form for the participant above 18 years (English)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear Participant

By signing this form, I am declaring my participation in this study.

I…… (Surname &Initials) hereby consent to be part of the study.

Thank you,

Place: ……

Signed: ……. **Date**: …….

Researcher: ……. ….. **Signed**: ……

Annexure M: Consent form for the participant above 18 years (Xitsonga)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Ku nghenelela eka ndzavisiso

Hiku sayina papilla leri, ndzi tiyisisa ku nghenelela eka ndzavisisio lowu.

Mina.....(Xivongo na ti inixiyali)

Inkomu

Ndzhawu.....

Sayina……. Siku……

Mulavisisi..... Sayina……...

Annexure N: Information letter for parent of participant under 18 years old (English)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear Participant/Guardian

Thank you for taking the time to read this information letter. I am a postgraduate student from the University of Limpopo, conducting a research study which focuses on focuses on the Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in Mopani District of Limpopo Province, South Africa".

There is an increased prevalence of GDM, and this medical condition can place the life of both the mother and infant at risk especially when it is poorly managed. The study wishes to inform interventions and policies which can be planned to reduce the prevalence of GDM in the country and subsequently reduce infant & maternal mortality and morbidity.

The researcher therefore asks permission from you for your child to participate in the study. Your child is no under no pressure to participate in this study, and you have the right to withdraw at any point without providing an explanation. There will be no penalty involved should you wish to withdraw. There are no risks in taking part in the study and there will not be any reward. Findings from the study will be analysed by the research team and used for presentations, reports, and research publications.

Thank you for considering this request. Please find the consent form attached for you to complete. Ethical approval has been obtained from the Faculty of Health Sciences Human Research Ethics Committee of the University of Limpopo (HREC Reference number…….).

Please forward any question or concern you may have regarding this research to the contact details provided below.

Student researcher:

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Research supervisor:

Prof Maimela E eric.maimela@ul.ac.za

Annexure O: Information letter for parent of participant under 18 years old (Xitsonga)

Department of Public Health

Faculty of Health Sciences

Private Bag X1106, Sovenga, 0727, South Africa

Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Ku nghenelela eka ndzavisiso

Ndzi khensa kuva u teka nkarhi u hlaya papila leri ra vuxokoxoko. Ndzi xichudeni xa ti dyondzo ta le henhla ta Yunivhesity ya Limpopo loyi a endlaku vulavisisi mayelana na "Ku endla model leyi ngana vumboni bya ndzavisiso yaku lawula vu vabyi bya chukele na leswi xungetaku ku byi vanga eka vayimani, na mbuyelo wa rihanyo eka vayimani na vana lavahaku tswariwaku eka Xifundhza ntsongo xa Mopani, e hansi ka Xifundhza xa Limpopo, e Afrika Dzhonga.

Kuna ntlakuko ka tinhlayo ya vuvabyi bya chukele eka vayimani na vuvabyi byinwani lebyi vekaka vutomi bya manana na nwana loyi ahaku tswariwaku e ndhozini loko by inga lawuriwi hi Ndlela ley faneleke. Vuvabyi bya chukele eke vayimani byi fambisana na nxungweto ka rihanyo lowu nga vangaka rifu na vuvabyi byinwani byo xungweta rifu. Ndzavisiso; pwu wu tsakela ku kumisisa swi ntshuxo na pholisi leswi ngata endla kuri kuva na ku hunguteka ka ti nhlayo ta vuvabyi bya chukele ka vayimani switlhela hunguta rifu eka vana na vayimani.

Mulavisisi u kombela mpfumelelo eka wena leswaku nwana wa wena a nghenelela eka vulavisisi lebyi. Nwana wa wena anga vekiwi e hansi ka ntshikelelo ku nghenelela vulavisisi naswona una lunghelo raku ti humesa nkarhi wihi kumbe wihi kuri hava xivangelo. Aku ngevi na nxupulo loko u tihumesa. Akungevi na ku vaviseka kumbe mbuyelo eka ku nghenelela ndzavisisio lowu. Mbuyelo wa vulavisisi lebyi wuta hlahluviwa hi valavisisi leswaku wuta tirhisiwa eka ti presentation, swiviko na ti publication ta ndzavisiso.

Ndza khensa kuva u tekela e nhlokweni xikombelo lexi. Kuma papilla ro nyika mpfumelelo leswaku uri tata. Papila ra mpfumelelo ri kumekili ku suka eka Faculty ya Health Sciences Human Research Ethics Committee ya Yunivhesithi ya Limpopo (HREC Reference number.....)

U komberiwa ku kongomisa swivutiso na swi swilelo mayelana na vulavisisi lebyi eka vuxokoxoko lebyi nga vekiwa laha hansi.

Xichudeni xa ndzavisiso

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Muleteri wa ndzavisisio

Prof Maimela E eric.maimela@ul.ac.za

Annexure P: Consent form for parent of participant under 18 years old (English)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear Parent/Guardian

By signing this form, you are declaring your child's participation.

I, …… (Surname & initials) have read (or had read to me by ……..) the Information Sheet. I understand what is required of my child. I do / do not consent for my child to participation in the study (Circle appropriate response). I agree/ do not agree for my child's voice to be recorded (Circle appropriate response). I do not feel that my child is being forced to participate in this study. I am aware that my child can withdraw from the study at any time should they wish to do so. I have been assured that if I refuse to allow my child to participate in the study or choose to withdraw at a later stage there will be no consequences for me or my child.

Caregiver/Parent Full Name: ……

Place……. Date……

Signed: ……

Researcher…….. Date…….

Annexure Q: Consent form for parent of participant under 18 years old (Xitsonga)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Ku nghenelela eka ndzavisiso

Hiku sayina papilla leri, u tiyisisa ku nghenelela ka nwana wa wena eka ndzavisisio lowu.

Mina.....(Xivongo na ti inixiyali) ndzi hlayile (kumbe ndzi hlayeriwile hi.....) papilla ra vuxokoxoko. Ndza swi twisisa leswi lavekekaka eka nwana wa mina. Ndzi nyika/ andzi nyiki mpfumelelo kuva leswaku nwana wa mina a nghenelela eka ndzavisiso lowu. (Khwatihahata nhlamulo leyi nga yona hi xirhendzevutana). Ndhza pfumela/ andzi pfumeli kuva rito ra nwana wa mina ringa kandziyisiwa (Khwatihahata nhlamulo leyi nga yona hi xirhendzevutana). Andzi twi nwana wa mina a sindzisiwile ku nghenelela eka ndzavisiso lowu. Ndza swi tiva leswaku nwana wa mina anga ti humesa eka ndzavisiso eka nkarhi wihi na wihi. Vandzi tiyisisili leswaku loko ndzi nga pfumeleli nwana wa mina a nghenelela eka ndzaivisiso kumbe ndzi hlawula ku ti humesa eka ndzavisiso exikarhi ka ndzavisiso, akungevi na nxupulo eka mina kumbe nwana wa mina.

Mavito ya Muhlayisi/mutswari ya helerile.....

Ndzhawu.....

Sayina……. Siku……

Mulavisisi..... Sayina…….

Annexure R: Information letter & accent form for participant under 18 years old (English)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear Participant

Your Parent/Guardian/Caregiver has given permission for you to be in research study. But first, we want to tell you all about it so you can decide if you want to be in it. If you do not understand, please ask questions. You can choose to be in the study, not be in the study or take more time to decide.

What is the name of the study?

Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in Mopani District of Limpopo Province, South Africa".

Who oversees the study?

Postgraduate student at University of Limpopo

What is the study about?

This research study wants to understand the prevalence, risk factors, maternal and infant outcomes of Gestational Diabetes Mellitus (GDM) in Limpopo Province. The information obtained will inform interventions and policies directed at treating this medical condition (GDM).

What will happen to me in the study?

If you choose to be in the study, you will be asked to complete a questionnaire and information on your medical file will be captured on the data entry form. Your name and personal information will be always kept safe and only the researcher & research supervisor will have access to the information.

Will I be paid to be in this study?

You will not be paid for participating in this study.

Do I have to be in the study?

You do not have to be part of the study if you do not want to. Once you are in the study, you can stop being in it at any time. Nobody will be upset with you if you do not want to be in the study or if you want to stop being in the study. No harm will come to you for being part of this study. If you have any questions or do not like what is happening, please tell the researcher.

You have had the study explained to you. You have been given a chance to ask questions. By writing your name below, you are saying that you want to be in the study.

Your full name…… Date……

Parent / Guardian Date and place

…… ……

Researcher Date and place

……. …….

Witness Date and place

……. …….

Annexure S: Information letter & accent form for participant under 18 years old (Xitsonga)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Eka mungheneleri wa ndzavisiso

Mutswari/muhlayisi wa wena u nyikile mpfumelelo leswaku u nghenelela ndzavisisio. Kambe hi lava kuku tivisa leswaku u fanele u ti tekela xiboho xaku nghenenela eka ndzavisisio kusungula. Loko u nga switwisisi, u komberiwa ku vutisa swivutiso. U nga hlawula ku nghenelela, kuka unga nghenelelo kumbe u teka nkarhi wa wena ku teka xiboho lexi.

Xana I yini vito xa ndzavisiso lowu?

Ndzavisiso; pwu wu tsakela ku kumisisa swi ntshuxo na pholisi leswi ngata endla kuri kuva na ku hunguteka ka ti nhlayo ta vuvabyi bya chukele ka vayimani switlhela hunguta rifu eka vana na vayimani.

I mani a letelaku ndzavisiso

Muchudeni loyi a yisaku ti dzondzo ta yela tale henhla e mahlweni na yunivhesiti ya Limpopo.

Xana ndzavisiso lowu wu mayelana na yini?

Ndzavisiso lowu wu lava ku twisisa ti nhlayo, swivangelo/nxungweto, mbuyelo ka vayimani na vana eka vuvabyi bya chukele ra vayimani e ka Xifundzha xa Limpopo

Xana kuya endleka yini hi mina eka ndzavisiso lowu

Loko u hlawula ku nghenelela eka ndzavisiso, uta komberiwa ku tata papilla ra swivutiso naswona vuxokoxoko bya fayili ya wena ya rihanyo byita tekiwa. Vito ra wena na vuxokoxoko bya wena byita hlayisiwa eka ndhawu yo hlayiseka laha byingata fikelela ntsena hi mulavisisi na muleteri wa yena.

Xana ndzita hakeriwa ku nghenelela eka ndzavisiso?

A wu nge hakeriwi ku nghenelela eka ndzavisiso.

Xana ndza boheleriwa kuva eka ndzavisiso?

Awu boheleriwi kuve eka ndzavisiso lowu loko ungari na ku tsakela. Loko se u nghenerili ka ndzavisiso, wa pfumelriwa ku tshika nkarhi wihi na wihi. Akuna munhu loyi angata khunguvanyiseka loko u nga tsakeli ku nghenelela kumbe u tshika e xikarhi ka ndzavisiso. Akuna ku vaviseka loku kungataku humelela loko u nghenelela ndzavisiso lowu. Loko uri na swivutiso kumbe u unga tsakeli leswingaku endlekeni, u komberiwa ku tivisa mulavisisi.

U hlamuseriwili hi ta ndzavisiso. U nyikiwile na nkarhi waku vutisa swivutiso. Hiku tsala vito ra wena laha hansi, u vula leswaku u tsakela ku nghenelela eka ndzavisiso lowu.

Mavito ya wena ya helerilwe

…….. Siku na Ndhawu……

…… ……

Xichudeni Siku na ndhawu

……. ……

Mbhoni **siku na ndhawu**

……. ……

Annexure T: Information letter for key participants (English)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear participant

Thank you for taking the time to read this information letter. I am a postgraduate Student from the University of Limpopo conducting a research study which focuses on the Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in Mopani District of Limpopo Province, South Africa".

There is an increased prevalence of GDM, and this medical condition can place the life of both the mother and infant at risk especially when it is poorly managed. GDM is associated with health risks which can result in mortality and morbidity of both the mother and infant. The study wishes to inform interventions and policies which can be planned to reduce the prevalence of GDM in the country and subsequently reduce infant & maternal mortality.

Information will be collected using a semi-structured interview. The interview is expected to be one session of approximately 30 – 45 minutes. To ensure confidentiality, information gathered will be stored in a storage system which is only accessible to the researcher and research supervisor. You are at no pressure to participate in this study, and you have the right at any point to withdraw. There will be rewards to for participating in this study.

Thank you for considering this request. Please find the consent form attached for you to complete. Ethical approval has been obtained from the Faculty of Health Sciences Human Research Ethics Committee of the University of Limpopo (HREC Reference number……...).

Please forward any question or concern you may have regarding this research to the contact details provided below.

Student researcher:

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Research supervisor:

Prof Maimela E eric.maimela@ul.ac.za

Annexure U: Information letter for key participants (Xitsonga)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Ku nghenelela eka ndzavisiso

Ndzi khensa kuva u teka nkarhi u hlaya papila leri ra vuxokoxoko. Ndzi xichudeni xa ti dyondzo ta le henhla ta Yunivhesity ya Limpopo loyi a endlaku vulavisisi mayelana na "Ku endian model leyi ngana vumboni bya ndzavisiso yaku lawula vu vabyi bya chukele na leswi xungetaku ku byi vanga eka vayimani, na mbuyelo wa rihanyo eka vayimani na vana lavahaku tswariwaku eka Xifundhza ntsongo xa Mopani, e hansi ka Xifundhza xa Limpopo, e Afrika Dzhonga.

Kuna ntlakuko ka tinhlayo ya vuvabyi bya chukele eka vayimani na vuvabyi byinwani lebyi vekaka vutomi bya manana na nwana loyi ahaku tswariwaku e ndhozini loko by inga lawuriwi hi Ndlela ley faneleke. Vuvabyi bya chukele eke vayimani byi fambisana na nxungweto ka rihanyo lowu nga vangaka rifu na vuvabyi byinwani byo xungweta rifu. Ndzavisiso; pwu wu tsakela ku kumisisa swi ntshuxo na pholisi leswi ngata endla kuri kuva na ku hunguteka ka ti nhlayo ta vuvabyi bya chukele ka vayimani switlhela hunguta rifu eka vana na vayimani.

Mulavisisi u kombela mpfumelelo eka wena leswaku nwana wa wena a nghenelela eka vulavisisi lebyi. Nwana wa wena anga vekiwi e hansi ka ntshikelelo ku nghenelela vulavisisi naswona una lunghelo raku ti humesa nkarhi wihi kumbe wihi kuri hava xivangelo. Aku ngevi na nxupulo loko u tihumesa. Akungevi na ku vaviseka kumbe mbuyelo eka ku nghenelela ndzavisisio lowu. Mbuyelo wa vulavisisi lebyi wuta hlahluviwa hi valavisisi leswaku wuta tirhisiwa eka ti presentation, swiviko na ti publication ta ndzavisiso. A hi nga heti timinete 30-45.

Ndza khensa kuva u tekela e nhlokweni xikombelo lexi. Kuma papilla ro nyika mpfumelelo leswaku uri tata. Papila ra mpfumelelo ri kumekili ku suka eka Faculty ya Health Sciences Human Research Ethics Committee ya Yunivhesithi ya Limpopo (HREC Reference number.....)

U komberiwa ku kongomisa swivutiso na swi swilelo mayelana na vulavisisi lebyi eka vuxokoxoko lebyi nga vekiwa laha hansi.

Xichudeni xa ndzavisiso

Ntshauba Elelwani Thelma elelwani.thelma@gmail.com

Muleteri wa ndzavisisio

Prof Maimela E eric.maimela@ul.ac.za

Annexure V: Consent form for key participant (English)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Dear participant

This study involves the audio recording of your interview with the researcher. Neither your name nor any other identifying information will be associated with the audio recording or the transcript. Only the researcher will be able to listen to the recordings.

The tapes will be transcribed by the researcher and checked for accuracy. Transcripts of your interview may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither your name nor any other identifying information (such as your voice) will be used in presentations or in written products resulting from the study.

By signing this form, I am allowing the researcher to audio tape me as part of this research. I also understand that this consent for recording is effective until the research is completed.

Thank you,

Place……

Signed: …… Date: ……

Researcher…… Signed……

Annexure W: Consent form for key participant (Xitsonga)

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4113/4614 Fax: (015) 268 3384

Eka mungheneleri wa ndzavisiso

Ndzavisiso wu katsa nkandziyiso wa mburisano exikarhi ka wena na mulavisisi. Vito ra wena na vuxokoxoko byi nwani bya wena abyinge hlanganisiwi na nkandziyiso kumbe lesingata tsariwa ku huma ka nkandziyiso.

Nkandziyiso wuta yingiseriwa hi mulavisisi kutani a tsala leswinga kandiyisiwa a tlhelea a kambisisa loko swiri swona. Vito ra wena na vuxokoxoko byi nwani bya wena (swo fana na rito) abyinge tirhisiwi eka ti presentations kumbe lesingata tsariwa ku huma ka ndzavisiso lowu.

Hiku sayina papilla leri, ndzi pfumelela mulavisisi kuva anga ndzi kandziyisa tani hi xiphemu xa ndzavisiso. Ndzi tlhela ndzi swi twisisa leswaku mpfumelelo lowu wa nkandziyiso wu tw tirha ku fikela e makumu ka ndzavisiso.

Inkomu

Ndzhawu.....

Sayina……. Siku…….

Mulavisisi.....Sayina

Annexure X: TURFLOOP RESEARCH ETHICS COMMITTEE APPROVAL

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3935, Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: **23 February 2022**

PROJECT NUMBER: **TREC/04/2022: PG**

PROJECT:

Title:	Development of Evidence-Based Management Model for Gestational Diabe Mellitus in Mopani District of Limpopo Province, South Africa.
Researcher:	ET Ntshauba
Supervisor:	Prof E Maimela
Co-Supervisor/s:	Dr TS Ntuli
	Prof MP Mamogobo
School:	Health Care Sciences
Degree:	Doctor of Philosophy in Public Health

PROF P MASOKO
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.**

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Annexure Y: LETTER SEEKING CONSENT FROM DEPARTMENT OF HEALTH: LIMPOPO PROVINCE

P.O Box 21
Tshilwavhusiku
0938

The Head of Department
Department of Health
Private Bag x 9307
Polokwane
0700

Dear: Sir/Madam

Request for permission to conduct research at Letaba Hospital; Nkhensani district hospital; Dzumeri Healthcare Centre; Thomo, Basani, Krematart and Hlaneki clinics.

I Ms Ntshauba Elelwani Thelma hereby request permission to conduct a research study at the abovementioned health facilities. The study is “Development of evidence-based management model for gestational diabetes mellitus and its associated risk factors, maternal and infant health outcomes in the Mopani District of Limpopo Province, South Africa.”. This study is conducted in partial fulfilment of the requirements for the Master of Public Health degree in the School of Health Sciences at the University of Limpopo.

The aim of the study is to develop an evidence-based management model for the mitigation of risk factors and the improvement of maternal and infant health outcomes associated with gestational diabetes mellitus in the Limpopo province.

I am looking forward to a favourable response from you.

Yours faithfully
Ntshauba ET
076 968 5588; email: elelwani.thelma@gmail.com

Annexure Z: LIMPOPO DEPARTMENT OF HEALTH APPROVAL LETTER

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

Department of Health

Ref : LP_2022-03-001
Enquires : Ms PF Mahlokwane
Tel : 015-293 6028
Email : Phoebe.Mahlokwane@dhsd.limpopo.gov.za

Ntshauba Elelwani Thelma

PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL FACILITIES

Your Study Topic as indicated below;

Development of evidence-based management model for gestational diabetes mellitus in Mopani District of Limpopo Province, South Africa

1. Permission to conduct research study as per your research proposal is hereby Granted.
2. Kindly note the following:
   a. Present this letter of permission to the institution supervisor/s a week before the study is conducted.
   b. This approval is ONLY for Basani Clinic; Dzumeri Clinic; Hlaneki Clnic; Kremetrat Clinic; Letaba Hospital; Nkhensani Hospital and ThomoClinic
   c. In the course of your study, there should be no action that disrupts the routine services, or incur any cost on the Department.
   d. After completion of study, it is mandatory that the findings should be submitted to the Department to serve as a resource.
   e. The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
   f. The approval is only valid for a 1-year period.
   g. If the proposal has been amended, a new approval should be sought from the Department of Health
   h. Kindly note that, the Department can withdraw the approval at any time.

Your cooperation will be highly appreciated

Head of Department **Date** 17/03/2022

pp

Private Bag X9302 Polokwane
Fidel Castro Ruz House, 18 College Street. Polokwane 0700. Tel: 015 293 6000/12. Fax: 015 293 6211.
Website: http/www.limpopo.gov.za

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Annexure Aa: MOPANI HEALTH DISTRICT APPROVAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH
MOPANI DISTRICT

Ref No: S4/2/2
Enquiries: S Chuma
Tel Direct: 015 811 6633
Email: Shadrack.Chuma@dhsd.limpopo.gov.za

To: **Ms. Ntshauba Elelwani Thelma**
P.O Box 21
Tshilwavhusiku
0938

PERMISSION TO CONDUCT RESEARCH IN THE DEPARTMENTAL HEALTH FACILITIES OF MOPANI DISTRICT: YOURSELF

1. Your letter dated the 24 March 2022 has reference.
2. This serves to inform you that permission is granted to your request to conduct research in the following health facilities of Mopani District: Dzumeri Health Centre, Hlaneki Clinic, and Basani Clinic, Kremetart Clinic and Thomo clinic.
3. Your research is on "**Development of evidence-based management model for gestational diabetes mellitus in Mopani District of Limpopo Province, South Africa".**
4. Note that this approval is valid for 1 year as per the approval from the provincial office.
5. You will be required to furnish the managers with this letter for the purposes of access and assistance.
6. You are further expected to abide by all prescripts governing public service during the course of your research.
7. Thanking you.

S. h — a
DIRECTOR: CORPORATE SERVICES

2022/03/29
DATE

Annexure Ab: Delphi technique phone call disposition

Student name: Ntshauba ET

PHASE 3 DATA COLLECTION: DELPHI TECHNIQUE

Date	Participant name	Phone	Able to participate?			Email address	Letter, Consent, Delphi survey form sent (√)
			Yes	No	Comment		

Annexure Ac: Validation of strategies using Delphi technique survey

Rating of strategies during Delphi round Expert

INVITATION: Delphi participants information sheet				
SECTION ONE: Short introduction My name is Ms Ntshauba Elelwani, am a Public Health Postgraduate student from University of Limpopo. The aim of the study which am conducting is to develop evidence-based management model for the mitigation of risk factors and improve maternal and infant health outcomes associated with Gestational Diabetes Mellitus (GDM) in Mopani District, Limpopo Province. Data has been collected and intervention strategies have been proposed by the researcher in line with achieving the aim of the study. The strategies have been proposed based on study findings, literature review, Sustainable Development Goal no 3 *"Ensuring healthy lives and promote well-being for all at all ages"*, GDM Management guidelines, Guidelines related to referral policy, National Core Standards, Ideal Hospital Realisation Framework and Theory. **For the strategies, please refer to pdf document.** To maintain your privacy, your name and name of hospital / company will not be required. **Should you agree to participate, please sign consent form at the end of this document.**				
SECTION TWO: Participants background information				
Year of birth:				
Gender:				
Highest educational qualification:				
Area of responsibility in the unit/section:				
Years of experience:				
SECTION THREE: EXPERTS INPUTS ON THE DEVELOPED STRATEGIES				
No	**Criteria**	**Yes(X)**	**No(X)**	**Comments**
	Goal and management practice: Response to these questions need to be based on examination of strategy goals in comparison with GDM management guidelines &			

	Sustainable developmentgoal no 3 objectives.			
1.	Are the strategy goals in line with Sustainable Development Goal no 3 objectives?			
2.	Are the strategy goals in line with GDM management guidelines?			
3.	Do the strategies have the potential to reduce maternal mortality, prevent deaths of newborns and reduce premature mortality from non-communicable diseases?			
	Context of strategies: Response to these questions must be based on how well strategies might be transferred in the context of this study.			
4.	Is the intended context of strategies consistent with SDG no 3 and GDM management guidelines?			
5.	How well suited are the strategies given the findings of the study?			
6.	Do all proposed strategies fit within the context of producing good maternal and infant health outcomes, improving quality of health provided to pregnant women with GDM?			
	Explanation of strategies: Response to these questions must be based on expert's judgement about explanation concerning practice			
7.	Are the explanation of the strategies sufficient to be used in			

	improve provision of quality health & services?			
8.	Is the explanation of strategies consistent with study findings?			
	Evidence to support the strategies: Response to these questions need to be based on the evidence of study findings, existing literature, management guidelines, referrals guidelines, NCS guidelines, Ideal Hospital Framework, SDG no 3.			
9.	Is there evidence to support the proposed strategies?			
10.	Is there relevant information about corresponding guidelines provided?			

CONSENT FORM

Please note there are no right or wrong answers to the questions. The researcher would like to hear your views and suggestions (under comments) on proposed intervention strategies. Your participation will benefit the department of health, health institutions, pregnant & non-pregnant women and community at large as we will be exploring current GDM practices.

Should you choose to participate, you will be asked not to disclose any content of the study. After completion of this study, the researcher will present the findings to hospitals/clinics which were under study as well as Department of Health. Researcher will analyse the data and no names will be included.

I understand this information and agree to participate fully under the conditions stated above:

Surname and Initial………. **Sign…**……. **Date…**……...

If you have any questions regarding this study, please contact: Name of researcher: Ntshauba ET **Email address:** elelwani.thelma@gmail.com

Annexure Ad: Model validation expert information letter & consent form

Department of Public Health
Faculty of Health Sciences
Private Bag X1106, Sovenga, 0727
Tel: 015 268 3332

Dear experts,

My name is Ms Ntshauba Elelwani, am a Public Health Postgraduate student from University of Limpopo. The aim of the study which am conducting is to develop evidence-based management model for the mitigation of risk factors and improve maternal and infant health outcomes associated with Gestational Diabetes Mellitus (GDM) in Mopani District, Limpopo Province. Data has been collected and intervention strategies have been proposed by the researcher in line with achieving the aim of the study and validated by the experts. Thereafter, an evidence-based management model which aims to reduce or mitigate risk factors and improve maternal and infant health outcomes associated with GDM was developed. Attached to this is a graphical representation of the model.

You are therefore recruited to participate in this study as experts to provide an expert input on the model depicted above. Should you agree to participate in this study, you will be required to complete a model validation form which is a questionnaire consisting of 3 domains with 13 items. You will be required to rate the item using a Likert scale (1 - 4) to rate the degree of relevance. Please note there are no right or wrong answers to the items. The researcher would like to hear your input on the model. Kindly note that you are asked not to disclose any content of the study. After completion of this study, the researcher will present the findings to hospitals/clinics which were under study as well as Department of Health. Researcher will analyse the data and no names will be included.

I understand this information and agree to participate fully under the conditions stated above:

Surname and Initial……… **Sign…**…… **Date…**……

If you have any questions regarding this study, please contact:
Name of researcher: Ntshauba Elelwani
Email address: elelwani.thelma@gmail.com

Annexure Ae: Model validation expert rating form

VALIDATION OF EVIDENCE-BASED MANAGEMENT MODEL FOR MITIGATION OF RISK FACTORS ASSOCIATED WITH GDM AND IMPROVE MATERNAL AND INFANT HEALTH OUTCOMES: A Content Validity Study

Dear experts,

This inventory contains 3 domains and 13 items related to programs/interventions aim at reducing risk factors associated with gestational diabetes and improve maternal & child health outcomes. Your expert judgement on the degree of relevance of each item to the measured domain is needed. Note that your review should be based on the definition and relevant terminologies provided to you. Kindly be objective and constructive as much as possible in your review and use the following rating scale:

Degree of relevance:

1 = the item is not relevant to the measured domain

2 = the item is somewhat relevant to the measured domain

3 = the item is quite relevant to the measured domain

4 = the item is highly relevant to the measured domain

Domain 1: PRE-PREGNANCY PROGRAMS/INTERVENTIONS TO REDUCE RISK FACTORS ASSOCIATED WITH GESTATIONAL DIABETES MELLITUS (GDM) **Definition:** Programs/interventions which can be facilitated to reduce risk factors associated with gestational diabetes before a woman in the community conceive.	
TESTED ITEMS	**RELEVANCE**
1. Programs to reduce risk factors associated with GDM can be helpful.	1 ○ 2 ○ 3 ○ 4 ○
2. Health practitioners involved with management of GDM need to receive training.	1 ○ 2 ○ 3 ○ 4 ○
3. Community particularly women need to be aware of GDM.	1 ○ 2 ○ 3 ○ 4 ○
4. Women in the community with risk factors of GDM need to consult clinic before pregnancy.	1 ○ 2 ○ 3 ○ 4 ○
5. Screening for non-communicable diseases (NCDs) particularly Diabetes can be helpful.	1 ○ 2 ○ 3 ○ 4 ○
6. Lifestyle modification such as healthy eating, physical activity can be effective.	1 ○ 2 ○ 3 ○ 4 ○
7. Health promotion and education need to be accessible in the communities (community radio stations, pamphlets, posters), be simple and easy to understand.	1 ○ 2 ○ 3 ○ 4 ○
8. Community leaders, traditional leaders and other stakeholders' involvement can be effective.	1 ○ 2 ○ 3 ○ 4 ○
Domain 2: ANTENATAL CARE PROGRAM TO REDUCE RISK FACTORS ASSOCIATED WITH GDM **Definition:** Health education on GDM during antenatal clinic visit in a group can be done before doctors' consultation and dieticians to be involved in relevant health education programs i.e., Diet control during pregnancy to avoid excessive weight gain.	

TESTED ITEMS	RELEVANCE
1. Including GDM as part of the health condition to be focused on during ANC educational programs can be helpful.	1 ○ 2 ○ 3 ○ 4 ○
2. Collaboration between health practitioners working in maternity staff and dieticians during ANC educational programs can be helpful.	1 ○ 2 ○ 3 ○ 4 ○
3. Visual presentations and educational materials in language that is easy to understand can make learning easier and more interesting.	1 ○ 2 ○ 3 ○ 4 ○
Domain 3: POSTPARTUM CARE TO REDUCE RISK ASSOCIATED WITH GDM **Definition:** Follow-up care on women who had GDM during pregnancy, infants born to mothers with GDM, and both the mother & baby to continue dietetics intervention as Outpatients.	
ITEMS TESTED	**RELEVANCE**
1. Long-term follow-up for development of Type 2 diabetes mellitus is important (6-12 weeks, once a year).	1 ○ 2 ○ 3 ○ 4 ○
2. Dietary control by dieticians to minimise long-term effects of GDM	1 ○ 2 ○ 3 ○ 4 ○

Annexure Af: Editorial language certificate

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University of Limpopo
Faculty of Health Sciences
School of Healthcare Sciences
https://www.ul.ac.za/

22/02/2024

CONFIRMATION OF EDITING AND PROOFREADING SERVICES

This letter serves as confirmation that the thesis titled 'DEVELOPING AN EVIDENCE-BASED MANAGEMENT MODEL TO MITIGATE THE RISK FACTORS ASSOCIATED WITH GESTATIONAL DIABETES MELLITUS IN THE MOPANI DISTRICT OF LIMPOPO PROVINCE, SOUTH AFRICA.' by PhD candidate NTSHAUBA ELELWANI THELMA, was professionally edited and proofread by Nkateko Masinga and her team at NSUKU Publishing Consultancy.

Best regards,

Nkateko Priscilla Masinga
Founder and Managing Director,
NSUKU Publishing Consultancy