

**Midwives' Understanding of Cardiotocography Monitoring and Interpretation in a
Selected District Hospital at Lepelle-Nkumpi Local Municipality, Limpopo
Province**

by

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MIDWIVES' UNDERSTANDING OF CARDIOTOCOGRAPHY MONITORING AND INTERPRETATION IN A SELECTED DISTRICT HOSPITAL AT LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO PROVINCE

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ABSTRACT

Cardiotocography (CTG) is a device used during antenatal and intrapartum care to monitor the foetal well-being and identify foetuses at risk of hypoxia. Midwives in antenatal and labour wards ought to be knowledgeable and competent in the monitoring and interpretation of cardiotocography as a clinical skill in order to deliver positive foetal outcomes. This study's purpose was to determine the midwives' knowledge and understanding in the preparation, monitoring and interpretation of the cardiotocography as a clinical skill in a selected district hospital at the Lepelle-Nkumpi Local Municipality, Limpopo Province.

The study employed a quantitative research approach in conjunction with the descriptive design to acquire data from 18 purposively sampled midwives involved in the monitoring and interpretation of the cardiotocography at the selected district hospital. Data were collected by means of non-participant observation using a checklist and a self-administered questionnaire. The Stata version 19.5 SE was utilised for data analysis with assistance of a statistician. While some of the participants demonstrated basic knowledge on the indication and purpose of the cardiotocography, the majority failed to correctly interpret and record the findings of the cardiotocography in monitoring pregnant women's progress.

The participants reported several challenges that included deficient in-service training, demanding workloads, and inadequate cardiotocography machines. Participants recommended increased staff complements in order to alleviate the problem of midwife shortages and work pressure, institutionalisation of a well-managed cardiotocography tracing paper procurement, and regular workshops on cardiotocography monitoring.

Key concepts: Cardiotocography; interpretation; midwife; monitoring; understanding.

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- To all the participants who took part in this study. The study would not have been possible without their participation.
- To my husband, for being the pillar of strength.
- My parents and siblings, for their love and support throughout this study.

DEDICATION

This study is dedicated to my family, especially my husband, Khokane Moses Sekgoka and children, Tokollo, Khumo, my parents and siblings, and my manager for their support and encouragement.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CEO	Chief Executive Officer
CTG	Cardiotocograph
DR C BRAVADO	Define Risk, C - Contractions, Bra - Baseline Rate, V - Variability, A - Accelerations, D - Decelerations, O - Overall impression
DSC	De Vries Shields Chiat Incorporated
EFM	Electronic Foetal Monitoring
ESMOE	Essential Steps in the Management of Obstetric Emergencies
ESMOE-EOST	Essential Steps in the Management of Obstetric Emergencies- Emergency Obstetric Simulation Training
FSEP	Foetal Surveillance Education Programme
FHR	Foetal Heart Rate
FIGO	International Federation of Gynaecology and Obstetrics
HIE	Hypoxic-Ischemic Encephalopathy
NICE	National Institute for Health and Care Excellence
NST	Non-Stress Test
OFSEP	Online Foetal Surveillance Education Programme
RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
SDG	Sustainable Development Goals
SGA	Small for Gestational Age

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Chapter 1 provides details of the background information, research problem, the study's purpose and significance, clarification of key concepts, theoretical foundations of the study, research methodology and research design, as well as the study's scope and structure.

1.2 BACKGROUND INFORMATION ABOUT THE RESEARCH PROBLEM

1.2.1 Source of the research problem

As an advanced midwife who worked at a tertiary hospital, the researcher has observed the skill gaps in monitoring and interpretation of Cardiotocography (CTG) when managing pregnant women in labour. In their study on best practice and research clinical obstetrics and gynecology, Pinas and Chandraharan (2016:33-47) found that many women in labour were being referred to a tertiary hospital due to 'foetal distress' and increased body mass index (BMI). During the assessment, the CTG was found to be 'reactive'.

Furthermore, when a woman in labour was referred for a comorbidity such as chronic hypertension or diabetes, the CTG was then found to have two or more features. These features included baseline foetal heart rate, presence of accelerations, absence or presence of decelerations, baseline variability, and uterine activity - classified as non-reassuring or abnormal, referred to as 'pathological' CTG (Pinas & Chandraharan, 2016:33-47).

The need to conduct this study was also propelled by the findings of a study by Mazwi (2020:68) on midwives' knowledge and practices regarding CTG utilisation in labour units at Waterberg district hospitals in Limpopo Province. The findings of the latter study highlighted obstacles such as human and material deficiencies, and continuous training shortcomings, which is detrimental to midwifery care provision. Participants in the study by Mazwi (2020:68) lamented the shortage of midwives, and commensurately

recommended that newly skilled midwives should be appointed to assist in service delivery as a mechanism to alleviate the prevalent staff shortages. The afore-cited study further proposed that CTG machines should be provided, and that nursing management should ensure the adequacy of midwife training, including in-service workshops and courses in post- basic midwifery and neonatal nursing science.

This study emanates from the perceived need to determine the understanding of midwives regarding CTG skill, when monitoring pregnant women in labour at a district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province. Comparable findings emerged in KwaZulu-Natal, where James, Maduna and Morton (2019:27) concluded that midwives lacked adequate CTG knowledge, largely due to limited training opportunities. In Jordan, Alsaraireh, Yehia and Khalaf (2023:193) likewise found midwives' knowledge and attitudes unsatisfactory, recommending comprehensive education programmes. O'Connor (2016:21) emphasised that CTG interpretation is a core competency for midwives, requiring annual demonstration of proficiency.

Additionally, the Royal College of Obstetricians and Gynaecologists in London (2020:11) reported that CTG abnormalities contributed to 59% of adverse outcomes in term labour cases reviewed in 2017, underscoring the critical importance of accurate monitoring and interpretation.

1.2.2 Background to the research problem

According to the National Integrated Maternal and Perinatal Care Guidelines for South Africa, labour is diagnosed in the event of the presence of persistent painful uterine contractions accompanied by at least one of the following: cervical effacement and dilatation, ruptured membranes, or the presence of a show (National Department of Health 2024b:57). During intrapartum care, maternal and foetal parameters are monitored at prescribed intervals to ensure safe progression. In the latent phase of labour, contractions, foetal heart rate, and maternal heart rate are assessed every two hours, while blood pressure, respiratory rate, temperature, and vaginal examinations are conducted every six hours. These examinations include evaluation of cervical dilatation, cervical length, the state of membranes, and the position of the foetal head.

Once the woman enters the active phase of labour, defined as cervical dilatation of five centimeters or more, monitoring becomes more frequent: maternal heart rate is checked every thirty minutes, contractions every two hours, and blood pressure, respiratory rate, and temperature every four hours. Vaginal examinations are performed every four hours, and every two hours once dilatation reaches eight centimeters, with urine assessed whenever passed.

Cardiotocography (CTG) is a central component of this monitoring process. It records foetal heart rate and uterine contractions, producing a paper trace that allows clinicians to evaluate foetal well-being (Myles 2016:701). Since its introduction in the 1960s, CTG has become a routine tool in obstetric practice worldwide (Chudáček, Spilka, Burša, Janků, Hruban, Huptych et al. 2014:14). The South African guidelines emphasise that midwives must be confident in interpreting CTG traces and able to respond appropriately to pathological patterns (National Department of Health 2024b:63). The purpose of CTG monitoring is not merely to record physiological activity but to provide actionable information that guides clinical decision-making, including whether intervention is required, and if so, its timing and nature. Importantly, CTG interpretation must always be contextualised within the broader clinical picture, including gestational age, foetal growth, foetal movements, and the stage of labour.

CTG traces reflect multiple aspects of foetal health indirectly, including neurological function, oxygenation, autonomic regulation of heart rate, and behavioural states such as sleep–wake cycles. These parameters are influenced by the intrauterine environment and the foetus's physiological reserves. When reserves are limited, uterine contractions may precipitate hypoxia, manifesting as decelerations in the heart rate. Early decelerations are typically associated with head compression, variable decelerations with cord compression, and late decelerations with compromised oxygenation. The ability to distinguish between these patterns is therefore critical for timely and appropriate intervention.

The legal and professional implications of CTG monitoring are equally significant. CTG recordings are considered legal documents and must be clearly labelled with the woman's details, signed, dated, and accompanied by an overall impression and documentation of any actions taken (Dippenaar & Da Serra 2019:260; National Department of Health 2016:23). Proper documentation ensures accountability and provides evidence of care in

medico-legal contexts. The overarching purpose of CTG is to identify potential threats to foetal well-being early enough to allow intervention before irreversible harm occurs (Chudáček et al. 2014:16).

The clinical aim of intrapartum CTG monitoring is to prevent hypoxic-ischaemic encephalopathy (HIE) and its sequelae, which include cerebral palsy, developmental delays, and perinatal mortality, while avoiding unnecessary operative interventions (Soumyashree et al. 2025:2). Misinterpretation of CTG traces can lead to either under-intervention, resulting in foetal compromise, or over-intervention, leading to avoidable caesarean sections and associated maternal risks. Samyraju, Ledger and Chandraharan (2021:2) caution that the term “foetal distress” is often misapplied, as many fetuses with abnormal CTG traces do not exhibit hypoxia or acidosis. Current practice therefore prefers the terminology “pathological CTG trace” or “acidotic pH,” which more accurately reflects the underlying physiology.

In summary, CTG monitoring is a cornerstone of intrapartum care, designed to safeguard foetal well-being while balancing maternal safety. Its effectiveness, however, depends entirely on the midwives’ ability to interpret traces accurately, contextualise findings within the clinical situation, and document interventions appropriately. Deficiencies in these skills not only compromise clinical outcomes but also expose practitioners and institutions to significant medico-legal risk.

1.3 RESEARCH PROBLEM

The researcher’s professional observations revealed a consistent gap in midwives’ knowledge and practice regarding CTG monitoring and interpretation. Despite CTG being a recognised cornerstone of intrapartum care, many pathological traces were either overlooked or inadequately reported. In several cases, abnormalities were only identified upon arrival at tertiary hospitals, even though midwives at the district level had monitored the women for extended periods prior to referral. This pattern highlights a systemic weakness in recognising and documenting CTG findings, with serious implications for maternal and neonatal outcomes.

Between 2021 and 2023, the district hospital referred approximately 485 labouring women to tertiary hospital, due to complications such as increased BMI, gestational

diabetes, and hypertensive disorders. Alarming, 282 of these referrals were later found to have pathological CTG traces, yet CTG abnormalities were not cited as referral indications. The consequences were significant: fourteen women delivered fresh stillbirths, while eleven neonates required admission to intensive care for respiratory distress syndrome or severe birth asphyxia. These outcomes underscore the urgent need for improved CTG interpretation at the district level.

International evidence reinforces these concerns. Sarmin Swarna, Dhar, Doly, Sikder, Bari et al. (2023:347–348) reported that 30% of neonates exposed to abnormal CTG traces developed respiratory distress syndrome, while 6% resulted in perinatal mortality. Such findings demonstrate the global relevance of CTG interpretation and its direct correlation with neonatal survival and morbidity. Midwives, as primary caregivers, are entrusted with managing both routine and complex obstetric conditions, yet deficiencies in CTG skills compromise their ability to respond effectively to emergencies (Wu, Lopez & Nichols 2022:41).

The medico-legal implications are equally pressing. Obstetrics and gynaecology remain the most litigated area of medical practice, with compensation claims surpassing those in other fields combined. Jha and Power (2022:1–12) emphasise that many cases stem from failures in CTG monitoring and interpretation, which could have been prevented through proper training and vigilance. In South Africa, malpractice claims in maternity wards have reached billions, with hundreds of avoidable neonatal deaths linked to poor monitoring (Sobuwa 2023:1). Such statistics illustrate the scale of the crisis and the risks posed by inadequate CTG practice.

International initiatives further highlight the importance of effective CTG use. The United Kingdom's "Saving Babies' Lives" care bundle identified foetal monitoring as one of four critical interventions to reduce stillbirths and early neonatal deaths (O'Connor 2016:21). Against this backdrop, the research problem is clear: midwives at the district hospital in Lepelle-Nkumpi Local Municipality demonstrate insufficient knowledge and competency in CTG monitoring and interpretation. This deficiency contributes to adverse maternal and neonatal outcomes, exposes practitioners to medico-legal risk, and undermines the broader goals of safe and effective intrapartum care.

1.4 PURPOSE OF THE STUDY

1.4.1 Research purpose

The purpose of the study was to determine the midwives' knowledge and understanding in the preparation, monitoring and interpretation of the CTG as a clinical skill in a selected district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province.

1.4.2 Research objectives

- To assess midwives' understanding in the preparation, monitoring and interpretation of the CTG as a clinical skill.
- To develop recommendations to enhance the midwives' competency in the preparation, monitoring and interpretation of the CTG.

1.4.3 Research questions/hypotheses

- Do midwives have knowledge in the preparation, monitoring and interpretation of the CTG as a clinical skill?
- What recommendations can enhance midwives' competency in the preparation, monitoring and interpretation of CTG by midwives?

1.5 SIGNIFICANCE OF THE STUDY

This study contributes to maternal and neonatal health by addressing the critical gaps in midwives' knowledge and practice of CTG monitoring and interpretation. By systematically examining midwives' understanding, it highlights how deficiencies in skill and confidence directly compromise foetal outcomes and increase medico-legal risks. The findings provide evidence-based recommendations for strengthening professional development through structured training, workshops, and improved resource provision. In doing so, the study supports safer intrapartum care, enhances accountability through proper documentation, and aligns with national and international priorities to reduce preventable stillbirths and neonatal morbidity. Ultimately, it demonstrates how targeted

interventions at district level can improve clinical decision-making, reduce litigation, and contribute to sustainable improvements in maternal and child health outcomes.

1.6 DEFINITIONS OF KEY TERMS

- **Midwife:** A licensed professional registered with the South African Nursing Council, (SANC) following completion of an acknowledged education and training regime (South Africa 2005:s5). Their role encompasses the management of pregnancy, labour, and the post-partum period, providing care to women, neonates, and families. Within this study, the term refers specifically to midwives practising in the district hospital who are expected to demonstrate competence in CTG monitoring and interpretation. Their responsibilities extend beyond routine care to include the identification of complications, initiation of appropriate interventions, and referral when necessary. The definition underscores the midwife's accountability in safeguarding maternal and neonatal health outcomes.
- **Cardiotocography:** A clinical device that measures the Foetal Heart Rate (FHR) and uterine contractions, producing a paper printout of the information it records (Myles 2016:701). In this study, the CTG refers to the device used by midwives to assess the maternal contractions and foetus condition during labour.
- **Monitoring:** Watching and checking a situation carefully for a period in order to discover something about it (Peters 2013:216). In relation to this study, monitoring refers to the continuous or periodic assessment of maternal contractions and foetal condition using CTG. Effective monitoring requires preparation, accurate placement of equipment, and consistent observation of the trace. It is not a passive activity but an active responsibility, demanding vigilance and timely recognition of abnormal patterns. The definition emphasises monitoring as a dynamic process that underpins safe intrapartum care and informs clinical decisions.
- **Interpretation:** An explanation or opinion of what something means (Murphy 2022:298). In relation to this study, interpretation refers to how midwives analyse CTG traces to determine whether foetal heart rate patterns are reassuring, non-reassuring, or pathological. Competent interpretation involves recognising accelerations, decelerations, baseline variability, and overall trends, then linking these findings to clinical guidelines and protocols. Interpretation is not merely technical but requires contextual judgement, as identical patterns may carry different implications

depending on labour stage or maternal condition. The definition underscores interpretation as a critical skill that directly influences intervention and outcomes.

- **Understanding:** Knowledge about a subject, situation, etc. or about how something works (Murphy 2022:625). With reference to this study, understanding refers to midwives' insight into CTG monitoring and interpretation, encompassing both theoretical knowledge and practical application. It involves recognising the purpose of CTG, preparing appropriately, monitoring effectively, and interpreting traces in line with established standards. Understanding is broader than skill alone; it reflects the integration of knowledge, confidence, and professional judgement. The definition highlights that without adequate understanding, midwives may misinterpret CTG findings, leading to compromised care and adverse outcomes.

1.7 THEORETICAL FOUNDATIONS OF THE STUDY

1.7.1 Research paradigm

A research paradigm represents the philosophical framework that guides how phenomena are understood and investigated. It encompasses assumptions about reality, knowledge, and the methods appropriate for inquiry (Kivunja & Kuyine 2017:26). In this study, the positivist paradigm was adopted because it emphasises observable facts, measurable variables, and systematic analysis. Positivism is rooted in the belief that social phenomena can be studied with the same rigour as natural sciences, using structured tools to generate reliable and replicable findings (Polit & Beck 2021:7). This orientation was particularly relevant for assessing midwives' knowledge and practice of CTG monitoring, where objective measurement of actions and responses was essential.

The positivist approach aligns with the hypothetico-deductive model of science, which builds knowledge through hypothesis formulation, operationalisation of variables, and empirical testing. By employing structured questionnaires and observational checklists, the study was able to quantify midwives' understanding of CTG and evaluate their ability to identify normal and abnormal foetal heart rate patterns. Positivism ensured that the data collected were not influenced by subjective perceptions but reflected observable behaviours and decisions. This methodological stance strengthened the validity of the findings and provided a sound basis for drawing conclusions about midwives' competencies.

At the same time, the study acknowledged critiques of positivism, particularly its tendency to overlook contextual and subjective dimensions of practice. To address this, the research incorporated elements of post-positivist flexibility, recognising that absolute objectivity is difficult to achieve in human sciences. While the primary focus remained on measurable outcomes, the interpretation of results considered the broader clinical environment, including workload pressures and resource constraints. This balanced application of positivism allowed the study to generate robust, evidence-based insights while remaining sensitive to the realities of midwifery practice in a district hospital setting.

1.7.2 Theoretical/conceptual framework/formal theory

1.7.2.1 Behavioural theory- Skinner's reinforcement theory

Skinner's reinforcement theory of behaviourism underpins this study by emphasising how actions are shaped through reinforcement and punishment. The theory suggests that individuals learn from the consequences of their behaviour, with positive reinforcement encouraging desired practices and negative reinforcement discouraging errors (Catania 1984:473-475). In the context of midwifery, CTG monitoring and interpretation are behaviours that can be strengthened through structured training, constructive feedback, and institutional support. Conversely, inadequate reinforcement—such as poor supervision or lack of resources—may perpetuate weak practices, leading to compromised care.

By applying Skinner's framework, the study situates midwives' CTG practices within a behavioural model that explains how competence is sustained or eroded. This perspective highlights the importance of reinforcement mechanisms such as workshops, mentorship, and policy interventions in shaping professional behaviour. It also demonstrates how theoretical principles can inform practical strategies to improve CTG interpretation, reduce adverse maternal and neonatal outcomes, and enhance accountability in clinical practice.

1.8 RESEARCH METHODOLOGY AND RESEARCH DESIGN

The methodology of this study was guided by the need to generate reliable, objective evidence about midwives' knowledge and practice of CTG monitoring and interpretation. A quantitative approach was selected because it allows for the systematic measurement of observable behaviours and knowledge levels, thereby producing results that can be analysed statistically and compared across participants (Polit & Beck 2021:7). This approach was complemented by a descriptive design, which is particularly suited to studies that aim to document and clarify existing practices without manipulating variables. By combining these elements, the study was able to capture both the breadth and depth of midwives' understanding of CTG in a district hospital setting.

The descriptive design was chosen to provide a clear account of midwives' preparation, monitoring, and interpretation of CTG, as well as the challenges they encountered in practice. This design enabled the researcher to observe and record behaviours as they occurred, ensuring that the findings reflected real-world practices rather than hypothetical scenarios. As Kivunja and Kuyine (2017:26) note, descriptive studies are valuable for identifying gaps in knowledge and practice, which can then inform targeted interventions. In this study, the design allowed for the systematic documentation of midwives' actions and decisions, thereby highlighting areas where training and support are most urgently required.

Data collection was conducted using two complementary methods: non-participant observation and self-administered questionnaires. Observation provided direct evidence of how midwives prepared for and conducted CTG monitoring, while questionnaires captured their self-reported knowledge and perceptions. This dual approach ensured triangulation of data, enhancing the validity of the findings (Park, Konge & Artino 2020:690). The use of structured tools, including checklists and closed-ended questions, further strengthened the reliability of the data by reducing subjectivity and ensuring consistency across participants.

The study site was a district hospital within Lepelle-Nkumpi Local Municipality, Limpopo Province, where midwives are the primary caregivers during labour. Eighteen midwives were purposively sampled, reflecting their direct involvement in CTG monitoring and

interpretation. Purposive sampling was appropriate because it ensured that participants possessed the relevant experience and responsibilities, thereby increasing the relevance of the findings (Polit & Beck 2021:7). Ethical considerations were integral to the methodology, with informed consent obtained from all participants and approval granted by the relevant health authorities and ethics committees.

Data analysis was conducted using Stata version 19.5 SE, with the assistance of a statistician. Statistical analysis allowed for the identification of patterns in midwives' responses and behaviours, as well as the comparison of questionnaire data with observational findings. This rigorous approach ensured that conclusions were grounded in empirical evidence rather than anecdotal impressions. By adopting a quantitative, descriptive design supported by structured tools and statistical analysis, the study was able to provide a robust account of midwives' knowledge and practice of CTG, thereby laying the foundation for evidence-based recommendations to improve maternal and neonatal outcomes.

1.9 VALIDITY AND RELIABILITY

Ensuring validity was central to this study, as it determined whether the research truly measured midwives' knowledge and practice of CTG monitoring and interpretation (Gray, Grove & Sutherland 2017:36). Validity was strengthened by aligning the data collection instruments with the study objectives and by using structured questionnaires and observation checklists that directly reflected the variables under investigation. As Polit and Beck (2021:7) emphasise, validity requires that findings accurately represent the phenomena being studied, and in this case, the instruments were carefully designed to capture both theoretical knowledge and practical application. Triangulation of data from questionnaires and observations further enhanced validity, as it allowed for comparison between self-reported knowledge and observed behaviours, thereby reducing bias and ensuring that the results reflected actual practice.

Reliability refers to other researcher's ability to produce similar results through replicable methods and processes in order to achieve consistent conclusions (Gray et al. 2017:36). Structured tools with closed-ended questions and standardised observation criteria were employed to minimise subjectivity and ensure uniformity across participants. Reliability was reinforced by conducting the study in a controlled environment, where all participants

were exposed to similar conditions, and by using statistical analysis to identify consistent patterns in the data. As Park, Konge and Artino (2020:690) note, reliability is achieved when repeated measurements yield stable results, and this study's design ensured that the findings could be replicated in similar contexts. Together, validity and reliability provided a rigorous foundation for the study, ensuring that its conclusions were both credible and applicable to improving midwifery practice in CTG monitoring.

1.10 ETHICAL CONSIDERATIONS

Ethical integrity was a cornerstone of this study, ensuring that the rights, dignity, and welfare of participants were safeguarded throughout the research process. Approval was obtained from the Research Ethics Committee of the Department of Health Studies at UNISA, as well as from the Limpopo Department of Health and the Capricorn District Manager. Informed consent was secured from all participants, who were provided with detailed information about the study's purpose, procedures, and their right to withdraw at any stage without penalty. Confidentiality was strictly maintained by anonymising responses and ensuring that no identifying details appeared in the final report. These measures were consistent with established ethical guidelines for nursing research, which emphasise respect, autonomy, and protection of participants (Polit & Beck 2021:7).

Beyond participant protection, ethical considerations extended to the integrity of the research process itself. Data collection was conducted transparently, with observation and questionnaire tools explained to participants in advance to avoid deception or coercion. The researcher also adhered to principles of beneficence and non-maleficence by ensuring that the study posed no harm and aimed to contribute positively to maternal and neonatal health outcomes. Academic honesty was upheld through accurate citation of sources, acknowledgement of contributions, and disclosure of any support tools used during the preparation of the dissertation. By embedding these ethical safeguards, the study not only complied with institutional requirements but also reinforced its credibility and trustworthiness as a contribution to nursing science.

1.11 SCOPE OF THE STUDY

The scope of this study was confined to a district hospital within Lepelle-Nkumpi Local Municipality in the Capricorn District, Limpopo Province, where midwives are the primary caregivers during labour and antenatal care. By focusing on this setting, the research examined the preparation, monitoring, and interpretation of CTG as a clinical skill among midwives directly responsible for maternal and neonatal outcomes. The study did not extend to tertiary hospitals or private facilities, thereby ensuring that findings reflected the realities of resource-constrained environments.

Eighteen midwives were purposively sampled, representing those actively engaged in CTG monitoring, and data were collected through structured questionnaires and non-participant observation. The scope was limited to knowledge, practice, and challenges related to CTG, excluding broader obstetric interventions or outcomes beyond foetal monitoring. Ethical clearance and institutional permissions defined the boundaries of the research, ensuring compliance with professional standards. While the study provides valuable insights into midwives' competencies, its findings are context-specific and may not be generalised to all healthcare settings. Nevertheless, the scope was sufficient to highlight critical gaps in CTG interpretation and to generate recommendations for strengthening midwifery practice in similar district-level contexts.

1.12 STRUCTURE OF THE DISSERTATION

- **Chapter 1: Orientation to the Study**

This chapter provides the study's overview by describing background information about the research problem, specifying the research objectives, aims, and also outlines the study's theoretical foundations, the methodology and the design, as well as the study's significance.

- **Chapter 2: Literature Review**

This chapter describes the CTG monitoring and the review of relevant literature pertaining to midwives' CTG understanding, experiences and interpretation.

- **Chapter 3: Research Design and Method**

The chapter outlines the design and method used in the study.

- **Chapter 4: Analysis, Presentation and Description of the Research Results**

The chapter presents data analysis and the discussion of results.

- **Chapter 5: Conclusions, Limitations and Recommendations**

This chapter presents the conclusions, limitations of the study and recommendations.

1.13 SUMMARY

In this chapter, the researcher highlighted the background information, research problem, the study's purpose and its significance, definitions of key and operational terms, the study's theoretical foundations, overview of the research design and methodology, as well as the study's scope and structure of the chapters.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents a literature review based on current knowledge and views about the midwives' understanding and experiences of CTG monitoring and interpretation. The researcher referred to research findings in the seminal sources of literature, such as the guidelines and research studies related to monitoring of the CTG.

2.2 CARDIOTOCOGRAPHY

2.2.1 CTG as a monitoring tool

As stated by the South Australian Perinatal Practice Guideline for 'Foetal Surveillance (Cardiotocography)', a CTG is an electronic method of simultaneously recording FHR, foetal movements and uterine contractions as an assessment method for foetal well-being, primarily in pregnancies that present with heightened risk of complications (South Australian Department for Health and Wellbeing 2020:8). The CTG's aim is to identify the foetuses who may be hypoxic and guide potential assessment of foetal wellbeing and method of delivery. The National Department of Health (2024b:68) asserts that CGT interpretation is sufficiently detailed in the guidelines produced by the International Federation of Gynaecology and Obstetrics (FIGO) and the National Institute for Health and Care Excellence (NICE). Figure 2.1 (overleaf) is a depiction of the CGT machine and printout.

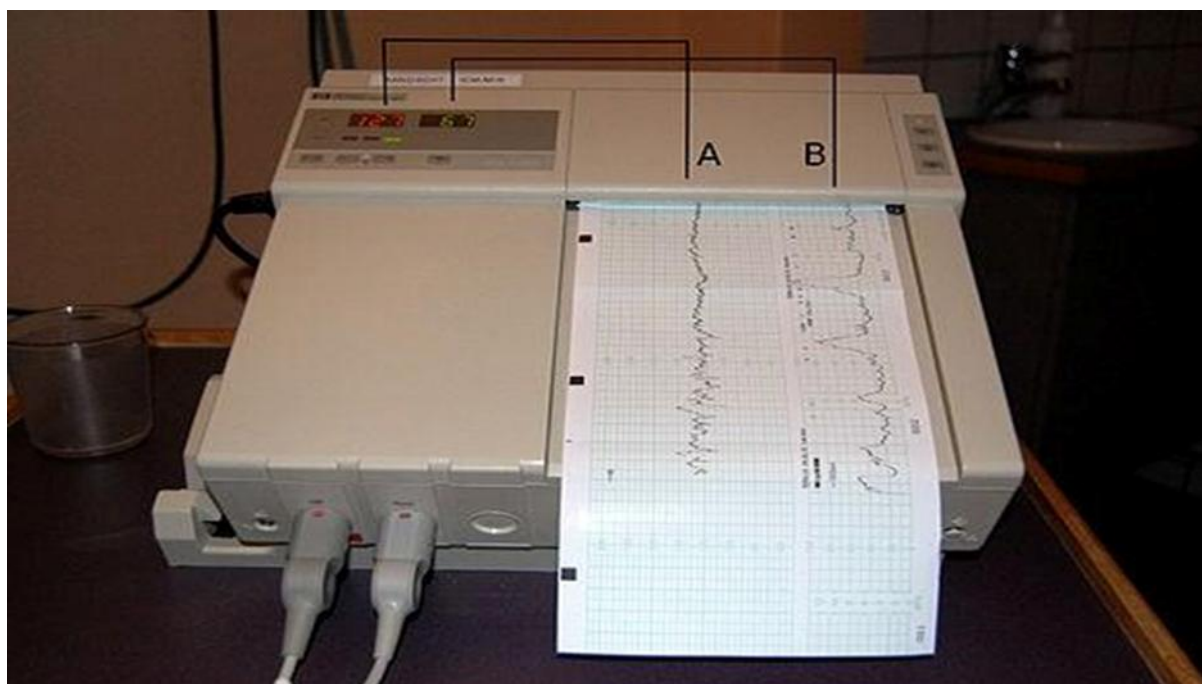


Figure 2.1 CTG machine with printout

As shown in Figure 2.1, the machine displays two transducers, the first transducer is the FHR transducer which detects the foetal heartbeat. The second transducer is a tocodynamometer that monitors the uterine contractions, and an elastic belt which holds the transducers in place on the abdomen of the mother. When in use, the CTG machine receives signals from the transducers and converts them into a visual representation on the screen that can be printed on a paper trace (Jayasooriya & Djapardy 2017:407; Kamel 2025:1).

In a report dated 11 October 2024, McKechnie (2024:1) indicated that the use of the CTG is for monitoring FHR and contractions occurring in the uterus. Moreover, the CTG is used prior to birth and during labour, as well as monitoring the foetus for any distress signs. Doctors and midwives are able to monitor the progress of the foetus by through the various aspects of the FHR.

2.2.2 Origin and purpose of CTG

Edward Hon, Roberto Caldeyro-Barcia and Konrad Hammacher developed and introduced modern-day CTG in the 1950s and early 1960s (Chudáček et al. 2014:14). Foetal heart sounds were described as early as 350 years ago, while mechanical

stethoscopes such as the Pinard horn were introduced in clinical practice approximately 200 years ago and the first commercial foetal monitor (Hewlett-Packard 8020A) was released in 1968 (Lovers, Daumer, Frasch et al 2025:853). Thus, the CTG's introduction as a technological innovation aimed at improving intrapartum surveillance by simultaneously recording foetal heart rate and uterine contractions (Alfirevic, Gyte, Cuthbert & Devane 2017:1). Its emergence marked a transition from intermittent auscultation to continuous electronic monitoring, offering clinicians a more objective and reliable means of detecting foetal compromise. Over the decades, CTG has become a routine component of obstetric practice worldwide, valued for its capacity to provide real-time information that guides clinical decision-making and supports safer maternal and neonatal outcomes (Lovers et al 2025:853).

The central purpose of CTG monitoring is to identify early signs of hypoxia and acidosis, conditions that can precipitate hypoxic-ischaemic encephalopathy, cerebral palsy, or perinatal death if not recognised promptly (Soumyashree et al. 2025:2). By analysing baseline heart rate, variability, accelerations, and decelerations, CTG offers indirect insight into foetal oxygenation, neurological integrity, and autonomic regulation. When interpreted accurately, CTG enables timely interventions such as intrauterine resuscitation or expedited delivery, thereby preventing irreversible harm. Its role is therefore both diagnostic and preventive, ensuring that foetal compromise is detected before it progresses to critical stages (Mediclinic 2023:1).

Beyond its clinical utility, CTG carries significant professional and medico-legal implications. Each trace is regarded as a legal document and must be labelled, signed, dated, and accompanied by an overall impression and record of actions taken (Dippenaar & Da Serra 2019:260; National Department of Health 2016:23). Proper documentation not only ensures accountability but also provides evidence of care in cases of litigation, particularly in obstetrics, which remains one of the most litigated medical fields (Jha & Power 2022:1–12). Thus, the origin and purpose of CTG extend beyond its technological function, encompassing both the safeguarding of foetal well-being and the reinforcement of professional responsibility in maternity care.

2.2.3 Monitoring process using the CTG

The monitoring process using CTG involves the systematic recording of foetal heart rate alongside uterine contractions to provide a continuous assessment of foetal well-being. Myles (2016:701) explains that the trace produced reflects the interplay between maternal uterine activity and foetal responses, offering clinicians indirect insight into oxygenation and neurological integrity. Effective monitoring requires careful preparation, including correct placement of transducers, calibration of the machine, and ensuring that maternal and foetal identifiers are clearly documented. As highlighted in the National Department of Health (2024b:63), CTG monitoring must be contextualised within the broader clinical picture, including gestational age, foetal growth, and stage of labour, to avoid misinterpretation.

During intrapartum care, CTG monitoring is used to detect early signs of foetal compromise, particularly hypoxia and acidosis, which may manifest as changes in baseline heart rate, variability, accelerations, or decelerations. Soumyashree et al. (2025:2) emphasise that accurate recognition of these variables allows for timely interventions such as intrauterine resuscitation or expedited delivery, thereby preventing hypoxic-ischaemic encephalopathy and other sequelae. The Royal College of Obstetricians and Gynaecologists (2020:11) further underscores that abnormalities in CTG traces contributed to more than half of adverse outcomes in term labour cases, demonstrating the critical importance of vigilant monitoring. CTG is therefore not a passive recording tool but an active decision-making aid that requires midwives to remain alert and responsive throughout labour (Potter 2025:1).

The monitoring process also carries professional and medico-legal responsibilities. Each CTG trace is considered a legal document and must be labelled, signed, dated, and accompanied by an overall impression and record of actions taken (Dippenaar & Da Serra 2019:260). Proper documentation ensures accountability and provides evidence of care in cases of litigation, particularly in obstetrics, which remains one of the most litigated medical fields (Jha & Power 2022:1–12). Samyraju, Ledger and Chandraharan (2021:2) caution that misinterpretation or misuse of CTG can lead to either under-intervention, resulting in foetal compromise, or over-intervention, leading to unnecessary operative deliveries. Thus, the monitoring process using CTG is both a clinical and ethical

responsibility, requiring midwives to combine technical skill with contextual judgement to safeguard maternal and neonatal outcomes.

2.2.3.1 Variables of CTG monitoring

According to the National Department of Health (2024b:68), details of the core aspects in interpretation of CTG include the following aspects:

Contractions

Contractions represent the uterine activity recorded on the lower channel of the CTG trace, providing essential information about frequency, duration, and intensity. NICE (2017:12) highlights that normal labour contractions occur three to five times in ten minutes, each lasting 40–60 seconds, while excessive frequency or prolonged duration may compromise foetal oxygenation. Monitoring contractions is vital because they directly influence foetal heart rate patterns, particularly decelerations. FIGO (2015:4) stresses that interpretation of CTG must always consider contraction activity, as foetal responses cannot be understood in isolation. Accurate assessment of contractions therefore ensures that interventions are appropriately timed and clinically justified.

Baseline FHR

The baseline FHR is based on the average heart rate observation over a ten-minute period, excluding accelerations and decelerations. According to FIGO (2015:3), a normal baseline lies between 110 and 160 beats per minute, reflecting adequate oxygenation and autonomic regulation. Deviations from this range may indicate hypoxia, infection, or maternal medication effects. Accurate identification of baseline rate is essential, as it provides the foundation for interpreting other CTG variables. Midwives must therefore remain vigilant in distinguishing true baseline from transient fluctuations.

Baseline variability

Baseline variability is based on the oscillations in the foetal heart rate around the baseline, reflecting the integrity of the autonomic nervous system. NICE guidelines (2017:12) emphasise that moderate variability (5–25 bpm) is reassuring, while reduced variability

may signal hypoxia, acidosis, or the influence of sedative drugs. Excessive variability, though less common, can also indicate foetal distress. Variability is considered one of the most critical indicators of foetal well-being, as it demonstrates the foetus's ability to adapt to intrauterine stress. Proper recognition of variability patterns is therefore central to safe CTG interpretation.

Accelerations

Accelerations are transient increases in foetal heart rate, typically rising by 15 bpm for at least 15 seconds, and are considered a reassuring sign of foetal health (RANZCOG 2021:5). They reflect intact neurological pathways and adequate oxygenation, often occurring in response to foetal movements or stimulation. The presence of accelerations during monitoring suggests that the foetus is not hypoxic and is coping well with labour. Their absence, however, does not always indicate pathology, particularly in the context of sleep cycles. Midwives must therefore interpret accelerations within the broader clinical picture.

Decelerations

Decelerations are transient decreases in foetal heart rate below the baseline, classified as early, variable, or late depending on their timing and morphology. Early decelerations are usually benign, linked to head compression, while variable decelerations often result from cord compression (Soumyashree et al. 2025:2). Late decelerations, however, are more concerning, as they suggest uteroplacental insufficiency and foetal hypoxia. Correct identification of deceleration type and frequency is vital for determining whether intervention is required. Misinterpretation can lead to either unnecessary operative deliveries or missed opportunities to prevent foetal compromise.

Early episodes of decelerations are considered normal and usually linked to head compression. The absence of other abnormal or non-reassuring features implies that further action is not required. An additional consideration is the clinical context in which decelerations occur, as identical patterns may carry different implications depending on labour stage or maternal condition. FIGO (2015:4) emphasises that recurrent late decelerations, especially when accompanied by reduced variability, are strongly predictive of foetal acidosis and require urgent intervention. Conversely, isolated variable

decelerations may be tolerated if variability and accelerations remain reassuring. Samyraju, Ledger and Chandraharan (2021:2) caution against the indiscriminate use of the term “foetal distress,” noting that many fetuses with abnormal CTG traces are not acidotic. Midwives must therefore interpret decelerations holistically, integrating them with other CTG variables and clinical findings to avoid both under- and over-intervention.

Overall Impression

The overall impression integrates all CTG variables to provide a holistic assessment of foetal well-being. FIGO (2015:4) recommends categorising CTG traces as normal, suspicious, or pathological, based on the combined evaluation of baseline, variability, accelerations, and decelerations. This synthesis ensures that isolated findings are not over-interpreted without context. Midwives must document their overall impression clearly, alongside any actions taken, as CTG traces are considered legal records (Dippenaar & Da Serra 2019:260). A well-reasoned overall impression supports clinical decision-making and enhances accountability in intrapartum care.

2.2.3.2 Interpretation

Interpretation of CTG traces requires midwives to integrate multiple variables—baseline heart rate, variability, accelerations, decelerations, and contraction patterns—into a coherent clinical judgement. FIGO (2015:4) recommends categorising traces as normal, suspicious, or pathological, ensuring that isolated findings are not over-emphasised without context. NICE (2017:12) stresses that interpretation must always be linked to the broader clinical picture, including gestational age, maternal condition, and stage of labour, as identical patterns may carry different implications.

Furthermore, Chapman and Charles (2018:63) state that an appropriate CTG interpretation requires a methodically structured assessment of its different aspects. Accordingly, the following DR C BRAVADO acronym is viewed as helpful in this regard: DR – Define Risk; C – Contractions; BRa – Baseline Rate; V – Variability; A – Accelerations; D – Decelerations; and O – Overall impression (Chapman & Charles 2018:63).

In addition, Soumyashree et al. (2025:2) highlight that accurate interpretation enables timely interventions to prevent hypoxic-ischaemic injury, while Samyraju, Ledger and

Chandrahara (2021:2) caution against indiscriminate use of the term “foetal distress,” which can lead to unnecessary interventions. Proper interpretation therefore demands both technical skill and contextual reasoning, supported by clear documentation of impressions and actions taken, as CTG traces are considered legal records (Dippenaar & Da Serra 2019:260).

2.3 OTHER STUDIES PERTAINING TO CTG MONITORING

Several international and local studies have examined midwives’ knowledge, attitudes, and practices regarding CTG monitoring, consistently highlighting gaps that compromise intrapartum care. James, Maduna and Morton (2019:27) reported that midwives in KwaZulu-Natal demonstrated inadequate CTG knowledge, largely due to limited training opportunities, while Alsaraireh, Yehia and Khalaf (2023:193) found similar deficiencies in Jordan, recommending structured education programmes to strengthen competency. Mazwi (2020:68) observed that midwives in Limpopo faced challenges such as staff shortages, inadequate equipment, and insufficient workshops, which hindered effective CTG utilisation. O’Connor (2016:21) stressed that CTG interpretation is a core competency requiring annual demonstration of proficiency, yet many midwives lack access to refresher training. Collectively, these studies underscore the global relevance of CTG monitoring and the urgent need for sustained professional development to improve maternal and neonatal outcomes.

2.3.1 Midwives knowledge and experience in monitoring and interpreting CTG

Midwives are expected to demonstrate competence in CTG monitoring and interpretation as part of their intrapartum responsibilities, yet several studies reveal persistent gaps in knowledge and practice. James, Maduna and Morton (2019:27) found that midwives in KwaZulu-Natal lacked adequate CTG knowledge, attributing this to limited training opportunities and insufficient exposure to updated guidelines. Similarly, Alsaraireh, Yehia and Khalaf (2023:193) reported unsatisfactory knowledge and attitudes among Jordanian midwives, recommending structured education programmes to strengthen competency. These findings highlight that deficiencies in CTG knowledge are not confined to one region but represent a global challenge in midwifery practice.

Practical experience also influences midwives' ability to interpret CTG traces accurately. Mazwi (2020:68) observed that midwives in Waterberg district hospitals faced challenges such as staff shortages, inadequate equipment, and limited workshops, which hindered effective CTG utilisation. O'Connor (2016:21) emphasised that CTG interpretation is a core competency requiring annual demonstration of proficiency, yet many midwives lack access to refresher training or mentorship. Alarming, studies have shown that up to 70% of CTG traces are misinterpreted by healthcare professionals, leading to inappropriate clinical decisions and delayed interventions. Without regular reinforcement of skills, midwives may struggle to distinguish between reassuring and pathological patterns, underscoring the importance of continuous professional development and institutional support.

The consequences of inadequate knowledge and experience are evident in adverse maternal and neonatal outcomes. The Royal College of Obstetricians and Gynaecologists (2020:11) reported that CTG abnormalities contributed to 59% of adverse outcomes in term labour cases reviewed in 2017, underscoring the critical importance of accurate monitoring and interpretation. Samyraj, Ledger and Chandraharan (2021:2) caution that many fetuses with abnormal CTG traces are incorrectly labelled as distressed, resulting in unnecessary operative deliveries. Strengthening midwives' knowledge and experience is therefore essential not only for improving clinical outcomes but also for reducing medico-legal risks and enhancing confidence in maternity services.

2.3.2 Midwives' views regarding monitoring and interpretation of CTG

Midwives' views on CTG monitoring often reflect both its perceived value and the challenges associated with its use. Hindley, Hinsliff and Thomson (2006:354-360) found that many midwives regarded CTG as a reassuring tool that provided objective evidence of foetal well-being, yet they also expressed concern that over-reliance on traces could undermine clinical judgement. This ambivalence illustrates how CTG is simultaneously seen as indispensable and problematic, particularly when interpretation skills are inconsistent or when contextual factors are overlooked.

Several studies highlight midwives' recognition of systemic barriers that affect their confidence in CTG interpretation. Mazwi (2020:68) reported that midwives in Limpopo identified shortages of machines and limited workshops as major obstacles, while Uusiku,

James, Sonti and Tuhadeleni (2021:20) observed similar frustrations in Namibia, where midwives emphasised the need for structured training to strengthen their practice. These perspectives demonstrate that midwives are acutely aware of how institutional support, or its absence, shapes their ability to use CTG effectively.

Midwives also stress the importance of contextualising CTG findings within the broader clinical picture. O'Connor (2016:21) argued that interpretation must be linked to maternal condition, gestational age, and stage of labour, a view echoed by Thellesen, Sorensen, Hedegaard, Rosthoej, Colov, Andersen et al. (2017:1075), who found that simulation-based training improved midwives' ability to integrate CTG patterns with clinical scenarios. These findings suggest that midwives value CTG as a guide but recognise that it cannot replace holistic assessment.

Concerns about medico-legal implications further shape midwives' perspectives. Dippenaar and Da Serra (2019:260) noted that midwives are conscious of CTG traces as legal documents, requiring clear labelling, signatures, and documentation of actions taken. Jha and Power (2022:1-12) confirm that obstetrics remains one of the most litigated medical fields, with CTG errors frequently cited in malpractice claims. Romijn, Bakker and Teunissen (2023:5) add that midwives often feel pressured by the fear of litigation, which influences their reliance on CTG even when clinical judgement might suggest otherwise.

Finally, midwives consistently call for enhanced education and institutional support to strengthen their confidence in CTG use. Jepsena, Blix, Cooke, Adrian and Maude (2022:600) found that midwives advocated for ongoing professional development and collaborative learning opportunities, while Alsaraireh, Yehia and Khalaf (2023:193) reported similar demands in Jordan. These views underline a shared recognition that CTG monitoring is indispensable, yet its effectiveness depends on sustained investment in midwifery education, adequate resources, and supportive practice environments.

2.4 RECOMMENDED MEASURES TO ENHANCE MIDWIVES' KNOWLEDGE ON THE INTERPRETATION OF CARDIOTOCOGRAPHY

During the Foetal Monitoring Webinar dated 21 February 2024, the National Department of Health (2024a) urged clinicians to be confident in their interpretation and responses to

the patterns of CTG through application of standardised management and documentation processes, where discrepancies from the 'normal' could occur. In addition, there are educational training programmes, workshops and post basic courses that are available for clinicians involved in the care of pregnant women.

2.4.1 Guidelines for CTG monitoring

The National Department of Health (2024b:3), through its *Integrated Maternal and Perinatal Care Guidelines for South Africa*, identified maternal and newborn health as a priority requiring urgent national attention. This aligns with the broader targets of the Sustainable Development Goals (SDGs) and the National Development Plan. Specifically, SDG 3.1 seeks to reduce the maternal mortality ratio to fewer than 70 deaths per 100 000 live births, while SDG 3.2 aims to eliminate preventable deaths among newborns and children. Achieving these targets depends heavily on the quality of antenatal and intrapartum care provided to pregnant women. To support this, the Department has endorsed recommendations from the triennial *Saving Mothers and Babies* reports, produced by ministerial committees, which call for the regular updating and strengthening of clinical guidelines addressing the most common causes of maternal and neonatal deaths in South Africa (Department of Health 2017-2019:19-32).

The *Guidelines for Maternity Care in South Africa* clearly outline the clinical indications for CTG monitoring during labour. These include women with a history of caesarean delivery, suspected intrauterine growth restriction, multiple pregnancy, pre-eclampsia, antepartum haemorrhage, and prolonged rupture of membranes exceeding 24 hours. Additional indications are suspected chorioamnionitis or offensive liquor, meconium-stained liquor, poor progress in labour, and the use of oxytocin infusion (National Department of Health 2016:46). By specifying these conditions, the guidelines provide midwives with a structured framework to identify high-risk scenarios where CTG monitoring is essential for safeguarding maternal and neonatal outcomes.

The *National Integrated Maternal and Perinatal Care Guidelines for South Africa* emphasise that CTG machines must be available in all hospitals managing high-risk women in labour (National Department of Health 2024b:66). The guideline specifies that one CTG machine is suitable for every two labour ward beds, although hospitals admitting only high-risk patients should ensure that each bed is equipped with its own machine.

Where shortages exist, the inadequate number of CTG machines must be formally documented, and the chief executive officer (CEO) notified, while foetal heart rate monitoring continues through auscultation. In addition, the guideline outlines general principles for CTG analysis, including the need for midwives to engage women and their birth companions, explain the purpose and findings of CTG monitoring, and respect maternal preferences. Importantly, midwives are cautioned against basing decisions solely on CTG findings; they must consider antenatal and intrapartum risk factors, maternal and foetal wellbeing, and labour progress. This approach is consistent with Skinner's learning theory of behaviourism, which underscores the role of reinforcement in shaping behaviour and suggests that individuals learn through the consequences of their actions.

According to the *NICE Guideline on Foetal Monitoring in Labour*, clinicians using CTG are advised to review previous foetal heart rate (FHR) monitoring results, including earlier CTG traces, as part of the hourly risk assessment. This review must be undertaken in conjunction with antenatal and intrapartum risk factors, with particular attention to any changes in baseline FHR, variability, or the presence of decelerations (National Institute for Health and Care Excellence [NICE] 2022:15). In addition, when assessing a CTG trace, clinicians should systematically evaluate contraction patterns, baseline FHR, variability, the presence or absence of decelerations and their characteristics, as well as the occurrence of accelerations. All findings must then be clearly documented to ensure accuracy, accountability, and continuity of care.

The *CTG Monitoring Standard* issued by the Western Australia Department of Health sets out the minimum requirements for CTG monitoring across maternity services (Western Australia Department of Health 2024:2). These requirements are designed to improve perinatal outcomes and minimise malpractice risks associated with CTG use in clinical practice. Health service providers are therefore obliged to ensure that all clinicians achieve and maintain demonstrable competence in performing and interpreting CTGs, commensurate with their level of responsibility and clinical experience in maternity care. To achieve this, the standard specifies the following series of educational requirements that must be consistently implemented and monitored across all facilities providing maternity services:

- Evidence of similar prior learning, or completion of an introductory programme in CTG monitoring must be demonstrated, with content stipulated by the health service's provider before a clinician is authorised to perform or interpret CTG traces;
- Review of the CTG monitoring policy, the CTG monitoring standard, and any relevant local maternity service guidelines, including clinical escalation pathways associated with CTG monitoring, is required;
- Annual CTG monitoring education must be completed, with content defined by the health service provider. The *Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) Online Foetal Surveillance Education Programme (OFSEP)* is formally endorsed for this purpose; and
- Completion of the *RANZCOG Foetal Surveillance Education Programme (FSEP)*, or an equivalent programme as determined by the health service provider, is recommended every three years to maintain competency.

The Mediclinic (2023:6) clinical guideline on foetal heart traces categorises CTG tracing into three aspects and the management thereof:

- **Normal:** Parents are reassured if all features are reassuring, including absence or presence of decelerations, baseline variability and foetal heart rate, as well as presence of uterine activity and accelerations.
- **Suspicious:** Non re-assuring classification of one of the features, and classification of the remaining features as reassuring – monitor and review CTG frequently to ensure that it does not become pathological. Attentive assessment the labouring woman by obstetrician or midwife, to identify the cause. Correction of the cause where possible. Further planning of care, taking the whole picture into account, including risk profile, progress of labour and parental preference, then communicate concerns and plan to parents.
- **Pathological:** Continue monitoring and urgently reviewing by senior midwife or obstetrician, exclude acute events and correct underlying causes if possible. Improve foetal oxygenation by positioning the woman on left lateral, give fluid bolus, stop oxytocic if any was given, give tocolytic and facilitate delivery if CTG remains pathological and communicate concerns and plan to parents.

These guidelines are aligned with Skinner's learning theory of behaviourism, which emphasises on the role of reinforcement in shaping behaviour (Catania 1984:473-475). Essentially, this theory proposes that individuals learn through the consequences of their actions.

2.4.2 Educational training programmes and workshops

Cull (2020:498), in a study on supporting student midwives to become safe practitioners, recommends that mentors use reflection to enhance the quality of teaching and learning outcomes by learning from errors and reinforcing successful practices. Overall, participants reported that the teaching was both useful and stimulating, and that their knowledge of CTG interpretation had improved significantly. Similarly, Carbonne and Sabri-Kaci (2016:111) found that an e learning programme for CTG analysis effectively enhanced the performance of maternity staff, with the flexibility to log in at any time and from any location potentially increasing its utilisation among practitioners.

As noted by James *et al.* (2019:6), midwives require regular CTG in service training to support effective and confident practice. It is therefore necessary to examine not only the training provided to midwives, but also the various approaches adopted in addressing different aspects of CTG. In addition, both the content and frequency of in-service training warrant review, given their influence on midwives' knowledge and skills, which ultimately shape the quality of perinatal care. In a related study, Mahada, Tshitangano and Mudau (2023:14), working in selected hospitals in the Vhembe District of Limpopo Province, found that staff incompetence negatively affects the quality of maternal health care services, and emphasised the need for continuous training of midwives.

Lukhele *et al.* (2025:5), in a study assessing midwives' competence in the interpretation of intrapartum CTG in public hospitals in Gauteng, highlight that there is a single structured training programme formally introduced and implemented across South Africa, namely the Essential Steps in the Management of Obstetric Emergencies and Essential Obstetric Simulation Training (ESMOE EOST). This programme is designed to reduce perinatal mortality by strengthening the knowledge and skills of obstetricians and midwives, and is typically delivered over a three-day period.

Similarly, Mulondo (2020:794), in a study conducted in Limpopo on factors associated with the underutilisation of antenatal care services, recommends the training of both

doctors and midwives in the Essential Steps in the Management of Obstetric Emergencies, as well as Helping Babies Breathe, with the aim of improving the quality of maternity care and outcomes.

Furthermore, Oleiwi (2018:32), in a study on the effectiveness of an educational programme on CTG for nurse midwives in maternity hospitals in Baghdad City, recommends that practitioners be encouraged to attend workshops, conferences and training programmes, and to regularly review and update nursing care practices related to CTG in order to enhance their clinical practice.

The South Australian Perinatal Practice Guideline for foetal surveillance (cardiotocography) recommends that CTG competency training be mandatory for all practitioners involved in the use and interpretation of CTGs in South Australian health facilities (South Australian Department for Health and Wellbeing 2020:16). Evidence from the research further indicates that a physiology-based approach to training, rather than reliance on pattern recognition alone, is more effective. In addition, it is recommended that all clinicians who use and interpret CTGs should possess up to date knowledge of foetal physiological responses to hypoxia, strong pattern recognition skills, and the ability to integrate principles of foetal physiology into each clinical situation.

Similarly, Sowmya, Gayathri, Ramesh and Jothi (2013:90), in their assessment of the effectiveness of a cardiotocography training programme on knowledge and skills among nurses in an obstetric department, found that prior to the training, 36.7% of participants demonstrated inadequate knowledge of general aspects of cardiotocography and the monitoring process, while 76.6% had inadequate knowledge of CTG interpretation. However, following the implementation of the training programme, the findings indicated a marked improvement, confirming the effectiveness of the intervention in enhancing both knowledge and skills among nurses working in maternity units.

2.4.3 Post-basic courses

Post basic midwifery training enables specialist midwives to practise as independent and competent practitioners who can deliver scientific, safe and comprehensive midwifery care to individuals, families and communities (SANC 2020:1). This position is supported by Mazwi (2020:67), who, in a study on midwives' knowledge and practices regarding the

utilisation of CTG in labour units at district hospitals in Limpopo Province, found that midwives demonstrated gaps in CTG interpretation. The study recommended that midwives be offered post basic midwifery training to strengthen their knowledge, enhance their competence in interpreting CTG findings, and enable them to take appropriate and informed clinical action.

2.5 SUMMARY

The literature review presents cardiotocography (CTG) as an essential monitoring tool, outlining its historical development, core functions and clinical purposes within maternity care. It highlights a range of factors that influence midwives' knowledge, experience and perceptions regarding the monitoring and interpretation of CTG in labour units. These factors include variations in training, exposure to clinical practice, and access to ongoing professional development. The review further illustrates how midwives engage with CTG technology during labour and how effectively it is integrated into routine clinical care.

Attention is also given to the complexities involved in interpreting CTG traces, including the need for both theoretical understanding and practical competence. In addition, the literature underscores the challenges associated with inconsistent interpretation and decision making. It demonstrates the importance of continuous education and skills reinforcement in improving clinical outcomes. Overall, the reviewed studies provide a comprehensive understanding of midwives' experiences and highlight gaps that may affect the quality of care. This synthesis therefore establishes a foundation for examining strategies to strengthen CTG competence in clinical practice.

CHAPTER 3

RESEARCH DESIGN AND METHOD

3.1 INTRODUCTION

This chapter outlines the research design and methodological approach adopted in the current study. It provides a detailed account of the processes followed to ensure that the study is conducted in a systematic and credible manner. The chapter begins by describing the overall research design that guided the inquiry and shaped the direction of the study. It further explains the sampling method used to select participants, as well as the characteristics of the study site and target population. The inclusion and exclusion criteria applied in selecting participants are also clearly defined. In addition, the chapter details the data collection approach and the specific methods employed to gather relevant information. Ethical considerations observed throughout the research process are discussed to demonstrate adherence to established standards. The procedures used for data analysis are also outlined to show how findings were generated and interpreted. Finally, the chapter addresses the rigour of the study, highlighting measures taken to ensure trustworthiness, credibility and dependability of the research outcomes.

3.2 RESEARCH DESIGN

According to Dannels (2018:402), research design refers to a plan that outlines all the components of a study in order to ensure that the findings are credible, free from bias and capable of being generalised. In this study, a non-interventional descriptive quantitative research design was applied. Non interventional research is defined as a design that measures and quantifies characteristics of a phenomenon of interest and study variables as they occur naturally in their real-world setting (Gray and Grove 2021:636). This design was considered appropriate for determining whether midwives are competent in assessing women using cardiotocography, as it enabled the researcher to obtain objective data on CTG interpretation skills, including the identification of normal and abnormal CTG variables, without interfering with or altering participants' clinical practice. In addition, Brink and Van Rensburg (2022:114) note that descriptive research designs are used to generate detailed information about specific characteristics within a field of study by providing an accurate picture of a phenomenon as it naturally occurs. In line with

this, a descriptive design was adopted, as the primary aim of the study was to describe the phenomenon of CTG monitoring and interpretation among midwives. The data collected were quantified in order to determine the level of understanding and engagement in CTG interpretation within the study context.

3.3 RESEARCH METHOD

The study adopted a quantitative approach within a descriptive research design in its exploration and quest to determine midwives' knowledge in the monitoring and interpreting CTG in a selected district hospital within the Lepelle Nkumpi Local Municipality, Limpopo Province. The research topic emerged from the researcher's professional experience in the selected hospital, where, due to referred labouring women, concerns were raised that midwives appeared to demonstrate limited competence in CTG monitoring and interpretation.

Descriptive studies provide the researcher with an opportunity to generate new meaning, describe existing phenomena, determine the frequency with which events occur and classify information (Gray and Grove 2021:84). A quantitative approach, in turn, focuses on quantifying data and allowing for the generalisation of findings from a study sample across different perspectives. It involves the systematic collection, analysis and interpretation of numerical data. In this study, the total population comprised 18 midwives who were purposively selected. Data were collected through questionnaires, and participants were also observed by the researcher during the process of CTG monitoring and interpretation in clinical practice.

3.3.1 Sampling

According to Brink and Van Rensburg (2022:149), purposive sampling involves the researcher identifying specific characteristics within the population of interest and then selecting individuals who meet those criteria in relation to the study phenomenon. In this study, purposive sampling was applied to include midwives at the hospital who actively engage in CTG usage and who represent one of the Capricorn district hospitals in Limpopo Province. The sample encompassed the entire population of 18 midwives, thereby ensuring that all relevant participants were incorporated.

3.3.1.1 Ethical issues related to sampling

- **Voluntary participation and autonomy**

The study population comprised 18 midwives allocated to the labour and antenatal wards. Participation, however, was entirely voluntary, with each individual retaining the right to decide whether or not to take part. Participants were afforded the opportunity to ask questions, decline involvement, or withdraw from the study at any stage, thereby ensuring that their autonomy and rights were fully respected.

- **Justice**

Participants' rights to fair selection were upheld throughout the sampling process. All midwives allocated to the labour and antenatal wards who were involved in the monitoring and interpretation of CTG were provided with the opportunity to take part in the study. This ensured that the selection process was equitable and inclusive, reflecting the principles of fairness and transparency.

3.3.1.2 Study site

The study was undertaken at a district hospital situated within the Capricorn District of Limpopo Province. This district comprises four municipalities, namely Blouberg Local Municipality, Lepelle-Nkumpi Local Municipality, Molemole Local Municipality, and Polokwane Local Municipality. The hospital selected for the study is one of three facilities located in Lepelle-Nkumpi Local Municipality. It provides maternity services to several surrounding villages, including Makotse, Ga-Ledwaba, Ga-Rakgoatha, Ga-Mphahlele, Sepanapudi, Ga-Masemola, and Zebediela. The following Figure 3.1 provides a visual illustration of Limpopo Province and its various districts and sub-Districts.

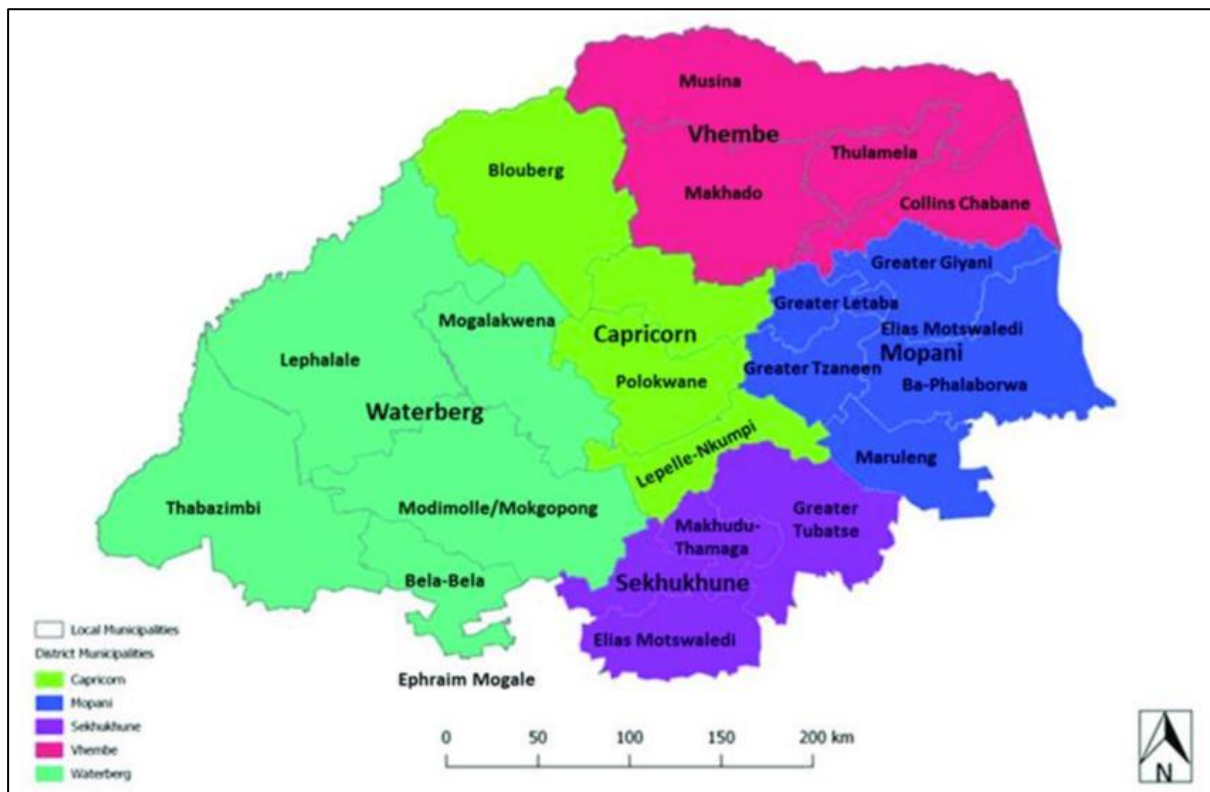


Figure 3.1 Map of Limpopo Province showing Limpopo Districts and Sub-Districts
(https://en.wikipedia.org/wiki/List_of_municipalities_in_Capricorn_district_Limpopo)

3.3.1.3 Population

The study population consisted of midwives allocated to the antenatal and labour wards of a selected district hospital within Lepelle-Nkumpi Local Municipality, Limpopo Province. In total, the population comprised 18 midwives, all of whom were eligible to participate in the research.

3.3.1.4 Sample

A sample is defined as a subset or fraction of a larger population selected by the researcher (Brink et al. 2022:140). In this study, the sample encompassed the entire population of 18 midwives, all of whom were engaged in the utilisation of CTG and allocated to the labour and antenatal wards of the district hospital.

3.3.1.5 Inclusion and exclusion criteria

Inclusion

Inclusion criteria focused on advanced midwives and midwives, those employed within the labour and antenatal units who manage pregnant women during labour at the district hospital in Lepelle-Nkumpi Local Municipality, Limpopo Province. These midwives were included in the study to ensure that participants reflected the professional group directly responsible for CTG monitoring and interpretation in this setting.

Exclusion

Exclusion criteria focused on midwives who were not allocated to the labour or antenatal wards at the time the data was collected, as well as those who were not engaged in CTG monitoring or interpretation. These considerations ensured that only participants directly involved in the relevant clinical practices were included in the study.

3.3.2 Data collection

Data collection refers to the methods employed by the researcher to address the research question (Maree 2016:112). In this study, non-participant observation and self-report techniques were utilised to gather information from the midwives. Observation is a recognised approach for collecting descriptive data on behaviours, events, and situations, and is particularly valuable in health sciences as it enables the researcher to witness behaviours as they occur (Brink et al. 2022:160). Complementing this, self-report techniques were used to elicit participants' perspectives, with questions designed to explore their thoughts, perceptions, attitudes, beliefs, feelings, motives, plans, experiences, levels of knowledge, and memories (Brink et al. 2022:163).

3.3.2.1 Data collection approach and method

Non-participant observation and self-administered questionnaires were employed in this study. Observations were structured, meaning that the behaviours or events to be recorded were specified in advance, together with the manner in which they would be documented (Brink et al. 2022:161). The researcher observed whether the midwives

interpreted the CTG, what elements were included in their interpretation, and whether the interpretation was accurate. Questionnaires were utilised as a self-report technique to address the objectives of the inquiry and to demonstrate alignment between their content, the research problem, and the study objectives.

3.3.2.2 Preparation and information session on data collection

The researcher developed both questionnaires and observation forms to guide data collection, ensuring alignment with the study objectives and existing literature on CTG monitoring. Prior to commencing the process, the researcher contacted the hospital's Chief Executive Officer (CEO) and the nursing service manager to establish rapport, seek permission, and discuss the involvement of participants, as well as to plan suitable dates for data collection.

Both the CEO and the nursing service manager responded positively, granting approval for the study to be conducted. Participants were identified as midwives allocated to the labour and antenatal wards. An information session was held on each day of data collection, during which the researcher outlined the purpose, objectives, and significance of the study, explained the procedures for data collection, and clarified what was expected of participants throughout the process. Questions raised by participants were addressed fully, ensuring transparency and understanding.

3.3.2.3 Characteristics of the data collection instrument

Data were collected through observation and self-report techniques. The questionnaire addressed variables such as participants' qualifications, age, years of experience as midwives, and their experience in using CTG to assess women during labour. It also explored the number of women assessed using CTG to date, the criteria considered when identifying reactive and non-reactive CTG patterns, the challenges encountered in CTG use and interpretation, and possible interventions to minimise those challenges. In addition, an observation tool was employed to determine whether midwives demonstrated the ability to prepare for CTG monitoring, what their interpretation entailed, whether CTG variables were correctly interpreted, whether findings were recorded, and, in cases of non-reactive or pathological CTG, whether the midwife reported the findings to a doctor.

3.3.2.4 Data collection process

The data collection process was designed to gather information that directly addressed the research problem, while also providing an audit trail with a clear explanation of how data were collected, how findings were derived, and the rationale for the chosen methods (Brink et al. 2022:157). Data were collected between 22 and 26 September 2025 from both day and night shift staff. Consent was obtained from patients to allow observation of the full process of CTG monitoring and interpretation. Each participant required approximately 15 minutes to complete the questionnaire and about 40 minutes to complete the monitoring and interpretation process under observation. In total, the researcher engaged 10 participants during the day shift and 8 during the night shift.

Day 1

On the first day of data collection, the researcher arrived at the hospital at approximately 06h40 to engage with day-shift participants. Immediately after the handover at the nurses' station, two midwives allocated to the antenatal ward were approached and informed about the research focus, questions, purpose, and significance of the study. Both midwives expressed interest in participating, after which the information sheet (Annexure F) was explained and provided. Consent forms (Annexure G) were signed, granting permission for the participants to complete the questionnaires and for the researcher to observe them during CTG monitoring and interpretation. The observation also included confirming whether CTG findings were documented and whether appropriate measures were taken following the outcomes of the CTG.

During the first day of data collection, the researcher remained with the initial participant at the nurses' station while other staff members commenced routine duties. Ensuring confidentiality and anonymity, the researcher and participant sat together to complete the questionnaire (Annexure H), which required eight minutes. The process then moved to the cubicle, where the participant monitored and interpreted the CTG of a woman undergoing induction of labour. The researcher introduced herself to the patient as a colleague of the midwife and explained that she was present to observe the monitoring and interpretation process. The participant required 38 minutes to complete the CTG assessment.

The second participant became available an hour later, having been occupied with ward activities. She completed the questionnaire (Annexure H) in ten minutes before proceeding to monitor and interpret the CTG of a patient admitted for an elective caesarean section scheduled for the following day. This process took 34 minutes.

The researcher then moved to the labour ward, where three midwives were allocated. After presenting the research topic, questions, purpose, and significance, and providing the information sheet (Annexure F), the midwives expressed willingness to participate, noting their challenges with CTG monitoring and interpretation and their hope that the study might address these issues. Consent forms (Annexure G) were subsequently signed.

One midwife indicated that she needed to assess a woman in labour. The researcher allowed time for the per vaginal examination before observing the CTG monitoring and interpretation. The process lasted 40 minutes, as the patient was a primigravida requiring reassurance and education on positioning during foetal heart assessment. Following this, the participant completed the questionnaire (Annexure H) in nine minutes.

At the nurses' station, the researcher approached the second participant, who was busy with patient records. Once she had finished, she completed the questionnaire in ten minutes before proceeding to monitor and interpret the CTG of a labouring woman. The process lasted 31 minutes.

In the next labour room, the third participant was admitting a patient and preparing to monitor and interpret the CTG. The researcher observed the entire process, which took 30 minutes. After completing the admission documentation, the participant filled in the questionnaire within 12 minutes. By the end of the day, the researcher had successfully collected data from five participants.

Day 2

On the second day of data collection, the researcher arrived at the hospital at approximately 06h30 to engage with day-shift staff from a different shift than those observed on the first day. The process began in the antenatal ward, where two midwives were allocated for duty. The researcher explained the purpose of the visit, including the

research focus, questions, objectives, and significance of the study. Both participants expressed interest, after which the information sheet (Annexure F) was explained and provided, and consent forms (Annexure G) were signed. To avoid disruption of their routine, the participants opted to complete the questionnaires first, positioning themselves separately at the nurses' station. Both completed the questionnaires within 12 minutes.

The researcher then accompanied the first participant to a cubicle, where she monitored and interpreted the CTG of a woman scheduled for induction of labour. The process lasted 30 minutes. In the next cubicle, the second participant was admitting a pregnant woman for an elective caesarean section. The researcher observed the monitoring and interpretation of the CTG, which took 32 minutes.

Subsequently, the researcher proceeded to the labour ward, where three midwives were on duty. After presenting the research focus, questions, purpose, and significance, and providing the information sheet (Annexure F), two participants agreed to take part, while the third indicated that her responsibilities in theatre, particularly attending to newborns, might limit her availability. Consent forms (Annexure G) were signed by the available participants. As the ward was quiet at the time, the two midwives completed their questionnaires separately at the nurses' station, requiring 14 minutes.

When routine assessments commenced for two pregnant women admitted with 'query labour', the first participant monitored and interpreted the CTG of one woman, completing the process in 30 minutes. The second participant undertook the CTG monitoring and interpretation for the second woman, which also lasted 30 minutes. Arrangements were then made with the midwife assigned to theatre to meet the following afternoon, as she indicated that the day's workload had left her too fatigued to concentrate on the questionnaire.

Day 3

On the third day of data collection, the researcher arrived at the hospital at 16h55 to meet the participant with whom an appointment had been arranged, as well as the night-shift staff. The participant was provided with the information sheet for review, and the consent form was signed, as details of the study had already been explained the previous day. She then completed the questionnaire (Annexure H) in ten minutes. A woman in labour

was subsequently assessed, and the researcher observed the participant monitoring and interpreting the CTG, a process that lasted 30 minutes.

The researcher then engaged with the night-shift participant allocated to the antenatal ward, where only one midwife is assigned per shift. After explaining the research focus, questions, purpose, and significance, the participant expressed willingness to participate. The information sheet (Annexure F) was explained and provided, and the consent form (Annexure G) was signed. The participant completed the questionnaire (Annexure H) in eight minutes, after which the researcher observed her monitoring and interpreting the CTG. The process lasted 30 minutes.

The researcher proceeded to the labour ward, where three midwives were allocated for the night shift. After outlining the research focus, questions, purpose, and significance, all three midwives agreed to participate. Information sheets (Annexure F) were explained and distributed, and consent forms (Annexure G) were signed. The first participant indicated that she needed to assess a labouring woman. The researcher allowed time for the per vaginal examination before observing the CTG monitoring and interpretation, which took 37 minutes. The participant then completed the questionnaire (Annexure H) in nine minutes.

Thereafter, the researcher engaged the remaining two participants at the nurses' station. One was asked to accompany her to an unoccupied delivery room to complete the questionnaire, which required nine minutes. The second participant was then invited to the delivery room and completed the questionnaire in eleven minutes. The researcher subsequently observed the second participant monitoring and interpreting the CTG, a process that lasted 30 minutes. The third participant, who did not have a labouring woman due for immediate assessment, monitored and interpreted the CTG of the patient previously assessed by the first participant, as a follow-up after two hours. This observation lasted 35 minutes. The researcher concluded the third day's data collection and scheduled the next visit for two nights later to engage with a different set of night-shift staff.

Day 4

On the fourth day of data collection, the researcher arrived at the hospital at approximately 18h45 to engage with the evening staff. The process began in the antenatal ward, where one midwife was allocated for the shift. After explaining the research focus, questions, purpose, and significance of the study, the participant expressed willingness to participate. The information sheet (Annexure F) was explained and provided, and the consent form (Annexure G) was signed.

The participant then completed the questionnaire (Annexure H) in ten minutes. When a pregnant woman required CTG monitoring, the researcher observed the midwife throughout the process, including the interpretation of the CTG, documentation of findings, and measures taken in response to the outcome. The observation lasted 36 minutes.

The researcher subsequently moved to the labour ward, where three midwives were allocated for the shift. After outlining the research focus, questions, purpose, and significance, all participants agreed to take part. Information sheets (Annexure F) were explained and distributed, and consent forms (Annexure G) were signed. At the nurses' station, the participants completed their questionnaires separately: the first in nine minutes, the second in ten minutes, and the third in thirteen minutes.

Approximately an hour later, one participant indicated it was time to assess a labouring woman. The researcher observed the CTG monitoring and interpretation, which took 30 minutes. Twenty minutes later, the second participant assessed another labouring woman, and the CTG process also lasted 30 minutes. Shortly thereafter, a new patient arrived for admission, and the third participant monitored and interpreted the CTG, completing the process in 30 minutes.

3.4 ETHICAL CONSIDERATIONS

This study received written approval from the Research Ethics Review Committee of the College of Human Sciences, University of South Africa (Annexure A). Permission to collect data was further obtained from the Limpopo Department of Health Research Committee (Annexure C) and the Capricorn District Manager (Annexure E). In addition,

the researcher met with the hospital's Chief Executive Officer (CEO) and Nursing Service Manager to discuss the data collection process and the selection of participants, ensuring that hospital services would not be disrupted.

On each day of data collection, participants were informed about the research focus, questions, purpose, and significance of the study. They were also made aware of the potential benefits and possible discomforts associated with participation. Participation was voluntary, and no obligation to consent was imposed. Those who agreed to take part were provided with an information sheet to keep and asked to sign a written consent form. Participants were reminded that they could withdraw from the study at any stage. Confidentiality was maintained by ensuring that no names were recorded and that only the researcher and designated members of the research team were aware of participants' involvement. Responses were anonymised so that no one could link participants to their answers.

Prior to observing participants during CTG monitoring and interpretation, the researcher introduced herself to the women being assessed as a midwife and sought their permission to observe the process. The confidentiality of the women was safeguarded by ensuring that no personal details were used in the reporting of findings.

3.5 DATA ANALYSIS

Quantitative data analysis refers to the manipulation of numerical data through statistical procedures, undertaken to describe phenomena or to assess the magnitude and reliability of relationships among them (Polit & Beck 2021:741). In this study, data collected through questionnaires and observational checklists were analysed statistically to identify patterns and relationships, with guidance provided by a statistician. The researcher captured the data in a Microsoft Excel spreadsheet before importing it into STATA for further analysis. Statistical procedures were employed to determine whether a significant correlation existed between midwives' knowledge of CTG and their accuracy in interpreting CTG tracings, in line with previous studies on CTG interpretation.

Descriptive statistics were applied to both questionnaire and observational data to summarise and describe the basic features of midwives' knowledge and experience in CTG monitoring and interpretation. Measures of central tendency and frequency

distributions were adopted to present the findings in a clear and accessible format. Responses requiring elaboration were captured in the spreadsheet, and their frequency distributions were examined. These measures facilitated the presentation of complex data in a more understandable form, primarily through tables.

3.6 RIGOUR OF THE STUDY: VALIDITY AND RELIABILITY

Brink et al. (2022:100) assert that rigour refers to critical aspects of the research process and is underpinned by the systematic scrutiny of each step. In this study, data were collected in a manner that was systematic, objective, and thorough, ensuring that analysis and interpretation were conducted in ways that minimised contamination and enhanced accuracy.

Reliability and validity are closely interrelated and were both considered in the selection of research instruments. As Brink et al. (2022:183) emphasise, there is little value in using an instrument that is reliable but not valid. Accordingly, the instruments employed in this study were chosen to ensure that they were both valid and reliable, thereby strengthening the credibility of the findings.

Validity

According to Gray and Grove (2021:1214), the validity of an instrument refers to the extent to which it accurately reflects or measures the construct under examination. In assessing validity, several forms of evidence are considered, including evidence based on the content of the test or scale, the response processes of participants, the internal structure of the instrument, its relationship to other variables, and the consequences of testing. In this study, the following aspects of validity were taken into account:

- **Content validity**

Content validity ensured that the questionnaire and observation checklist adequately covered the domains of CTG monitoring and interpretation relevant to the research objectives. In addition, content validity focuses on examining the extent of a measurement method's incorporation of all composite aspects relevant to the assessment of a construct (Gray & Grove 2021:1216). In this study, the researcher and guidance by her supervisor

and expert in research and the field of study, ensured that the variables included in the data collection tools comprehensively addressed all aspects of CTG monitoring and interpretation. This process was undertaken to determine midwives' knowledge and experience in CTG use, thereby strengthening the accuracy and relevance of the instruments employed.

- **Construct validity**

Construct validity concerns the extent to which an instrument genuinely measures the theoretical construct it is intended to assess. This requires careful examination of the alignment between the conceptual definition of a variable and its operationalisation within the research tools (Gray & Grove 2021:1227). In this study, particular attention was given to ensuring that the instruments captured the theoretical dimensions of CTG monitoring and interpretation. Prior to data collection, the supervisor—an expert in both research methodology and the substantive field—reviewed the tools to establish their construct validity. This process confirmed that the instruments were appropriately designed to measure midwives' knowledge and practice in CTG interpretation, thereby reinforcing the credibility of the study's findings.

- **Criterion-related validity**

Criterion-related validity is demonstrated when scores obtained from an instrument are amenable to being utilised for inferring performance on another criterion or variable (Gray & Grove 2021:1235). In this study, validity was strengthened through purposive sampling, whereby all midwives at the hospital were included because of their direct involvement in CTG monitoring and interpretation. By engaging the entire population of 18 midwives, the findings were representative of those routinely responsible for CTG usage in clinical practice. Furthermore, the application of identical data collection tools and procedures across all participants ensured consistency, comparability, and fairness, thereby reinforcing the validity of the study outcomes and enhancing the credibility of the inferences drawn.

Reliability

Reliability is the dependability and consistency of a research instrument in measuring a variable (Brink et al. 2022:245). Internal consistency refers to the extent to which repeated measurements of a phenomenon yield stable and consistent results (Taherdoost 2016:34). In this study, reliability was strengthened by ensuring that both the questionnaire and the observation checklist were carefully designed to examine variables directly related to CTG monitoring and interpretation. Under the guidance of the supervisor, the instruments were reviewed to confirm that they consistently captured the intended constructs, thereby enhancing the dependability of the findings and reinforcing the overall trustworthiness of the study.

3.7 SUMMARY

This chapter outlined the methodological processes employed in the study. It detailed the data collection approach and methods, including the preparatory activities and information sessions conducted with participants. The chapter further described the characteristics of the data collection instruments, the step-by-step data collection process, and the ethical considerations underpinning the study. In addition, it explained the procedures for data analysis and highlighted the strategies adopted to ensure validity, reliability, and overall trustworthiness of the research.

The chapter also emphasised the importance of systematic organisation in the collection and handling of data, ensuring that consistency was maintained across all participants and settings. It demonstrated how ethical safeguards were integrated into every stage of the process to protect participants' rights and confidentiality. Furthermore, it highlighted the role of supervisory oversight in strengthening the rigour of the study, particularly in validating the instruments used. Finally, the chapter established a clear methodological foundation upon which the subsequent presentation of results and discussion is derived in Chapter 4.

CHAPTER 4

ANALYSIS, PRESENTATION AND DESCRIPTION OF THE RESEARCH RESULTS

4.1 INTRODUCTION

This chapter presents the analysis, presentation, and description of the research results. The chapter focuses primarily on data management and analysis, the detailed presentation of research findings, and an overview of the key outcomes. It also provides a summary of the results to highlight the most significant patterns and relationships identified during the study.

In addition, the chapter demonstrates how the data collected through questionnaires and observational checklists were systematically organised and analysed to ensure accuracy and reliability. It outlines the descriptive statistics used to summarise midwives' knowledge and practices in CTG monitoring and interpretation, and explains how these findings were compared with existing literature. The chapter further highlights the practical implications of the results, linking them to the broader objectives of the study. Finally, this chapter preludes the discussion in Chapter 5, where the findings are interpreted in relation to theoretical frameworks and policy considerations.

4.2 DATA MANAGEMENT AND ANALYSIS

Self-administered questionnaires were distributed to all 18 midwives allocated to the labour and antenatal wards, and every questionnaire was completed and returned. In addition, the researcher conducted non-participatory observations, focusing on how participants monitored women using CTG and interpreted the tracings. This dual approach ensured that both self-reported knowledge and observed practice were captured for analysis.

Data analysis was undertaken in consultation with a statistician, using STATA version 19.5 SE. Initially, the researcher captured the data into a Microsoft Excel spreadsheet, which was subsequently imported into STATA for statistical processing. Continuous variables that were normally distributed were summarised using means and standard deviations, while those not normally distributed were reported using medians and

interquartile ranges. Categorical variables were analysed through frequency counts and percentage distributions.

This structured approach to data management allowed for systematic organisation, minimised errors, and ensured that the findings were presented in a clear and accessible format. The combination of descriptive statistics and frequency distributions provided a comprehensive overview of midwives' knowledge and practices in CTG monitoring and interpretation. Tables and figures were employed to simplify complex data, enabling patterns and relationships to be identified more effectively.

By integrating both questionnaire responses and observational data, the analysis offered a balanced perspective that strengthened the validity and reliability of the findings. This methodological rigour ensured that the results were not only statistically sound but also reflective of the realities of clinical practice.

4.3 RESEARCH RESULTS

The results of the study comprise three main components: the demographic characteristics of the participants, the responses on CTG knowledge obtained through the questionnaires, and the observational data relating to CTG monitoring and interpretation. Together, these elements provide a comprehensive picture of midwives' knowledge and practices in relation to CTG usage.

The findings are presented systematically, with demographic data offering context to the professional background of participants, followed by questionnaire responses that highlight levels of knowledge and understanding. Observational results complement these insights by illustrating how CTG monitoring and interpretation were performed in practice.

To enhance clarity and accessibility, the results are communicated using tables and graphs, which summarise complex data into visual formats that allow for easier comparison and interpretation. These visual aids highlight key trends, patterns, and relationships, thereby strengthening the presentation of findings.

This structured approach ensures that the results are not only statistically sound but also practically meaningful, offering insights into both the theoretical knowledge and applied

practices of midwives in CTG monitoring. The chapter thus provides a balanced foundation for the subsequent discussion, where the implications of these findings are explored in relation to existing literature and clinical practice.

4.3.1 Demographic characteristics

The demographic profile of the sample included age, professional qualifications, years of experience as midwives, and the number of women assessed using CTG. These variables provided essential context for interpreting the findings, as they reflected both the professional background and clinical exposure of the participants.

Age distribution offered insight into generational differences in CTG knowledge and practice, while qualifications highlighted the level of formal training received. Years of experience were considered to assess how accumulated clinical exposure influenced competence, and the number of women assessed using CTG served as an indicator of practical engagement with the technology. Together, these characteristics strengthened the analysis by linking knowledge and practice to relevant demographic factors, thereby enhancing the credibility of the study's findings. Table 4.1a below is a depiction of the 18 sampled midwives' demographic characteristics.

Table 4.1a Demographic characteristics of participants (N=18)

Demographic variable	Characteristic	Frequency	Percentage (%)
Age (years)	21-30	7	38.9
	31-40	2	11.1
	41-50	6	33.3
	51-60	3	16.7
Qualification	Midwife	17	94.4
	Advanced midwife	1	5.6
Years of experience	0-5 years	10	55.6
	6-10 years	5	27.8
	11-15 years	2	11.1
	16-20 years	0	0.0
	21-25 years	0	0.0
	26-30 years	1	5.6
Number of women CTGed	Many	1	5.6
	100-2000	9	50.0
	2100-4000	2	11.1
	4100-6000	3	16.7
	6100-8000	2	11.1
	8100-10000	1	5.6

Table 4.1a depicts the respondents' age distribution, ranging from 21 years to 60 years, their qualifications, as well as years of experience ranging from 0 to 30 years and the number of women assessed using CTG. According to the data in Table 4.1a, 38.9% of the respondents were between the ages of 21 years and 30 years, while 11.1% were aged 31-40 years, 33.3 % were in the 41-50 years cohort, and 16. 7% were in the of 51–60-year age group. Of the 18 respondents, 94.4% were midwives and 5.6% advanced midwife.

The results further reflect years of experience. In this regard, 55.6% of the respondents had 0-5 years' experience, 27.8% had 6-10 years of experience, while 11.1% had 11-15 years of experience, and none of the respondents were in the category of 16-20 years and 21-25 years of experience. Furthermore, only 5.6% of the respondent had 26-30 years of experience. Table 4.1.a also indicates that 5.6% of the respondents have assessed 'many' women in labour through the CTG. Other respondents engaged the question by taking a number of CTG traced per day, and multiplied by the number of days they worked per month and further multiplied the answer by the number of years they worked as midwives. Consequently, the following estimated figures of women assessed through the CTG were obtained: 50% of the respondents assessed $\pm$ 100-2000, 11.1%

assessed $\pm 2100-400$, 16.7% assessed $\pm 4100-6000$, while 11.1% $\pm 6100-8000$ and 5.6% respondent assessed $\pm 8100-10000$ women in labouring with the use of the CTG.

Table 4.1b Participants age and years of experience

Tabulation	Summary
N	18
Age	39.056 (12.105)
Years of experience	5.000 2.000 8.000

Table 4.1b illustrates that the mean age of respondents was 39.056 years, with a standard deviation of 12.105, indicating that the average participant was in their late thirties. For years of experience, the median was 5.000 with an interquartile range of 2.000 to 8.000, reflecting variability across the sample.

These results show that more than half of the respondents had five or fewer years of midwifery experience. Although the typical level of experience was five years, the spread between the lower-middle and upper-middle quartiles ranged from three to six years, highlighting differences in clinical exposure among participants.

4.3.2 Responses to variables in the questionnaire

The questionnaire administered to participants was designed to assess both theoretical knowledge and practical understanding of CTG monitoring and interpretation. Respondents were asked to provide information on the indications and purposes of CTG use, as well as their ability to distinguish between reactive and non-reactive CTG patterns in terms of variability. Questions also explored participants' knowledge of possible causes of reduced variability, thereby testing their capacity to identify clinical factors that may influence CTG readings.

In addition, the instrument sought to capture the challenges midwives encounter when using or interpreting CTG, together with their perspectives on strategies to minimise such difficulties. This approach ensured that the questionnaire not only measured factual knowledge but also elicited practical insights into the barriers faced in clinical practice and the potential solutions that could enhance CTG interpretation.

4.3.2.1 Indication and purpose of CTG

Table 4.2 Indication and purpose of CTG (N=18)

Indication and purpose of CTG	Frequency	Percentage
High risk pregnant women	2	11.1
Newly admitted patients and six hours reviews	1	5.6
Monitor foetal condition	10	55.6
Monitor FHR	9	50.0
During labour	2	11.1
Identify foetal abnormalities	4	22.2
Diagnose and act appropriately	5	27.8
Monitor maternal and foetal wellbeing	3	16.7

Table 4.2 illustrates the range of indications for CTG monitoring as reported by respondents. A total of 11.1% highlighted its use among high-risk pregnant women, while 5.6% identified newly admitted patients and six-hourly reviews as key indications. More than half of the respondents (55.6%) emphasised monitoring the overall foetal condition, and 50% specifically noted monitoring the foetal heart rate (FHR). In addition, 11.1% mentioned CTG use during labour, 22.2% identified its role in detecting foetal abnormalities, 27.8% referred to its importance in diagnosing and acting appropriately, and 16.7% highlighted its contribution to monitoring both maternal and foetal wellbeing.

Collectively, these responses demonstrate that the participants possessed acceptable knowledge regarding the indications and purposes of CTG monitoring. The findings suggest that midwives recognised CTG as a critical tool not only for routine surveillance of foetal wellbeing but also for identifying abnormalities and guiding timely clinical interventions. This breadth of responses reflects an understanding of CTG's multifaceted role in obstetric care, thereby reinforcing the validity of the study's assessment of midwives' knowledge and practice.

4.3.2.2 Features of reactive CTG

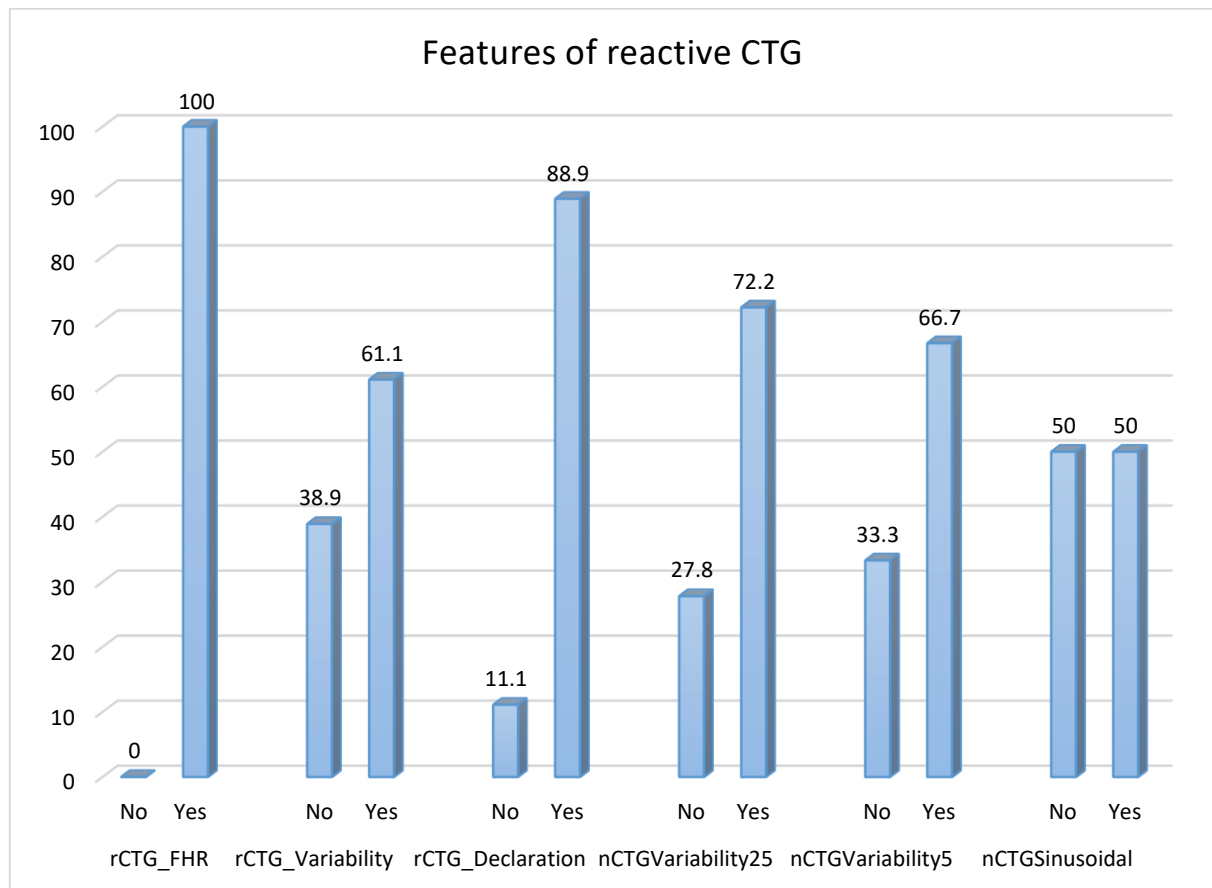


Figure 4.1 Features of reactive CTG (N=18)

Figure 4.1 illustrates respondents' knowledge of the features of a reactive CTG. All participants (100%) correctly identified a foetal heart rate (FHR) between 110–160 bpm as a defining feature. In addition, 61.1% recognised variability between 5–25 bpm as characteristic of a reactive CTG, while 38.9% did not consider this variability range to be significant. The figure further shows that 88.9% of respondents regarded the presence of none or early decelerations as a feature of a reactive CTG, whereas 11.1% did not.

These findings suggest that although respondents demonstrated awareness of some key features of a reactive CTG, gaps in knowledge remain. In particular, the failure of 38.9% of participants to acknowledge variability between 5–25 bpm as a critical feature indicates limited understanding of CTG interpretation. This highlights the need for strengthened training and continuous professional development to ensure midwives consistently recognise the essential parameters of reactive CTG patterns.

4.3.2.3 Features of non-reactive CTG in terms of variability

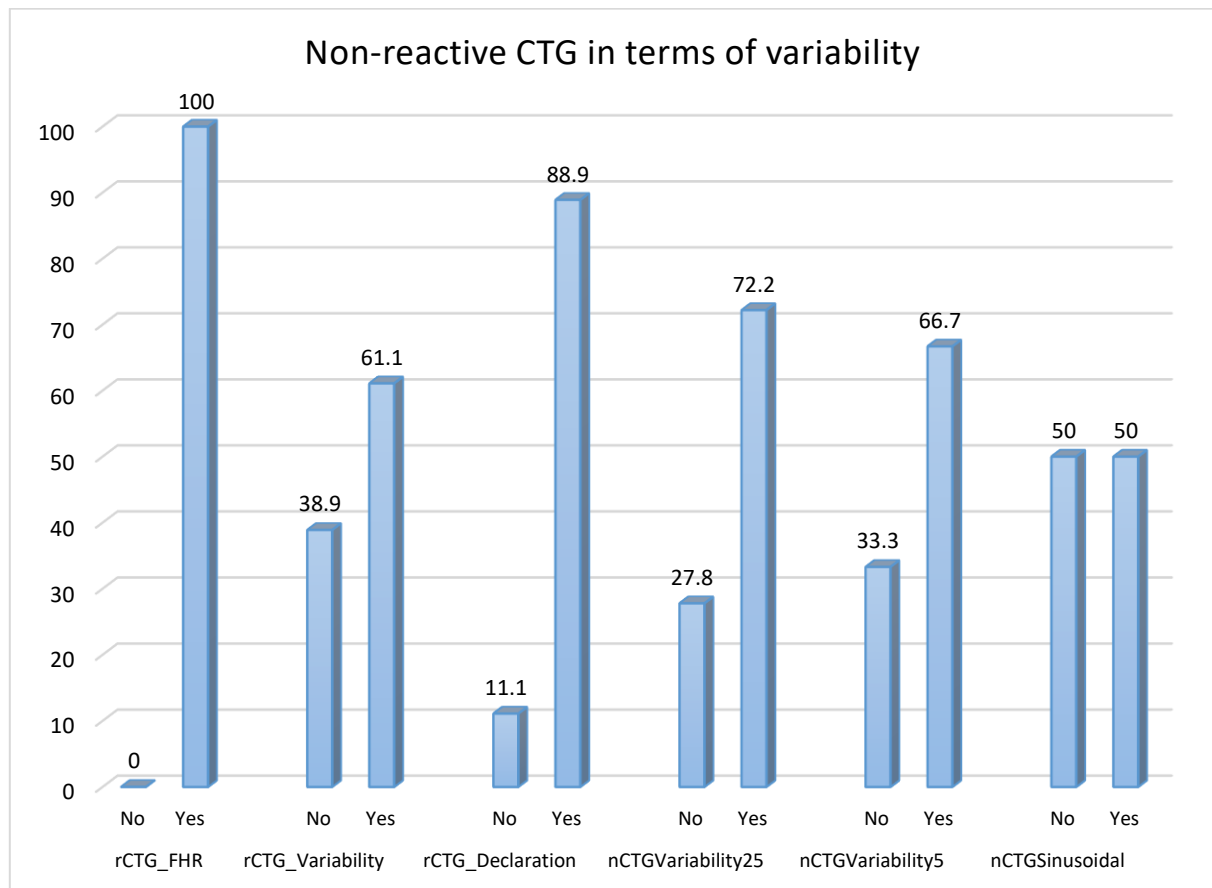


Figure 4.2 Features of a non-reactive CTG in terms of variability (N=18)

Figure 4.2 illustrates respondents' knowledge of the features of a non-reactive CTG. A majority (72.2%) recognised variability above 25 bpm sustained over 25 minutes as an indication of non-reactivity, while 27.8% did not consider this feature significant. Similarly, 66.7% identified variability below 5 bpm sustained over 30 to 50 minutes as an indicator of non-reactive CTG, and 50% acknowledged the sinusoidal pattern as a feature of abnormal variability.

Taken together, these findings reveal notable gaps in knowledge. Specifically, 30.6% of respondents were not aware that bandwidth amplitudes outside the normal range of 5–25 bpm are considered abnormal when sustained over 30 minutes. Normal variability is defined as a bandwidth amplitude of 5–25 bpm, whereas values below 5 bpm or above 25 bpm over prolonged periods reflect poor or abnormal variability, which is a hallmark of non-reactive CTG. The results therefore highlight the need for strengthened training to

ensure midwives consistently recognise abnormal variability patterns and respond appropriately in clinical practice.

4.3.2.4 Possible causes of reduced variability

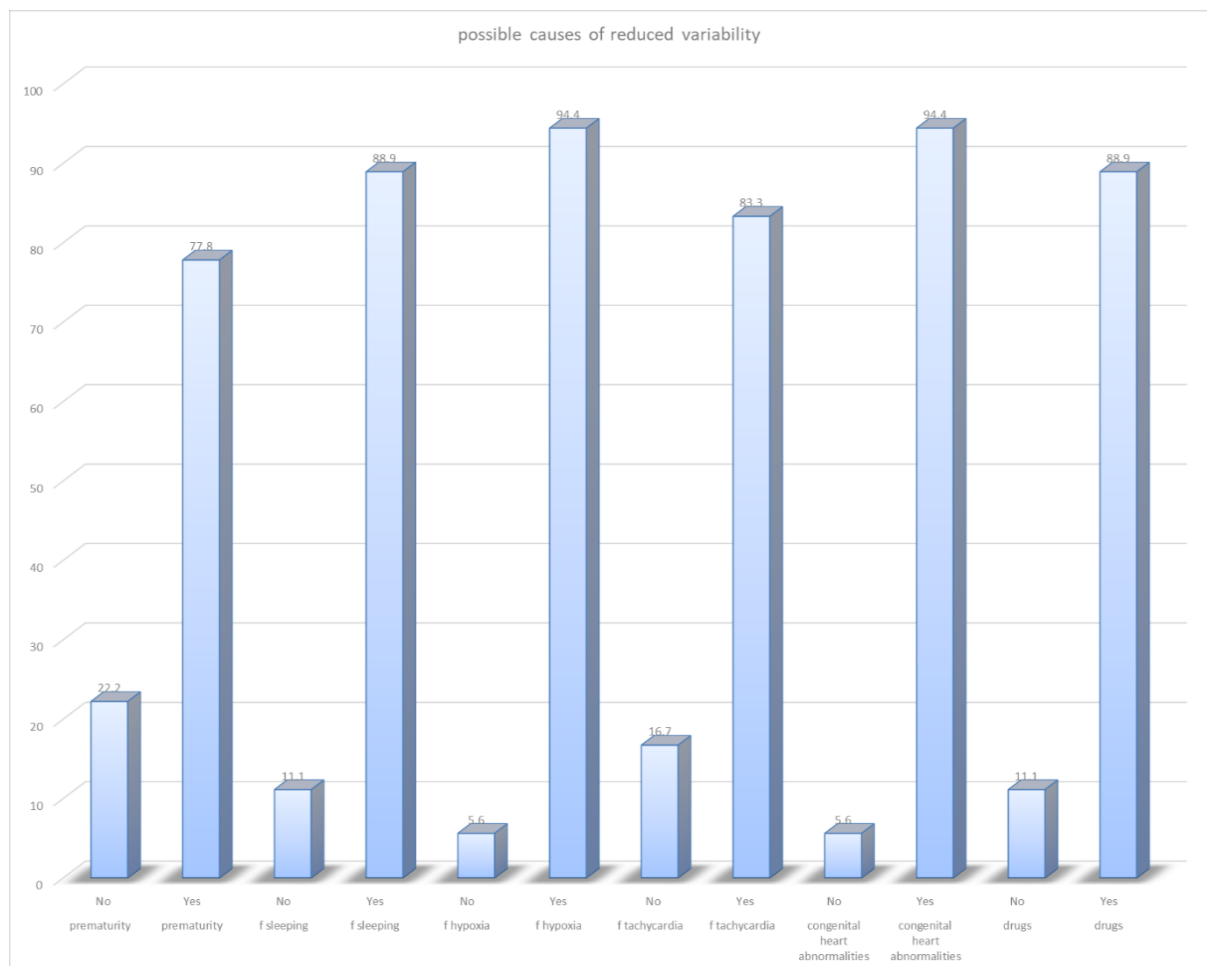


Figure 4.3 Possible causes of reduced variability (N=18)

Figure 4.3 illustrates respondents' knowledge of possible causes of reduced variability in CTG tracings. A majority (77.8%) identified prematurity as a contributing factor, while 88.9% recognised foetal sleep states. Foetal hypoxia was highlighted by 94.4% of respondents, and 83.3% associated foetal tachycardia with reduced variability. Similarly, 94.4% acknowledged congenital heart abnormalities as a possible cause, and 88.9% noted that certain drugs, such as opiates, may also reduce variability.

These findings suggest that respondents demonstrated moderate awareness of the clinical factors influencing CTG variability. While most participants correctly identified

several key causes, the overall pattern indicates that knowledge was only average, with gaps remaining in the comprehensive understanding of variability determinants. This highlights the importance of ongoing education and reinforcement of CTG interpretation skills to ensure midwives can consistently recognise and respond to abnormal patterns in clinical practice.

4.3.2.5 Challenges faced when using or interpreting the CTG

Table 4.3 Challenges faced when using or interpreting CTG (N=27)

Challenges	Frequency	Percentage (%)
Midwives' shortage	5	27.8
Shortage of CTG machines	6	33.3
Lack of in-service training on CTG	8	44.4
Tracing paper shortage	3	16.7
Non-serviced CTG machines	5	27.8

Table 4.3 highlights several challenges faced by respondents when using or interpreting CTG. A total of 27.8% noted the shortage of midwives as a limiting factor, while 33.3% identified the shortage of CTG machines. The most frequently reported challenge was the lack of in-service training on CTG, cited by 44.4% of respondents. In addition, 16.7% mentioned shortages of CTG paper tracings, and 27.8% highlighted the issue of non-serviced CTG machines.

These findings indicate that inadequate in-service training is the most significant barrier to effective CTG interpretation, followed closely by equipment shortages and maintenance issues. The results suggest that both human resource constraints and infrastructural limitations undermine the consistent and accurate use of CTG in clinical practice. Addressing these challenges through targeted training programmes, improved resource allocation, and regular servicing of CTG machines would enhance midwives' competence and confidence in CTG monitoring and interpretation.

4.3.2.6 Interventions to minimise challenges faced with CTG skill

Table 4.4 Interventions to minimise challenges faced when interpreting the CTG (N=28)

Interventions to minimise challenges	Frequency	Percentage (%)
Hiring more midwives	4	22.2
Managed CTG tracing paper procurement	1	5.6
CTG in-service training	12	66.7
Provision of CTG guidelines	2	11.1
Provision of more CTG machines	9	50.0

Table 4.4 presents respondents' views on interventions that could minimise the challenges faced when interpreting CTG. A total of 22.2% suggested that hiring more midwives would reduce workload pressures, while 5.6% emphasised the importance of well-managed procurement of CTG tracing paper. The majority (66.7%) highlighted in-service training on CTG skills as the most effective intervention. In addition, 11.1% recommended the provision of CTG guidelines, and 50% indicated that supplying more CTG machines would alleviate existing constraints.

These findings demonstrate that midwives are aware of practical interventions to strengthen CTG interpretation. The emphasis on in-service training reflects recognition of the need for continuous professional development to enhance competence and confidence in CTG use. Resource-related solutions, such as increasing the number of machines and addressing staffing shortages, were also frequently mentioned, underscoring the importance of both human and infrastructural support. Collectively, these responses highlight that improving training opportunities, alongside better resource allocation, would significantly minimise the challenges encountered in CTG monitoring and interpretation.

4.3.3 Observation findings

Participants were observed during the preparation and monitoring of CTG, with particular attention given to whether findings were correctly interpreted, accurately recorded, and appropriately reported. The observations focused on the practical application of CTG monitoring, including the steps taken to prepare the equipment, the consistency of monitoring practices, and the accuracy of interpretation in relation to established clinical guidelines.

The researcher also assessed whether participants escalated cases of non-reactive or pathological CTG to the attending doctor, thereby evaluating adherence to clinical protocols and responsiveness to abnormal findings. This observational component provided valuable insights into the alignment between midwives' theoretical knowledge and their practical execution of CTG monitoring, highlighting strengths as well as areas requiring further training and support.

4.3.3.1 Preparation for the CTG monitoring

Table 4.5 Preparation for the CTG monitoring (N=18)

Preparation	Frequency	Percentage (%)
Correctly prepared	18	100
Not correctly prepared	0	0

Table 4.5 shows that all participants (100%) were able to correctly prepare for CTG monitoring. Each midwife conducted abdominal palpation and auscultation to identify the foetal heart prior to initiating monitoring, and subsequently placed the probe accurately on the woman's abdomen. This demonstrates that the respondents possessed the necessary foundational skills for CTG preparation and adhered to standard clinical procedures.

The consistency of these practices across all participants reflects a strong level of competence in the preparatory phase of CTG monitoring. Proper preparation is critical to ensuring accurate tracings and reliable interpretation, and the findings suggest that midwives in this study were proficient in establishing the conditions required for effective CTG use. This observation provides reassurance that gaps in CTG practice are less likely to stem from preparation errors, but rather from subsequent stages of monitoring and interpretation.

4.3.3.2 CTG interpretation

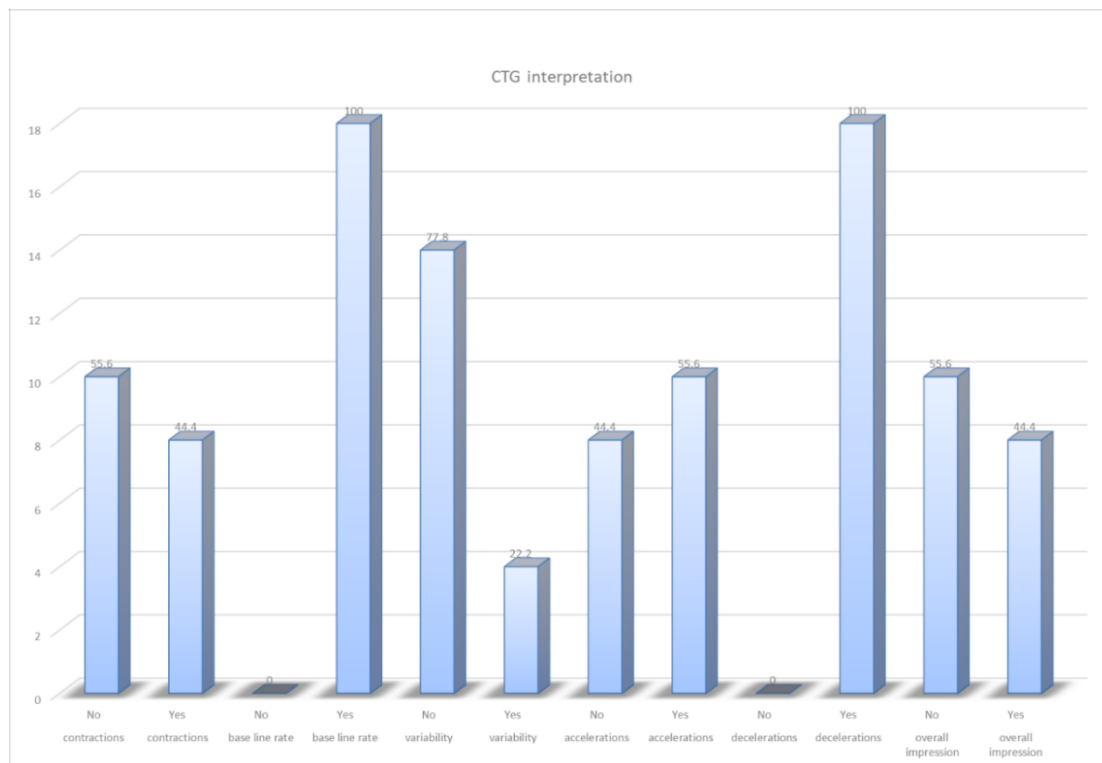


Figure 4.4 Features entailed in CTG interpretation

Figure 4.4 illustrates the extent to which participants incorporated key parameters when interpreting CTG tracings. All respondents (100%) included the baseline rate and decelerations in their interpretation, while 44.4% considered contractions and 55.6% included accelerations. Only 22.2% accounted for variability, and 44.4% provided an overall impression of the CTG.

These findings indicate that although participants consistently recognised baseline rate and decelerations, other critical features such as variability and accelerations were less frequently considered. The omission of variability by the majority of respondents is particularly concerning, as it is a central feature in CTG interpretation. Overall, the results suggest that CTG interpretation among participants was compromised, reflecting gaps in comprehensive assessment and underscoring the need for strengthened training to ensure accurate and holistic evaluation of CTG tracings.

4.3.3.3 Variables interpretation on CTG findings

Table 4.6 Interpretation, recording and reporting of CTG findings

Variables	Frequency	Percentage (%)
CTG interpretation		
Able to interpret CTG	3	16.7
Not able to interpret CTG	15	83.3
CTG recording		
Recorded CTG findings	5	27.8
CTG findings not recorded	13	72.2
Pathological CTG reporting		
Reported pathological CTG	5	27.8
Pathological CTG not recorded	5	27.8
N/A	8	44.4

Table 4.7 depicts notable gaps in participants' ability to interpret, record, and report CTG findings. Only 16.7% of the midwives were able to correctly interpret the CTG tracings, while the majority (83.3%) were unable to do so. With regard to documentation, 27.8% recorded their findings after interpretation, whereas 72.2% did not record any results. In terms of escalation, 27.8% reported non-reactive or pathological CTG findings to the doctor, 27.8% failed to report, and 44.4% did not encounter non-reactive or pathological CTG outcomes during the observation, thus no reporting was required.

These results indicate a clear compromise in the interpretation, recording, and reporting of CTG findings among participants. The limited ability to interpret tracings accurately, coupled with inconsistent documentation and reporting practices, suggests deficiencies in both knowledge application and adherence to clinical protocols. Such gaps pose risks to timely clinical decision-making and highlight the urgent need for targeted in-service training, reinforcement of documentation standards, and structured reporting guidelines to strengthen CTG practice and ensure patient safety.

4.3.4 Comparison of responses to observed findings

Table 4.7 Responses compared to observation of CTG interpretation

Responses	Interpretation			P-value
	Don't know	Know	Total	
N	15 (83.3%)	3 (16.7%)	18 (100.0%)	
Reactive CTG				
Don't know	8 (53.3%)	0 (0.0%)	8 (44.4%)	0.216
Know	7 (46.7%)	3 (100.0%)	10 (55.6%)	
Non-reactive CTG				
Don't know	12 (80.0%)	0 (0.0%)	12 (66.7%)	0.025
Know	3 (20.0%)	3 (100.0%)	6 (33.3%)	
Possible causes				
Don't know	7 (46.7%)	0 (0.0%)	7 (38.9%)	0.245
Know	8 (53.3%)	3 (100.0%)	11 (61.1%)	

Table 4.7 compares questionnaire responses with observed findings on CTG interpretation using Fisher's exact test. During observation, 83.3% of participants were unable to interpret CTG tracings correctly, while only 16.7% demonstrated accurate interpretation. Interestingly, questionnaire responses showed that 53.3% could not identify the features of a reactive CTG, compared with 44.4% observed to lack this knowledge. Conversely, 46.7% of respondents reported recognising all features of a reactive CTG, while 55.6% were observed to demonstrate awareness of these features. The P-value of 0.216 confirmed that these differences were statistically non-significant.

For non-reactive CTG, 80.0% of respondents failed to identify its features in the questionnaire, while 66.7% were observed to lack this knowledge. In contrast, 20.0% of respondents reported recognising all features, compared with 33.3% observed to demonstrate awareness. This difference was statistically significant, confirmed by a P-value of 0.025, indicating robustness of the finding. Finally, regarding possible causes of reduced variability, 46.7% of respondents could not identify them in the questionnaire, while 38.9% were observed to lack this knowledge. Conversely, 53.3% reported awareness of causes, compared with 61.1% observed to demonstrate recognition. The P-value of 0.245 confirmed that these differences were non-significant.

Overall, the comparative analysis highlights that while questionnaire responses and observed practices were broadly aligned, discrepancies existed, particularly in recognising non-reactive CTG features, where observation revealed stronger awareness

than self-reported knowledge. The statistically significant difference in this domain underscores the importance of practical assessment in complementing self-reported measures, thereby providing a more accurate reflection of midwives' competence in CTG interpretation.

4.4 OVERVIEW OF RESEARCH FINDINGS

The aim of this study was to determine the understanding of midwives regarding CTG skills when monitoring pregnant women in labour at a district hospital in Lepelle-Nkumpi Local Municipality, Limpopo Province. The objectives were twofold: first, to assess midwives' knowledge of CTG monitoring and interpretation; and second, to recommend measures that could enhance knowledge and strengthen competence in CTG interpretation. The study adopted a purely descriptive design, ensuring that the findings reflected the actual practices and perceptions of the participants without inferential bias. Importantly, there were no missing values, which enhanced the reliability and completeness of the dataset.

The study population comprised all 18 midwives working at the hospital, each of whom completed the questionnaire. In addition, the researcher conducted direct observations of all participants during the preparation, monitoring, and interpretation of CTG. This dual approach—combining self-reported data with observed practice—provided a comprehensive understanding of midwives' knowledge and skills, while also allowing for comparison between theoretical responses and practical application. The inclusion of the entire population strengthened the validity of the findings and ensured that the results were representative of the midwifery workforce at the study site.

4.4.1 Demographic characteristics

The findings revealed that the majority of midwives (38.9%) were young, between the ages of 21–30 years. This suggests that labour wards at the study site are staffed predominantly by younger, less experienced midwives rather than older, more seasoned practitioners. These results corroborate existing literature by Sarker et al. (2023:539), who reported that nearly half (47.6%) of participants in their hospital-based study on intrapartum CTG effectiveness were aged between 25–29 years. Similarly, Salman and Al-Fayyadh (2022:733) found that 46% of midwives in their study on ethical practices in

delivery rooms were aged 21–25 years. Taken together, these findings highlight a consistent pattern across different contexts: midwifery practice in labour wards is increasingly characterised by younger professionals, which may have implications for skill development and retention.

The study further revealed that more than half of the participants (55.6%) had between 0–5 years of experience in CTG monitoring and interpretation. Out of the 18 midwives, only one was an advanced midwife, and half of the respondents reported having assessed between 100–2000 women using CTG. These demographic characteristics underscore the predominance of newly qualified midwives at the selected hospital, compounded by an overall shortage of staff. This aligns with Terry and Spendlove (2025:12), whose interpretative phenomenological analysis demonstrated that staff shortages create a self-perpetuating cycle: limited personnel restrict access to development opportunities, which in turn leads to frustration, disillusionment, and attrition among midwives. The present study therefore reinforces the broader literature by showing that shortages of experienced staff not only compromise CTG competence but also hinder professional growth and retention, ultimately affecting the quality of maternal care.

4.4.2 Indication and purpose of the CTG

The results revealed that midwives demonstrated knowledge regarding the indications and purposes of CTG monitoring. Respondents identified eight key variables, including its use for high-risk pregnant women, newly admitted patients with six-hourly reviews, monitoring foetal condition, monitoring foetal heart rate (FHR), use during labour, identifying foetal abnormalities, diagnosing and acting appropriately, and monitoring maternal and foetal wellbeing. This breadth of responses reflects an awareness of CTG's multifaceted role in intrapartum care, encompassing both routine surveillance and the detection of abnormal foetal patterns requiring intervention.

These findings are consistent with the National Institute for Health and Care Excellence (NICE) guideline on foetal monitoring in labour (2022:10), which emphasises that continuous CTG monitoring is recommended in the presence of antenatal and intrapartum risk factors, to evaluate the baby's condition during labour, monitor the heart rate, and assess contractions. The alignment between respondents' knowledge and

international guidelines suggests that midwives at the study site possess acceptable theoretical understanding of CTG indications. However, the results also highlight the importance of translating this knowledge into consistent practice, particularly given the observed gaps in interpretation and reporting.

4.4.3 Features of a reactive and non-reactive CTG

The results indicated that midwives in this study placed greater emphasis on foetal heart rate (FHR) as a feature of CTG interpretation, while giving less consideration to variability, decelerations, and sinusoidal patterns when distinguishing between reactive and non-reactive CTG. This selective focus suggests that although participants recognised the centrality of FHR, their understanding of other critical parameters was limited, thereby compromising comprehensive CTG interpretation.

By contrast, Alsaraireh et al. (2023:197), in their study assessing midwives' knowledge and attitudes regarding CTG use and interpretation, found that midwives demonstrated poor knowledge of the normal range and determinants of the FHR baseline, but acceptable knowledge of the normal range and determinants of FHR variability. The divergence between the two studies may be explained by differences in participant profiles. In Alsaraireh et al.'s study, all respondents were qualified, advanced midwives, whereas in the present study only one advanced midwife was included among 18 participants, with the remainder being less experienced practitioners. This demographic imbalance likely contributed to the observed gaps in knowledge, particularly regarding variability and sinusoidal patterns, which require more advanced interpretive skills.

The findings therefore highlight the importance of experience and advanced training in shaping midwives' competence in CTG interpretation. While younger and less experienced midwives may demonstrate awareness of basic parameters such as FHR, they often lack the depth of knowledge required to interpret more complex features. This underscores the need for structured in-service training and mentorship programmes to bridge the gap between foundational knowledge and advanced interpretive competence.

4.4.4 Possible causes of reduced variability

It is noteworthy that 87.9% of respondents demonstrated awareness of the possible causes of reduced variability, including prematurity, foetal sleep states, hypoxia, tachycardia, congenital heart abnormalities, and the influence of drugs such as opiates. However, this finding stands in contrast to the earlier result where 38.9% of respondents did not consider variability as a feature of reactive CTG. This inconsistency suggests that while midwives may possess theoretical knowledge of the causes of reduced variability, they are not entirely confident in applying this knowledge to CTG interpretation. Such uncertainty compromises the ability to distinguish between normal and abnormal patterns, thereby affecting clinical decision-making.

Clinicians, however, are expected to demonstrate confidence in CTG interpretation and to respond appropriately to variations from the normal range. The Integrated Maternal and Perinatal Care Guidelines of South Africa emphasise the importance of a standardised process of CTG interpretation, documentation, and management (National Department of Health, 2024b:63). This process requires clinicians to consistently recognise deviations from normal variability and act promptly to safeguard maternal and foetal wellbeing. The observed gaps in this study therefore highlight the need for structured in-service training and reinforcement of national guidelines to ensure that midwives not only understand the causes of reduced variability but also apply this knowledge effectively in practice.

4.4.5 Challenges faced when using and interpreting CTG

The results indicated that midwives experienced several challenges when using and interpreting CTG. These included a lack of in-service training, heavy workloads that limited concentration during CTG interpretation, shortages of tracing paper, insufficient numbers of CTG machines, and equipment that was not regularly serviced. Collectively, these barriers reflect both human resource and infrastructural constraints that undermine the consistent and accurate application of CTG monitoring in labour wards.

These findings are consistent with the study by Kelly et al. (2024:6), which examined intrapartum electronic foetal monitoring practices against a major patient safety framework. Their results revealed that the range of system influences on foetal safety is

extensive and diverse. Structural issues such as inadequate staffing levels and high workloads were rated as the most critical, followed by equipment defects and variability in practice guidance. Importantly, Kelly et al. also highlighted process-related challenges, including unclear task allocation, situational pressures, communication breakdowns, and cultural factors, all of which can compromise safe and effective CTG use.

The present study therefore reinforces the broader literature by demonstrating that challenges in CTG interpretation are not limited to individual knowledge gaps but are embedded within systemic and organisational contexts. Addressing these barriers requires a dual approach: strengthening midwives' skills through continuous training and mentorship, while simultaneously improving staffing levels, resource availability, and equipment maintenance. Without such interventions, CTG monitoring risks becoming inconsistent, thereby jeopardising maternal and foetal outcomes.

4.4.6 Interventions to minimise challenges faced with CTG skill

The results indicated that 66.7% of respondents strongly recommended in-service training as the most effective intervention to minimise challenges faced when using or interpreting CTG. This finding is consistent with Lukhele et al. (2025:6), who emphasised that programmes aimed at improving midwives' knowledge and skills should be strengthened through printed educational materials, outreach visits, continuing education workshops, the influence of opinion leaders, and audited feedback. The importance of training was further underscored during observation, where 66.7% of participants failed to identify non-reactive CTG, a gap that could negatively affect timely intervention and foetal outcomes. These results concur with Sarker et al. (2023:542), who demonstrated that non-reactive CTG records are strongly associated with perinatal asphyxia, requiring instant and adequate obstetric decisions to safeguard foetal wellbeing.

Similarly, Maleta, Tau and Bopape (2024:154) recommended sustained investment in training programmes to improve the quality of midwifery care and reduce maternal and neonatal morbidity and mortality. Beyond training, resource-related challenges were also highlighted. The shortage of CTG paper tracing was evident, as only one machine had a functioning paper trace, delaying monitoring and interpretation. This finding aligns with Mazwi (2020:67), who recommended ensuring guaranteed supply and availability of equipment to promote effective service delivery. Furthermore, the issue of non-serviced

CTG machines was confirmed when participants placed the probe for FHR but failed to use the toco for contractions, indicating faulty sensors. Mohlala et al. (2023:345) similarly identified equipment maintenance as a critical impediment to optimal intrapartum monitoring, recommending the incorporation of mandatory computerised maintenance management systems and regular inspections by skilled technicians to improve the quality of maternity equipment in Limpopo hospitals.

Taken together, these findings highlight that interventions must address both human and infrastructural dimensions. Strengthening in-service training will enhance midwives' interpretive competence, while ensuring adequate resources, reliable equipment, and systematic maintenance will create an enabling environment for safe and effective CTG monitoring.

4.4.7 Monitoring, interpretation, recording and reporting of CTG findings

All participants were able to conduct abdominal palpation and auscultation and correctly apply the CTG probe on the women's abdomen, demonstrating competence in the preparatory phase of CTG monitoring. However, despite this foundational skill, 83.3% of participants were found to lack the necessary interpretive skills, which poses a significant risk to the management and outcome of labour. This finding concurs with Mazwi (2020:62), who reported that midwives experienced challenges in CTG interpretation and recommended consistent in-service training and workshops to strengthen knowledge, empower practitioners, and enable them to interpret findings accurately and make appropriate interventions.

Furthermore, deficiencies were noted in documentation and reporting practices. A total of 72.2% of participants did not record CTG findings, and 27.8% failed to report pathological CTG results to the doctor. These gaps undermine continuity of care and delay timely interventions, thereby compromising patient safety. In contrast, Geyer et al. (2021:96) emphasised that patient record-keeping provides proof that care is based on systematic assessment and planning, while also offering a comprehensive account of the patient's condition and care trajectory. The lack of documentation and reporting observed in this study therefore highlights a critical weakness in clinical practice, reinforcing the need for structured training not only in CTG interpretation but also in adherence to documentation and escalation protocols.

4.4.8 Comparison of responses to the questionnaire and observation findings

Fisher's exact test was applied to compare questionnaire responses with observed practices. The results indicated that 83.3% of participants were unable to interpret CTG tracings, while 53.3% of questionnaire responses revealed that respondents did not know the features of reactive CTG. In contrast, during observation 55.6% were able to identify reactive CTG features. The P-value of 0.216 confirmed that these differences were statistically non-significant, suggesting that knowledge gaps in recognising reactive CTG features were consistent across both self-reported and observed measures.

For non-reactive CTG, 80.0% of respondents reported not knowing its features, while 66.7% were observed to lack this knowledge. Only 20.0% of respondents and 33.3% of observed participants demonstrated awareness of non-reactive CTG features. The P-value of 0.025 confirmed that these findings were statistically significant, highlighting a robust gap in knowledge and practice regarding non-reactive CTG interpretation. Finally, in relation to reduced variability, 46.7% of respondents and 38.9% of observed participants failed to identify its possible causes, while 53.3% and 61.1% respectively demonstrated awareness. The P-value of 0.245 confirmed that these differences were non-significant.

Overall, the findings reveal a lack of knowledge and confidence in CTG interpretation, particularly in recognising non-reactive patterns, which are critical for timely obstetric intervention. The current study concurs with James et al. (2019:6), who concluded that CTG knowledge remains a challenge for practising midwives in South Africa, with many lacking the competence required for accurate interpretation. These results underscore the urgent need for structured in-service training, mentorship, and reinforcement of standardised guidelines to ensure that midwives can reliably interpret CTG tracings and respond appropriately to foetal distress.

4.5 SUMMARY

This chapter presented the research results derived from both the questionnaire responses and direct observations of midwives' practices in CTG monitoring and interpretation. The findings were systematically organised to provide a comprehensive overview of the study outcomes. All sample characteristics were discussed in detail,

offering a clear demographic profile of the participants and contextualising their knowledge, experiences, and challenges.

The results highlighted important strengths, such as midwives' competence in CTG preparation, alongside notable weaknesses, particularly in interpretation, documentation, and reporting. Comparative analysis using Fisher's exact test further revealed discrepancies between self-reported knowledge and observed practice, underscoring the need for continuous training and systemic support. The chapter therefore provided a holistic account of the study findings, laying the foundation for the subsequent discussion and recommendations.

CHAPTER 5

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter provides an integrated overview of the study design and methods, summarises and interprets the key findings, and draws conclusions based on the evidence presented. It further outlines the limitations encountered during the research process, presents practical recommendations to strengthen CTG monitoring and interpretation, and discusses the contributions of the study to midwifery practice and maternal health. Finally, the chapter closes with concluding remarks that highlight the significance of the study and its implications for future research and practice.

5.2 AN OVERVIEW OF THE RESEARCH DESIGN AND METHOD

The study adopted a quantitative descriptive research design to explore and determine midwives' knowledge and experiences in the monitoring and interpretation of CTG at a district hospital in Lepelle-Nkumpi Local Municipality, Limpopo Province. This design was appropriate as it allowed for the systematic description of practices and perceptions without manipulating variables, thereby providing a clear picture of the current state of CTG competence among midwives.

A total population of 18 midwives was purposively selected, ensuring that the study captured the perspectives and practices of all midwives working in the labour ward at the time of data collection. Data were gathered through two complementary approaches. First, participants completed a self-administered questionnaire designed to assess their theoretical knowledge and self-reported experiences of CTG monitoring and interpretation. Second, the researcher conducted non-participant observations of each midwife during the preparation, monitoring, and interpretation of CTG. This dual method provided both subjective and objective insights, enabling comparison between reported knowledge and observed practice.

The use of a complete population strengthened the reliability of the findings, as no sampling bias was introduced. Moreover, the combination of questionnaires and

observations enhanced the validity of the study by triangulating data sources, thereby offering a comprehensive understanding of midwives' competence and challenges in CTG use.

The purpose of the study was to determine the midwives' understanding and experiences concerning the preparation, monitoring and interpretation of CTG as a clinical skill.

The research objectives were:

- To assess midwives' knowledge in the preparation, monitoring and interpretation of the CTG as a clinical skill.
- To develop recommendations to enhance the midwives' competency in the preparation, monitoring and interpretation of CTG.

The research questions were:

- Do midwives have knowledge in the preparation, monitoring and interpretation of CTG as a clinical skill?
- What recommendations can enhance midwives' competency in the preparation, monitoring and interpretation of CTG by midwives?

A typical descriptive study was employed, as the intention was to provide a detailed account of midwives' knowledge and experiences in the preparation, monitoring, and interpretation of CTG as a clinical skill. The descriptive design was appropriate because it allowed the researcher to capture and present the realities of practice without manipulation of variables, thereby reflecting the authentic context of CTG use in the labour ward.

Data collection was structured to quantify the level of understanding and engagement with CTG interpretation. This was achieved through a self-administered questionnaire, which elicited midwives' theoretical knowledge and self-reported practices, and non-participant observation, which enabled the researcher to directly assess the preparation, monitoring, and interpretation of CTG in real-time clinical settings. The combination of these methods provided both subjective and objective insights, allowing for triangulation and enhancing the validity of the findings.

5.3 SUMMARY AND INTERPRETATION OF THE RESEARCH FINDINGS

This section presents the consolidated findings from both the questionnaire responses and observational data. The results covered midwives' knowledge of the indications and purposes of CTG, features of reactive and non-reactive CTG, variability and its possible causes, challenges encountered in CTG use, and suggested interventions to address these challenges. Observable practices were also assessed, including preparation, monitoring, interpretation, documentation, and reporting of CTG findings. Comparisons between self-reported knowledge and observed practice provided deeper insights into areas of alignment and discrepancy.

The study revealed that midwives were between the ages of 21 and 60, with the majority (38.9%) being young, aged 21–30 years. Their professional experience ranged from 0 to 30 years, though most (55.6%) had only 0–5 years of experience in CTG monitoring and interpretation. Out of the total population of 18 midwives, only one held a postgraduate diploma in midwifery and neonatal nursing science. These demographic results indicate that labour wards are predominantly staffed by younger and less experienced midwives, with limited advanced qualifications.

This demographic profile provides important context for interpreting the study's findings. While midwives demonstrated awareness of CTG's purpose and indications, significant gaps were evident in their ability to interpret reactive and non-reactive CTG patterns, identify variability, and document or report findings consistently. The predominance of younger, less experienced midwives suggests that the challenges observed may be linked to limited exposure, insufficient training, and systemic resource constraints.

5.3.1 Indication and purpose of the use of the CTG

The question of indication and purpose of CTG use was analysed under categorical variables, with frequency and distribution recorded. Midwives identified eight key variables: CTG monitoring for high-risk pregnant women, newly admitted patients with six-hourly reviews, monitoring foetal condition, monitoring foetal heart rate (FHR), use during labour, identifying foetal abnormalities, diagnosing and acting appropriately, and monitoring maternal and foetal wellbeing. These responses demonstrate that midwives possess a basic level of knowledge regarding the indications and purposes of CTG.

However, when compared to the National Integrated Maternal and Perinatal Care Guidelines for South Africa (the findings reveal a partial understanding. According to the guidelines, the primary purpose of CTG is to assess foetal wellbeing during viable pregnancies, both antenatally and intrapartum, in order to provide information that guides decision-making about whether medical intervention is required, and the timing and nature of such intervention. While the midwives' responses reflected awareness of CTG's role in monitoring and identifying abnormalities, they did not consistently articulate its broader function as a decision-support tool for clinical management.

This suggests that although midwives are familiar with the operational aspects of CTG, their knowledge remains limited in relation to its strategic purpose within maternal and perinatal care. Strengthening this understanding through structured training and alignment with national guidelines is therefore essential to ensure that CTG monitoring translates into timely, evidence-based interventions that safeguard maternal and foetal outcomes.

5.3.2 Features of reactive CTG

With regard to reactive CTG, all respondents correctly identified the foetal heart rate (FHR) baseline of 110–160 beats per minute as a defining feature. However, variability and decelerations were not consistently considered, indicating a partial understanding of the criteria for reactive CTG. This selective focus on FHR alone suggests that midwives may rely heavily on the most obvious parameter, while overlooking other critical features that contribute to a comprehensive interpretation.

According to international and national guidelines, a reactive CTG is characterised not only by a normal baseline FHR but also by the presence of variability and accelerations, with the absence of concerning decelerations. The omission of variability and decelerations in respondents' answers therefore reflects a knowledge gap that could compromise accurate classification of CTG patterns. This finding underscores the need for structured training that emphasises the holistic assessment of CTG tracings, ensuring that midwives move beyond reliance on a single parameter to incorporate all relevant features in their interpretation.

5.3.3 Features of non-reactive CTG in terms of variability

In relation to non-reactive CTG, the study revealed significant knowledge gaps among midwives, with 80.0% of respondents unable to identify its features and only 33.3% demonstrating recognition during observation. This limited awareness reflects a critical weakness, as non-reactive CTG patterns are strongly associated with foetal compromise and require urgent clinical intervention. The findings therefore highlight that while midwives may recognise the baseline FHR of reactive CTG, their ability to distinguish abnormal tracings remains inadequate. Such gaps in interpretive competence underscore the need for structured in-service training, mentorship, and reinforcement of national guidelines to ensure that midwives can reliably identify non-reactive CTG and respond appropriately to safeguard maternal and foetal outcomes.

5.3.4 Possible causes of reduced variability

When respondents were asked about the possible causes of reduced variability, only 46.7% failed to identify all the given variables, indicating that the majority were aware of potential causes such as prematurity, foetal sleep states, hypoxia, tachycardia, congenital heart abnormalities, and the influence of drugs. This suggests that midwives possess a reasonable level of theoretical knowledge regarding the factors that can reduce variability. However, the results also revealed uncertainty about the normal range of foetal heart variability, which is critical for distinguishing between physiological and pathological patterns. This partial understanding highlights a gap between recognising causes and confidently applying knowledge in clinical interpretation, reinforcing the need for structured training that integrates both theoretical knowledge and practical application of CTG variability assessment.

5.3.5 Challenges faced when using or interpreting the CTG

The results indicated that midwives experienced notable challenges when using and interpreting CTG. Among these, lack of in-service training emerged as the most frequent barrier, reported by 44.4% of respondents. Additional challenges included heavy workloads that made it difficult to concentrate on CTG interpretation, as well as shortages and poor servicing of CTG machines. These findings highlight that both human resource constraints and infrastructural deficiencies undermine the effective use of CTG in labour

wards. The predominance of training-related challenges suggests that midwives recognise the need for continuous professional development to strengthen their interpretive competence. At the same time, systemic issues such as workload pressures and equipment shortages point to broader organisational barriers that require urgent attention to ensure safe and reliable intrapartum monitoring.

5.3.6 Interventions to minimise challenges faced when interpreting CTG

Five interventions to minimise the challenges were mentioned frequently by the respondents. In response to the challenges identified, 66.7% of participants strongly suggested in-service training as the most effective intervention to minimise difficulties in CTG interpretation. This recommendation aligns with previous studies, such as Lukhele et al. (2025:6), which emphasised strengthening midwives' competence through printed educational materials, outreach visits, continuing education, workshops, and audited feedback.

Observations further confirmed the importance of training, as participants who lacked interpretive skills struggled to identify non-reactive CTG patterns, potentially compromising foetal outcomes. In addition to training, respondents highlighted the need for adequate resources, including a consistent supply of CTG tracing paper, increased availability of machines, and regular servicing to ensure functionality. These findings are consistent with Mazwi (2020:67), who recommended guaranteed equipment supply, and Mohlala et al. (2023:345), who advocated for mandatory computerised maintenance management systems and regular inspections by skilled technicians.

Collectively, the interventions proposed underscore that improving CTG practice requires a dual focus: enhancing midwives' knowledge and interpretive competence through continuous training, while simultaneously addressing systemic resource and equipment constraints to create an enabling environment for safe and effective intrapartum monitoring.

5.3.7 Details of the CTG interpretation

The findings revealed that 83.3% of the respondents were unable to interpret the CTG correctly, largely due to technical issues such as malfunctioning toco transducers, which

prevented contractions from being recorded. As a result, the majority of participants did not include contractions as part of their interpretation, nor did they attempt manual assessment to compensate for the equipment failure. In addition, participants demonstrated limited understanding of variability interpretation, which further compromised their ability to provide a comprehensive overall impression of the CTG. These gaps highlight the dual challenge of inadequate technical knowledge and unreliable equipment, both of which undermine accurate CTG interpretation and delay timely obstetric interventions. Addressing these deficiencies requires not only structured in-service training to strengthen interpretive competence but also systematic maintenance of CTG machines to ensure that midwives can reliably assess both foetal heart rate and uterine activity.

5.3.8 Monitoring, interpretation, recording and reporting of CTG findings

The findings revealed that all participants (100%) prepared correctly for CTG monitoring by conducting abdominal palpation and auscultation to identify the foetal heart and by correctly placing the CTG probe on the women's abdomen. This demonstrates competence in the preparatory phase of CTG use. However, despite this strength, the majority of participants were unable to interpret the CTG tracings accurately, with 83.3% failing to provide a correct interpretation. In addition, 72.2% did not record the findings of the CTG, and 27.8% failed to report pathological CTG results to the doctor. These gaps in interpretation, documentation, and reporting compromise continuity of care and delay timely interventions, thereby placing maternal and foetal wellbeing at risk. The findings underscore the need for structured in-service training, reinforcement of documentation protocols, and systemic support to ensure that CTG monitoring translates into effective clinical decision-making and improved outcomes.

5.3.9 Comparison of responses to the questionnaire and observation findings

A comparison of responses to the questionnaire and observation findings revealed notable discrepancies in midwives' knowledge and practice of CTG interpretation. While 53.3% of respondents did not demonstrate knowledge of the features of reactive CTG, observation showed that 44.4% of participants failed to identify these features in practice. Similarly, 80.0% of respondents were uninformed about the features of non-reactive CTG, compared to 66.7% observed to be unaware during clinical assessment. Regarding

reduced variability, 46.7% of respondents did not recognise the possible causes, while 38.9% of participants were uninformed during observation. These results collectively indicate that participants lacked sufficient knowledge and confidence in CTG interpretation, with gaps evident across both self-reported and observed measures.

The study applied Skinner's behaviour reinforcement theory to strengthen learning during observation. Fewer participants managed to correctly interpret CTG tracings, but those who did were complemented, and the researcher engaged them in discussion of the outcomes. This reinforcement approach provided immediate feedback and encouragement, thereby promoting positive behaviour and supporting the acquisition of interpretive skills. The findings therefore highlight that while knowledge gaps remain significant, reinforcement strategies can play a valuable role in improving midwives' competence in CTG interpretation.

5.4 CONCLUSIONS

The demographic profile of the study revealed that the majority of midwives were young (21–30 years) and relatively inexperienced, with most having between 0–5 years of practice, and only one holding a postgraduate qualification in midwifery and neonatal nursing science. This composition of the workforce shaped the findings, as younger and less experienced midwives demonstrated competence in preparatory tasks such as abdominal palpation, auscultation, and probe placement, yet struggled with higher-order skills of CTG interpretation, documentation, and reporting. Knowledge gaps were evident in recognising features of reactive and non-reactive CTG, understanding variability, and identifying causes of reduced variability. These deficits were confirmed through both questionnaire responses and observation, with discrepancies highlighting that self-reported knowledge did not consistently translate into practice.

The challenges faced by midwives were compounded by systemic constraints, including lack of in-service training, heavy workloads, and inadequate or poorly serviced CTG machines. These barriers limited their ability to concentrate on interpretation and undermined confidence in clinical decision-making. Observed practices revealed that while midwives prepared correctly for CTG monitoring, the majority failed to interpret tracings accurately, did not record findings, and in some cases neglected to report pathological CTG results. Collectively, these findings underscore that midwives'

competence in CTG monitoring is hindered by both individual knowledge gaps and structural deficiencies. Addressing these issues requires a dual strategy: strengthening midwives' interpretive skills through continuous professional development and mentorship, while simultaneously improving resource provision and systemic support to ensure safe and effective intrapartum monitoring.

5.5 RECOMMENDATIONS

The following recommendations are derived from the study's findings as articulated in Chapter 4 and summarised in the preceding Section 5.3:

5.5.1 Recommendations for Limpopo Department of Health

- To consider appropriate staff establishment for the purpose of reducing the staff shortages and easing the midwives' work pressures.
- To earmark professional development by enrolling participants for a post-graduate midwifery diploma and neonatal nursing science to improve their skill and knowledge concerning CTG monitoring and interpretation.
- Ensure that all midwives allocated in antenatal and labour wards are trained in basic steps regarding management of obstetric emergencies (ESMOE), as it includes the content regarding the CTG monitoring and interpretation.
- Conducting regular in-service training on CTG programmes for improving midwives' knowledge in monitoring and interpreting the CTG.

5.5.2 Recommendations for nursing management of the hospital

- A well-managed CTG tracing paper procurement and supply of CTGs should be ensured to enhance quality service delivery in the monitoring of foetal wellbeing.
- To ease the pressure of work on midwives, implement the 'over time' policy as a short-term plan while awaiting assistance from the provincial department.

5.5.3 Recommendations for midwives

- To optimally utilise the standard CTG operating procedure (SOP) and policies available in the ward.
- To apply for the post-graduate diploma in midwifery and neonatal nursing science when such an opportunity is presented.

5.5.4 Recommendation for further research

Further studies should be conducted on a nationwide scale to explore midwives' experiences with the monitoring and interpretation of CTG. Expanding the scope beyond a single district hospital would provide a clearer and more representative picture of midwives' knowledge, practices, and challenges across diverse healthcare settings in South Africa. Such research could identify regional variations, highlight systemic gaps, and strengthen the evidence base for policy interventions aimed at improving intrapartum monitoring.

The findings from broader studies would also reinforce the need for empowerment of midwives through structured training, mentorship, and continuous professional development, positioning CTG as a critical clinical skill. By integrating national perspectives, future research could inform the design of standardised training programmes, resource allocation strategies, and guideline implementation, ultimately contributing to safer maternal and neonatal outcomes nationwide.

5.6 CONTRIBUTIONS OF THE STUDY

The study contributes to the body of knowledge on intrapartum monitoring by providing empirical evidence of midwives' knowledge, experiences, and challenges in CTG use within a South African district hospital context. It highlights the demographic realities of a predominantly young and inexperienced workforce, identifies critical knowledge gaps in recognising reactive and non-reactive CTG features, and exposes systemic barriers such as inadequate training, workload pressures, and poorly serviced equipment. By triangulating questionnaire responses with observational data, the study offers a nuanced understanding of both perceived and actual practices, thereby reinforcing the need for structured in-service training and resource support. Importantly, the research

underscores CTG as a vital clinical skill requiring empowerment and continuous professional development, while also demonstrating the practical value of behaviour reinforcement strategies in strengthening interpretive competence. These contributions provide a foundation for policy dialogue, curriculum development, and future nationwide studies aimed at improving maternal and neonatal outcomes.

5.7 LIMITATIONS OF THE STUDY

This study was conducted in a single hospital within the Capricorn District, with a total population of 18 midwives. While the findings provide valuable insights into midwives' knowledge, experiences, and challenges in CTG monitoring and interpretation, the limited scope restricts the generalisability of the results to other hospitals in South Africa. Different districts and provinces may present varied contexts, including distinct management systems, resource availability, and service delivery provisions, which could influence midwives' competence and practice. It is therefore recommended that similar studies be undertaken across multiple districts and provinces to generate a more comprehensive national perspective and to strengthen the evidence base for policy and training interventions.

5.8 CONCLUDING REMARKS

This study assessed midwives' knowledge and experiences of CTG preparation, monitoring, and interpretation, and recommended measures to enhance competence in these areas. The findings demonstrated that participants possessed basic knowledge of the indication and purpose of CTG and prepared correctly for monitoring by conducting palpation and auscultation to identify the foetal heart and accurately placing the probe. However, significant gaps were evident in interpretation skills, documentation, and reporting, which were compounded by systemic challenges such as inadequate in-service training, heavy workloads, and poorly serviced CTG machines. These shortcomings highlight the urgent need for targeted interventions to strengthen midwives' interpretive competence and ensure reliable intrapartum monitoring.

To address these challenges, participants suggested interventions including structured in-service training and improved resource provision, while the study further recommends that the Limpopo Department of Health ensure adequate supply and maintenance of CTG

machines. Moreover, all midwives and doctors working in maternity units should complete the **Essential Steps in Managing Obstetric Emergencies (ESMOE)** programme, which incorporates CTG content, with drills conducted at least monthly in line with the **National Integrated Maternal and Perinatal Care Guidelines for South Africa** (National Department of Health, 2024b:9). Such measures would empower midwives, enhance their interpretive skills, and ultimately contribute to safer maternal and neonatal outcomes across healthcare facilities.

In addition, the study underscores the importance of bridging the gap between theoretical knowledge and clinical practice. While midwives demonstrated awareness of CTG's purpose and prepared adequately for monitoring, their inability to interpret tracings accurately and report pathological findings reflects a disconnect that can compromise patient safety. Reinforcement strategies, such as immediate feedback during training and mentorship, may help consolidate learning and foster confidence in CTG interpretation. By integrating continuous education with supportive supervision and reliable equipment provision, healthcare systems can ensure that CTG monitoring fulfils its intended role as a critical decision-support tool in safeguarding maternal and neonatal wellbeing.

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File: Cardiotocography diagram (accessed 14 August 2025)

ANNEXURES

**ANNEXURE A: Ethical clearance certificate from the Research Ethics Committee:
Department of Health Studies, UNISA**

 UNISA university of south africa	
College of Human Sciences_CREC	
Date: 13/04/2025 Dear: Mrs Matimu Pollet Sekgoka	NHREC Registration # : (Rec-240816-062) Ref #: 6025 Name: Mrs Matimu Pollet Sekgoka Student #: 45599009
Decision: Ethics Approval from 13 April 2024 to 12 April 2026	
Researcher: Mrs Matimu Pollet Sekgoka No 56a Compensatie street Polokwane Polokwane 45599009@mylife.unisa.ac.za 083 377 8091	
Supervisor: Professor Johanna Mathibe-Neke jmneke62@gmail.com	
Midwives' understanding and experiences of Cardiotocography Interpretation in a selected district hospital at Lepelle-Nkumpi local Municipality, Limpopo province	
Qualification: MA (Nursing Science)	
Thank you for the application for research ethics clearance by the College of Human Sciences_CREC or the above-mentioned research study Ethics approval is granted for one year.	
The low -risk application was reviewed by the College of Human Sciences_CREC on 13 April 2025 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The proposed research may now commence with the provisions that: 1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics. 2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Human Sciences_CREC. 3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application. 4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.	



5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date (**12 April 2026**). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

Additional Conditions

1. Disclosure of data to third parties is prohibited without explicit consent from Unisa.
2. De-identified data must be safely stored on password protected PCs.
3. Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
4. Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.
5. Kindly note that the College of Human Sciences_CREC requires the submission of regular progress reports to be submitted **(annually)**. In line with section 7.2 of the Unisa Policy on Research Ethics (2024).

Note

The reference number 6025 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,



Prof K J Malesa
Chair of College of Human Sciences_CREC
E-mail: maleskj@unisa.ac.za



Professor Omwoyo Bosire Onyancha
Executive Dean / By delegation from the Executive Dean of College of Human Sciences_CREC
E-mail: onyanob@unisa.ac.za



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ANNEXURE B: Letter requesting consent from the Department of Health: Limpopo Province

PERMISSION LETTER

**RESEARCH TITLE: MIDWIVES' UNDERSTANDING AND EXPERIENCES OF
CARDIOTOCOGRAPHY MONITORING AND INTERPRETATION IN A SELECTED
DISTRICT HOSPITAL AT LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO
PROVINCE**

Researcher: (Matimu Pollet Sekgoka)

Request for permission to conduct research at Lebowakgomo hospital

April 2025

Dr N Ramalivhana

Chairperson: Research committee

Limpopo Department of Health

015-293 6028/6410

Dear Sir

I, Matimu Pollet Sekgoka plan to conduct research under the supervision of JM Mathibe-Neke, a professor in the Department of Health Studies towards a Master's Degree, at the University of South Africa. Please note that we have no funding for this study. I am kindly requesting for a permission to collect data for my research study entitled 'Midwives' understanding and experiences of Cardiotocography monitoring and interpretation in a selected district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province'.

The aim of the study is to determine the midwives' understanding of the use and interpretation of Cardiotocography (CTG) in a selected district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province.

Your institution has been selected because it falls under district hospital in Capricorn District, Limpopo Province and is transferring labouring women to a tertiary institution due to foetal distress.

The study will entail the participants filling in questionnaires given to them and the researcher observing them during use and interpretation of CTG. The ethical considerations of autonomy, beneficence, non-maleficence and justice will be observed throughout the study.

The benefits of this study will contribute to the Midwives' knowledge in interpreting CTG and can be used as a point of reference to the midwives who will be wishing to expand on the topic.

Potential risks are not anticipated for this study. Feedback procedure will entail sharing the results of the study with participants and presentation of the research at a conference.

Should you have concerns about the way in which the research has been conducted, you may contact Prof JM Mathibe-Neke at 012 429 6443 or mathijm@unisa.ac.za. You can also contact the research ethics chairperson of the CREC College Research and Ethics Committee, Prof KJ Malesa on 012 429 4780, Email malesj@unisa.ac.za if you have any ethical concerns.

Yours sincerely



Matimu Pollet Sekgoka
Student Researcher

ANNEXURE C: Letter of approval: Department of Health: Limpopo Province



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

• DEPARTMENT OF
HEALTH

Ref : LP_2025-06-017
Enquires : Legodi P
Tel : 015-293 6028/6410
Email : Malesela.Legodi@dhsd.limpopo.gov.za

MRS MATIMU POLLET SEKGOKA

CC: UNIVERSITY TO ENSURE COMPLIANCE WITH CLAUSE 2d OF THIS APPROVAL LETTER s

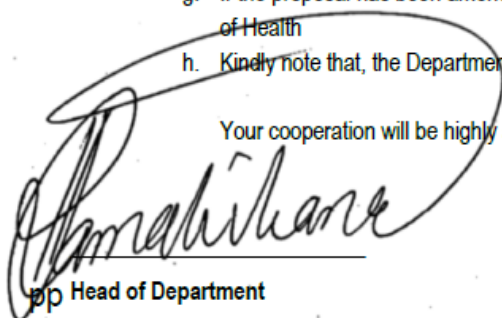
PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL FACILITIES

Your Study Topic as indicated below;

MIDWIVES' UNDERSTANDING AND EXPERIENCES OF CARDIOTOCOGRAPHY INTERPRETATION IN A SELECTED DISTRICT HOSPITAL AT LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO PROVINCE

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 office of District Executive Manager a week before the study is conducted.
 - b. This permission is **ONLY** for Lebowakgomo Hospital
 - 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.



pp Head of Department

6/8/2025

Date

Private Bag X9302, Polokwane 0700
Fidel Castro Ruz House, 18 College Street, Polokwane 0700
Tel: 015 293 6000. Fax: 015 293 6211. Website: www.doh.limpopo.gov.za

The heartland of Southern Africa - *development is about people!*

ANNEXURE D: Letter requesting consent from the Capricorn district manager

APPLICATION TO COLLECT DATA AT THE DEPARTMENT OF HEALTH INSTITUTION

Department of Health
Capricorn District Manager
015 290 9252

Dear Sir/Madam

I, Matimu Pollet Sekgoka student no 45599009 under the supervision of JM Mathibe-Neke, a professor in the Department of Health Studies towards a Master's Degree, at the University of South Africa. I am kindly requesting for a permission to collect data for my research study entitled 'Midwives' understanding and experiences of Cardiotocography interpretation in a selected district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province'.

I have already acquired CREC (UNISA) approval letter and provincial Department of Health approval for data collection. The envisaged date for data collection is 22 September 2025 to 26 September 2025.

Your assistance on this matter will be highly appreciated.

Kind regards
Matimu Pollet Sekgoka

ANNEXURE E: Letter of approval: Capricorn district manager



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH CAPRICORN DISTRICT

REF : S.5/3/1/2
ENQ : Makgaloa M.O
TEL : 015 290 9252

FROM: DISTRICT EXECUTIVE MANAGER

TO : Sekgoka Matimu Pollet – Student No: 45599009
No 36 Puffadder Street
Serala View
Polokwane
0699

Email: matimupollet@gmail.com

**SUBJECT: APPROVAL TO CONDUCT RESEARCH IN DEPARTMENTAL FACILITIES:
MIDWIVES' UNDERSTANDING AND EXPERIENCES OF CARDIOTOCOGRAPHY
INTERPRETATION**

The above matter refers: -

1. Permission to conduct the above research is hereby granted for a 1-year period.
2. The permission is **ONLY** for Lebowakgomo Hospital.
3. Kindly be informed that:
 - In the course of your research there should be no action that disrupts the services.
 - Kindly note that the Department can withdraw the approval at any time.
4. Your cooperation will be highly appreciated.

DISTRICT EXECUTIVE MANAGER
MR LETSHOKGOHLA ME

28/08/2025

DATE

ANNEXURE F: Information letter for the participants



Information letter for the participants

April 2025

Title: Midwives' understanding and experiences of Cardiotocography monitoring and Interpretation in a selected district hospital at Lepelle-Nkumpi local Municipality, Limpopo Province.

Dear Prospective Participant

My name is Matimu Pollet Sekgoka and I am doing research with JM Mathibe-Neke, a professor, in the Department of Health Studies towards a Master's Degree, at the University of South Africa. We have no funding for this study. We are inviting you to participate in a study entitled Midwives' use and interpretation of Cardiotocography (CTG) at one of South Africa's Capricorn District Hospitals.

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to determine the midwives' understanding and experiences of the use and interpretation of Cardiotocography and to recommend measures to enhance knowledge on Cardiotocography use and interpretation.



University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

WHY AM I INVITED TO PARTICIPATE?

You are invited as you are directly involved in the use and interpretation of the CTG. This study aims to assess your experience and knowledge regarding the use and interpretation of the CTG.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves questionnaires and observation by the researcher, you will be responding to a researcher administered questionnaire and be observed during the use and interpretation of the CTG. Questions asked will be about the interpretation of the CTG as shown in the annexure below, and it will take about 5 to 10 minutes to complete.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any point of the study.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The study will contribute to the midwives' knowledge in interpreting a CTG. Will enhance the quality of care regarding the use of the CTG and reduce fetal complications and can be used as a point of reference to the midwives who wish to expand on the topic.



ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There are no anticipated risks for participating in this study.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be recorded anywhere and no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and no one will be able to connect you to the answers you give. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard in her house at Polokwane for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research



ANNEXURE G: Consent for participation in the study



I, _____ (participant name), confirm that the person asked
consent to take part in this research has told me about the nature, procedure, potential
benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the
information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in
the study.

I understand that my participation is voluntary and that I am free to withdraw at any
time before the questionnaires are submitted without penalty.

I am aware that the findings of this study will be processed into a research report,
journal publications and/or conference proceedings, but that my participation will be
kept confidential unless otherwise specified.

I agree to the recording of the questionnaires and observation.

I have received a signed copy of the informed consent agreement.

Participant's name and surname..... (please print)

Participant's signature..... Date.....

Researcher's name and surname..... (please print)

Researcher's signature..... Date.....



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ANNEXURE H: Data collection tool

PAGE 1: To be completed by the midwife at the observation site

Questionnaires for Midwives

Qualification..... Age.....

Years of experience as a midwife.....

Do you have any experience in using the CTG to assess women during labour?

Yes/No

How many women have you assessed using the CTG so far?

Kindly state the indication and purpose of the use of the CTG?

What would you consider as a reactive CTG? Tick the relevant responses

Variable	Yes	No
Foetal Heart rate between 110 to 160 bpm		
Variability between 5-25bpm		
Decelerations are none or early		

What would you consider a non-reactive CTG in terms of variability?

Variable	Yes	No
Variability below 5bpm over 30 to 50 minutes		
Variability of above 25bpm over 25 minutes		
Sinusoidal		

What would be the possible causes of reduced variability? Tick relevant responses

Variable	Yes	No
Prematurity		
Fetus sleeping		
Foetal hypoxia		
Foetal tachycardia		
Congenital heart abnormalities		
Some drugs like opiates		

Did you ever experience challenges when using or interpreting the CTG? If yes, kindly elaborate on the challenges.

How can these challenges be minimised, according to you?



PAGE 2: Checklist for the researcher
Structured observation questions

Did the Midwife prepare for the CTG monitoring correctly?

Conducted abdominal palpation and auscultation to identify the foetal heart.

Yes....No....

Was the CTG probe correctly applied to the woman's abdomen? Yes...No...

What motivated this interpretation? Tick where appropriate.

Variable monitored	Yes	No
C: Contractions		
Bra: Baseline rate		
V: Variability		
A: Accelerations		
D: Decelerations		
O: Overall impression		

Was the CTG finding variables correctly interpreted? Yes...No....

Was the finding of the CTG recorded? Yes....No.....

In case of non-reactive or pathological CTG, did the Midwife report to the doctor?



ANNEXURE I: Letter from the statistician

Freddy's Research and Diagnostics Hub



Fast Quality Diagnosis

2255 IKHAMBI STREET

ROSSLYN GARDENS

AKASIA

0182

Enquiries.FRDH@gmail.com

062 720 2742

Date: 10 November 2025

Data Analysis Certificate

This serves to confirm that: I, **Freddy Mokadi Mabetlela**, in my capacity as the appointed **Epidemiologist** and **Biostatistician**, have conducted data capturing, cleaning, and data analysis for the study of **Matimu Sekgoka**, with the study title: **Midwives' understanding and experiences of cardiotocography interpretation in a selected district hospital at Lepelle-Nkumpi Local Municipality, Limpopo Province.**

I therefore certify that the data analysis was conducted accurately, following robust and stringent statistical principles.

I further direct and encourage any related queries to me.

Kind Regards

Freddy Mokadi Mabetlela

BSc (Med) Medical Sciences (UL)

BSc (Hons) Medical Microbiology (UL)

MSc Veterinary Sciences (UP)

MSc Epidemiology (Infectious diseases) (WITS)

ANNEXURE J: Language editor's letter

TO WHOM IT MAY CONCERN

I, the undersigned, hereby confirm my involvement in the language editing of the dissertation manuscript belonging to **Mrs Matimu Pollet Sekgoka (Student Number: 45599009)**, submitted to me in respect of her fulfilment of the requirements for the **Master of Arts (MA)** in Health Studies degree registered with the University of South Africa (UNISA), and entitled:

Midwives' understanding of cardiotocography monitoring and interpretation in a selected district hospital at Lepelle-Nkumpi local municipality, Limpopo Province

I attest that all possible means have been expended to ensure the final draft of **Mrs M.P. Sekgoka's** dissertation manuscript reflects both acceptable research methodology practices and language control standards expected of postgraduate research studies at her level.

In compliance with ethical requirements in research, I have further undertaken to keep all aspects of **Mrs M.P. Sekgoka's** study confidential, and as her own individual initiative.

Sincerely,

T.J. Mkhonto.

BA Ed: North-West University, Mahikeng (1985)

M Ed: School Administration; University of Massachusetts-at-Boston, USA, Harbor Campus (1987)

DTech: Higher Education Curriculum Policy Reform, Design & Management; University of Johannesburg, (2008)

All enquiries:

T.J. Mkhonto

Cell: +27(0)60 401 8279

Email: mkhonto9039@gmail.com

Signed: _____

Dr T.J. Mkhonto

Independent Academic Editor

Date: 15 April 2026

dd/mm/yyyy



Themba J. Mkhonto
Associate Member

Membership number: MKH001
Valid through April 2027

060 401 8279
mkhonto9039@gmail.com

www.editors.org.za

ANNEXURE K: Turnitin summary

Similarity Report	
PAPER NAME	AUTHOR
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WORD COUNT	CHARACTER COUNT
26016 Words	163992 Characters
PAGE COUNT	FILE SIZE
118 Pages	3.2MB
SUBMISSION DATE	REPORT DATE
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1	uir.unisa.ac.za Internet	3%
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4	hdl.handle.net Internet	<1%
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8	University of South Africa on 2026-01-16 Submitted works	<1%

Sources overview