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# PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN MPUMALANGA PROVINCE – DESCRIPTIVE STUDY

submitted in fulfilment of the requirements for the degree

Magister Curationis

by

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# ABSTRACT

**Background**

Stillbirth remains a global challenge and traumatic loss to women, families, communities, nurses and society at large despite all efforts made to reduce it. Globally 2.6 to 3 million stillbirths occur each year. Unexplained intrauterine deaths are the most common primary cause of perinatal deaths in South Africa. The placenta plays a key role in maintaining a healthy pregnancy. Malperfusion of the placenta may result in lesions associated with stillbirths. Placental lesions reflect various physical, social and environmental exposures which can be identified during an examination of the placenta. The researcher examined the placentas in singleton-term stillbirths in a single-site descriptive study to describe placental lesions of stillbirths in the selected hospital.

**Aim and objectives**

This study describes macroscopical and microscopical placental lesions of stillbirths in a selected public hospital in the eMalahleni sub-district in the Nkangala district in Mpumalanga Province with a perspective on the history of socioeconomic status, nutritional status, lifestyle, and others such as environment and season.

**Research design and methods**

A quantitative non-experimental observational descriptive study was conducted by examining the placentas of 89 term stillbirth babies in the labour ward for macroscopic lesions. A questionnaire was used to capture clinical data from patient files on variables of interest related to macroscopic and microscopic lesions for stillbirth cases. IBM SPSS Statistics version 28 package was used to analyse the data.

**Findings**

Statistical association and significance were found between the following variables: stillbirth and number of antenatal care visits (0.0035); birth weight and mid-upper arm circumference (0.013); birth weight and maternal vascular malperfusion (0.001); birth weight and birth attendant (0.034); type of stillbirth and birth attendant (0.033); type of stillbirth and previous obstetric history (0.038); cord insertion and smoking/substance abuse (0.012); cord insertion and haemoglobin (0.029); cord length and meconium histiocytes (0.031); cord diameter and syphilis (0.030); placental weight and onset of labour (0.012); placental weight and foetal vascular malperfusion (0.004); colour of membranes and maternal inflammatory response (0.002); colour of membranes and meconium histiocytes (0.000), and colour of membranes and syphilis (0.053).

**Significance and Conclusion**

Examination of the placenta may help to define the causes in more than 90% of stillbirth cases, inform the research and decrease stillbirth rates.

**Key terms/concepts:** Placental findings, placental lesions, term singleton stillbirths, unexplained stillbirths, stillbirth.

# DEDICATION

First and foremost, I thank the Almighty for granting me the wisdom and grace to see this dissertation through. I would be making a mistake if I forgot to mention my son Andile and my daughter Ntokozo for believing in me, which kept my spirit and motivation high during the study.

# DECLARATION

I, Johannah, Ouma Vilane, declare that this dissertation entitled **"PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN MPUMALANGA PROVINCE – DESCRIPTIVE STUDY"** is my own work, and all the sources I have used or quoted have been acknowledged using a complete reference.

This dissertation has not been submitted for any degree at the University of Pretoria or any academic institution.

**JOHANNAH OUMA VILANE**

**Date:** 08 May 2024

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# LIST OF ABBREVIATIONS/ACRONYMS

| Abbreviation/Acronym | Meaning |
|---|---|
| AIDS | Acquired Immune Deficiency Syndrome |
| AMA | Advance Maternal Age |
| ART | Antiretroviral Treatment |
| BMI | Body Mass Index |
| CARMA | Campaign on Accelerated Reduction of Maternal New-born and Child Mortality |
| CDC | Centres for Disease Control and Prevention |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| ESMOE | Essential Steps in Management of Obstetric Emergency |
| FIGO | International Federation of Obstetrics and Gynaecology |
| FVM | Foetal Vascular Malperfusion |
| HCG | Human Chorionic Gonadotropin |
| HIV | Human Immune Deficiency Virus |
| MNCWH | Maternal New-born Child and Women Health and Nutritional Strategic Plan for Maternity Care in South Africa |
| MUAC | Mid-Upper Arm Circumference |
| MVM | Maternal Vascular Malperfusion |
| NDoH | National Department of Health |
| NDP | National Development Plan |
| NHI | National Health Insurance |
| NHPP | National Health Promotion Policy |
| $NO_3$ | Nitrogen Oxide |
| PAH | Poly Aromatic Hydrocarbons |
| PIPP | Perinatal Problem Identification Program |
| PM 10 | Particulate Matter 10 |
| PM 2.5 | Particulate Matter 2.5 |
| PMTCT | Prevention of Mother to Child Transmission |
| Rh | Rhesus Factor |
| SARS-CoV-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| SDG | Sustainable Development Goals |
| $SO_2$ | Sulphur Dioxide |
| STI | Sexually Transmitted Infections |
| TB | Tuberculosis |
| TORCH | Toxoplasmosis, Rubella Cytomegalovirus, Herpes Simplex, and HIV |
| UFP | Ultrafine Particulate |
| vs | versus |
| UN | United Nations |
| UNICEF | United Children Fund |
| WHO | World Health Organisation |

# CHAPTER 1: ORIENTATION OF THE STUDY

## 1.1 INTRODUCTION/BACKGROUND

Stillbirth accounts for three-quarters of perinatal deaths globally (Reinebrandt, Leisher, Coory, Henry et al. 2017:213). The global stillbirth rate is at 13.9 per 1000 births (WHO, 2018). All countries are required to meet the target of less than 12 per 1000 births as set by the World Health Organization (WHO, 2014:9). Most stillbirths (91.53%) occur during the antepartum period (Shanker, Saini & Gupta, 2020:289). According to the United Nations (UN), sub-Saharan Africa is the region with the highest stillbirth rate and the largest number of stillbirths, and South Africa is amongst these countries (UN 2020:43). Most stillbirths are preventable if the actions set by WHO in Every New-born Action plan (2014:9) can be taken and the cause of the stillbirth identified. The cause of most stillbirths (53.27%) remains unknown (Shanker, Saini & Gupta, 2020:289). The Perinatal Problem Identification Programme (PIPP) report recommended that funding and research resources must be directed at identifying the causes of unexplained intra-uterine deaths (Saving Mothers and Babies Executive Summary 2017-2019:17).

Many disorders associated with stillbirths are potentially modifiable for example demographic, environmental, nutritional, and lifestyle factors (Reinebrandt, Lesher, Coory, Henry et al., 2017:289). A healthy lifestyle in pregnancy can reduce a woman's risk of stillbirth (WHO, 2020:19). Undernutrition, overweight, and obesity are associated with poor pregnancy outcomes (Symington, Baumgartner, Malan, Zandberg et al., 2018:9). Obesity, overweight and excessive weight gain during pregnancy leads to maternal conditions like gestational diabetes and hypertensive disorders which can also result in poor maternal and perinatal outcomes (WHO, 2016:14). Placental findings in maternal obesity and gestational diabetes are abnormal cord insertion, umbilical cord knots, hyper coiling, umbilical cord thrombosis and placental infarcts (Wright, Macindoe & Green, 2019:11). Calcium deficiency is associated with an increased risk of pre-eclampsia which is the major cause of explained stillbirths (WHO, 2020:14). Maternal vascular malperfusion is always associated with pre-eclampsia and other hypertensive disorders (Kulkarni, Palanianppan & Evans 2019:180; Paules, Youssef, Rovira, Crovetto et al., 2019:614). Anaemia and folic acid deficiency can result in poor perinatal outcomes and increase the incidence of congenital abnormalities. Severe anaemia in pregnancy may lead to placental abruption and stillbirth (Shi, Chen, Wang, Sun et al., 2022:9). Tuberculosis in pregnancy increases the risk of perinatal deaths (WHO 2016:52). Tuberculosis may result in infection of the placenta and causes congenital tuberculosis (Tiwari & Kumar, 2017:2). Placental findings in perinatal tuberculosis include chronic necrotizing granulomas

and villitis (Goldstein, Gallagher, Beck, Kumar et al. 2020:9). A high daily caffeine intake of >300mg per day is associated with a risk of pregnancy loss and low birth weight (WHO, 2020:14). Maternal caffeine intake is associated with uteroplacental vasoconstriction (Reijnders et al. 2019:74).

A previous obstetric history of stillbirth can lead to recurrent stillbirth (Bedwell, Blaike, Danna, Sutton et al. 2020:1211). Placentas from pregnancies with a stillbirth prior have increased placental pathology which are: low placental weights, infarcts, calcifications, and poor placental perfusion (Graham & Heazell 2020:49). Gross pathologies of the placenta have been linked to stillbirths (Tiwari, Gupta & Jain, 2021:1). Smaller/larger placentas, long/short cords, thick/thin cords, abnormal cord insertion like circumvallate, succenturiate lobes, velamentous insertion, and battledore are associated with perinatal morbidity and mortality (Tiwari, Gupta & Jain, 2021:1).

Microscopic pathologies which are classified under foetal vascular malperfusion are: foetal thrombotic vasculopathy, and delayed villous maturation are associated with excessive supply of nutrients in women with obesity, diabetes, and excessive weight gain in pregnancy (Lema, Mremi, Amsi, Pyuza et al., 2020:2).

Microscopic pathologies classified as maternal vascular malperfusion e.g., chorangiosis, decidual arteriopathy, and villous vascularity may be triggered by maternal conditions such as diabetes and hypertensive disorders (Lema, Mremi, Amsi, Pyuza et al., 2020:2). Maternal inflammatory microscopic pathologies e.g., chronic villitis, chronic histiocytic intervillositis, and chronic placentitis have been linked to stillbirths (Tiwari, Gupta & Jain, 2021:20).

There is growing evidence that linked maternal infection (HIV, TB, Syphilis) with abnormal placental pathology, which reported abnormal placental villous maternal vascular malperfusion (Weckman, Ngai, Wright, McDonald et al., 2019:5). Histopathology examination results reported in several studies indicated that maternal and foetal vascular malperfusion and maternal inflammatory response were associated with stillbirths (Weckman, Ngai, Wright, Mc Donald et al., 2019:5).

(HIV/Syphilis), poor nutrition, inadequate gestational weight gain, unplanned pregnancy, induced abortions, late antenatal booking, defaulting in antenatal schedules, and substance and alcohol abuse are factors that may result in negative pregnancy outcomes and are associated with intimate partner violence (Alhusen, Ray, Sharp, Bullock et al., 2015:101). Pregnancies with no antenatal care are associated with a higher risk of antepartum stillbirths (Dandona, Majumder, Akbar, Bhattacharya et al., 2019:12). The World Health Organization recommends a clinical enquiry about the possibility of intimate partner violence during all antenatal visits (WHO, 2016:45).

Maternal age older than 35 years and younger than 16 years and a short interpregnancy interval may be associated with poor pregnancy outcomes (Lawn, Blencowe, Waiswa, Amouzou et al., 2016:598). Advanced maternal age (>35) is associated with a variety of pregnancy complications and specific placental pathology related to pregnancy-induced hypertension, gestational diabetes and increased BMI (Zhang, Wang & Qi et al., 2022). Foetal growth restriction was discovered to be the common cause of poor perinatal outcomes (Newtonraj, Kaur, Gupta, Kumar et al., 2017:4).

Maternal smoking and passive smoking according to a study conducted by Tesema, Marinovich, Haberg, Gissler et al., (2020:193) in Ethiopia is another factor that contributes to unexplained stillbirths. Cigarette smoking and substance abuse causes damage to the placenta (vasoconstriction) which results in foetal lesions and low placental weight (Gibbins, Pinar, Reddy, Saade et al., 2020:8; Wright, Macindoe, Green et al., 2019:11).

Indoor air pollution accounted for about 30% of stillbirths (Khan, Zhang, Islam, Islam et al., 2017:2). Household pollutants reduce the oxygen carrying capacity of blood to the body tissue of the foetus, the foetus is then deprived of oxygen leading to intra-uterine growth retardation, stillbirth, and low birth weight (Khan, Zhang, Islam, Islam et al., 2017:2). However, several researchers attributed unexplained stillbirths to ambient air pollution. Exposure to particulate matter (PM) air pollution in the third trimester is associated with an increased stillbirth risk and increased overall stillbirth rate for all pregnant women (Defranco, Hall, Hossain, Chen et al., 2015; Yang, Tan, Mei, Wang et al., 2018:507). Fine particulate matter crosses the maternal foetal barrier and disturbs foetal growth development (Ha, Hu, Roussas-Rous, Haidong et al., 2018:e114). Stillbirth rates increase with an increase in the mean concentration of carbon monoxide (CO), sulphur dioxide ($SO_2$) and nitrous oxide ($NO_2$) throughout pregnancy and especially in the third trimester (Faiz, Rhoas, Demissie, Kruise et al., 2013:538). Air pollutants disrupt the endocrine system especially the thyroid and result in neurological and metabolic changes in the foetus with adverse pregnancy outcomes (Yang, Tan, Mei, Wang et al., 2018:505). Hyperthyroidism is linked to abnormal placental perfusion and abnormal placental lesions and abruption (Gibbins, Pinar, Reddy, Saade et al. 2020:8; Saroyo, Harzif, Anisa, Charilda et al., 2021:3). Air pollutants interfere with oxygen uptake to the foetus and therefore interfere with the development of the growing organs (Green, Sarovar, Maliq, Basu et al., 2016:874). Prenatal exposure to inhaled particulate matter and carbon monoxide in household and ambient air pollution causes placental inflammatory response, leading to hypoxic ischaemia and foetal vascular thrombosis which may contribute to poor perinatal outcomes such as stillbirth (Wylie, Matenchi, Kishashu, Fanzi et al., 2017:14).

The Covid-19 pandemic has profoundly affected the healthcare system worldwide and has increased socio-economic challenges. Lockdown may have increased intimate partner violence (victims trapped with perpetrators), unemployment due to job losses, alcohol and substance abuse, depression, and post-traumatic stress disorders (Evans, 2020:3). Covid-19 caused an increase in stress and anxiety levels of pregnant women which can result in depression which may influence the pregnancy outcome (O'Sullivan, Burns, Leavy, Leroi et al., 2021:). The pandemic has disrupted the healthcare systems, all focus and resources were channelled towards Covid-19 (Khalil, Blakeway, Samara, O'Brien et al., 2021:e112). As a result of lockdown restrictions, pregnant women missed antenatal care appointments and appointments were cancelled, the eight-visit antenatal care contact model was put in place to prevent stillbirths, was disrupted (UN: A Neglected Tragedy, 2020:29). The direct effect of Covid-19 infection on the foetus may be Covid placentitis (inflammation of the placenta) which may influence the pregnancy outcome (Linehan, Birkbeck, Araten-Bergman, Baumbusch et al., 2021:263; O'Sullivan, 2021). Covid-19-related placental lesions are thrombosis and placental necrosis which may lead to foetal demise (Bouachba et al., 2021:1; Schwartz et al., 2021:1).

The researcher seeks to describe trends of placental lesions, which might lead to a future study to determine the relationships between the placental lesions in term singleton stillbirths and maternal medical conditions, socioeconomic status, environmental, season, BMI/nutritional status as factors that may have contributed to stillbirths in a selected public hospital in eMalahleni Sub-District in Mpumalanga Province. Strong evidence suggests that various exposures, whether socially, physically or environmentally, may be interpreted by the fetoplacental unit and may result in malperfusion of the placenta which may contribute to adverse perinatal outcomes.

Examination of the placenta may help to determine the cause of stillbirth (Kulkarni, Palaniappan & Evans, 2017:184). Abnormal placental structure and function are associated with stillbirth and a histopathological examination of the placenta is recommended following stillbirth (Graham & Heazell 2020:183). It is recognized that up to 25% of stillbirths may have a recognizable abnormality causing foetal demise (Wright, Macindoe & Green 2019:11). Abnormal placental perfusion is associated with most unexplained stillbirths (Wu, Lin, Zheng et al. 2021:6). Placental examination is routinely recommended to identify causes of stillbirth (Gibbins, Pinar, Reddy, Saade et al. 2020:10). This study added to previous knowledge. It assisted in describing placental lesions of unexplained stillbirths. Placental findings helped in classifying unexplained perinatal deaths because of the reluctance to consent to autopsy. The findings of this study indicated treatment options in subsequent pregnancies which led to a decrease in preventable perinatal mortality, thus contributing to reaching the WHO action plan,

the national 2030 milestones, and attaining the SGD 3 of good health and well-being in maternity wards (Every New-born Baby 2014:8; UN 2015a).

### 1.2. PROBLEM STATEMENT

The placenta plays an important role in determining the outcome of pregnancy (Tiwari et al., 2021:1). Normal growth and survival of the foetus depends on the placenta (Gualdoni, Jakobo, Barril, Ventureira et al., 2022:2). It is an organ of foetal adaptation to the maternal environment (Barros dos Reis, 2020:1) and provides oxygen, nourishment and waste disposal. The placenta acts as a barrier against most infections (Yong, Chang, Chakraborty, Rajaraman et al., 2021:2). The placenta is called the “chronicle of intra-uterine life” because it provides intra uterine events (Raymond & Redline, 2015:S21). The placenta has dual blood circulation which is maternal and foetal (Ernst, 2018:551). Uninterrupted blood flow of maternal and foetal blood circulation is vital for normal placental functioning and to support foetal growth (Ernst, 2018:551).

Impaired placental circulation is related to placental dysfunction (Peng, Cai, Li, Huang et al., 2021:6). Most diseases and infections in pregnancy are reflected in the placenta (Goldstein, Gallagher, Beck, Kumar et al., 2020:1). Maternal diseases, lifestyle and infections may affect the maternal and foetal circulation, disrupt the normal functioning of the placenta and may result in abnormal placentation, placental malperfusion and inflammation (Raymond & Redline, 2015:S21; Nikkels, Evers, Kwee, Schuit, Brouwers et al., 2021:2). Malperfusion of the placenta may cause placental lesions. Placental lesions may lead to insufficient transportation of nutrients and oxygen to the foetus, and result in intrauterine growth restriction and adverse pregnancy outcomes including stillbirth (Gibbins, Pinar. Reddy, Saade et al., 2020:2; Kulkarni, Palanianppan & Evans 2021:3). Placental disease/lesions reflect various exposure that may contribute to stillbirths (Gibbins, Pinar, Reddy, Saade et al., 2020:2). The selected public hospital where the researcher is stationed continues to experience an increased stillbirth rate of up to 53.2 per 1000 live births, which is far above the set target. There is an increased percentage of macerated stillbirths (Mhlophe, 2019:101) as evidenced by the statistics collected in the maternity ward from the beginning of 2020 until the end of 2021 and as discussed in the quarterly reviews by the Perinatal Morbidity and Mortality Committee. A previous study conducted in the same selected public hospital (Mhlophe, 2019:101) revealed that 80% of the demised foetuses were confirmed intrauterine deaths on admission and 50% of the stillbirths were unexplained and were delivered by women from the local eMalahleni sub-district. Most of these women were single, black, and unemployed. About 56% initiated their antenatal care in the second trimester (Mhlophe, 2019:72). According to the National Department of Health’s (NDoH) update on the Maternity Case Record, screening

for mental health and counselling for domestic violence is mandatory. Improvements were also made to the partogram to improve the perinatal outcome. These updates of the NDoH made the researcher include these variables in the study (Maternity Case Record:7).

Even though the NDoH prioritizes the rights of every newborn, more perinatal deaths are still a problem in some parts of South Africa and in particular the selected public hospital. The researcher conducted a non-experimental prospective observational descriptive study where macroscopic and microscopic placentas from single-term stillbirths were examined. The following maternal demographics were collected from the patient's record: maternal medical conditions, socioeconomic status, demographic, environmental factors and lifestyle habits to determine the contributory factors for foetal demise.

### 1.3 RESEARCH QUESTION

"What are the placental findings in term singleton stillbirths in a selected public hospital in eMalahleni sub-district in Mpumalanga Province?"

### 1.4 AIM OF THE STUDY

The overall aim of the study was to assess and describe the placental findings of the macroscopic and microscopic placenta examination in singleton term stillbirths in a selected public hospital at eMalahleni sub-district in Mpumalanga Province.

### 1.5 OBJECTIVES OF THE STUDY

- To examine placentas of term singleton stillbirths macroscopically and microscopically for placental findings related to stillbirths in a selected public hospital.
- To describe the characteristics and trends of the placental lesions of the stillbirths.

### 1.6 DEFINITION OF KEY TERMS / CONCEPTS

The **placenta** is an essential temporal organ which links the mother and the foetus during pregnancy, provides nutrition, oxygen and facilitates the exchange of other substances from the mother to the foetus, assists with waste excretion and provides a protective environment for the foetus (Ernst 2018:551). Placental and umbilical cord abnormalities are linked with stillbirths (Tiwari, Gupta & Jain, 2021:1). Abnormal placenta patterns may provide information about the pathogenesis of unexplained stillbirths (Ananthan, Nanavati, Sathe, Balasubramanian et al., 2019:21). For this study findings from macroscopic and microscopic placental examination will be used to provide insight into causative factors of foetal demise.

**Placental findings** are the principal outcomes of research; it is what the research suggests based on the data collected (Lema, Mremi, Amsi, Pyuza et al., 2020:12). For this study placental findings refer to the macroscopic and microscopic findings following the examination of the placentas which will be linked to the maternal conditions, maternal lifestyle and environmental factors to determine the cause of stillbirth.

**Term pregnancy** is the gestation period of 37 to 40 weeks in human pregnancy calculated from the last normal menstrual period (Lema et al., 2020:6) and is applicable to this study.

**Singleton** refers to a pregnancy with one foetus (Lema, Mremi, Amsi, Pyuza et al., 2020:12). For this study singleton will refer to the delivery outcome where a single baby is delivered.

**Stillbirth** is defined as a baby born without signs of life after a given threshold (Blencowe, Cousens, Jassir, Say et al., 2016:e100). The definition recommended by WHO (Making Every Baby Count, 2016:18) is a baby born with no signs of life at ≥ 28 weeks of gestation with a birth weight of ≥1000g and length of ≥35cm. For this study, only placentas of stillbirth babies between 37 and 40 weeks of gestation formed part of the study irrespective of birth weight.

## 1.7 CONTEXT / SETTING

Study setting is the physical location and conditions in which data collection took place in the study (Polit & Beck, 2017:744). The study was conducted in a public hospital in the sub-district of eMalahleni in Nkangala District in Mpumalanga Province. The selected public hospital functions as a level two (2) and three (3) hospital, serving as a referral hospital for two (2) districts, which are Nkangala and Gert Sibande, with six (6) sub-districts, 89 Primary Health Care facilities and 22 mobile clinics, and in urban and semi-rural areas, surrounded by many informal settlements. The area is surrounded by coal mines which attracts lots of immigrants from neighbouring countries like Mozambique, Zimbabwe, Swaziland, Lesotho and others. It has a high-risk antenatal outpatient clinic that is run by doctors, where all high-risk women who are referred from other hospitals and clinics are seen. There is an antenatal ward with 29 beds where women with pregnancy-related disorders are admitted for monitoring. The labour ward has eight (8) delivery suites and four (4) high care suites where women with antepartum and intrapartum complications are monitored. For postnatal care, there is a 39-bed ward where women who delivered normally and by caesarean section are monitored. The maternity department is run by the following healthcare workers: consultants (who are specialists), medical officers, advance midwives, midwives, and student midwives.

### Standard placental examination procedure

A standardized placental examination procedure is used in the maternity ward of the selected public hospital which could assist in yielding the desired results. The placenta is identified and

placed on a flat surface. Excess blood is removed with a paper towel. The shape and type of the placenta are noted and the colour, cord insertion, presence of succenturiate lobe, cord length, knots, coiling and cord blood vessels of the foetal surface are observed. The maternal surface is observed for colour, retroplacental clots, completeness of cotyledons, infarcts, and calcifications. The membranes are observed for completeness. The placenta is then weighed, and the mass is compared with the body mass of the baby. The placenta should weigh 1/6 of the baby's weight (Redline,2022:546). The placenta is then disposed of according to hospital policy and infection control principles. According to the selected hospital policy, placentas with macroscopic abnormalities and an unexplained stillbirth will be sent for histology.

According to the South Australian Perinatal Practice Guideline, the following are the indications for histological placental examination (See Table 1.1):

**Table 1.1: Indications for histological placental examination**

| Maternal conditions | Foetal conditions | Placental indications |
|---|---|---|
| Poor obstetric history | Perinatal loss (stillbirth, early neonatal loss) | Placental abnormalities detected antenatally |
| History of more than 2 miscarriages | Intrauterine growth restriction | Placental abruptio |
| Maternal medical conditions (hypertensive disorders, diabetes, autoimmune diseases, severe anaemia) | Macrosomia | Placenta praevia |
| Drug or alcohol abuse | Meconium-stained liquor | Abnormal placenta (infarct, retroplacental clot). |
| Prolonged rupture of membranes, with suspected chorioamnionitis | Foetal anaemia | Abnormal cord (thrombosis, true knot, large or small placenta. |
| Oligo/polyhydramnios | Rhesus isoimmunization | Velamentous cord insertion |
| | | Suspected placental injury |

Indications for placental histology requests in South Africa according to a study conducted by Malusi, Schubert, Theron, Wright et al. (2019:65) are abruptio placentae, chorioamnionitis, foetal anomalies, foetal distress, hypoxic ischaemic encephalopathy, maternal hypertensive disorders, unexplained intrauterine death, intrauterine growth restriction, maternal disease and preterm of unknown aetiology. Most of the placentas submitted for placental histology were for unexplained stillbirths.

## 1.8 ASSUMPTIONS

Assumptions are statements accepted as true (Kivunja & Kuyini 2017:17). Assumptions regarding reality can be studied objectively (Kivunja & Kuyini 2017:27). The researcher remained distant to and independent from the study. Eighty-nine placentas were examined by the researcher using a pre-tested standardized tool. The questionnaire was adapted from a reliable WHO source (Making Every Baby Count 2016:17). The macroscopic and microscopic findings of the placentas and clinical information in the patient records were regarded as true. The information in the patient records was used to explain the phenomenon of concern or causal relationships of interest in the selected public hospital. No tampering or alterations were made to the information obtained. The researcher preserved the anonymity and confidentiality of the records. The researcher assumed that all the information in patients' records is true, even though some of the information in the maternity case record book is sensitive information. Some patients might not divulge information such as intimate partner violence or the use of herbal or traditional medicine. Patients might have contracted Covid-19 but were not aware because they were not tested. These factors could threaten the validity of the study.

## 1.9 SIGNIFICANCE / CONTRIBUTION

**Clinical practice**: The study identified abnormalities in the placentas of term singleton stillbirth babies. Midwives will be more aware of abnormalities and will refer and identify patients at risk.

**Education**: Midwives will be taught about the abnormal placental findings related to stillbirths.

**Research**: The findings will serve as a platform for further studies in the placentas of stillborn babies. Recommendations are made for future research.

## 1.10 CONCEPTUAL FRAMEWORK

The researcher chose a midwifery-related conceptual framework of shared mechanisms of socio-economic determinants and particulate air pollution exposure contributing to adverse pregnancy outcomes to support the topic under study as the mentioned determinants may be reflected in both macro and microscopical placental examination. Refer to Figure 1 below.

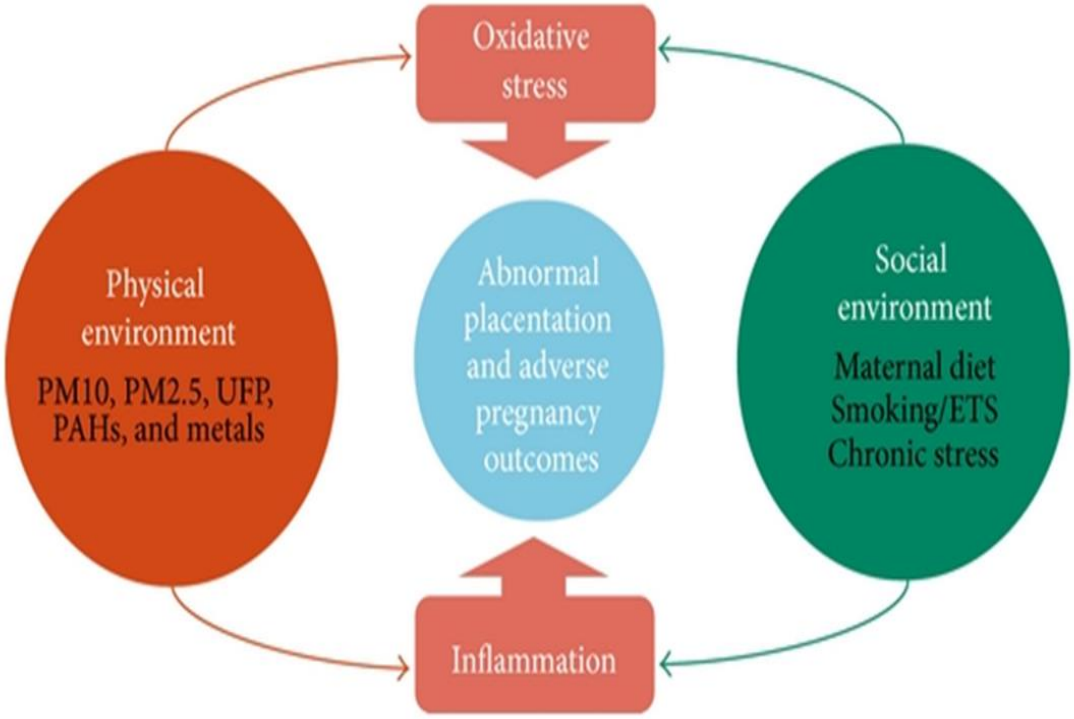


**Figure 1: A conceptual framework of shared mechanisms of socio-economic determinants and particulate air pollution exposure contributing to adverse pregnancy outcomes (Erickson & Arbour, 2014:5).**

**Physical environment**: The 1st trimester of pregnancy is critical during implantation and placental formation. The two events are susceptible to disturbances which may result in abnormal placentation and implantation. Maternal conditions such as pregnancy-induced hypertension, obesity, diabetes mellitus and others may alter the placenta due to vasoconstriction and inflammatory response, abnormal placental lesions develop which may lead to adverse pregnancy outcomes. Particulate air pollution (indoor and ambient) includes carbon monoxide, nitrogen oxide, sulphur dioxide and may induce foetal hypoxia and cause oxidative stress. Oxidative stress can be interpreted on the foetal placenta unit as inflammatory lesions, vasculopathy and infarction (Erickson & Arbour, 2014:7).

**Social environment**: Low socio-economic status indicators include obesity, underweight, micronutrient deficiencies, cigarette/alcohol and substance abuse, intimate partner violence, and psychological factors (anxiety and depression). Chronic life stressors and inadequate dietary intake lower the immune system, increase the inflammatory response, and increase susceptibility to numerous infections and ailments such as Syphilis, HIV, TB and chorioamnionitis. The fetoplacental unit becomes affected and necrosis, infarction and inflammation occur. Adequate diet and micronutrient intake provide resilience against

oxidative stress and inflammation and thus improve the pregnancy outcome (Erickson & Arbour, 2014:2).

## 1.11 RESEARCH DESIGN AND METHODS OVERVIEW

The researcher used a prospective observational descriptive study. A descriptive design describes the phenomenon and its characteristics by using observation and a survey tool to gather data (Siedllecki, 2020:8). According to Aggarwal and Ranganath (2019) a descriptive study describes the distribution of one or more variables without regard to any causal factor. In his study, 89 term singleton stillbirth placentas were examined.

### 1.11.1 Research methods

According to Polit and Beck (2017:742), research methods refer to techniques used to structure a study and gather and analyse information following a systemic order. In this study, the researcher planned to follow a prospective descriptive research design where the stillbirths needed to occur after the mother was followed up and the placentas were examined.

### 1.11.2 Population / unit of analysis and sampling

A research population refers to people with common characteristics that the researcher intends to study (Polit & Beck, 2016:739). This study included 89 term singleton placentas from stillbirths, from October 2022 until the end of July 2023 in a selected public hospital at Emalahleni sub-district in Mpumalanga Province.

### 1.11.3 Sampling method and sample size

Sample refers to a small set of population consisting of participants who are selected to participate in a study (Polit & Beck, 2017). In this study a unit of analysis and not the population was used, and the focus was the placentas of term stillbirths. The sampling method in this study is non-probability purposive sampling which refers to intentionally or purposefully selecting of participants based on certain characteristics that are related to the purpose of the research (Polit & Beck, 2017:252).

Sample size refers to the number of subjects who participate in a study (Grey, Grove & Sutherland (2017:691). Since the researcher intended to use clinical data from patient files and the placentas from the cases, representation is necessary. The average of stillbirths from the beginning of January of 2021 to the end of December 2021 was 21 stillbirths per month in the selected public hospital. The researcher's data collection period was from the beginning of October 2022 until the end of July 2023. The estimated number of stillborn babies within the data collection period would be 105, the researcher would therefore select 100 cases over 10 months to increase reliability and to thoroughly describe the characteristics of the variables

under study. Therefore, non-probability purposive sampling was selected to examine the placentas of the stillborn that met the inclusion criteria and fell within the study period as advised by the statistician.

**Inclusion criteria**

Placentas from women who delivered term stillbirth babies between 37 and 40 weeks irrespective of parity and age in the selected public hospital in the eMalahleni sub-district in Mpumalanga Province were included.

**Exclusion criteria**

Placentas of women who had stillbirths delivered at the clinics and referring hospitals were excluded from the study because the placentas would not be available for examination.

## 1.12 ETHICAL CONSIDERATIONS

Approval from the Ethics Committee of the University of Pretoria was sought. The proposal was registered with the National Health Research database. Permission from the Mpumalanga Department of Health, the district manager of the eMalahleni sub-district and the CEO of the selected public hospital was requested.

**Confidentiality**

All clinical information and findings acquired from the patients' files will be kept confidential, kept under lock and key and at a designated area.

**Beneficence**

Beneficence is an act of mercy or kindness. It involves balancing the benefits against the risks and costs involved (Leedy & Ormord, 2016:102). The purpose of undertaking the study is to assist patients, the community and society of the selected sub-district. The study contains no risks, and no harm was inflicted on patients.

**Non-maleficence**

This study includes examination of placentas and collection of clinical information from the patient’s records. No harm was inflicted on patients.

**Respect for human dignity**

The researcher ensured the right to self-determination and the right to full disclosure. The researcher holds the assumption that all women attending the selected healthcare facility have disclosed all the appropriate information correctly. As a result, the confidentiality thereof was maintained throughout the study (Leedy & Ormrod, 2016:105).

**Right to privacy and confidentiality**

The researcher ensured that all data is kept under the strictest confidence and kept under lock and key for 15 years in a safe and designated area to prevent any unauthorized access to the patient records and the collected data. Codes/registration numbers and not the real names are used to identify patient records and the placentas.

**Informed consent**

The managers of Nkangala district, eMalahleni sub-district and the CEO of the selected public hospital were approached through written official letters since their consent is the key to the success of the study.

**Consent form**

Women admitted to the labour ward with confirmed intrauterine deaths were screened by the investigator for eligibility. Those who met the inclusion criteria were introduced to the study objectives. Only those who voluntarily gave informed consent to the study were enrolled and were given a consent form to sign. Parents/guardians of women under 18 years were approached, objectives of the study explained and were allowed to voluntarily give informed consent. Women who delivered intrapartum stillbirths were approached immediately after delivery and were recruited as the first group. The unit of analysis is placentas from term stillbirths, consent for the use and disposal of human tissue were obtained from women who delivered stillborns in the maternity ward of the selected public hospital. In African communities some cultural beliefs are that stillborn babies need to be buried with placentas. The researcher therefore respected the belief, and even if the placenta had gross macroscopic lesions, it was not sent for histology.

**Honesty**

The report of findings was done completely and honestly.

## 1.13 ORGANISATION OF THE STUDY

Chapter 1: Outline the introduction and background leading to the research problem, aim and objective, clarification of key concepts, an overview of the methodology, study setting, and ethical considerations are provided.

Chapter 2: Highlights literature related to this study.

Chapter 3: Describes the research design and methodology.

Chapter 4: Discusses the data analysis and interpretation.

Chapter 5: Presents a conclusion of the findings as well as recommendations for further research.

## 1.14 SUMMARY

The introduction, background of the study, the research problem, aim and objective as well as clarification of the key concepts were discussed. An overview of the methodology and ethical considerations was briefly discussed in this chapter. The next chapter highlights the literature related to the placenta and placental examination.

# CHAPTER 2 LITERATURE REVIEW

## 2.1 INTRODUCTION

Chapter 1 introduced and outlined the study. This chapter discusses the literature review conducted for the study.

## 2.2 LITERATURE REVIEW

A literature review is an organised, written presentation of what has been published on a topic and involves researching, reading and understanding literature relevant to a study (Burns, Grove & Gray, 2017:120). A literature review involves researching, reading and understanding published literature relevant to the study, including books and journal articles (Brink, van der Walt & van Rensburg, 2018:55). A literature review forms the building blocks to support the study (Machi & McEvoy, 2016:5). The purpose of a literature review is to convey what is currently known regarding the topic of interest and to assist researchers to comprehend and extend their knowledge of the phenomenon under study (Polit & Beck, 2017:733). In this study, the purpose was to provide knowledge about placental findings in terms of stillbirth.

The researcher used Google Scholar, Scopus, Science Direct, PubMed, Open Access Journal and BMC (BioMed Central) databases to identify evidence-based articles on abnormal placental findings related to term singleton stillbirth cases published between 2010 and 2023.

## 2.3 STILLBIRTH

Stillbirth is a global health problem (WHO, 2016). In 2015, stillbirths accounted for over half of the global perinatal deaths (NHS England, 2015:213). The global burden of stillbirths has been referred to as a neglected tragedy (United Nations Children's Fund [UNICEF], 2020). In South Africa, the perinatal mortality rate is 30 per 1,000 births; the stillbirth rate is 21 per 1,000 births, and the neonatal mortality rate is 9 per 1,000 births (NDOH, 2020). In 2020, the Department of Health introduced interventions to reduce the neonatal mortality rate, but stillbirths were not included (NDOH, 2020:16). A systematic review of globally reported causes of stillbirth found that the most frequent categories given were unexplained; antepartum haemorrhage; infection; complications during labour and birth, and placental complications (Reinebrandt, Leisher, Coory, Henry et al., 2018:218). Moreover, many countries did not report any information about these deaths.

In 2016, unexplained intrauterine deaths were the commonest primary cause of perinatal deaths in South Africa (Statistics SA, 2016).

Pregnancy is a time of joyful anticipation about the arrival of a new family member, but when the foetus goes still the birth becomes tragic (WHO, 2020). More than one third of stillbirths occur in Sub-Saharan Africa. More pregnant women attend antenatal clinics to deliver healthy babies, yet each year 2 million babies are stillborn, and 1 stillbirth occurs every 16 seconds (WHO, 2020). Stillbirths occur in families of all races, ethnicities, and income levels and women of all ages. Poor and vulnerable populations are the most affected, especially families of low socio-economic status (WHO, 2016). Stillbirths negatively affect the parents, doctors, midwives and society. Grieving mothers and their relatives blame the healthcare workers and the health system for the loss. Negative effects, particularly on parental mental health, might be moderated by the empathic attitudes of care providers and tailored interventions (Heazell, Siassakos, Blencowe, Burden, Bhutta et al., 2016:612).

This chapter discusses the interventions to reduce stillbirth globally, in Africa and South Africa; the role of a normal placenta in maintaining normal pregnancy, including implantation and placentation; the anatomical structure of the placenta at term and its function; maternal health and pregnancy outcomes; effects of maternal conditions, hypertensive disorders, gestational diabetes, cardiovascular diseases, thyroid disorders, and iron deficiency on the placenta; maternal infections that have a profound effect on the placenta, such as maternal toxoplasmosis, rubella, cytomegalovirus, herpes simplex (TORCH), HIV, syphilis, tuberculosis, malaria, Covid-19, bacterial (streptococcus) as well as maternal lifestyle, including intimate partner violence, obesity, undernutrition, substance abuse/alcohol, tobacco/cigarette, maternal stress, depression, and anxiety. Herbal medication has an anti-implantation, utero-trophic, embryotoxic and teratogenic effect. The chapter also describes the effect of ambient and household air pollution on the placenta; previous obstetric history, including short pregnancy interval, previous stillbirth, maternal age which affects the placenta and the utero-environment, and the role of placenta pathology in perinatal pathology. Figure 2.1 represents the effect of the physical environment, maternal-paternal biological factors, and social factors on the placenta.

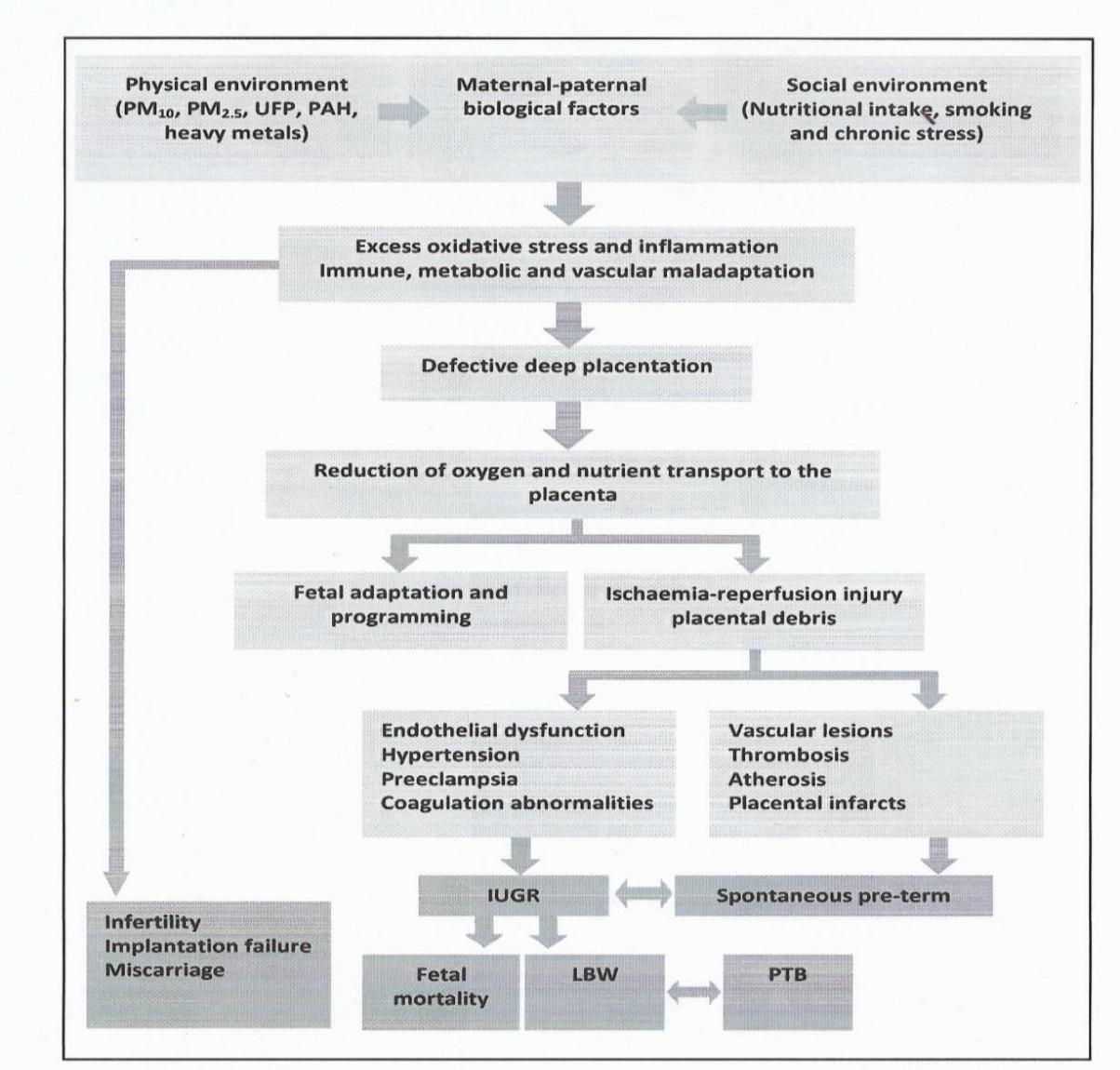


**Figure 2.1 The effect of the physical environment, maternal-paternal biological factors and social environment on the placenta. Source: (Ahmad, 2020)**

The physical environment, maternal/paternal factors and social environment may affect the placenta and lead to adverse perinatal outcomes (Ahmad, 2020). Ambient and indoor air pollution, which include particulate matter (PM2.5 and PM10), ultra-fine particles (UFP), polycyclic aromatic hydrocarbons (PAH), and heavy metals, are a major risk to human health (WHO, 2019). Air pollutants may cross the placental barrier and cause oxidative stress as a result of hypoxia which may induce placental alterations, which include deep and defective placentation (Saenen, Martens, Neven, Alfano et al., 2019). In 2022, the United Nations (UN) climate change conference was held at Sharm el-Sheikh in Egypt and urged global communities to take immediate action to prevent air pollution and protect pregnant women, newborns, families, and communities against climate change (UN, 2022). The climate change crisis has been linked to poor maternal and perinatal outcomes. Climate hazards, including

extreme heat, are associated with increased risks of developing complications that lead to adverse maternal, newborn and child health (WHO, 2023).

Maternal and paternal biological factors, including obesity, have additional risk in pregnancy such as gestational diabetes, diabetes mellitus, hypertensive disorders, and pre-eclampsia, and are associated with poor pregnancy outcomes such as small-for-gestational-age, large for gestational age, preterm births, and stillbirths. Preconception paternal health and lifestyle can cause epigenetic changes in sperm, which may influence placentation, and in turn may influence maternal and perinatal outcomes adversely (Murugappan, Li, Leonard, Winn, Druzin & Eisenberg, 2021). A retrospective analysis of live births to healthy mothers between 2009 and 2016 in Stanford, USA, found that if the father was diagnosed with a metabolic syndrome (diabetes, high blood pressure and obesity) there was an increased risk for preeclampsia with and without adverse maternal outcomes: abnormal placentation including placenta accrete spectrum, placenta previa, and placental abruption (Murugappan, Li, Leonard et al., 2021). Maternal and paternal advanced age have effects on adverse pregnancy outcomes (Alio, Salihu, McIntosh, August et al., 2012:433). Maternal psychosocial status may affect fetoplacental blood flow which may lead to abnormal placentation (Dahlerup, Egsmose, Siersma, Mortensen et al., 2018). Stress and anxiety may lead to impaired fetoplacental blood flow, which may lead to abnormal placentation (Dahlerup, Egsmose, Siersma, Mortensen et al., 2018).

Despite the Millennium and Sustainable Development Goals to improve maternal and perinatal health, the global burden of adverse pregnancy outcomes remains high due to ineffective strategies or knowledge gaps. The impact of infection in pregnancy on placental vascular development and adverse birth outcomes is not fully understood (Weckman, Ngai, Wright, McDonald & Kain, 2019). Placental and umbilical cord pathologies are frequent conditions associated with stillbirth that are not easily detected during pregnancy because they are asymptomatic and therefore difficult to diagnose and are associated with most unexplained stillbirths (Wu, Ren, Zhu, Peng, Zhang & Li, 2021). A study in Bihar, India found that intimate partner violence (IPV) was associated with increased risk for miscarriage and stillbirths (Dhar, McDougal, Hay, Atmavilas et al., 2018). HIV/ART is associated with placental lesions which include acute chorioamnionitis, low placental weight, and maternal vascular malperfusion (Ikumi, Malaba, Pillay, Cohen, Mdlala, et al., 2021:719). In Nepal, Covid-19 led to increased stillbirth rates (Ashish, Gurung, Kinney et al., 2020). In the United Kingdom and the United States, perinatal deaths increased during the Covid-19 pandemic as a result of a wide range of placental lesions associated with Covid-19 (Bouachba Allias, Nadaud, Massardier, Mekki et al., 2021:99). Placental lesions are associated with adverse perinatal outcomes and severity of neonatal morbidity. Macro and micro placental examinations may assist in determining the

cause of death especially if correlated with maternal clinical conditions, to reduce the rate of unexplained stillbirths (Malusi Schubert, Theron & Wright, 2019; Thirumalaikumar, Ramalingam & Marton, 2019).

## 2.4 INTERVENTIONS TO REDUCE STILLBIRTHS

Several interventions and strategies have been introduced to reduce stillbirths.

### 2.4.1 Global Strategy for Women's Children's and Adolescent Health (2016-2030)

In 2016, the World Health Organization (WHO) introduced the Global Strategy for Women's Children's and Adolescent Health (2016-2030) to end preventable deaths through the reduction of maternal mortality to less than 70 per 100 000 live births, and perinatal deaths to less than 12 per 100 000 live births. The strategy emphasises that epidemics of HIV and tuberculosis (TB) need to be eradicated and air pollution reduced to promote health and wellbeing. After the introduction of the Sustainable Development Goals (SDG) goals in 2016, pregnancy-related preventable morbidity and mortality continued to rise, which led the World Health Organization to recommend comprehensive guidelines on routine antenatal care for pregnant women and adolescent girls to manage specific pregnancy-related complications (WHO, 2016). The guidelines include:

- Dietary interventions: protein, calcium, iron, folic acid and lowering daily caffeine to < 300mg to reduce pregnancy loss and improve perinatal outcomes.
- Full blood count or the use of a haemoglobin meter for diagnosing anaemia during pregnancy.
- A clinical enquiry about intimate partner violence should be strongly considered for assessing conditions that may be caused by or complicated by intimate partner violence.
- All pregnant women should be asked about tobacco use and past and present exposure to second-hand smoking at every antenatal visit.
- Past and present substance and alcohol use should be ruled out. HIV and syphilis provider-initiated counselling and testing should be integrated.
- In settings where TB is prevalent, systemic screening for active TB should be considered for all pregnant women as part of antenatal care. TB and HIV contribute to the prevalence of anaemia.
- The count-to-ten kick charts should be used for early detection of reduced foetal movement in settings where there is a high prevalence of unexplained stillbirth. Antenatal care models with a minimum of 8 contacts are recommended to reduce perinatal mortality. One ultra-sound scan before 24 weeks to estimate gestational age is recommended to reduce post-term pregnancy complications.

### 2.4.2 Every Newborn Action Plan (ENAP), 2014

The number of stillbirths has reduced more slowly than maternal mortality or mortality in children under 5 years of age. The Every Newborn Action Plan provides countries with a roadmap for ending preventable newborn deaths and stillbirths and reducing disability by 2030 (WHO & UNICEF, 2014). The ENAP has a target of 12 or fewer stillbirths per 1,000 live births in every country by 2030 (Lawn, Blencowe, Waiswa, Amouzou, Mathers, Hogan, Flenady, Frøen et al., 2016:587). Countries in Africa and in areas afflicted by conflict need to double their progress to meet the target. There is a need to keep records and registrations of all births, stillbirths, and neonatal and maternal deaths in health facilities to increase data availability and enable targeting interventions effectively (Lawn, Blencowe, Waiswa, Amouzou, Mathers, Hogan, Flenady, Frøen et al., 2016:588).

Figure 2.2 represents the strategies recommended in Every Newborn Action Plan for communities to set the agenda and prioritization of stillbirths in all reports and initiatives (Lawn, Blencowe, Waiswa, Amouzou, Mathers, Hogan, Flenady, Frøen et al., 2016:588).

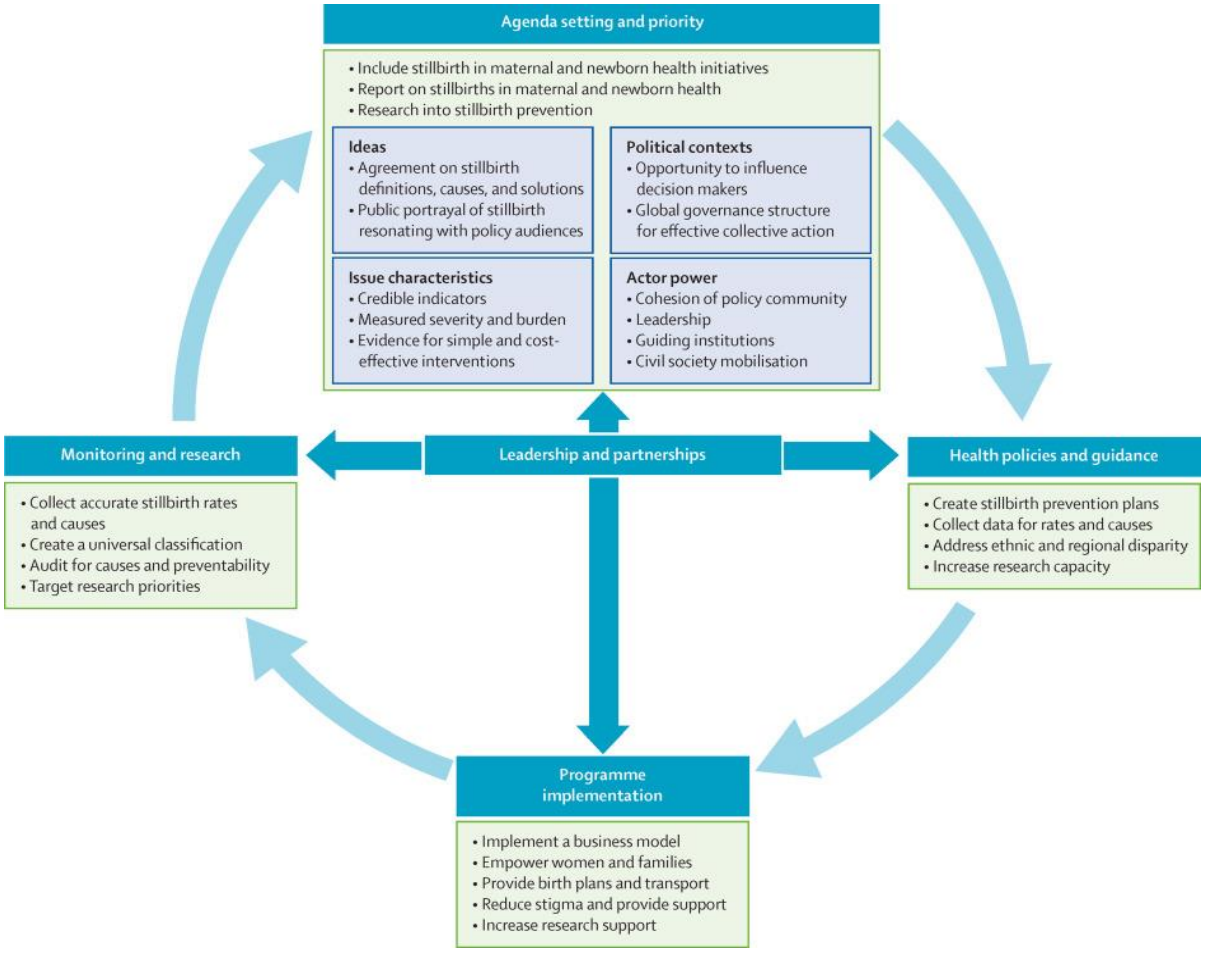


**Figure 2.2 Every Newborn Action Plan strategy to prevent and reduce stillbirths Source: Froen, Friberg, Lawn, Bhutta, et al., (2016:574)**

The following strategies are recommended to prevent and reduce stillbirths (Froen, Friberg, Lawn, Bhutta, et al., (2016**:**574):

- Stillbirth should be regarded as a core health indicator used to measure quality of care. Prenatal health should be regarded as a crucial foundation for long-life health and to integrate action of prenatal to maternal and newborn health initiatives.
- Specific actions like advocacy, policy formulation, monitoring and increasing support in stillbirth research and improvement in data coverage are needed to reduce stillbirths.
- Strong leadership is needed globally to reduce stillbirth. Institutions should have the mandate to lead efforts to prevent and reduce stillbirths by promoting healthy and safe pregnancies, empowering women and their families on the risk factors, providing birth plans and transport, reducing stigma and providing support to women and their families.

### 2.4.3 Campaign on Accelerated Reduction of Maternal Newborn and Child Mortality in Africa (CARMMA), 2009

In 2009, the African Union launched the Campaign on Accelerated Reduction of Maternal Newborn and Child Mortality in Africa (CARMMA) in Addis Ababa (CARMMA Report ,2013:27). Africa had a high burden of maternal perinatal mortality. Most of the deaths were due to preventable causes. CARMMA was launched to improve maternal and perinatal health and to lower the high levels of maternal and perinatal morbidity and mortality and was also adopted by South Africa.

### 2.4.4 National Development Plan, 2030

In 2014, the National Department of Health (NDOH) implemented the National Development Plan (2030) to establish a community-oriented primary care approach, based on a network of decentralised health centres. The aim was to provide health care for all by progressively improving TB prevention and cure, reducing the prevalence of non-communicable chronic diseases like hypertension and diabetes, and reducing maternal, infant and child mortality. Primary healthcare teams and community health specialists, including obstetricians and midwife specialists, provided care to families and communities, and a nutrition intervention programme for pregnant women and young children was developed and introduced. A healthy lifestyle through healthy eating habits and physical activity was promoted. Health education in priority areas such as combating smoking and alcohol abuse was strengthened. The prevention and control of epidemic burdens such as HIV/AIDS were prioritized (NDOH, 2014).

### 2.4.5 Strategic plan for maternal, newborn, child and women's health (MNCWH) and nutrition, 2012-2016

In South Africa, the maternal, perinatal and under-5 mortality rates remained unacceptably high. In 2011, the Department of Health introduced the Strategic plan for maternal, newborn, child and women's health (MNCWH) and nutrition. The purpose was to accelerate the reduction of maternal and child morbidity and mortality through the implementation of evidence-based interventions aimed at improving maternal health and child survival through the following strategies (DOH, 2012-2016:14).

- Antenatal first visit should be initiated at 20 weeks.
- HIV counselling, testing and ART should be initiated per appropriate PMTCT guidelines.
- Introduction of dedicated ambulances for obstetric patients.
- Improvement in intrapartum care, the correct use of partograms and standard protocols for the management of obstetrics emergencies (ESMOE).

### 2.4.6 Perinatal death audit system

In 1996, the Perinatal Problem Identification Programme (PIPP) was designed and developed in South Africa as a facility audit tool for perinatal deaths. Since South Africa's commitment to achieving Millennium Development Goal 4, the use of the PPIP is now mandatory for all facilities delivering pregnant mothers and caring for newborns (Rhoda, Greenfield, Muller, Prinsloo, Pattinson, Kauchali & Kerber, 2014:160). To prevent stillbirths, the cause of death and the circumstances during pregnancy need to be investigated and identified. In 2016, unexplained stillbirths remained the primary cause of unexplained stillbirths in South Africa (Statistics South Africa, 2016).

### 2.4.7 Guidelines for Maternity Care in South Africa, 2016

Global commitment to reduce the unacceptably high maternal and perinatal morbidity and mortality rates in low- and middle-income countries led South Africa to cooperate with major role players in the provision of health services, and address causes of maternal and perinatal deaths. In 2016, the Department of Health introduced Guidelines for Maternity Care in South Africa, which also made provision for community-based services by ward-based primary health outreach teams. The guidelines included clinical management protocols to ensure quality health care services rendered to women during pregnancy, labour and the puerperium (Department of Health, 2016:13). In South Africa, maternity care is an integral component of primary health care and a free health service for all pregnant women (Hlongwane, Botha, Nkosi & Pattinson, 2022). All maternity facilities should be able to screen for HIV infection and promote early initiation of antiretroviral treatment, promote preventable interventions in the prevention of anaemia, provide calcium supplementation to prevent hypertensive disorders,

promote and improve accessibility to family planning services to women and their partners, ensure 24-hour access to functioning emergency obstetric care, and train all health care workers involved in the care of pregnant women in the Essential Steps in the Management of Obstetric Emergencies (ESMOE-EOST) programme (Hlongwane, Botha, Nkosi & Pattinson, 2022**:**1). The objectives of the national maternity guidelines are to give guidance to doctors and midwives in district clinics, community centres and district hospitals in the provision of quality obstetric care.

### 2.4.8 National Health Insurance (NHI) Bill, 2023

The National Health Insurance (NHI) Bill, which aims to provide universal access to quality healthcare services in South Africa, was approved by the National Assembly in June 2023. The object of the NHI Bill is to provide universal access to quality healthcare for all South Africans as enshrined in the Constitution, which recognises healthcare as a fundamental human right (NDOH, 2023).

The introduction of the NHI includes the primary health care (PHC) package (community outreach to provide care to families and communities). Care will be provided at the PHC level based on health promotion and prevention, including prioritising maternal, prenatal, and neonatal services to assist in reducing the perinatal mortality rate (NDOH, 2023).

### 2.4.9 MomConnect

In 2016, the Department of Health designed MomConnect: an exemplary implementation of the Health Normative Standards Framework in South Africa to provide crucial health information to mothers during pregnancy and in the postpartum period up to one year post-delivery via mobile phone technology, and to strengthen antenatal care services (Seebregts, Barron, Tanna, Benjamin & Fogwill, 2016:125). This service provides text messages to pregnant women and new mothers in their language of choice and answers pressing questions about pregnancy-related issues. Messages include different stages of pregnancy and physiological changes, the importance of regular attendance at the antenatal clinic, the importance of monitoring foetal movements, danger signs in pregnancy and puerperium, and exclusive breastfeeding and immunization. Pregnant women who are registered are also given the opportunity to complain about or to compliment the services they have received in the clinics. To date, over 95% of clinics and health facilities are connected (Seebregts, Barron, Tanna, Benjamin & Fogwill, 2016:135).

### 2.4.10 National Health Promotion Policy (NHPP) and Strategy, 2015

In 2015, the Department of Health implemented the National Health Promotion Policy and Strategy as a framework for South Africa to integrate health promotion into all health

programmes to allow people to increase control over their health and to make healthy choices (NDOH, 2015).

South Africa implemented the National Health Promotion Policy intending to reduce maternal and perinatal mortality (Mostert, 2021:118). The purpose of this strategy was to mobilize disadvantaged communities to take ownership of their health. Various methods were utilized such as home visits by health promoters, and health education programmes in public health facilities, targeting pregnant women. Social media were utilized to promote preventive services which would lead to preventive health to decrease the rate of maternal and perinatal mortality with special emphasis on stillbirth. Educational programmes included breastfeeding, healthy eating habits, immunization campaigns, prevention of violence against women and children, and prevention of substance abuse and stop smoking campaigns. The NHPP played a major role in improving maternal health and improved perinatal and maternal mortality in South Africa (Mostert, 2021:122).

## 2.5 ROLE OF THE PLACENTA IN MAINTAINING NORMAL PREGNANCY

The placenta is a vital temporal organ that is formed in the uterus during pregnancy and connects the foetus to the uterus. The placenta is attached to the uterine wall and develops shortly after implantation of the blastocyst day 5 after fertilization. The blastocyst contains two layers, namely the trophoblast and syncytio-trophoblast. The trophoblast, which is the outer layer, produces a proteolytic enzyme which can erode maternal decidua and maternal blood vessels chorionic villi are formed, which invade the maternal decidua. Implantation after conception continues with the invasion of the endometrium which is called decidua. Two membranes, the amnion (formed from the inner cell mass) and chorion, is formed from the trophoblast. The placenta and membranes are completely formed by the 12th to 13th week of pregnancy and continue to grow throughout the pregnancy (Burton & Jauniax, 2015:S6.el).

The placenta is a disc-like shaped foeto-maternal organ. It comprises the placental disc which has two surfaces. The chorionic plate (foetal surface) is greyish and shiny with blood vessels. Two membranes, amnion and chorion, are attached to the foetal surface. The umbilical cord is also attached to the foetal surface and the insertion should normally be centrally by mid-gestation. A normal cord length is 55-60cm, the diameter is 2.0-2.5cm, and normal placental coiling is ≤ 3 coils in 10cm. The umbilical cord has 3 blood vessels (2 arteries and 1 vein). The two umbilical arteries return deoxygenated blood to the maternal circulation for oxygenation. One umbilical vein carries oxygenated blood from the maternal circulation to the foetus. These blood vessels branch out to cover the foetal surface to form the villous tree. The umbilical cord is covered by Wharton's jelly which protects the blood vessels. The basal plate (maternal surface) is deep reddish and has 20-22 cotyledons. The placenta at term has a diameter of

22cm, a thickness of 2-2.5cm, and weighs approximately 450g, which represents 1/6 of the foetal weight (Burton & Jauniax, 2015). During implantation, there are four complex interactions or processes between the endometrium and the embryo that lead to normal placentation, namely orientation, apposition, adhesion, and invasion (Jansen, Kabstelein, Kleinrouweler, Van Leeuwen et al., 2020:984).

After fertilization and implantation, around day 5, the blastocyst is formed and will eventually implant, which contains the blastocyst cavity inner cell mass and outer cell called trophoblast, which becomes the placenta (Jansen, Kabstelein, Kleinrouweler, Van Leeuwen et al., 2020:984). The fertilized blastocyst embeds in the uterine wall. The placenta has villi (finger-like projection cells) which are lined with cells known as cytotrophoblasts and syncytiotrophoblasts. The cytotrophoblasts (outer cells) breach the uterine wall and begin to reshape the spiral blood vessels. The reshaping of the spiral blood vessels is called remodelling. The remodelled blood vessels become the source of maternal blood supply to the placenta (Burton, Cindrova-Davies, Wa-Yung, Jauniaux, 2021:F54). The placenta develops to bring oxygen and nutrients to the foetus and remove harmful waste. The first trimester is a critical period in pregnancy involving implantation and the initial phase of placentation, two events highly susceptible to disturbances of various social or environmental exposures (Erickson & Arbour, 2014). If there is any dysfunction in the four processes, abnormal placentation can occur, which may lead to defective deep placentation with adverse perinatal outcomes. The great obstetrical syndromes (pregnancy-induced hypertension and preeclampsia), foetal growth restriction, placental abruption, preterm labour and stillbirth share the same etiological mechanism arising from defective deep placentation (Brosens, Puttemans & Benagiono, 2019:439). Figure 2.3 summarises implantation and placentation.

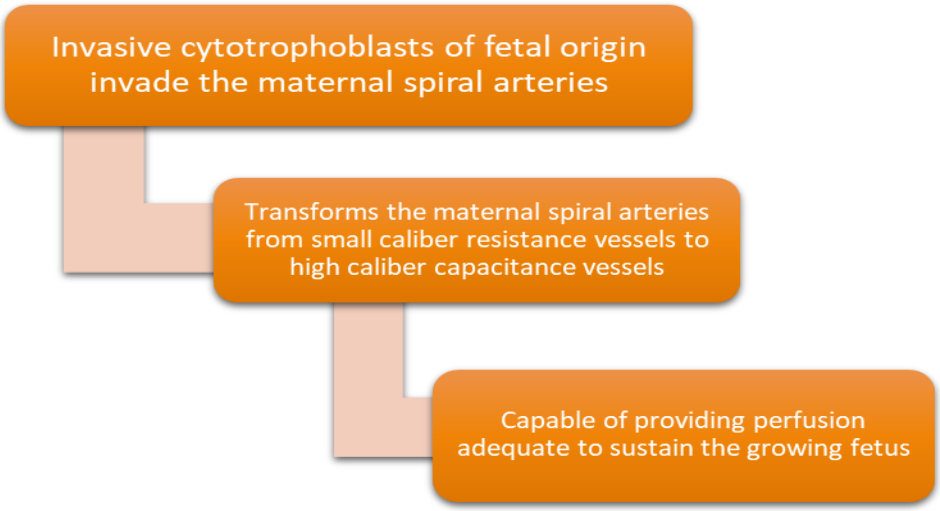


**Figure 2.3 Implantation and placentation summary**

**Adapted from: Jansen, Kabstelein, Kleinrouweler, Van Leeuwen et al. (2020:984)**

The placenta plays a critical role in determining the outcome of pregnancy (Ptacek, Smith, Garrod, Bullough, Bradley et al., 2016). Optimal growth and function of the placental vasculature are essential to support foetal development *in utero* and for a successful pregnancy. Healthy foetal development depends on the placenta for nutrients (nutrition function) and oxygen supply which is the respiratory function (Weckman, Ngai, Wright, McDonald & Kain, 2019:1924). The placenta removes waste and performs the endocrine function by producing hormones (HCG, oestrogen, progesterone) and growth factors, and acts as a barrier to protect the foetus against immune attacks, toxins, and infectious agents. Altered foetal growth and placental abnormalities are the most prevalent known risk factors for stillbirth (Wu, Ren, Zhu, Peng et al., 2021:308). Abnormal placental perfusion is associated with and accounts for most of the unexplained stillbirth (Gibbins, Pinar, Reddy, Saade, Goldenberg et al., 2020:709). Maternal pregnancy conditions, infections, and lifestyle may result in abnormal or malperfusion of the placenta (Freedman, Silver, Gibbins, Hogue, Goldenberg et al., 2019**:**383).

## 2.6 MATERNAL HEALTH AND PREGNANCY OUTCOMES

Pregnancy outcomes depend on maternal health. Maternal social status determines the health status. Healthy mothers deliver healthy babies. A woman's preconception health status plays an important role because the development of a healthy placenta depends on the state of the lining of the uterus (endometrium) 14 weeks before conception (Reijnders, Mulders, van der Windt et al., 2018:75). The preconception period is the most neglected. Development of the placenta starts with implantation of the blastocyst 5 days after fertilization. By 18 to 20 weeks of pregnancy, the placenta is fully developed but continues to grow as the foetus grows throughout pregnancy and takes over the transfer of oxygen and nutrients to the fertilized egg, ensuring that the foetus is fully nourished. Proper placentation and vascularization depend on maternal health status, especially the health of the endometrium before fertilization (Thornburg, Bianchi, Brier, Gilbert, Earnest et al., 2021:345). Behind a healthy baby is a healthy placenta, foetal growth depends on a healthy placenta (Thornburg, Bianchi, Brier, Gilbert, Earnest et al., 2021:348). Maintaining a healthy placenta is key for foetal development and a healthy pregnancy. Maternal nutrition plays a key role in pregnancy. A healthy maternal nutritional status will result in a healthy size placenta with good blood flow and a good transfer of sufficient oxygen supply and nutrients from the mother to the baby. Nutritional stress, which could be either under or overnutrition will lead to inadequate placentation, vascularity, placenta insufficiency and adverse pregnancy outcomes (Thornburg, Bianchi, Brier, Gilbert, Earnest et al., 2021:348). Maternal conditions such as hypertensive disorders and diabetes are associated with malnutrition (high BMI). The weight of the placenta directly correlates with the

maternal weight (Reijnders, Mulders, van der Windt et al., 2018:78). Maternal lifestyle habits such as smoking, alcohol consumption or taking recreational drugs cause placental dysfunction because of their vasoconstriction effect on the placental blood vessels (Reijnders, Mulders, van der Windt et al., 2018:78).

Figure 2.4 depicts the pathways by which the maternal lifestyle affects the placenta.

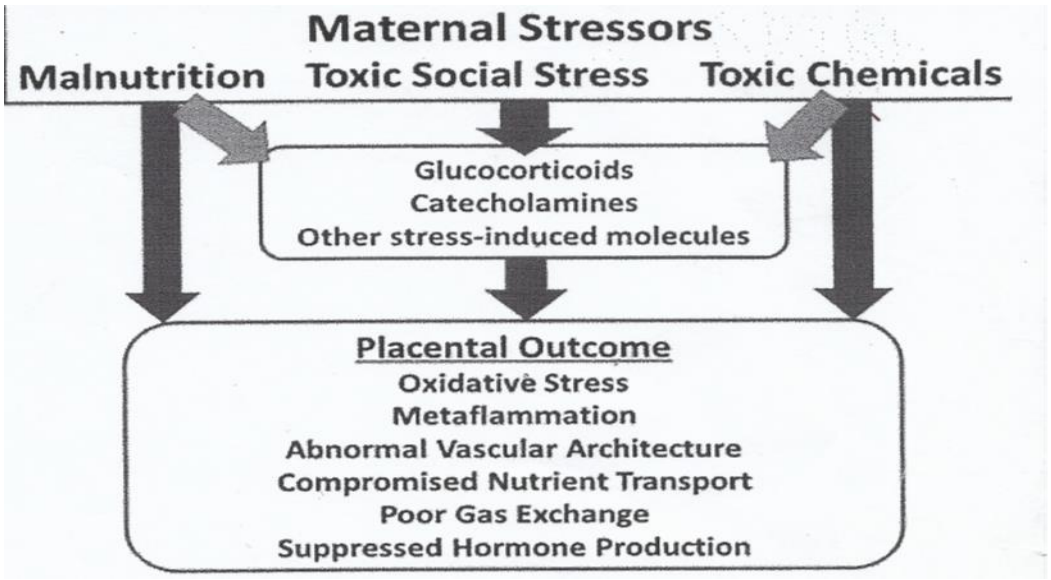


**Figure 2.4 Diagram representing the pathways by which the maternal lifestyle affects the placenta. Source: Thornburg, Bianchi, Brier, Gilbert, Earnest et al., (2021:350)**

Figure 2.5 outlines the pathways by which the maternal social status affects the placenta.

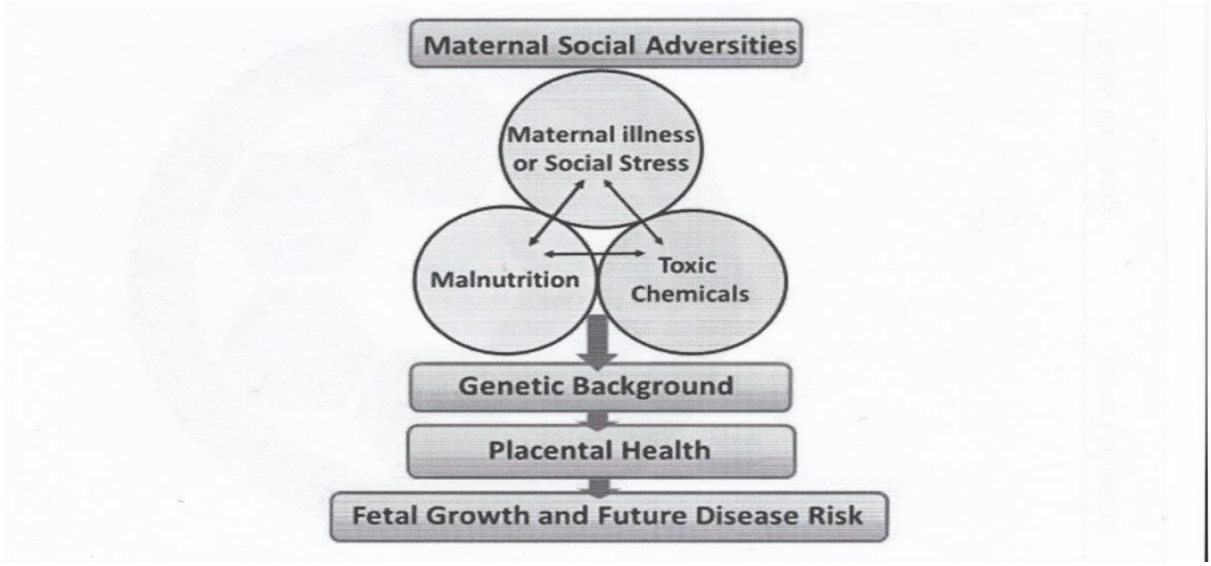


**Figure 2.5 Pathways by which the maternal social status affects the placenta. Source: Thornburg, Bianchi, Brier, Gilbert, Earnest et al., (2021:351)**

## 2.7 EFFECT OF MATERNAL CONDITIONS ON THE PLACENTA

Maternal illnesses, infections and autoimmune diseases may lead to placental dysfunction with associated adverse outcomes that include maternal and perinatal outcomes. Changes in the placental haemodynamic due to maternal illnesses impact foetal growth and may contribute to poor pregnancy outcomes including stillbirth. The placenta may also influence the maternal condition, such as pre-eclampsia and cardiac conditions (Ramlakhan, Johnson & Roos-Hesselink, 2020:718).

Hypertensive disorders in pregnancy are one of the most common direct causes of maternal mortality and are responsible for perinatal morbidity and mortality (Department of Health, 2016). Hypertensive disorders are classified into four categories. Gestational hypertension is defined as a new onset of hypertension after 20 weeks of gestation with no proteinuria but returning to normal by 12 weeks postnatally. Preeclampsia/eclampsia refers to hypertension that develops after 20 weeks of gestation with proteinuria. Superimposed preeclampsia is chronic hypertension associated with preeclampsia (Melchiorre, Giorgione & Thilaganathan, 2021:S954).

Preeclampsia is a specific pregnancy hypertensive disorder that is characterised by the presence of three major signs: elevated blood pressure, and proteinuria, and it is diagnosed after 20 weeks of gestation. Preeclampsia is a known risk factor for stillbirth. Preeclampsia is a disease of the placenta because the presence of the placenta is responsible for the development of preeclampsia rather than the foetus (Melchiorre, Giorgione & Thilaganathan ,2021:S954). The disease is attributed to abnormal superficial implantation (impaired trophoblastic invasion), poor placental perfusion, inflammation, ischaemia and hypoxia, resulting in diminished blood supply to the placenta, which may lead to placenta insufficiency and adverse pregnancy outcomes such as foetal growth restriction and stillbirth (Zhang, Haymar, Al Sayyed, Dygulski et al., 2022:9517). Gross placental findings in the presence of preeclampsia are smaller than expected placentas. Infarcts and retro-placental clots are the common findings on gross placental examination of placentas that are affected by preeclampsia. Most histopathological findings are increased villous ischemia, increased syncytial knots, fibrin necrosis, and thickening of the trophoblastic membrane (Donthi, Malik, Mohamed, Kouser, Subramanian & Manikyam, 2020). Preeclampsia is associated with an increased prevalence of both villous and vascular histological lesions of the placenta (Melchiorre, Giorgione & Thilaganathan, 2021:S962).

### 2.7.1 Gestational diabetes (GDM)

The rise of maternal obesity has been followed by an increase in gestational diabetes. Gestational diabetes is high blood glucose levels affecting pregnant women. Sometimes it is

called diabetes during pregnancy. It is characterised by impaired glucose tolerance (WHO, 2013). Worldwide pregnancies are affected by gestational diabetes. The World Health Organization's (Zaccara, Paganoti, & Mikami, 2022:385) diagnostic criteria for gestational diabetes are a high plasma level of glucose (hyperglycaemia); fasting plasma glucose of 7mmol/l; glucose tolerance test of 11.1 mmol/l, and random plasma glucose of 11.1mmol/l. Gestational diabetes is also known as a condition in which a hormone made by the placenta prevents the body from using insulin effectively (Zaccara, Paganoti, & Mikami, 2022:385). Glucose builds up in the blood instead of being absorbed by the cells. High plasma glucose levels are associated with modification or changes in human placenta structure which may have a direct effect on the growth and development of the foetus. The change in the placenta is associated with inflammation and oxidative stress that may lead to chronic foetal hypoxia (Jarmuzek, Wielgos & Bomba-Opon, 2015:102). Adverse perinatal outcomes (macrosomia, birth trauma, respiratory distress, hypoglycaemia, congenital abnormalities, intrauterine growth retardation and stillbirths) are associated with placental dysfunction as a result of abnormal glucose metabolism (Carrasco-Wong, Moller, Giachini, Lima, Toledo, Stojanova, Sobrevia & San Martin, 2020). Macroscopically a diabetic placenta is enlarged, thick and plethoric. Placenta findings in gestational diabetes pregnancies show the following microscopic lesions: villous immaturity, villous fibrinoids necrosis, and chorangiosis (Jarmuzek, Wielgos & Bomba-Opon, 2015:102). Perivillous fibrin deposits, thickening of the basal membrane and villous oedema are other lesions found in gestational diabetes mellitus. The placental pathologic changes in gestational diabetes occur in both well and poorly controlled gestational diabetes mellitus (Jarmuzek, Wielgos & Bomba-Opon, 2015:103).

Figure 2.6 depicts the placental pathology in gestational diabetes.

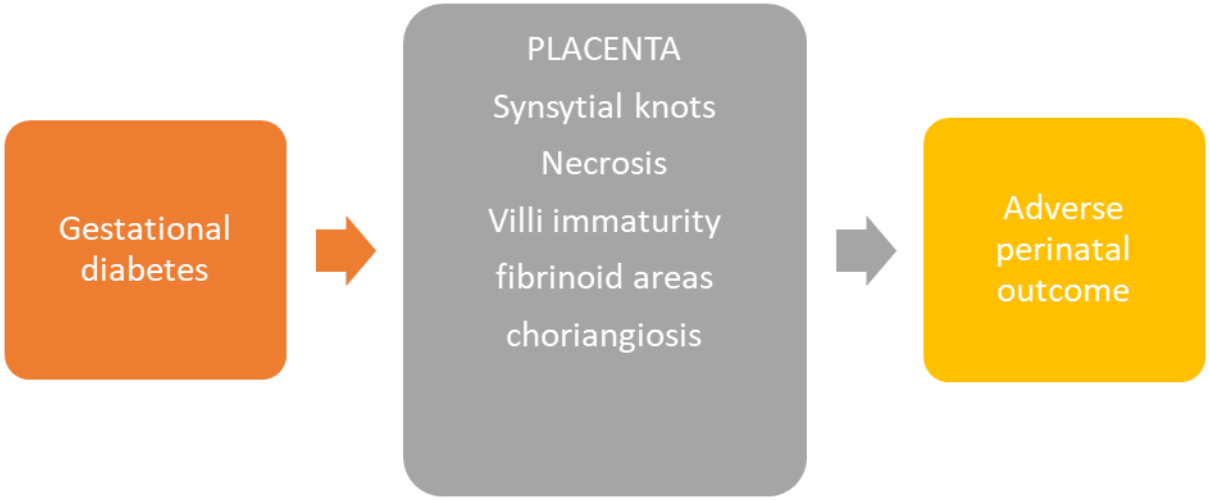


**Figure 2.6 Placental pathology in gestational diabetes mellitus. Adapted from: Carrasco-Wong, Moller, Giachini, Lima, Toledo et al., (2020)**

### 2.7.2 Cardiovascular diseases

Proper placental development is mostly influenced by maternal cardiovascular factors (Ramlakhan, Johnson & Roos-Hesselink, 2020:718). Physiological changes in the maternal vascular system initiate the remodelling of the maternal spiral arteries to increase oxygen and nutrients to flow to the developing foetus (Ramlakhan, Johnson & Roos-Hesselink, 2020:719).

Cardiovascular diseases complicate between 1% and 4% of pregnancies. A retrospective study of stillbirths between 2012 and 2016 in Shanghai, China found that stillbirths were more common among women with abnormal placental perfusion (APP) than those with normal placental perfusion (Wu, Ren, Zhu, Peng, Zhang & Li, 2021:308). The study associated the development of preeclampsia and placental inflammation with cardiovascular diseases (Wu, Ren, Zhu et al., 2021:308). Maternal vascular malperfusion and abruption were prevalent in placentas from pregnancies of women with congenital heart disease (Ramlakhan, Johnson & Roos-Hesselink, 2020). A study in Norway and Sweden found that placental abruption was also associated with women's increased risk of later developing cardiovascular disease (DeRoo, Skjaerven, Wilcox, Klungsoyr et al., 2016:505). The compromised maternal haemodynamic status in cardiac diseases may lead to a decrease in placental perfusion with subsequent growth restriction of the foetus (McBride, Bernstein, Sybenga, Mc Lean, Orfereo et al., 2022:51). Placental findings in the presence of cardiovascular diseases include hypoplasia, villitis of unknown aetiology and acute chorioamnionitis which may lead to adverse pregnancy outcomes.

### 2.7.3 Maternal hypo/hyperthyroidism

Thyroid disorders are common endocrine disorders affecting pregnant women with significant perinatal outcomes (Bargunam, Kanakaraya, Jigalur & Reddy, 2023:1). The human placenta not only supplies nutrients and oxygen to the foetus and removes waste products, but it also functions as an endocrine organ throughout pregnancy (Barjaktarovic, Korevaar, Chaker, Jaddoe et al., 2017:653). Pregnancy has a profound impact on the thyroid gland and its function. There is an increase in the synthesis of thyroxine (T4) and triiodothyronine (T3) under the influence of the placental Human Chorionic Gonadotropin (HCG) hormone (Bargunam, Kanakaraya, Jigalur & Reddy 2023:2). The placenta metabolises the maternal thyroxine (T4) and triiodothyronine (T3). The maternal thyroid hormone regulates foetal development via the effect of the placenta (Özoğul, Micili, Baykara, Pekçetin et al., 2010:972). Therefore, the thyroid hormone plays a critical role in placental development and is a key factor during implantation (Spencer, Bubner, Bain & Middleton, 2015). Thyroid disease in pregnancy affects both the mother and foetus. Thyroid dysfunction (both hypo- and hyperthyroidism) pre-pregnancy and during pregnancy is associated with increased maternal and perinatal adverse outcomes. Hypothyroidism in pregnancy refers to an increase in serum thyroid stimulating

hormone (TSH) and a decrease in serum free thyroxine (FT4) (Kiran, Sheikh, Humayun & Islam, 2021:1562). Hypothyroidism is associated with an increased incidence of abortion and obstetric complications such as pre-eclampsia, low birth weight, and foetal death. Histological findings in the presence of thyroid disease include syncytial knots which may cause serious permanent growth retardation (Özoğul, Micili, Baykara, Pekçetin et al., 2010:973). Hyperthyroidism is associated with maternal vascular malperfusion, such as decidua vasculopathy, defective placentation and severe foetal vascular malperfusion in the second and third trimesters (Barjaktarovic, Korevaar**,** Chaker**,** Jaddoe et al., 2017:654). In South Africa, screening for thyroid dysfunction during the first and subsequent antenatal visits is mandatory because it may assist in improving maternal and neonatal health (NDOH, 2016).

### 2.7.4 Maternal iron deficiency (severe anaemia)

Maternal iron deficiency or anaemia is defined as a maternal haemoglobin level of <10g/dl (NDOH, 2016). The normal haemoglobin levels in pregnancy range between 11.5 and 13.5g/dl (Tabrizi & Barjasteh, 2015:211). Anaemia during pregnancy affects about half of all pregnant mothers in developing countries and is the major indirect cause of maternal mortality (Gebremeskel, Mulu, Kumbi & Ergete, 2020:777). Maternal anaemia can directly cause poor growth of the foetus *in utero* due to inadequate oxygen flow to the placental tissue or is an indirect indicator of maternal nutritional deficiency. Maternal anaemia may cause the chorionic villi capillaries to increase in number and to dilate, degenerate and become fibrotic due to nutritional demands of the foetus that may not be fulfilled. Perivillous fibrin deposition further decreases the transfer of essential nutrients from the mother to the foetus. The intervillous space widens in the anaemic placenta (Gebremeskel, Mulu, Kumbi & Ergete, 2020:782). Mondal, Baske and Biswas (2017:1400) identified the following placental lesions in the presence of maternal anaemia: fibrinoid necrosis and villous fibrosis. Gross placental findings in maternal anaemia include increased weight and placental thickness, increased number of cotyledons calcifications, and syncytial knots that adversely affect perinatal outcomes (Khan, Srivastava, Fardan & Haque, 2020:144). Severe anaemia in pregnancy may lead to placenta abruption which may lead to stillbirth (Shi, Chen, Wang, Sun et al., 2022). The Guidelines for Maternity Care in South Africa (NDOH, 2016) indicate that all pregnant women should undergo a haemoglobin measurement at the first antenatal visit, and if ≥ 10g/dl, it should be repeated between 28 and 32 weeks and again at 36 weeks. All women should receive iron supplements, namely Folic acid and Ferrous Sulphate.

### 2.7.5 Maternal mental health

Pregnancy causes many physical and biochemical changes. The placenta plays a very important role as an endocrine organ regulating important hormones that impact the wellbeing of the mother and the foetus. The placenta must be in a good state to protect the foetus against

prenatal stress. The stress hormone *cortisol* released by the mother in a healthy placenta is converted to an inactive form of cortisone to protect the foetus. Maternal catecholamines released during stress affect the foetus via the effects on placental functioning (Thomas, 2020). Vital functions of the placenta like vascularisation and nutrient transportation are compromised. Adverse placental changes may occur, which could lead to perinatal morbidity and mortality. Another role of the placenta in mental health is to regulate maternal mood (Thomas, 2022). In Iran, during the Covid-19 pandemic, depression and anxiety among pregnant women increased dramatically compared to non-pregnant women (Abdoli, Falahi, Kenarkoohi et al., 2020). Governments globally implemented various principles to contain the pandemic and promote adherence to social distancing measures (Bonell, Michie, Reicher, Bear, Yardley et al., 2020:617). Social distancing referred to physical separation by reducing the number of times people came into close contact with each other, and social isolation rules affected the close family support of pregnant women. In London, lockdown led to missed and reduced appointments, increased intimate partner and domestic violence, and higher levels of stress, depression and anxiety, which in many cases resulted in alcohol and substance abuse (Bonell, Michie, Reicher, Bear, Yardley et al., 2020:618). Impaired placental functioning affects the maternal mood in the early postpartum period (puerperium psychosis, and depression) because of the low level of human placental lactogen and other lactogenic hormones produced. Placenta lesions such as placental hypoplasia are associated with stress (Bronson & Bale, 2015). Chronic stress affects the ability of the foetus to absorb iron in the third trimester (Bronson & Bale, 2015).

### 2.7.6 Effect of maternal infections on the placenta

Globally, there were an estimated 289,000 maternal deaths in 2013, and the sub-Saharan Africa region accounted for 62% of global deaths (WHO, 2013). In 2013, the World Health Organization launched the Maternal and Perinatal Death Surveillance and Response (MNDSR) guidance to strengthen notification, quantification and determination of causes and avoidability of maternal and neonatal deaths and stillbirth (WHO, 2013). The goal was to orient the measures necessary for their prevention.

Infections are a major threat to human reproductive health (WHO, 2013). In South Africa, most intrauterine deaths, preterm labour and antepartum haemorrhage of unknown origin are attributed to chorioamnionitis as a result of placental infection/inflammation (Stats, 2022). Mild to moderate infection before pregnancy is not of much concern, but maternal infection during pregnancy is associated with adverse maternal and perinatal morbidity and mortality. Maternal adverse outcomes include sepsis, respiratory distress, obstetric haemorrhage, and death. Perinatal outcomes may include prematurity, stillbirth, and congenital infections, which result in abnormalities (Megli & Coyne, 2022:68). Systemic maternal infection and consequent

inflammation disrupts the placental vasculogenesis (formation of blood vessels in the human placenta) and angiogenesis (growth of blood vessels from existing vasculature) (Weckman, Ngai, Wright et al., 2019). Placenta vascular development plays a vital role in healthy foetal development. Maternal infection therefore has an impact on placental vascular development and growth. Alterations in placental haemodynamics impact foetal growth and contribute to poor birth outcomes including preterm delivery, small-for-gestational age, stillbirth and low birth weight (Weckman, Ngai, Wright et al., 2019). These complications may be due to various bacterial, viral, parasitic or fungal maternal infections occurring at any stage of pregnancy. Although the placenta serves as a defence organ against infection, some micro-organisms bypass the maternal-foetal interface due to an unknown mechanism utilised by certain viruses which weakens this placental barrier resulting in maternal-foetal transmission (Yu, Wei, Duan, Schmitz, Sakurai et al., 2021:622).

Infection and inflammation of the placenta are associated with pregnancy complications. Placental macrophages called Hoffbauer cells are foetal-origin macrophages residing in the placenta that are involved in responding to placental infection and are responsible for protecting the developing foetus (Fakonti, Pantazi, Bokun & Holder, 2022). These are the only immune cells present in the villous placenta which are responsible for controlling and preventing transmission of infection to the developing foetus (Reyes & Golos, 2018). The other functions of the Hoffbauer cells are to maintain a homeostatic condition in the placenta, tissue remodelling, development and immune regulation. The Hoffbauer cells can be detected from six weeks to the end of gestation. They respond directly to pathogens that access the placenta e.g., syphilis, HIV, and other pathogens. In maternal HIV infection, despite antiretroviral treatment, there is a disruption in placental haemodynamics that is associated with adverse perinatal outcomes (Fakonti, Pantazi, Bokun & Holder, 2022). Abnormal placental development and growth of the vasculature is a driver behind infection-induced adverse perinatal outcomes (Weckman, Ngai, Wright et al., 2019). Other pathogens may cross the placenta and be directly transmitted to the foetus, and the foetus may be born with congenital infections, such as congenital syphilis, that could lead to neonatal mortality and morbidity.

### 2.7.7 Maternal TORCH

TORCH (Toxoplasma gondii, rubella, cytomegalovirus, herpes simplex virus) infections may cross the maternal foetal barrier and disrupt these placental functions (Wang, Li, Ma, Zhang, Wang, Cui & Wang, 2019:336). TORCH is asymptomatic and may be discovered in clinical settings where routine ANC screening is performed. Gross placental findings in the presence of TORCH may be a large and oedematous placenta. Microscopically findings are chronic villitis and intervillositis, and chorioamnionitis (Ziadi, 2011).

### 2.7.8 Maternal HIV/ART

HIV and syphilis infections are a continuing public health concern in developing countries, especially South Africa (Hoque, Hoque, van Hal & Buckus, 2021:296). More than 95% of pregnant women in South Africa attend public health facilities for antenatal care and receive antiretroviral therapy, which also works as a preventive measure for mother-to-child transmission of HIV (Hoque, Hoque, van Hal & Buckus, 2021). In their retrospective study of 1,503 pregnant women at a public health facility in Durban, Natal, Hoque, Hoque, van Hal and Buckus (2021) found a high prevalence, incidence and seroconversion of HIV and syphilis among older participants. Higher rates of seroconversion and incidence of HIV and syphilis suggested that the participants may potentially transmit these infections to the unborn babies and affect the pregnancy outcomes negatively (Hoque, Hoque, van Hal & Buckus, 2021). Before the introduction of compulsory ART for pregnant women, the mother-to-child transmission rate ranged between 15% and 40% (Zungu, 2015). Since the introduction of ART, the mother-to-child transmission rate has been reduced to less than 2% in some parts of South Africa. More research is required on the cause-and-effect of HIV, the effect of HIV on the placenta, the impact of ART on the placenta, and the outcome of babies born to HIV-positive mothers (Zungu 2015; Ikumi**,** Malaba, Pillay, Cohen, Mdlala et al., 2021). Although the administration of antiretroviral treatment (ART) during pregnancy is effective in improving maternal outcomes and reducing mother-to-child HIV transmission, does not reverse HIV-associated pregnancy adverse outcomes, especially in women who start ARV before pregnancy (Bruce-Brand, Wright & Schubert, 2021). ART administered during pregnancy may disrupt the regular immune system of pregnancy (Akoto, Norris & Hemelaar, 2021). The introduction of PrEP (Pre-Exposure Prophylaxis) has also increased the use of ART in pregnancy. Despite the use of antiretrovirals, placenta pathologies associated with HIV infection are still common such as acute chorioamnionitis, low placental weight, maternal vascular malperfusion, chronic inflammation and chronic villitis, which are associated with foetal death (Ikumi, Malaba, Pillay, Cohen, Mdlala et al., 2021; Weckman et al., 2019).

### 2.7.9 Syphilis

Syphilis is one of the most common sexually transmitted infections globally (WHO, 2019). Syphilis is a bacterial sexually transmitted infection from unprotected sexual intercourse or intimate physical contact with someone who is infected. Syphilis is a systemic infection caused by the spirochete treponema pallidum. Syphilis is of concern during pregnancy because it can be transmitted vertically via the placenta from the mother to the foetus to cause congenital syphilis. In 2016, 661,000 cases of congenital syphilis which resulted in stillbirths and neonatal deaths were reported (WHO, 2019). Congenital syphilis may be associated with several adverse pregnancy outcomes such as spontaneous abortions, stillbirths, preterm labour and

neonatal deaths. Congenital syphilis is the second leading cause of preventable stillbirths globally (WHO, 2019). Between 2014 and 2018, syphilis among women and congenital syphilis rose alarmingly in the United States of America (Adhikari, Bhattarai, Basnet, Joshi et al., 2021). Maternal syphilis is associated with a 21% increased risk for stillbirth, a 6% increased risk for preterm delivery, and a 99% increased risk of neonatal death (Adhikari, Bhattarai, Basnet, Joshi et al., 2021). HIV co-infection compromised the elimination of maternal syphilis according to a study conducted in Nepal (Adhikari, Bhattarai, Basnet Joshi et al. 2021).

In 2019, the World Health Organization introduced the Triple Elimination of Mother-to-Child Transmission (EMTCT) of HIV, hepatitis B and syphilis approach. The aim was to give every child the best chance to start a healthy life, free from preventable communicable diseases (WHO, 2019).

In South Africa, the Department of Health's maternity guidelines (2016) recommend screening at the first visit before 20 weeks of gestation, and if the test is negative, to be repeated at 32 weeks. If the test is positive, a three-weekly dose of 2.4 mu Benzathine Penicillin is given intramuscularly (NDOH, 2016:104). Sexual partners of pregnant women need to be tested and treated which is difficult to do, and if not, may result in re-infection of pregnant women.

Congenital syphilis may lead to perinatal death or long-term morbidity. Histological findings include proliferative vascular changes, chronic villitis, villous immaturity, acute and chronic villitis, necrotising funisitis, and the presence of spirochetes (Bishop & Matich, 2020). The traditional histological triad seen in placentas consists of enlarged hypercellular villi, proliferative villous vasculature, and villitis. Recognition of congenital syphilis is important in aiding diagnosis, leading to appropriate follow-up and treatment for both mother and infant (Bishop & Matich, 2020).

### 2.7.10 Tuberculosis (TB)

Tuberculosis re-emerged as a serious health concern as a result of the AIDS epidemic and immigration from areas where the disease is endemic and multi-drug resistance, with 8.8 million people worldwide affected in 2010 (Triverdi, Gupta, Sood, Singh, Tewari, Agarwal & Agarwal, 2020:42). Infections with mycobacterium tuberculosis are globally prevalent with the following descriptions of placental pathology: Placental TB shows predominantly neutrophilic and histiocytic response in the form of villitis and intervillitis, which is due to the innate immune response. In their study in Kanpur, India, Triverdi, Gupta, Sood, Singh et al., (2020:45) found that this innate response contributes more to tissue injury than protection and leads to the intrauterine death of the foetus.

Tuberculosis remains an important clinical and public health issue in South Africa, which has one of the highest TB burdens in the world (Moyo, Ismael, van der Walt, Ismael, Mkondo, Dlamini et al., 2022:1172). South Africa is one of the 30 countries with a high TB burden that, in 2020, collectively contributed to 86% of the estimated incident cases worldwide (Moyo, Ismael, van der Walt, Ismael, Mkondo, Dlamini et al., 2022:1173).

Tuberculosis is the leading infectious cause of perinatal mortality globally. Maternal TB has a potential risk for the foetus. Immunological changes in pregnancy may increase susceptibility to TB and may result in late foetal death. TB may affect the pregnancy outcome either by placental damage or direct harm to both mother and child. Placental findings in maternal TB can be tubercular placentitis, acute/chronic villitis and intervillitis (necrotising granuloma). Maternal TB is not easily diagnosed. Diagnosis of TB in pregnancy is often missed or delayed due to its clinical presentation overlapping with pregnancy symptoms and can sometimes be asymptomatic. Systemic screening for active TB should be considered for all pregnant women as part of antenatal care in settings where TB is prevalent (WHO, 2016).

### 2.7.11 Maternal malaria

In Chandigarh, India, Sharma and Shukla (2017:117) emphasised that malaria in pregnancy poses a great health risk to the mother and her foetus and results in complications, such as abortion, stillbirth, intrauterine growth retardation, and low birth weight. In 2018, sub-Saharan Africa had an estimated 11 million pregnancies that were exposed to malaria infection (WHO, 2020). In North Shoa, Ethiopia, malaria infection among pregnant women attending antenatal care in malaria-endemic regions increased and primigravidas were three times at risk (Feleke, Adamu & Gebreweld, 2020). Malaria is a blood-borne disease caused by a deadly parasite called Plasmodium falciparum (WHO, 2020). Placental malaria, characterised by the accumulation of Plasmodium-infected red blood cells in the placental intervillous space, is the primary mechanism through which malaria in pregnancy causes adverse perinatal outcomes (Zakama, Ozarslan & Gaw, 2020:163). The parasite binds itself to the maternal red blood cells and destroys them, which may lead to maternal anaemia. Maternal malaria-infected erythrocytes cross the utero-placental barrier and infect the placenta, resulting in placental malaria (Zakama, Ozarslan & Gaw, 2020). Placental malaria triggers increased placental inflammatory response, impairs trophoblast invasion, causes narrow spiral artery formation, and poor placental perfusion which is the primary cause of adverse perinatal outcomes. Histopathological lesions and exposure to plasmodium faciparum infections in placenta also increase the risk of preeclampsia (Obiri, Erskine, Oduro, Kusi, Amponsah et al., 2020). Increased placental lesions and fibrinoid necrosis are also found in placental malaria (Moeller, Nyengaard, Larsen, Nielsen et al., 2019:1428).

### 2.7.12 Maternal COVID-19

The World Health Organization (WHO) declared the novel coronavirus (COVID-19) outbreak a global pandemic in March 2020. The WHO expressed concern over the spread and severity and called on countries to act to contain the virus (Cucinotta & Vancelli, 2020:157). The WHO and UNICEF warned of a decline in vaccinations during COVID-19 due to disruptions in the delivery and uptake of immunisation services caused by the COVID-19 pandemic, especially in low- and middle-income countries (Stein, Ward & Cantelmo, 2020).

The COVID-19 pandemic had a profound impact on healthcare systems and potentially on pregnancy outcomes. In their systematic review, Chmielewska, Barratt, Townsend, Kalafat, van der Meulen et al., (2021:e769) found that global maternal and foetal outcomes worsened during the pandemic, with an increase in maternal deaths, stillbirth, ruptured ectopic pregnancies, and maternal depression. The study emphasised an urgent need to prioritise safe, accessible and equitable maternal care within the strategic response to the pandemic and future health crises (Chmielewska, Barratt, Townsend, Kalafat, van der Meulen et al., 2021:e770). A study in Augusta, USA, found that pregnant women were more likely to contract COVID-19 than others and had a greater chance of complications, including placental damage that could lead to stillbirth (Schwartz, Baldewijns, Benachi, Bugatti, Collins, De Luca et al., 2022:517). Chronic histiocytic intervillositis and syncytiotrophoblast necrosis accompanied SARS-CoV-2 infection of syncytiotrophoblast in live-born and stillborn infants. However, SARS-COV-2 infection was associated with higher rates of foetal death particularly if the infection occurred at birth (Schwartz, Baldewijns, Benachi, Bugatti, Collins, De Luca et al., 2021:518). Asymptomatic mothers with mild Covid-19 symptoms were among those who had stillbirths (Schwartz, Baldewijns, Benachi, Bugatti, Collins, De Luca et al., 2022). The stillbirth rate increased in the USA during the COVID-19 pandemic (Centers for Disease Control [CDC] and Prevention, 2020). One in 80 deliveries during the Covid-19 pandemic was a stillbirth. The virus may infect the placenta and cause Covid placentitis, therefore the CDC urged all pregnant women to be vaccinated against Covid-19. Placental findings in Covid-19 infection may include foetal vascular malperfusion (FVM). Lesions associated with FVM are villitis, villous thrombi, intervillositis, trophoblast necrosis and fibrin deposition which may lead to foetal demise (Bewley, Lee, Popescu & Oviedo, 2021; Bouachba, Allias, Nadaud, Massardier, Mekki et al., 2021).

Pregnant women with comorbidities such as hypertension, diabetes and cardiovascular diseases were more likely to experience severe Covid-19-related outcomes, which cause adverse birth outcomes (Wong, Tan, Omar, Mustangin, Singh, Salker, Aziz & Shafiee, 2022). In their study in Kuala Lumpur, Malaysia, Wong, Tan, Omar, Mustangin, Singh, Salker, Aziz

and Shafiee (2022:94) reported the frequency of histopathology associated with Covid-19 placentitis, including subchorionitis, chorioamnionitis, intervillositis and villitis (see Figure 2.7).

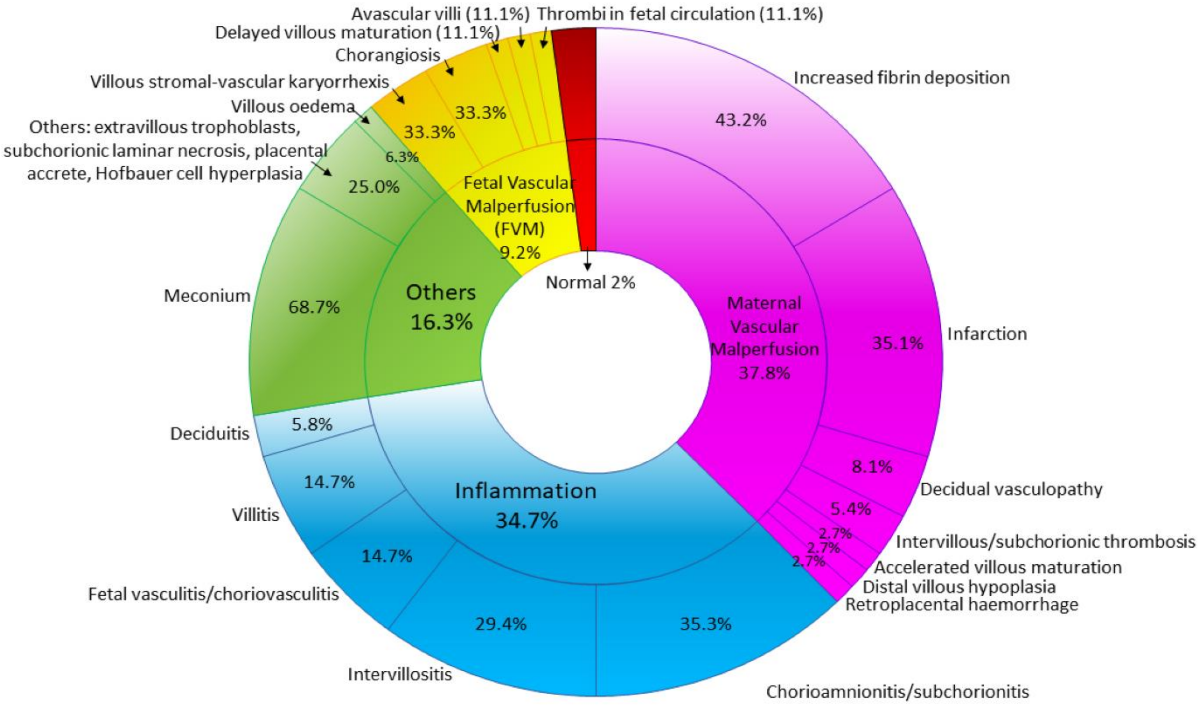


**Figure 2.7 Frequency of reported histopathological features of SARS-CoV-2-infected second and third trimester placentas. Source: (Wong, Tan, Omar, Mustangin, Singh, Salker, Aziz & Shafiee (2022:94)**

### 2.7.13 Bacterial infections (B streptococcal infections)

Chorioamnionitis is an intrauterine bacterial infection of the placenta, umbilical cord, amniotic fluid, and amnion and chorion that occurs before or during labour. Streptococcus B was identified in a study conducted by Reid, Oakeshott, Kerry, Hay et al., (2017). Group B streptococcus is among the bacterial infections that may cause acute chorioamnionitis. Mode of entry may be a genital tract infection, repeated vaginal examinations, bacterial vaginosis, prolonged rupture of membranes, prolonged labour and others. Midwives lack the skills for screening for chorioamnionitis during antenatal care, and there are no screening tools for chorioamnionitis (du Plessis, van Rooyen, Ham-Baloyi, 2021). Many studies recommended the administration of group B streptococcal vaccination to pregnant women to prevent this type of infection. Group B streptococcal colonization is a risk factor for colonization in subsequent pregnancies (WHO, 2017). Gross placental findings in the presence of chorioamnionitis are opaque membranes (Roberts, 2019). Histological findings in the presence of B streptococcus infection are diffuse infiltration of neutrophils, acute funisitis and acute villitis (Roberts, 2019).

## 2.8 EFFECTS OF MATERNAL LIFESTYLE ON THE PLACENTA

### 2.8.1 Intimate partner violence (IPV)

Intimate partner violence (IPV) refers to behaviour by an intimate partner or ex-partner that causes physical, sexual or psychological harm, including physical aggression, sexual coercion, psychological abuse and controlling behaviours (WHO, 2017:29). Intimate partner violence against women is a critical public health issue that transcends social and economic boundaries and is considered a major obstacle towards the 2030 women's, children's and adolescents' health goals in low- and middle-income countries (LMICs) (Coll, Erwerling, Garcia-Moreno, Hellwig & Barros, 2020). In 2020, Tiruye, Chojenta, Harris, Holliday and Loxton (2020:192) found that IPV against women, including partner's controlling behaviour, was significantly associated with pregnancy loss in Ethiopia. A study in Sokoto, Northwest Nigeria, found that the majority of the participants had experienced IPV, including their partners' controlling behaviour, while pregnant but did nothing because of fear (Oche, Adamu, Abubakar et al., 2020). Foetal death following placenta abruption with no maternal condition or without clear reason was also associated with IPV (Oche, Adamu, Abubakar et al., 2020:2). Alhusen, Ray, Sharps and Bullock (2015:101) state that the effects of IPV on maternal and neonatal outcomes are multifaceted and largely preventable. The effects on maternal health include insufficient or inconsistent prenatal care, poor nutrition, inadequate weight gain, substance use, and increased prevalence of depression, while adverse neonatal outcomes include low birth weight, preterm birth, small for gestational age, and maternal and neonatal death. In South Africa, IPV is a silent health epidemic and South Africa is one of the top five countries with a high prevalence of intimate partner violence (*Daily Maverick*, 14 June 2022). Worldwide, 50% of women and girls aged 15 and older have experienced intimate partner violence (Pallitto, Garcia-Moreno, Jansen, Heise, Ellsberg, Watts et al., 2013:3). In addition, pregnancy-associated intimate partner violence is associated with high perinatal and neonatal mortality and contributes to pregnancy complications, unwanted pregnancy, depression, substance abuse and other mental conditions (Pallitto, Garcia-Moreno, Jansen, Heise et al., 2013). Women who experience intimate partner violence during pregnancy may be three times more likely to suffer death and perinatal death.

Various forms of intimate partner violence are experienced during pregnancy. Physical violence is the highest. Most trauma experienced by pregnant women is to the abdomen which may lead to rupture of membranes, placental abruption or ruptured uterus. Many abusers use sexual violence which exposes the pregnant partners to STIs, including HIV and syphilis. Sexual coercion leads to unplanned, unwanted pregnancies and abortions. Women experiencing IPV may begin antenatal care late and may frequently miss appointments. Intimate partner violence in pregnancy may be associated with poor maternal weight gain,

intrauterine growth retardation, preterm labour, and stillbirth. IPV contributes to mental health problems, stress anxiety, and depression. Clinical enquiry and screening for all women should be done to identify women who are experiencing IPV to offer interventions that will lead to improved outcomes (WHO, 2017).

### 2.8.2 Obesity

Obesity is a rising medical concern. Maternal obesity is associated with an increased risk of miscarriage, foetal death, infant death, and major birth defects. Pregnancy requires a healthy diet including adequate intake of energy, protein, vitamins and minerals through the consumption of green leafy vegetables, meat, fish, beans, nuts, whole grains, and fruit to meet the needs of the mother and the foetus. Maternal overweight and obesity cause pregnancy complications such as gestational diabetes, hypertension and preeclampsia and affect foetal growth (WHO, 2016). Maternal malnutrition is a key determinant of poor perinatal outcomes and excessive weight gain during pregnancy (WHO, 2016).

Maternal nutrition has an impact on foetal development and gestational outcomes. In Brazil, Miele, Souza, Caldero, Feitosa, Leite, Rocha Filho et al., (2021:2398) assessed the nutritional status of 1,165 nulliparous pregnant women by body mass index (BMI) and mid-upper arm circumference (MUAC), associated with dietary patterns and sociodemographic characteristics. The odds of adverse outcomes were higher in non-white obese women with high carbohydrate consumption (Miele et al., 2021).

A study in Romania found that obesity was associated with other risk factors such as gestational diabetes and hypertensive disorders, foetal macrosomia, and late stillbirths in pregnancy, which are associated with maternal inflammatory response, abnormal and malperfusion of the placenta, with an increase in maternal and perinatal morbidity and mortality (Tabacu, Istrate-Ofiteru, Manolea, Dijmarescu et al., 2022). A study of placental histological changes of obese mothers in Mosul, Northern Iraq found syncytial knotting, villous fibrinoid necrosis, perivillous fibrin deposits, chorangiosis, villous oedema, decidual fibrinoid necrosis, increased inflammation, and decidual fibrinoid necrosis (Hasan & Al-Allaf, 2020).

### 2.8.3 Undernutrition

Undernutrition in pregnancy refers to a maternal nutritional state where the nutrient stores and micro and macronutrient intake is less than that needed to achieve optimal maternal and newborn outcomes (Tyoti, Varinder & Jasbir, 2018). Women who are underweight are at increased risk of maternal or adverse pregnancy outcomes. Pregnancy is a period of placental development. Adequate intake of macro and micronutrients during pregnancy promotes these processes. Proper placental development and function are a result of the preconception health status of women. The role of the preconceptual endometrium for optimal placentation is

important. The most important period which will determine effective implantation and placental development is 14 weeks before conception which is the most neglected period. During this period the endometrium becomes receptive for implantation (Malusi, Schubert, Theron & Wright, 2019).

### 2.8.4 Substance/alcohol use

Normal placental vascular development is important for foetal growth and positive pregnancy outcomes (Gualdoni, Jacobo, Barril, Ventureira & Cebral, 2022). Alcohol use throughout pregnancy irrespective of gestation disrupts the normal placental function, may alter normal homeostasis and leads to adverse pregnancy outcomes. Maternal alcohol consumption impairs the supply of oxygen to the foetus due to poor placental vascularity leading to hypoxia, intra-uterine growth restriction and stillbirth. Ethanol interferes with placental transportation of nutrients, oxygen, and waste products. Antenatal exposure to alcohol alters transportation of foetal iron, leads to foetal iron deficiency anaemia which further results in growth restriction. Alcohol intake during pregnancy increases the risks of placental abruption and abnormal placentation (Gualdoni, Jacobo, Barril, Ventureira & Cebral, 2022). Maternal alcohol consumption reduces placental weight and size, and is associated with maternal malperfusion, and umbilical cord contraction. All pregnant women should be asked about their alcohol and substance use (past and present) throughout their antenatal visits (WHO, 2016).

### 2.8.5 Tobacco/cigarettes

Healthcare providers should ask all pregnant women about tobacco use (past and present) and exposure to second-hand smoking as early as possible in pregnancy and at every antenatal care visit. Due to the vasoconstriction effect of nicotine in cigarette smoking, placental damage may occur. It broadens the basement membrane and decreases the vascularity. Smoking is linked to both maternal and foetal vascular lesions which may lead to foetal growth restriction and placenta abruption (Gibbins, Pinar, Reddy, Saade, Goldenberg et al., 2020:709).

### 2.8.6 Herbal medication

Traditional and complementary medicines refer to a broad set of healthcare practices, approaches, knowledge, and beliefs that include plants, animal and mineral-based medicines, and spiritual therapies, alone or in combination, to treat, diagnose and prevent illness or maintain well-being. Africa is a home of traditional medicine, which is used for disease prevention and treatment of ailments (WHO, 2017).

Sub-Saharan Africa is a region where herbal medicine is traditionally and culturally acknowledged (James, Wardle, Steel & Adams, 2018). Herbal medicine is used in more than 80% of conditions including pregnancy conditions (Wang, Chen, Wang, Liu et al., 2022:14).

Herbal medicine is used as part of maternal care to treat pregnancy-related problems such as nausea and vomiting, urinary tract infection, facilitation of labour and to prevent anaemia and to improve the wellbeing of the mother and foetus (Hajj & Holst, 2020). In 2018, Zamawe, King, Jennings and Fottrell examined associations between the use of herbal medicines and adverse pregnancy outcomes in rural Malawi. The study found that there is an association between the use of herbal medicine and adverse perinatal outcomes (Zamawe, King, Jennings & Fottrell, 2018). Herbal medicine is thought to be a factor in inadequate access and usage of maternal health care services such as antenatal care (Laelago, 2017). Safety concerns regarding herbal medicine are mainly attributed to the herbal ingredients. Some herbal medications have anti-implantation, uterotrophic, embryotoxicity, and teratogenic effects when used during pregnancy (Laelago, 2017).

## 2.9 EFFECTS OF MATERNAL EXPOSURE TO AIR POLLUTANTS ON THE PLACENTA

Air pollution is a risk to human health (WHO, 2022). Air pollution is associated with placental oxidative stress which decreases the supply of oxygen and nutrients to the growing foetus and therefore may lead to adverse perinatal outcomes (Saenen, Marterns, Neven, Alfano, Bové et al., 2019). Maternal exposure to air pollution influences vascular placental resistance which may result in preeclampsia and foetal growth restriction (Oudir, Tekola-Ayele, Canty, Sciscione et al., 2021).

The environment contains various types of air pollutants that reduce placental function and increases the risk of preeclampsia and therefore contribute to adverse effects on human health, which includes adverse pregnancy outcomes (Mandakh, Oudin, Erlasson, Isaxon et al., 2021). Air pollution comprises different pollutants such as carbon oxides, nitrogen oxides, sulphur dioxide, polycyclic aromatic hydrocarbons (PAH), particulate matter (PM 2.5 and PM10) black carbons, and others (Ahmad, 2020). Maternal exposure to air pollution during pregnancy is exacerbated by social environmental factors such as smoking, second-hand smoke, poor nutritional intake and chronic stress, and may result in adverse pregnancy outcomes (Erickson & Arbour, 2014). Maternal exposure to environmental pollutants is associated with implantation failure and impaired placentation (Hettfleisch, Stein Bernardes, Carvalho, Manfre Pasro et al., 2017). The developing foetus is susceptible to environmental pollutants (Grippo, Zhang, Chu & Guo et al., 2018).

Figure 2.8 depicts the effects of air pollution on the placenta, foetus, and maternal health.

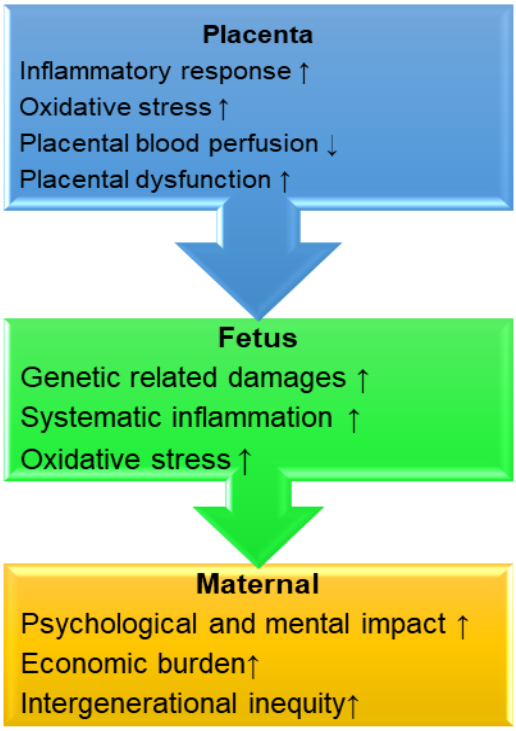


**Figure 2.8 Effects of air pollution on the placenta, foetus and maternal health**. **Adapted from: Zhang, Zhang, Wang, Xu et al., (2021).**

A study in China found that maternal exposure to elevated temperatures increased the risk of preeclampsia, eclampsia and pregnancy-induced hypertension as well as the prevalence of gestational diabetes (Xiong, Chen, Mu, Li, Di, B et al., 2020). Pregnancy creates a specific vulnerability to climate change and severe heat, wildfire smoke, flooding, and extreme weather increase the risk for stillbirths, preterm birth and low birth weight. When the environmental temperature exceeds the maternal body temperature, vasodilation and sweat secretion occurs, which decreases uterine and umbilical cord blood flow (Poeran, Birnie, Steegers & Bonsel, 2016). The World Health Organization and the International Federation of Obstetrics and Gynaecology (FIGO) have linked the climate change crisis to poor maternal and perinatal outcomes.

South Africa is a country with poor air quality (Department of Environmental Affairs, 2016:191) Mpumalanga has 12 Eskom coal-fired stations and is classified under the Highveld Priority Areas, which burns millions (Department of Environmental Affairs, 2016:195) of tonnes of coal each year that are associated with poor air quality. The air quality has not improved in the past ten years. The air has elevated concentrations of pollutants including sulphur dioxide (SO2), particulate matter (PM10) and nitrogen oxide (NO3), due to the transportation and burning of coal which are responsible for the majority of indoor and ambient air pollution (Department of Environmental Affairs, 2016**:**187). EMalahleni townships are surrounded by coal mines and big metal plants that use coal. The coal mines blast two or three times a day and each blast

lifts immense black dust clouds, and more coal dust is lifted in the air. Fires constantly break out in active and abandoned mines and cause spontaneous combustion which emits toxic concentrations of methane, carbon dioxide (CO2) and carbon monoxide (CO) (Department of Environmental Affairs, 2016:187).

Circulatory particles from air pollution may cross the placental barrier, cause hypoxic lesions, and induce placental alterations (Saenen, Marterns, Neven, Alfano et al., 2019:214). Exposure to polycyclic aromatic hydrocarbons and particulate matter may induce oxidative stress and placental inflammation that may promote defective and deep placentation where normal perfusion of oxygen and nutrients to the foetus will be reduced and adverse pregnancy outcomes may occur which include preterm birth, intrauterine growth restriction, miscarriage, and stillbirth. The big coal mines and burning industries also pollute water (Amegah, Nayha & Jaakkola, 2017).

Air pollution is divided into indoor/household pollution and ambient/outdoor pollution (Siddika, Balogun, Amegah & Jaakkola, 2016).

### 2.9.1 Indoor/household air pollution

Indoor air pollution refers to pollutant levels in residential homes that are generated from household fuel combustion, such as wood, paraffin, coal and gas are affected by outdoor air pollution (WHO, 2022). Worldwide, around 2.3 billion people still cook using solid fuels (e.g., wood, crop waste, coal and dung) and paraffin (kerosene) in open fires. Burning biomass emits large amounts of pollutants. Burning organic matter emits particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), sulphur dioxide (SO2), lead, mercury, and other hazardous air pollutants (HAPs) (WHO, 2022).

In Ghana, air pollution from biomass fuel burning was found to contribute to placental damage and stillbirth (Amegah & Jaakkola, 2007:7). In Dar es Salaam, Tanzania, prenatal exposure to household air pollution and inhaled particulate matter and carbon monoxide was associated with foetal thrombosis, vasculitis, chronic villitis, and chronic chorioamnionitis which contributed to poor perinatal outcomes (Wylie, Matechi, Kishashu, Fawzi, Premii et al., 2017:138). Indoor air pollution may result in placental lesions such as chorangiosis (Ahmad, 2020). Particulate matter is present in both indoor and ambient air pollution. Carbon dioxide reduces the oxygen-carrying capacity of maternal haemoglobin, which affects the oxygen delivery to the foetal circulation. Maternal exposure to particulate matter air pollutants lowers the efficiency of the placental function, resulting in malperfusion and stillbirth (Siddika, Rantala, Antikainen, Balogun, Amegah et al., 2020).

### 2.9.2 Ambient air pollution

Ambient or outdoor pollution is caused by emission of pollutants especially from particulate matter (PM2,5 and PM10) emitted by cars, mine dumps, power plants, sewage treatment, oil refineries, and industries, and burning coal. Particulate matter refers to inhalable air particles that are suspended in the atmosphere which contain sulphates, nitrates, black carbon, mineral dust and water. Both PM10 and PM2.5 pose a risk to human health because they are inhalable and able to penetrate human lungs and be absorbed into the bloodstream (WHO, 2022). The size of the particles has a more potential effect, the smaller the particles, the greater the potential of causing more harm to human health. The placenta is an immunological and physical barrier. Inhaled pollutants, especially PM2.5, are easily transported from the lung alveoli to the capillaries, dissolved and circulated into the bloodstream via the pulmonary artery, and may enter the uteroplacental vascular system and cause placental pathologic changes, decrease the transplacental function, with adverse perinatal outcomes (Saenen, Martens, Neven, Alfano et al., 2019).

Maternal exposure to ambient air pollution during pregnancy might increase the susceptibility to placenta growth and function and is associated with increased risks of preeclampsia as well as increases in blood pressure (Engstrom, Mandakh, Garmie, Masoumi et al. 2021). Maternal hypertensive disorders such as preeclampsia and foetal growth restriction may be consequences of air pollution exposure to the placenta. Acute air pollution exposure may influence placental vascular resistance (Ouidir, Tekola-Ayele, Canty, Grantz et al., 2020). Air pollutants may adversely affect the growth and development of the placenta and the foetus. In Guangzhou, China, Liu, Ye, Chen, Li et al., (2019) examined the effects of prenatal exposure to air particulate matter on the risk of preterm birth. The risk of preterm birth was positively associated with PM2.5 and PM1 concentrations and PM was reported in both the placenta and the umbilical cord blood of the participant pregnant mothers exposed to ambient air pollution (Liu, Ye, Chen, Li et al., 2019). Exposure to PM 2.5 causes inflammation of the placenta and placenta lesions such as chorioamnionitis, intervilosities, and chronic villitis (Wylie, Matechi, Kishashu, Fawzi et al., 2017).

## 2.10 EFFECTS OF MATERNAL AGE ON THE PLACENTA

### 2.10.1 Advanced maternal age

Advanced maternal age refers to a mother's age of ≥35 years in pregnancy. Advanced maternal age is increasing in developed and developing countries. The widespread use of contraceptives, postponement of pregnancy because of career goals and advances in assisted reproductive techniques, contribute to this problem (Kahveci, Melekoglu, Evruke, Cetin et al., 2018). Advanced maternal age has been associated with a variety of pregnancy

complications and specific placental pathology related to preeclampsia/pregnancy-induced hypertension, gestational diabetes and increased BMI, as these conditions increase with maternal age. Advanced maternal age is associated with maternal vascular malperfusion. Stillbirth doubles by the late 30s and increases by three to four times by the mid-40s (Hirata, Katsukura, Henmi, Ozawa et al., 2021). Generally, the function of various organs deteriorates with age. Advanced maternal ageing affects the uterine environment. Maternal ageing decreases the quality of the oocytes and hormones that are responsible for or involved in the implantation process and may lead to poor implantation, placentation and decidualization. The implantation process involves many hormones, proper signalling and decidualization (endometrial changes) for proper implantation. Advanced maternal age is associated with chronic inflammation. Placental lesions associated with AMA are mostly maternal vascular malperfusion (Miremerg, Frig, Rona, Herman et al., 2020).

### 2.10.2 Effects of advanced paternal age

Placenta growth and development is also influenced by paternal genes. Harmful gene mutation is frequently seen in older men >40. A population-based retrospective study of the effect of paternal age on foetal outcomes between 1989 and 2005 found a relationship between paternal age and adverse perinatal outcomes, including low birth weight (LBW), preterm birth, stillbirth and small for gestational age (SGA) (Alio, Salihu, McIntosh et al., 2012:427). The study found that infants born to fathers aged 40-45 years had a 24% increased risk of stillbirth but a reduced risk of SGA. Infants born to fathers over 45 years old had a greater risk for LBW (19%), preterm birth (13%), and very late preterm birth (VPTB) (29%) than those born to fathers aged 29-39 years (Alio, Salihu, McIntosh et al., 2012:435).

### 2.10.3 Effect of teenage pregnancy

Teenage pregnancy is a global issue in developed and developing countries and occurs mostly in marginalized communities. Teenage pregnancy occurs between 15 and 19 years in developing countries (WHO, 2019). Most teenage pregnancies occur due to social issues, such as sexual abuse, gender-based violence, and intimate partner violence, and most of girls face considerable pressure into early marriage. Covid-19 contributed to an increase in statistics of teenage pregnancy. In South Africa, an increased rate of teenage pregnancy was recorded during the Covid-19 pandemic according to the statistics that were released by the Gauteng Department of Health (Baron, Subedar, Letsoko, Pillay et al., 2022). Studies conducted by Okeke, Idriss-Wheeler and Yaya (2020) and Zulaika, Bulbarelli, Nyothack, van Eijk et al., (2022) in Kenya concluded that because of Covid-19 lockdown restrictions, and closure of schools, there was an increased vulnerability to sexual abuse and sexual activities of teenagers. Teenage pregnancy remains the major contributor to maternal and perinatal morbidity and mortality in Romania (Ursache, Lozneanu, Bujor, Cristofor et al., 2023). Health

risks and complications of teenage pregnancy arise because of an immature reproductive system (Ursache, Lozneanu, Bujor, Cristofor et al., 2023). Teenagers are at increased risk of developing preeclampsia, puerperium endometritis, and systemic infections (Kyozuka, Murata, Fukusda, Yamagushi et al., 2021). They deliver low birth weight, preterm neonates, congenital abnormalities and even stillbirths. Teenage pregnancy is associated with placenta abruption (Kyozuka, Murata, Fakusda, Yamagushi et al., 2021).

## 2.11 EFFECT OF SHORT PREGNANCY INTERVAL ON THE PLACENTA

Short interpregnancy intervals of less than 12 months have been associated with increased risk of low birth weight, preterm birth, small for gestational age, and low Apgar score. In 2006, the World Health Organization recommended 24 months before attempting a next pregnancy and 33 months before the next month to promote healthier maternal and child health outcomes. A short birth interval is associated with adverse maternal and perinatal outcomes (McLaughlin, Benson, Scaglione, Saviers-Steiger et al., 2022). A short birth interval is common among women in low- and middle-income countries. Adverse consequences of a short pregnancy interval may include poor maternal nutrition status and folate depletion. A short pregnancy interval is also associated with abnormal placentation as a result of abnormal remodelling of the endometrial blood vessels and incomplete healing of the uterus (Pimentel, Ansari, Omer, Gidado et al., 2020). Abruption placenta, placenta previa and preterm premature rupture of membranes may occur as a result of short pregnancy intervals (Pimentel, Ansari, Omer, Gidado et al., 2020).

## 2.12 EFFECT OF PREVIOUS STILLBIRTHS ON THE PLACENTA

Implantation and placentation involve vascular adaptation of the uterus and the spiral artery remodelling in the development of the placenta. The process is disturbed by uterine blood supply and placental oxidative stress. Failure of the process of implantation and placentation may result in late pregnancy complications associated with placental dysfunction. A history of two or more stillbirths or miscarriages may be associated with an increased risk of placental dysfunction disorders and should be regarded as a risk factor in antenatal care (Gunnarsdottir, Stephansson, Cnattingius, Akerud & Wikström, 2014). The intervention of prophylaxis treatment of low dose Aspirin is recommended to prevent placenta dysfunction (Gunnarsdottir, Stephansson, Cnattingius, Akerud & Wikström, 2014). Placental pathological lesions such as villitis of unknown aetiology, massive perivilous fibrin deposit, and chronic histiocytic intervillositis are recurrent risks in pregnancy (Chen & Roberts, 2017).

## 2.13 PLACENTA PATHOLOGY (PLACENTAL LESIONS) AND PERINATAL MORTALITY

Placental lesions or abnormalities are a common cause of death in stillbirth (Man, Hutchinson, Heazell, Ashworth et al., 2016). A placental lesion is defined as placenta disease that occurs due to a poorly developed or damaged placenta that may lead to insufficient transportation of oxygen and nutrients to the foetus and result in adverse pregnancy outcomes which include placental insufficiency which may result in stillbirth (Yu, Wei, Duan, Schmitz, Sakurai, Wang, Wang, Zhao, Hon & Wu, 2021: 620-626). Normal spiral arterioles of the uterine endometrium are thick-walled muscular arterioles with small lumens supplying the maternal blood to the endometrium. During implantation of the blastocyst the arterioles change, and the walls create enlarged vascular channels that feed maternal blood into the intervillous space of the developing placenta of the blastocyst (remodelling). Remodelling continues in the second trimester. Defective deep transformation of the myometrium segments of the spiral arterioles may produce lesions. Reduced blood flow secondary to reduced vascular capacity or vascular occlusion may lead to hypoxic-ischaemic injury. Defective spiral artery remodelling may result in arterial occlusion that may produce infarction (uteroplacental hypoxia). Placenta pathology is divided into two categories: gross/macro pathology findings and histology/micro pathological findings.

### 2.13.1 Gross/macroscopic examination of the placenta and clinical significance

The placenta is an underexplored and underappreciated organ. In South Africa, midwives and obstetricians are expected to examine the placenta and record the findings in the maternity case record book as part of the routine third stage of labour (NDOH, 2016), paying attention to the aspects indicated in Table 2.1.

**Table 2.1 Gross/macroscopic examination of the placenta and clinical significance**

| Placental part | Aspects to identify on examination |
|---|---|
| Cord | -Measurements of length and diameter (short and long cord) may have an adverse pregnancy outcome. An excessively long cord is associated with entanglement and true knots and short cords are associated with decreased foetal movements. Thickness and thinness may indicate maternal diabetes, raised maternal BMI or intrauterine foetal growth restrictions.<br>-Check for blood vessels (2 arteries and 1 vein).<br>-Note for cord insertion, coiling, knots, obstruction, and thrombi.<br>-Note for the insertion of the cord velamentous, battledore insertion may harm pregnancy outcomes.<br>-Check for patches (which may indicate infection) discolouration, haemorrhage, masses and nodules. |

| | |
|---|---|
| Membranes | -Check for completeness.<br>-Note the colour of the membranes (discolouration and opacity) which may indicate chorioamnionitis.<br>-Note the insertion of the membranes to exclude circumvallate. |
| Placental disc | **Foetal surface**<br>-Identify nodules, masses, cysts, or discolouration.<br>-Inspect for evidence of haemorrhage, thrombosis, or disruption.<br>-Measure the disc in three dimensions.<br>**Maternal surface**<br>-Check cotyledons for completeness.<br>-Check blood clot/haematoma (retroplacental clot) which is associated with placenta abruption.<br>-Infarcts and calcifications are associated with necrosis which causes loss of intervillous blood flow and result in acute hypoxia.<br>-Note colour congestion.<br>-Weigh the disc and compare with the gestational age, placental weight below the 3rd and 10th percentile or above the 90th percentile may result in adverse pregnancy outcomes. |

Source: National Department of Health (2016:93)

### 2.13.2 Histological/microscopic examination of the placenta and clinical significance

Histological findings are defined as an examination of placental tissues by a pathologist using a microscope to see signs of damage or other abnormalities (Khong, Mooney, Ariel, Balmus et al., 2016:698-713).

#### 2.13.2.1 Indications for placental histology

Indications for placental histology include maternal, foetal/neonatal and placental indications (Roberts, Baergen, Boyd, Carreon et al., 2023) (see Table 2.2).

**Table 2.2 Indications for placental histology**

| | |
|---|---|
| Maternal indications | Systemic maternal disorders/chronic diseases, maternal diabetes, hypertensive disorders, anaemia, unexplained 3rd trimester bleeding.<br>Maternal infections: HIV/AIDS, TB, syphilis, TORCH and any unexplained pregnancy complications. |
| Foetal/neonatal indications | Intra-uterine growth restriction, stillbirth or any perinatal death, compromised clinical conditions, low Apgar score of less than 6/10, |

| | |
|---|---|
| | severe anaemia, hydrops fetalis, birth weight of less than 10th percentile, seizures, infection, congenital abnormalities, admission to NICU and high care. |
| Placental indications | Physical abnormality, infarcts, vascular retro placental clot, abnormal colour/opacity or malodour, small or large placentas for gestational age, umbilical cord lesions, e.g., absence of Wharton's jelly, total length of less than 32cm at term, thrombosis, torsions, true knots. |

Figure 2.9 presents the macroscopic (gross) and microscopic (histological) examination of the placenta.

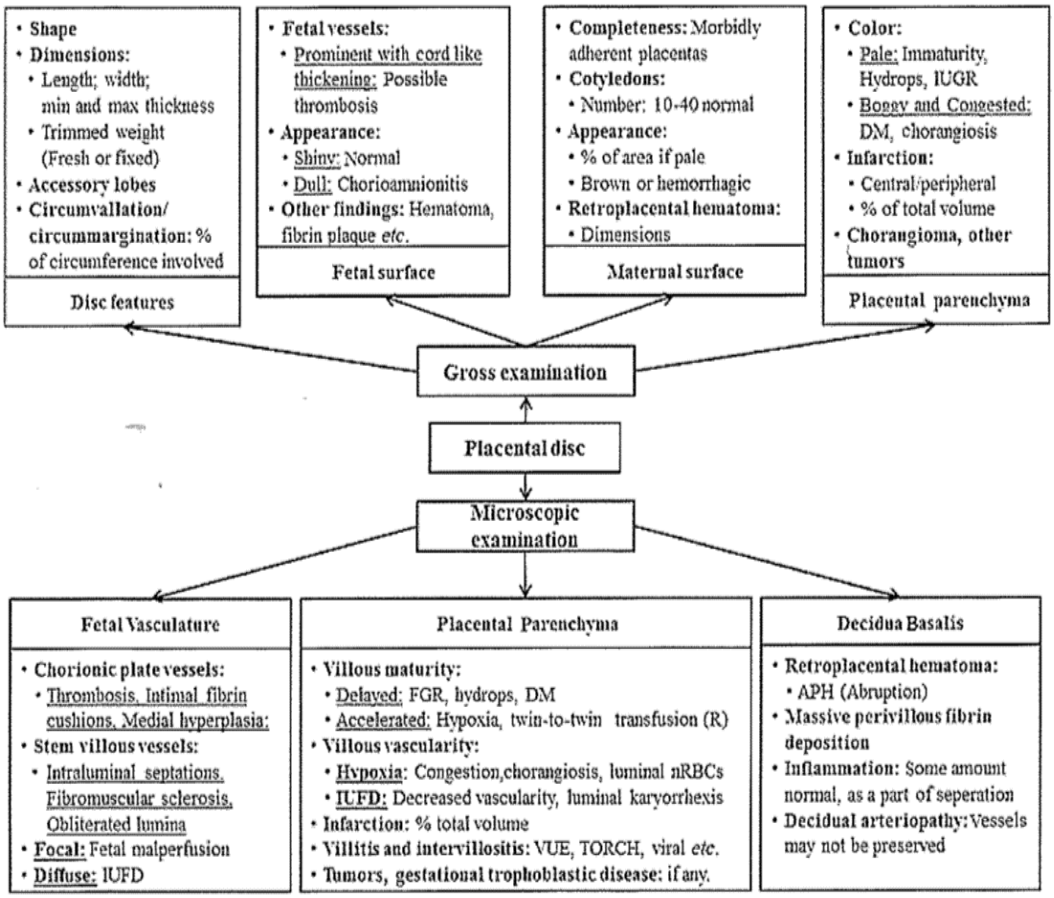


**Figure 2.9 Macroscopic (gross) and microscopic (histological) examination of the placenta.** Source: Kulkarni, Palanianppan and Evans (2017:580)

Figure 2.10 describes the possible findings on gross and microscopic examination of a placenta from a woman with a clinical history of preeclampsia, which led to a placental pathological diagnosis of maternal vascular malperfusion.

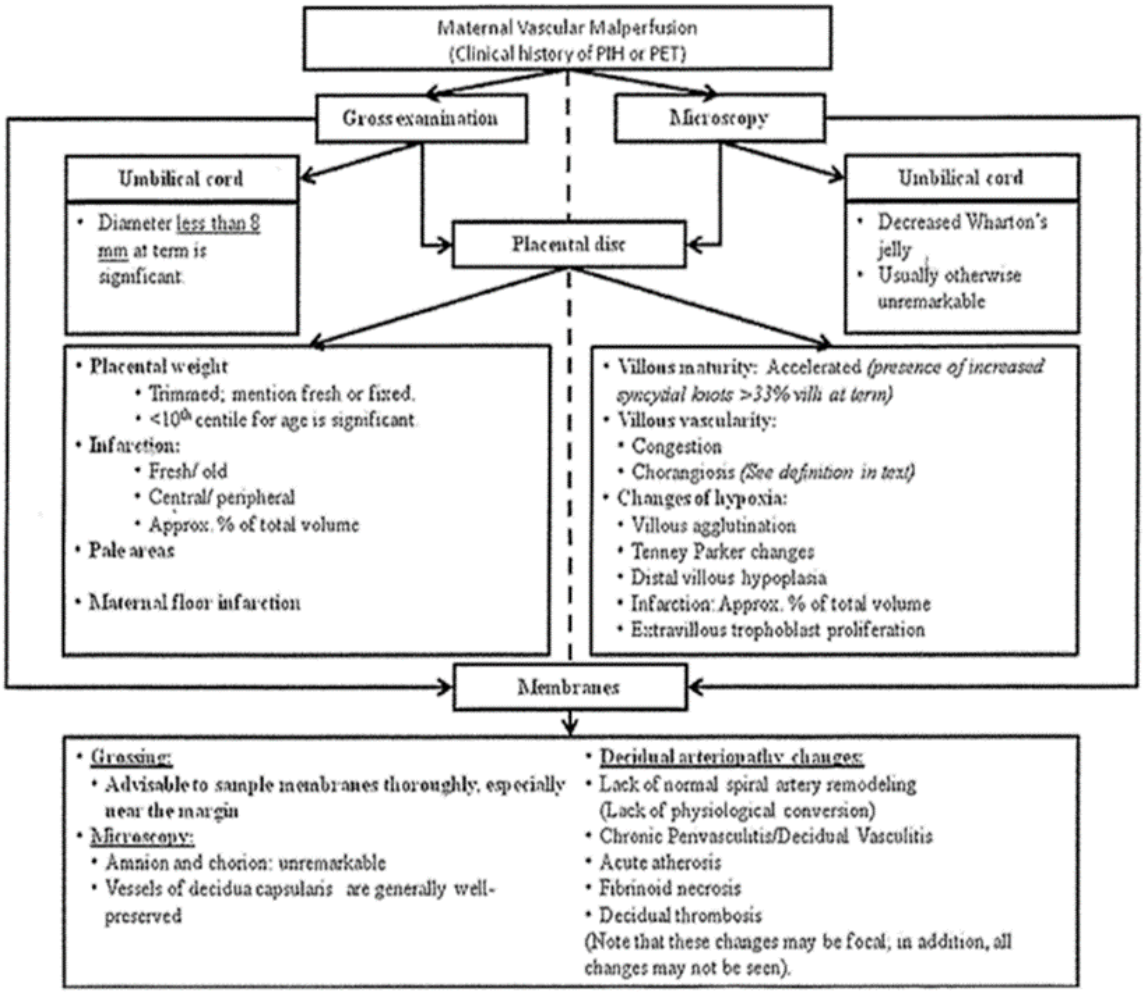


**Figure 2.10 Schematic pathways representing maternal vascular malperfusion possible findings on macro- and microscopic placental examination for women with a clinical history of pregnancy-induced hypertension and preeclampsia. Source: Kulkarni, Palanianppan and Evans (2017:581).**

Placental examinations, both macro- and microscopically, permit the study of the intrauterine environment of the foetus and foetal responses to maternal disease, infections, lifestyle, maternal age, previous obstetric complications such as previous stillbirth, short pregnancy interval, and environmental exposure. The placenta is infrequently examined or sometimes overlooked. Placental examination should form an essential component of the autopsy in cases of foetal or neonatal death. A placental examination may yield information about the impact of the intrauterine environment on the foetus. It provides insight into the pathogenesis of adverse foetal/neonatal outcomes and gives useful information for diagnosis and treatment of sick newborns. Placenta lesions may cause brain injuries during pregnancy, labour and delivery and may be associated with neonatal hypoxic-ischaemic encephalopathy. Placental examination both macroscopically and microscopically may reduce the number of unexplained

stillbirths and litigations of health institutions. It may be used during counselling to explain the probable cause of foetal demise to the grieving mothers.

## 2.14 SUMMARY

This chapter discussed the literature review conducted for the study. The literature review covered stillbirth, the effects of the physical environment on the placenta, interventions to reduce stillbirths, the Guidelines for Maternity Care in South Africa, the effects of maternal conditions (medical, infections, lifestyle, exposure to physical environment pollutants, maternal age, short pregnancy interval, previous stillbirth) on the placenta, and adverse pregnancy outcomes.

Chapter 3 describes the research design and methodology of the study.

# CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

## 3.1 INTRODUCTION

Chapter 2 discussed the literature review conducted for the study. This chapter discusses the research design and methodology of the study.

## 3.2 AIM AND OBJECTIVES OF THE STUDY

The study aimed to assess and describe the placental findings of macroscopic and microscopic placenta examinations in singleton term stillbirths in the selected public hospital in the eMalahleni sub-district in Mpumalanga Province.

To achieve the aim, the objectives were to:

- Examine placentas of term singleton stillbirths macroscopically and microscopically for placental findings related to stillbirths in the selected public hospital.
- Describe the characteristics and trends of the placental lesions of the stillbirths.

The study wished to answer the following question:

What are the placental findings in term singleton stillbirths in the selected public hospital in the eMalahleni sub-district in Mpumalanga Province?

## 3.3 RESEARCH DESIGN

A research design is an overall plan for addressing a research question, including specifications for enhancing the integrity of the study (Polit & Beck, 2017:513). The research design is a blueprint for conducting a study and indicates the basic strategies a researcher will use to answer the research questions (Brink, van der Walt & van Rensburg, 2018:101). In this study, the researcher used a quantitative, prospective, observational and descriptive research design.

### 3.2.1 Quantitative

A quantitative research design collects and analyses numerical data to describe and explain the phenomenon under study (Gray, Grove & Sutherland, 2017). A quantitative study is a formal, non-experimental, objective, rigorous, systematic process of generating numerical information about the world (Polit & Beck, 2017). Quantitative research incorporates deductive reasoning and analyses numerical data by means of statistical procedures to describe relationships between two or more variables without manipulation or interference (Leedy & Ormrod, 2015).

### 3.2.2 Prospective

In prospective studies outcomes are examined before their occurrence and followed up over a period, to determine the occurrence (Ranganathan & Aggarwal, 2018:184). In this study, 89 term singleton stillbirth placentas were examined after delivery, and maternal clinical data from the first antenatal care visit, labour, and delivery as well as the neonatal status was collected from the maternity case record book, using a data-collection tool to describe the placental findings of stillbirths in the selected public hospital.

### 3.2.3 Descriptive

A descriptive design describes the phenomenon and its characteristics by using observation and a survey tool to gather data (Siedllecki, 2020:8). Descriptive studies describe the distribution of one or more variables and characteristics of the variables, without regard for any causal factors (Ranganathan & Aggarwal, 2018:184; Leedy & Ormrod, 2015). A descriptive design is adopted to describe and interpret the current status of individuals, conditions and events. In this study, descriptive information was sought during the examination of placental findings related to the patient's demographic, environmental and socio-economic factors that were linked to the stillbirths.

### 3.2.4 Observational

Observational studies examine and explore the naturally occurring relationship between the exposure and the outcome of the study. . In this study, the researcher examined placentas from term singleton stillbirths and linked the findings to the maternal characteristics to determine the association of maternal characteristics with stillbirths.

## 3.3 STUDY SETTING

A study setting is the physical location and conditions in which data collection took place in the study (Polit & Beck, 2017:744). The study was conducted in a public hospital in the sub-district of eMalahleni in Nkangala District in Mpumalanga Province. The selected public hospital functions as a level 2 and 3 hospitals, serving as a referral hospital for 2 districts, which are Nkangala and Gert Sibande, with 6 sub-districts, 89 Primary Health Care facilities and 22 mobile clinics, and in urban and semi-rural, surrounded by many informal settlements. The population of Nkangala district is about 1,357,744. The area is surrounded by coal mines which attracts lots of immigrants from neighbouring countries like Mozambique, Zimbabwe, Swaziland, Lesotho, and others.

The sub-district and the surrounding area where the researcher is stationed is called eMalahleni which means "a place of coal", and is classified as the Highveld National Priority Area due to the majority of coal-fired electricity generating plants, and is surrounded by coal

mines and mine dumps which are a legacy of the coal industry. Coal mines and coal-fired power stations produce large amounts of waste into the atmosphere which results in air pollution (Department of Environmental Affairs, 2016:186). The smoke produced from the power stations affects air quality (Department of Environmental Affairs, 2016:186). The product of fossil fuel combustion from coal is mercury and carbon dioxide. The negative effects of mercury are alteration and damage to DNA and the chromosomes, which results in birth defects, miscarriages, and stillbirths (Department of Environmental Affairs, 2016:188). Several squatter camps or informal settlements are situated close to the coal mines. The camps have no electricity supply and rely on coal for fuel. Many of the informal settlement dwellers are pregnant women who inhale the polluted air from the mines. Contaminants in the air may cross the placenta and disrupt foetal development which may affect their unborn infants. Moreover, mining activities and processes pollute water (Department of Environmental Affairs, 2016). In Ghana, Amegah and Jaakkola (2017:3) found that biomass fuel use and consumption of unsafe water (polluted by mining activities) were associated with stillbirths and other adverse pregnancy outcomes.

Table 3.1 presents the stillbirth rates obtained from the monthly Perinatal and Maternal Mortality reviews conducted in the selected public hospital from the beginning of 2020 until the end of 2021. The stillbirth rate was calculated from the number of stillbirths and divided by the number of total births per thousand births.

**Table 3.1 Stillbirth rate for 2020-2021 as reflected in perinatal morbidity and mortality statistics of the selected hospital**

| Month (2020) | Fresh stillbirths | Macerated stillbirths | Stillbirth rate | Total |
|---|---|---|---|---|
| **January** | 5 | 4 | 21.6 | **9** |
| **February** | 8 | 3 | 27.4 | **11** |
| **March** | 3 | 14 | 43.1 | **17** |
| **April** | 4 | 12 | 42.0 | **16** |
| **May** | 2 | 14 | 41.1 | **16** |
| **June** | 3 | 19 | 52.3 | **22** |
| **July** | 2 | 19 | 51.4 | **21** |
| **August** | 2 | 14 | 40.8 | **16** |
| **September** | 5 | 14 | 44.7 | **19** |
| **October** | 4 | 17 | 50.2 | **21** |
| **November** | 6 | 16 | 53.2 | **22** |
| **December** | 7 | 21 | 56.0 | **28** |

| Month (2021) | Fresh stillbirths | Macerated stillbirths | Stillbirth rate | Total |
|---|---|---|---|---|
| **January** | 8 | 22 | 59.5 | **30** |
| **February** | 10 | 12 | 44.3 | **22** |
| **March** | 4 | 15 | 38 | **19** |
| **April** | 8 | 15 | 44.6 | **23** |
| **May** | 8 | 16 | 47.3 | **24** |
| **June** | 4 | 17 | 38.2 | **21** |

| | | | | |
|---|---|---|---|---|
| **July** | 7 | 13 | 42.6 | **20** |
| **August** | 4 | 15 | 40.6 | **19** |
| **September** | 10 | 14 | 49.8 | **24** |
| **October** | 5 | 11 | 32.2 | **16** |
| **November** | 10 | 13 | 42.1 | **23** |
| **December** | 4 | 15 | 38.85 | **19** |

## 3.4 RESEARCH METHODOLOGY

Polit and Beck (2017:510) describe research methodology as the steps, procedures and strategies taken to investigate the problem being studied and to analyse the collected data. Research methods are the techniques researchers use to structure a study and to gather and analyse information relevant to the research question (Polit & Beck, 2017:517). The research methodology includes the population/unit of analysis; sample and sampling; data collection and analysis.

### 3.4.1 Unit of analysis

A unit of analysis is the entire aggregate of people or objects in which a researcher is interested (Brink, van der Walt & van Rensburg, 2018:114). In this study, the unit of analysis consisted of singleton placentas from stillbirths as the focus was the placentas of term single stillbirths. A unit of analysis is the main parameter that is being investigated in the study (Polit & Beck, 2017). In this study, the unit of analysis was the placentas of term singleton stillbirths which were delivered in the selected public hospital.

### 3.4.2 Sampling and sample

Sampling is the process of selecting a sample from a population to obtain information regarding a phenomenon in a way that represents the population of interest (Brink, van der Walt & van Rensburg, 2018:115). The researcher used purposive or non-probability sampling to intentionally select placentas for the study (Polit & Beck, 2017:252). Term singleton placentas from stillbirths from all women who delivered at the selected hospital, and had consented to participate in the study, and within the study period were sampled.

Sample size refers to the number of participants in a study (Gray, Grove & Sutherland, 2017:691). The researcher used clinical data from patient files and the placentas from the cases for proper analysis and correlation of the variables of interest.

A unit of analysis and not the population was used, and the focus was the placentas of term single stillbirths. The average of stillbirths from the beginning of January 2021 to the end of December 2021 was 21 stillbirths per month in the selected public hospital. The researcher collected data from the beginning of October 2022 until the end of July 2023. The estimated number of stillbirths within the study period was 105. The statistician recommended utilising

100 placentas from selected cases to increase reliability and adequately describe the characteristics of variables under study.

Only placentas of women with confirmed intrauterine foetal death (IUFD) with a gestation of 37-40 weeks who delivered in the labour ward of the selected public hospital were included in the study. Placentas of women with confirmed intrauterine foetal death with a gestational age of < 37 weeks and > 41 weeks who delivered in the labour ward of the selected public hospital were excluded. The final sample size was 89, because of women who did not consent to participate in the study.

### 3.4.2 Data collection

Data collection is the process of collecting data related to the research question in a systematic way to address a research problem (Polit & Beck, 2017:510; Brink, van der Walt & van Rensburg, 2018:133). Pregnant women admitted to the labour ward were approached after counselling for eligibility who were ≥ 37 to 40 weeks of gestation by calculations from the first day of the last normal menstrual period which was confirmed by sonar. Pregnant women with confirmed intrauterine foetal death (IUFD) with a gestation of 37-40 weeks were included in the study. Informed consent for participating in the study and for placenta disposal were obtained from the women. Women admitted with foetal heart sounds who delivered fresh stillborns were approached after delivery for consent. Purposive secondary data, collected from the records in the patient files, was used (Kabir, 2016). The researcher collected the clinical maternal history from the maternity registers and patient files for stillbirths.

The researcher used a detailed data-collection questionnaire, adapted from the WHO *Making Every Baby Count* (2016:17) (see Annexure C). The tool was piloted on 20 cases, yielded the desired outcome which were presented and approved by the perinatal mortality committee of the selected hospital. The data collection questionnaire consisted of 5 sections:

**Section A: Maternal demographic profile**: Maternal age, education, and marital status

**Section B: Antenatal care**: Parity, gravidity, previous obstetric history, gestation at first antenatal care visit, pregnancy planned, contraceptives used, number of antenatal care visits, nutritional status, exposure to environmental factors, mental health screening, lifestyle habits, history of intimate partner violence, use of herbal medication, Covid-19 infection, vaccination against Covid-19, HIV status, ARV/PrEP, syphilis status, haemoglobin at booking, Rhesus factor, and maternal comorbidities.

**Section C: Labour and delivery**: Onset of labour, method of delivery, gestational age at delivery, foetal heart sound on admission, partogram used, and attendant at delivery.

**Section D: Status of the baby**: Sex, birth weight, and type of stillbirth.

**Section E: Placental findings:** Macroscopic/gross placental and microscopic/histology placental findings.

### 3.4.2.1 Clinical history

The maternal clinical history was collected from the maternity case record book and the maternity register using a data collection tool. The clinical history included the following:

- **Demographic profile**: Maternal age, residential address, educational status, marital status, and race.
- **Previous obstetric history:** Parity and gravidity, history of previous miscarriage, stillbirth, and neonatal death.
- **Present obstetric history:** Gestational age at first antenatal care visit, pregnancy planned, use of contraceptives, number of antenatal care visits, booking bloods done and the results (syphilis, HIV, Rhesus factor, and haemoglobin).
- **Maternal comorbidities:** Chronic hypertension, preeclampsia, heart disease, diabetes, thyroid disease, and TB.
- **Maternal infections**: Covid-19 infection and other infections affecting the reproductive system.
- **Maternal nutritional status:** Body mass index (BMI), mid-upper arm circumference (MUAC).
- **Maternal lifestyle:** Cigarette smoking, alcohol/substance abuse and intimate partner/domestic violence.
- **Labour and delivery:** Foetal heart sound on admission, onset of labour, method of delivery, gestational age at delivery, partogram used.
- **Status of the baby**: Sex, birth weight, type of stillbirth.

### 3.4.2.2 Macroscopic examination

The macroscopic examination included the weight and dimensions of the placenta, the cord, and the membranes.

- **Placental weight:** All placentas were weighed using an electronic scale and the weights were plotted on the placenta weight for gestational charts as potential predictors of placental efficiency.
- **Placental disk dimensions:** Measurements of the placental disks were done of three dimensions: length, width and thickness. The maternal surface was observed for infarcts, calcifications, and completeness of the cotyledons. The foetal surface was observed for colour and thrombi.
- **Description of the umbilical cord:** Description of the umbilical cord insertion was noted, the cord length and diameter measured, the cord coiling, cord knots cord colour, and the

number of cord blood vessels were recorded. The umbilical cord was also assessed for cord oedema or inflammation to exclude funisitis.

- **Description of the membranes:** The membranes were observed for colour/opacity and completeness to exclude signs of ascending maternal infection.
- **Placenta preparation for histological micro examination:** After gross examination, the placental disks, membranes and cord were then prepared for histological examination. The placentas, membranes, and cords were put in a biohazard placenta bucket, fixed with fixation liquid of 10% buffered Formalin, labelled and sent to the local National Health Laboratory Services for capturing before they were sent to Tshwane National Health Laboratory Services.

Figure 3.1 summarises the data-collection procedure.

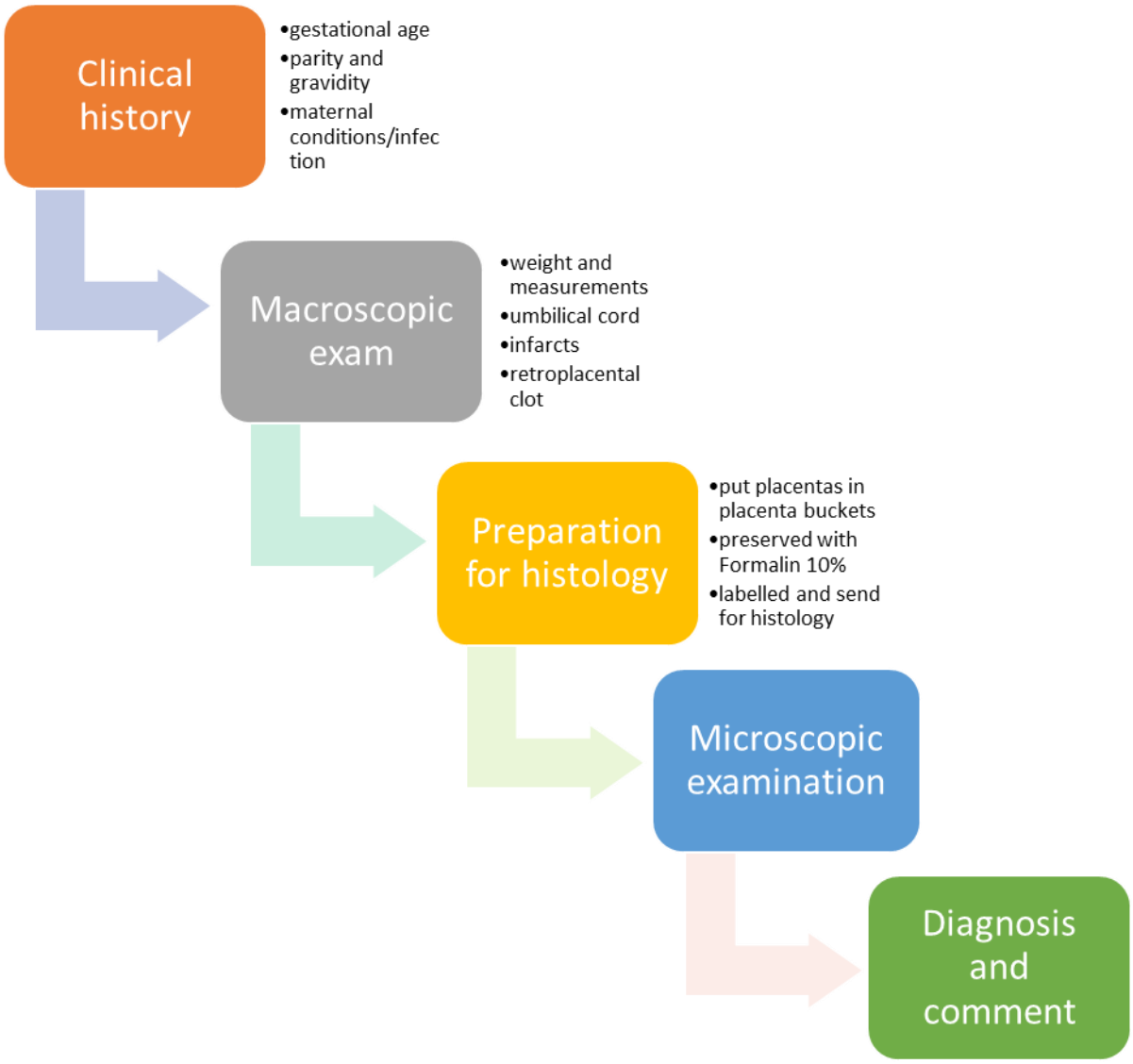


**Figure 3.1 Data-collection procedure**

The clinical history was collected from the patients' maternity case records and maternity registers and recorded in the data-collection tool. Placentas of term singleton stillbirths were collected immediately after delivery. They were macroscopically examined for completeness, retro-placental haematoma, meconium staining, infarcts, calcifications, cord for knots, hypercoiling, and the presence of 3 blood vessels. The placentas were weighed and compared with the placenta weight for gestational age chart (Redline, 2015:523). The placental diameter and cord thickness were measured and recorded according to the standard operational procedure of the selected hospital (see Annexure E). After the macroscopic examination, placentas were put in placenta buckets. Formalin 10% was added to preserve them. The placentas were labelled and sent for histology. Histology results were received after 4-6 weeks, already interpreted, authorized by a senior pathologist in an easy-to-read format. The researcher and the Perinatal Morbidity and Mortality Committee under the leadership of a specialist doctor then discussed and concluded every case in their monthly meetings before the findings were recorded.

#### 3.4.2.3 Variables

A variable is an attribute that takes on different values and is any quality or characteristic in a research investigation that has two or more possible values (Polit and Beck, 2017:748; Leedy & Ormrod, 2015:179). Ranganathan and Aggarwal (2016:2) describe a variable as a measurable attribute across the study. Variables can be independent or dependent. An independent variable is a variable that the researcher studies as a possible cause of something (Leedy & Ormrod, 2015:179). Maternal characteristics collected from the clinical files included the following specific variables: maternal demographic characteristics, maternal education, marital status, previous obstetric history, gestational age at first visit, number of antenatal visits, maternal nutritional status, exposure to environmental factors, mental health screening, medical conditions and infections, lifestyle habits, labour and delivery, and status of the neonates. A dependent variable is a variable that is being measured or tested and is not changed by other variables (Polit & Beck, 2017:748). In this study, the dependent variable was stillbirth.

### 3.4.3 Data analysis

Data analysis is the systematic organisation and synthesis of research data (Polit & Beck, 2017:525). Descriptive data analysis was used to organise and present the data in a meaningful way to help identify patterns and trends (Polit & Beck, 2017; Leedy & Ormrod, 2015; Kabir, 2017). The statistician used Excel 2016 to capture the data and the IBM SPSS Statistics program version 28 to analyse the data, and presented the results in percentages tables, pie charts, bar graphs and other graphs (Polit & Beck, 2017; Kabir, 2017). The Pearson chi-square was used to test the hypothesis, frequency and distribution of variables.

Descriptive data analysis was used which is defined as numbers that summarize the data with the purpose of describing the characteristics of the variables and to influence conclusions (Leedy & Ormrod, 2016:243). Numbers are meaningless unless a pattern that lie beneath them is found (Kabir, 2017:277).

The data was coded. Coding is the process of assigning numbers or symbols to the data collection tools that are already completed (Kabir, 2017:277). The data was then reduced to suitable forms to report conclusions and findings of the unit of analysis (Kabir 2017:277). The large amount of data was condensed into a few manageable groups, put in tables, and organised according to the frequency of variables for further analysis (Kabir, 2017:277).

### 3.4.5 Validity and reliability

The quality of research is determined by its validity and reliability.

#### 3.4.5.1 Validity

Validity is the degree to which an instrument measures what it is supposed to measure (Polit & Beck, 2017:194; Leedy & Ormrod ,2016:97).

The researcher ensured that the sample size was large enough as advised by the statistician and used a questionnaire adapted from WHO *Making Every Baby Count* (2016:17) and a standardised placenta examination tool. The placenta examination tool is a standardised tool that was used in the selected public hospital. Internal validity is the extent to which the design and data allow the researcher to draw accurate conclusions and other relationships within the data collected (Leedy & Ormrod, 2016:85). The questionnaire, placenta examination tool and histology report were presented and discussed at the selected public hospital's Perinatal Morbidity and Mortality Committee. Midwives are trained to examine placentas macroscopically. As an experienced midwife, the researcher is a member of the Perinatal Morbidity and Mortality Committee of the selected public hospital comprising a multidisciplinary team which includes a specialist paediatrician and district specialists. The committee meets monthly and is headed by a specialist obstetrician who works with pathologists from Tshwane NHLS where microscopic placental examination is done. Midwives/doctors are mandated by the National Department of Health's *Guidelines for Maternity Care in South Africa* (2016:93) to examine all placentas for completeness and abnormalities including placentas following a stillbirth to exclude placenta insufficiency, abruptio placentae, infection, true knots or other abnormalities in the cord including the number of blood vessels.

The researcher ensured content and construct validity by using a validated tool. The measurement tool was piloted, yielded desired outcomes which was approved by the Perinatal Mortality Committee of the selected hospital.

- **Content validity.** Content validity refers to the extent to which a measurement instrument is a representative sample of the content area being measured (Polit & Beck, 2017:303; Leedy & Ormrod, 2015:97).
- **Construct validity.** Construct validity refers to the extent to which an instrument measures a characteristic that cannot directly be observed but is assumed to exist based on the patterns in people's behaviour (Leedy & Ormrod, 2015:97). Some questions found in the measurement instrument, such as intimate partner violence, could not be measured, therefore the researcher relied on the honesty of the participant responses.

#### 3.4.5.2 Reliability

Reliability refers to "the degree of consistency or dependability with which the instrument measures the attribute it is designed to measure. If the instrument is reliable, the results will be the same each time the test is repeated" (Polit & Beck, 2017:304).

Using reliability allowed the scores to be free from measurement error and consistent (Polit & Beck, 2017:304). The placenta examination tool used in the hospital is a standardised tool and the questionnaire was adapted from the WHO (2016:71) which are reliable sources.

#### Objectivity

Objectivity means the researcher is not influenced by personal feelings and opinions (Leedy & Ormrod, 2015:105). The researcher did not tamper with or alter the findings of the placenta examination, or the clinical information obtained from the records.

## 3.5 SUMMARY

The chapter discussed the research design and methodology of the study, including the setting, unit of analysis, sample and sampling, data collection and analysis, and the reliability and validity of the data-collection methods and instruments. Chapter 4 discusses the data analysis, interpretation and the results.

# CHAPTER 4 DATA COLLECTION AND ANALYSIS, AND FINDINGS

## 4.1 INTRODUCTION

Chapter 3 describes the research design and methodology of the study. The study aimed to assess and describe the placental findings of macroscopic and microscopic placenta examinations in singleton term stillbirths in the selected public hospital in the eMalahleni sub-district in Mpumalanga Province. To achieve the aim, the objectives were to examine placentas of term singleton stillbirths macroscopically and microscopically for placental findings related to stillbirths in the selected public hospital and to describe the characteristics and trends of the placental lesions of the stillbirths.

This chapter discusses the data collection and analysis, and the findings.

## 4.2 DATA COLLECTION

Data collection took place in the maternity ward of the selected public hospital from October 2022 to July 2023. The sample consisted of 89 placentas from term singleton stillbirths. The researcher used a detailed data-collection questionnaire, adapted from the WHO *Making Every Baby Count* (2016:17) to collect data from the maternity case records and the maternity registers.

The data-collection questionnaire consisted of five sections as indicated in Table 4.1.

**Table 4.1 Data-collection questionnaire**

**Table 4.1 Data-collection questionnaire**

| Section | Description |
|---|---|
| A | Maternal demographic profile |
| B | Antenatal care |
| C | Labour and delivery |
| D | Status of the baby |
| E | Placental findings |

### 4.2.1 Section A: Participants' demographic profile

Section A covered the participants' age, education, marital status, and race/ethnicity (see Table 4.2). Of the participants, 78% (n=69) were 18-35 years old and 22% (n=20) were above 35 years old; 86% (n=77) had secondary education; 9% (n=8) had primary education, 3% (n=3) had tertiary education, and 0,1% (n=1) was home-schooled; 91% (n=81) were single,

0,07% (n=6) were married and 2% (n=2) was divorced, and 96% (n=85) were black and 4% (n=4) were white. The selected hospital is a tertiary hospital and 75% (n=67) of the participants were referrals from the district hospitals and the local clinics with either reduced foetal movements, no foetal heartbeat, with preeclampsia, or antepartum haemorrhage while 25**%** (n=22) of the participants were self-referrals (see Table 4.2).

**Table 4.2 Participants' demographic profile**

| **Demographic profile** | | **Number (N=89) Perc %** | |
|---|---|---|---|
| Age | <18 | 0 | 0% |
| | 18-35 | 69 | 78% |
| | >35 | 20 | 22% |
| Education | Primary | 8 | 9% |
| | Secondary | 77 | 87% |
| | Tertiary | 3 | 3% |
| | Home-schooled | 1 | 1% |
| Marital status | Married | 6 | 7% |
| | Single | 81 | 91% |
| | Divorced | 2 | 2% |
| Race | Black | 85 | 96% |
| | White | 4 | 4% |
| Referral | Referred | 67 | 75% |
| | Self-referral | 22 | 25% |

**Discussion**

- **Maternal age**

Of the participants, 78%, (n=69) were 18 to 35 years old, 22% (n=20) were older than 35, and none were younger than 18. In India, stillbirths were associated with teenage pregnancy and with advanced maternal age (Tiwari, Gupta & Jain, 2021). In China, advanced and very advanced maternal age >40 years was associated with an increased risk of adverse perinatal outcomes, including stillbirths (Wu, Ren, Zhu, Peng, Zhang & Li, 2021). Advanced maternal age is associated with poor implantation and poor placental perfusion because of the reduced hormones responsible for or involved in the implantation process (Mondal, Baske & Biswas, 2017).

- **Maternal education**

Of the participants, 87% (n=77) had secondary education, 9% (n=8) had primary, 3% (n=3) had tertiary education, and 1% (n=1) was home-schooled. In Ethiopia, maternal education had an impact on maternal knowledge about health issues, the utilisation of antenatal care services and stillbirth (Tesema, Gezie & Nigatu, 2020).

- **Marital status**

The majority of the participants (91%**,** n=81) were single, 7% (n=6) were married, and 1% (n=1) were divorced. Maternal marital status has an impact on perinatal outcomes as it affects women's emotional and economic support. Women who are not married have an increased risk of stillbirth due to socio-economic insecurity and lack of psychological support (Bedwell, Blaikie, Danna, Sutton et al., 2020).

- **Maternal race/ethnicity**

Of the participants, 96% (n=85) were Black and 4% (n=4) were White. Maternal race is associated with an increased risk of stillbirth due to socio-economic discrepancies (Mhlophe, 2019).

- **Referral**

Of the participants, 75% (n=67) were referred from the district hospitals and clinics for risk factors, and 25% (n=22) were self-referrals who presented to the selected hospital with either antepartum bleeding, reduced or absence of foetal movements. According to the Department of Health's maternity guidelines, 2016, women with risk factors should be referred to higher-level institutions of service.

### 4.2.2 Section B: Antenatal care

Section B consisted of 9 items covering antenatal care information and was obtained from the patient records. Table 4.3 lists the participants' antenatal care information.

Of the participants, 64% (n=57) were multigravida, 21% (n=19) were primigravida, and 15% (n=13) were grand multipara. Regarding previous obstetric history, 75% (n=67) had no previous obstetric history; 18% (n=16) had previous abortions; 4% (n=4) had previous stillbirths, and 1% (n=1) had a molar pregnancy. Of the participants, 57% (n=51) were late bookers (>20 weeks), 30% (n=27) booked early (<20 weeks) and 12% (n=11) were unbooked. Of the participants, 54% (n=48) had 4-7 antenatal visits, 35% (n=31) had 1-3 visits, and 12% (n=11) did not attend the antenatal clinic. The majority of the participants, 93% (n=83) were not on contraceptives and 6% (n=6) were on contraceptives. Of the pregnancies, 54% (n=48) were not planned and 40% (n=36) were planned.

Regarding BMI/MUAC, 35% (n=31) were obese, 16% (n=14) were overweight, 13**%** (n=12) were healthy and 1% (n=1) was underweight. The researcher found 35% (n=31) files with no body mass index and mid-upper arm circumference recorded. Of the participants, 90% (n=80) were non-smokers, 5% (n=5) were passive smokers, and 4% (n=4) were active smokers; 90% (n=80) took no alcohol or substances, 9% (n=8) took alcohol, and 1% (n=I) was on substances

(crystal methamphetamine) throughout pregnancy. Of the participants, 80% (n=71) were rhesus positive,18% (n=16) had no rhesus status indicated, and 2% (n=2) were rhesus negative and did receive anti-D immunoglobulin (RhoGAM). Of the participants, 5% (n=5) had a positive syphilis status and were not treated, 16% (n=14) had an unknown syphilis status, and 15% (n=13) were anaemic.

**Table 4.3 Participants' antenatal care**

| ***Antenatal care*** | ` | **N=89** | **Percentage %** |
|---|---|---|---|
| *Parity and gravidity* | Primigravida | 19 | 21% |
| | Multigravida | 57 | 64% |
| | Grande multipara | 13 | 15% |
| *Previous obstetric history* | Abortion | 16 | 18% |
| | Stillbirth | 4 | 4% |
| | Neonatal death | 1 | 1% |
| | Molar pregnancy | 1 | 1% |
| | None | 67 | 75% |
| *Gestational age at first visit* | <20 wks. | 27 | 31% |
| | >20 wks. | 51 | 57% |
| | Unbooked | 11 | 12% |
| *Number of antenatal visits* | 0 | 11 | 12% |
| | 1-3 visits | 31 | 35% |
| | 4-7 visits | 47 | 53% |
| *Contraceptives used* | Yes | 6 | 7% |
| | No | 83 | 93% |
| *BMI/MUAC* | Healthy | 12 | 13% |
| | Overweight | 14 | 16% |
| | Obese | 31 | 35% |
| | Underweight | 1 | 1% |
| | Not done | 31 | 35% |
| *Exposure to environmental factors* | Active smoker | 4 | 4% |
| | Passive smoker | 5 | 6% |
| | Not smoking | 80 | 90% |
| *Lifestyle habits* | Alcohol | 8 | 9% |
| | Substances | 1 | 1% |
| | None | 80 | 90% |
| *Rhesus factor* | Negative | 2 | 3% |
| | Positive | 62 | 69% |
| | Not done | 25 | 28% |
| *Mental health screening* | Done | 26 | 29% |
| | Not done | 63 | 71% |

**Discussion**

In South Africa, antenatal care aims to reduce maternal and perinatal mortality. Good quality antenatal care can improve birth outcomes through preventive measures, proper assessment, identification of high-risk factors, and proper management (NDoH, 2016).

- **Participants' parity and gravidity**

Parity and gravidity are associated with an increased risk of adverse perinatal outcomes. Of the participants, 64% (n=57) were multigravida, 21% (n=19) were primigravida, and 15% (n=13) were grande multipara. In their study on maternal and foetal risk factors for stillbirths, Gardosi, Madurasinghe, William, Malik and Francis (2013) found that zero (0) parity and parity of three (3) or more were at increased risk for stillbirths.

- **Previous obstetric history**

Previous obstetric history of abortions and stillbirths is a risk factor for stillbirth (Lema, Mremi, Amsi et al. 2020). Of the participants, 75% (n=67) had no previous obstetric history, 18**%** (n=16) had abortions, 4% (n=4) had stillbirths, 1% (n=1) had neonatal death, and 1**%**(n=1) had a molar pregnancy.

- **Gestational age at first visit**

Late antenatal care booking and no antenatal attendance are associated with stillbirth. In this study, 57% (n=51) of the participants were late bookers, and 12% (n=11) were not booked.

The World Health Organization (2016) and Seebregts, Barron, Tanna, Benjamin and Fogwill (2016) stress the importance of antenatal care and regular attendance for positive birth outcomes. The Department of Health's maternity guidelines (2016) recommend that the first visit be after the first missed period for a positive perinatal outcome. The sooner antenatal care is initiated, the better problems can be detected in time, treatment can be started and women with high-risk conditions can be referred. Inappropriate timing of the first antenatal booking is associated with poor pregnancy outcomes, which include perinatal deaths, and stillbirths (Tesema, Gezie & Nigatu, 2020).

- **Number of antenatal visits**

Of the participants, 53% (n=47) attended more than four antenatal care visits, 35% (n=31) had 1-3 visits and 12% (n=11) did not attend antenatal clinic at all. The World Health Organization (2016) and the South African Department of Health (2016) recommend eight (8) antenatal care visits to reduce perinatal mortality. A study in Northern Tanzania found that fewer antenatal visits were associated with stillbirths (Lema, Mremi, Amsi, Pyuza et al., 2020). In Durban, Natal, an increased number of antenatal visits was associated with less adverse perinatal outcomes, including stillbirths (Hoque, Hoque, van Hal & Buckus, 2022). Antenatal visits present opportunities for reaching pregnant women with interventions (Hoque, Hoque, van Hal & Buckus, 2022).

- **Contraceptive use**

Of the participants, 93% (n=83) did not use contraceptives and 54% (n=48) pregnancies were not planned. Family planning is the most impactful single intervention for saving the lives of mothers and babies, and increased family planning coverage and contraceptive prevalence can avoid stillbirths (McGee, Chola, Tugendhaft, Mubaiwa et al., 2016). The United Nations (2015) Sustainable Goals 2030 target is for 63% of women in sexual relationships to be on contraceptives. Women must make their own informed decisions regarding their sexual and reproductive health. Harmful gender norms, biases and inequalities negatively impact the rights of women and girls to safe, quality, and affordable healthcare services (WHO, 2020).

- **Body mass index (BMI)/Mid-upper arm circumference (MUAC)**

Of the participants, 35% (n=31) were obese, 35% (n=31) had no weight recorded, 16% (n=14) were overweight,14% (n=12) were healthy (good weight), and 1% (n=1) were underweight. Maternal nutrition has an impact on foetal development and gestational outcomes. In Brazil, Miele, Souza, Caldero, Feitosa et al., (2021) assessed the nutritional status of 1,165 nulliparous pregnant women by body mass index (BMI) and mid-upper arm circumference (MUAC), associated with dietary patterns and sociodemographic characteristics. The body mass index and mid-upper arm circumference reflect the maternal nutritional status, but the mid-upper arm circumference has advantages over the body mass index because it does not require calculation and is independent of pre-pregnancy weight (Miele, Souza, Caldero, Feitosa et al., 2021). A study in Romania found that obesity was associated with other risk factors such as gestational diabetes and hypertensive disorders, foetal macrosomia, and late stillbirths in pregnancy, which are associated with maternal inflammatory response, abnormal and malperfusion of the placenta, with an increase in maternal and perinatal morbidity and mortality (Tabacu, Istrate-Ofiteru, Manolea, Dijmarescu et al., 2022).

- **Mental health**

Pregnancy causes many physical and biochemical changes. The placenta plays an important role as an endocrine organ regulating hormones that impact the well-being of the mother and the foetus. Mental health screening was only done on 29% (n=26) of the participants, and 71% (n=63) were not screened. Of the screened participants, 27% (n=24) were recorded as zero score, 1% (n=1) were recorded as two and three, and requiring referral but were not referred, and 1% (n=) had no recorded score.

The maternal mental health status must be assessed and a score between zero and three (0-3) allocated during all antenatal visits. A score of 0 means that the woman is psychologically stable and a score of 2 and 3 needs referral for psychological assessment, intervention and

support (NDoH, 2016). Adverse placental changes may occur, which could lead to perinatal morbidity and mortality. Another role of the placenta in mental health is to regulate maternal mood (Thomas, 2020). In Iran, during the COVID-19 pandemic, depression and anxiety among pregnant women increased dramatically compared to non-pregnant women (Abdoli, Falahi, Kenarkoohi et al., 2020).

- **Exposure to environmental factors**

Of the participants, 90% (n=80) did not smoke, 6% (n=5) were passive smokers, and 4% (n=4) were active smokers. Maternal exposure to air pollution during pregnancy is exacerbated by social environmental factors such as smoking, second-hand smoke, poor nutritional intake and chronic stress, and may result in adverse pregnancy outcomes (Erickson & Arbour, 2014). Smoking cigarettes actively or passively and using drugs during pregnancy are associated with an increased risk of foetal growth restriction, which is a major cause of stillbirths (Gardosi, Madurasinghe, William, Malik & Francis, 2013).

- **Lifestyle habits**

Of the participants, 90% (n=80) did not take alcohol or substances, 9% (n=8) took alcohol, and 1% (n=1) took substances during pregnancy. Maternal lifestyle habits such as alcohol consumption or taking recreational drugs cause placental dysfunction because of their vasoconstriction effect on the placental blood vessels (Reijnders, Mulders, van der Windt et al., 2018). Alcohol intake during pregnancy increases the risk of placental abruption and abnormal placentation (Gualdoni, Jacobo, Barril, Ventureira & Cebral, 2022). Maternal alcohol consumption reduces placental weight and size and is associated with maternal malperfusion and umbilical cord contraction. All pregnant women should be asked about their alcohol and substance use (past and present) throughout their antenatal visits (WHO, 2016).

- **Rhesus factor**

Of the participants, 80% (n=71) had rhesus-positive blood, 2% (n=2) had rhesus-negative blood and did receive anti-D, and 18% (n=16) had no rhesus factor recorded.

Rhesus incompatibility occurs when the mother's blood type is Rh negative and her foetus's blood type is Rh positive. Rhesus incompatibility has been an important cause of neonatal morbidity and mortality, including stillbirth (Aliyo, Ashenafti & Abdusalam, 2023). If the woman has rhesus negative blood and the foetus has rhesus positive blood, sensitization may occur which may lead to stillbirth. Sensitization may be prevented by the administration of RhoGAM or anti-D which is a medicine that prevents the blood from making antibodies. To reduce RH incompatibility that may cause haemolytic disease of the newborn (HDN), the government

should encourage communities and pregnant women through health education as they follow antenatal care (ANC) to screen Rh-D types (Aliyo, Ashenafti & Abdusalam, 2023).

- **Maternal comorbidities/infections**

Of the participants, 21% (n=19) were HIV positive,19% (n=17) had preeclampsia,15% (n=13) had anaemia, 6% (n=5) had syphilis, 2% (n=2) had cardiac disease, 2% (n=2) had diabetes, 1% (n=1) had TB, 1% (n=1) had epilepsy, (n=1) had asthma, and 2% (n=2) had Covid-19. Table 4.4 and Figure 4.1 summarise the participants' maternal conditions/diseases.

**Table 4.4 Summary of participants' maternal conditions/diseases**

| Maternal condition/infection | N=89 | Percentage % |
|---|---|---|
| HIV+ | 19 | 30% |
| Preeclampsia | 17 | 27% |
| Anaemia | 13 | 21% |
| Syphilis | 5 | 8% |
| Cardiac disease | 2 | 3% |
| Diabetes | 2 | 3% |
| TB | 1 | 2% |
| Epilepsy | 1 | 2% |
| Asthma | 1 | 2% |
| Covid-19 | 2 | 3% |

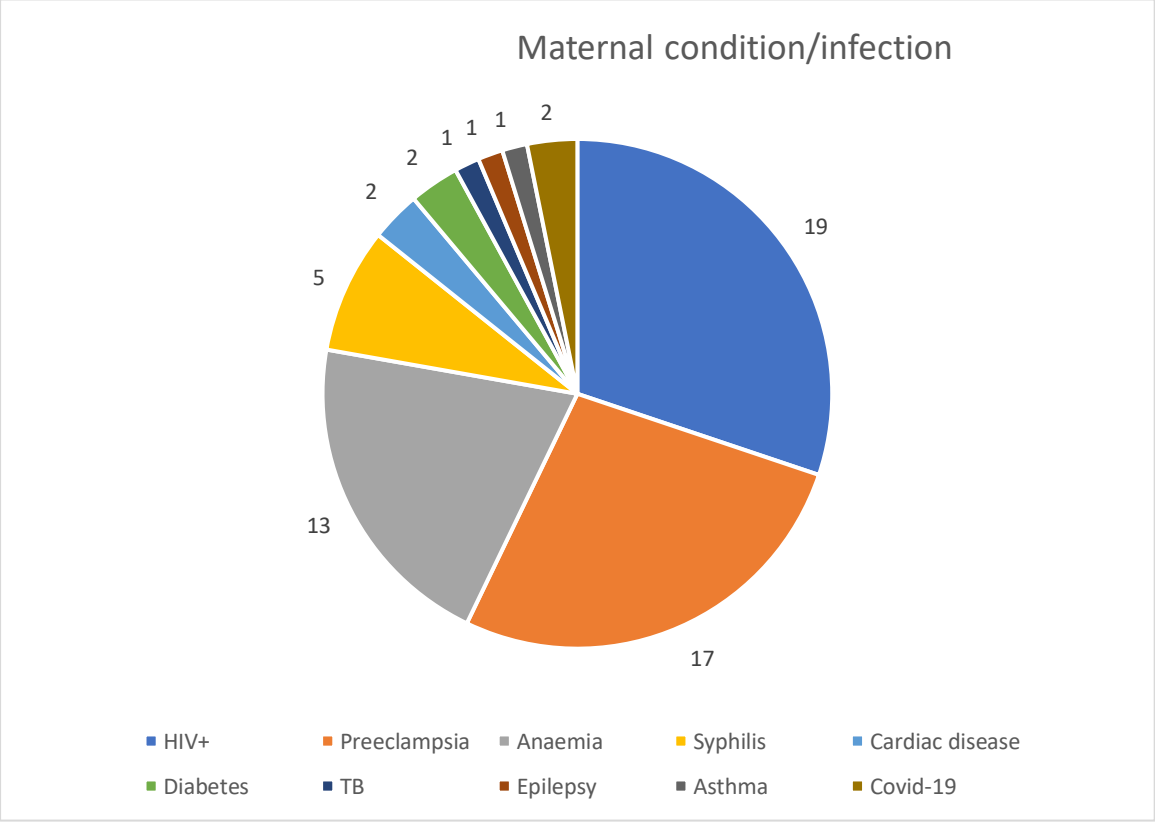


**Figure 4.1 Summary of participants' maternal comorbidities/infections**

**Discussion**

Of the participants, 71% (n=63) had maternal medical diseases or conditions as indicated in Figure 4.2. Of the participants, 30% (n=19) had HIV (HIV+), 27% (n=17) had preeclampsia, 21% (n=13) had anaemia, and 8% (n=5) had syphilis. Maternal diseases such as hypertensive disorders and diabetes are mostly associated with an increased risk of stillbirth (Tesema, Gezie & Nigatu, 2020). Maternal diseases and infections may lead to placental dysfunction which increases the risk of adverse maternal and perinatal outcomes, including stillbirths. In a tertiary care centre in India, Tiwari, Gupta and Jain (2021) found that more than half of the women who had stillbirths had medical disorders or conditions. In their study in South Africa, Ikumi, Malaba, Pillay, Cohen, Mdlala et al., (2021) found that HIV-positive women were at increased risk of developing placental pathologies such as maternal vascular malperfusion and increased chronic and acute maternal inflammatory response (chorioamnionitis). Congenital syphilis is preventable if testing and treatment are provided early during antenatal visits, yet babies are still dying from the infection (WHO, 2019).

### 4.2.3 Section C: Labour and delivery

The section on labour and delivery examined the onset of labour, method of delivery, gestational age at delivery, foetal heart sound on admission, partogram use, and attendant at delivery.

Of the participants, 65% (n=58) had a spontaneous onset of labour, 29% (n=26) had an induction, 2% (n=2) had self-induction of labour through backstreet insertion of Cytotec, 84% (n=75) had normal vertex deliveries and 16% (n=14) had caesarean sections. Regarding gestational age at delivery, 98% (n=87) were 37-40 weeks and 2% (n=2) were 41-42 weeks of gestation due to a discrepancy in the last normal menstrual period and the sonar results on admission. Of the participants, 90% (n=80) had no foetal heart sounds on admission and 10% (n=9) had foetal heart sounds on admission. The partogram was used on 17% (n=15) of the participants in labour and 83% (n=74) were not monitored. Of the participants, 71% (n=63) were attended by midwives only during delivery and 29% (n=26) were attended by midwives and doctors. Table 4.5 summarises the participants' labour and delivery.

**Table 4.5 Participants' labour and delivery**

| **Labour and delivery** | | **N=89** | **Percentage %** |
|---|---|---|---|
| Onset of labour | Induction | 29 | 33% |
| | Spontaneous | 58 | 65% |
| | Self-induced | 2 | 2% |
| Method of delivery | Normal vertex delivery | 75 | 84% |
| | Caesarean section | 14 | 16% |
| Gestational age at delivery | 37-40 wks | 87 | 98% |
| | 41-42 wks | 2 | 2% |

| | | | |
|---|---|---|---|
| Foetal heart sound on admission | Yes | 9 | 10% |
| | No | 80 | 90% |
| Partogram used | Yes | 15 | 17% |
| | No | 74 | 83% |
| Attendant at delivery | Midwife | 63 | 71% |
| | Midwife & Doctor | 26 | 29% |

**Discussion**

- **Onset of labour**

Induction of labour can be performed soon or within 24 hours after foetal death is confirmed (Brosens, Puttemans & Benagiono, 2019). Maternal preferences, gestational age, and previous obstetric history are taken into consideration. An elective and emergency caesarean section can be performed depending on the indications, for example, antepartum, or intrapartum bleeding in case of placenta abruption or two previous caesarean sections (Kovo & Schriber, 2021). Delivery should be expedited in the presence of sepsis or rupture of membranes. Delivery must not be prolonged after confirmation of foetal death to prevent complications associated with coagulation (disseminated intravascular coagulopathy) (Kovo & Schriber, 2021).

- **Method of delivery**

Of the participants, 84% (n=75) had normal vertex deliveries and 16% (n=14) had caesarean section deliveries. Vaginal delivery is recommended after spontaneous labour or following induction of labour. In Ethiopia, Tesema, Gezie and Nigatu (2020) found that most women had vaginal deliveries after stillbirth.

- **Gestational age at delivery**

Of the participants, 98% (n=87) delivered at 37-40 weeks and 2% (n=2) delivered at 41-42 weeks. Despite advances in healthcare, stillbirth rates remain relatively unchanged. Muglu, Rather, Arroyo-Manzano, Bhattacharya, Balchin et al., (2019) conducted a systematic review to quantify the risks of stillbirth and neonatal death at term (from gestation) according to gestational age between 1990 and 2018 in high-income countries. The findings suggest a significant additional risk of stillbirth, with no corresponding reduction in neonatal mortalities when term pregnancies continue to 41 weeks compared to delivery at 40 weeks (Muglu, Rather, Arroyo-Manzano, Bhattacharya, Balchin et al., 2019).

- **Foetal heart sounds on admission**

Of the participants, 90% (n=80) had no foetal heart sounds on admission and 10% (n=9) had foetal heart sounds on admission. Macerated stillbirths are identified by peeling of the skin

which indicates that foetal death occurred more than 24 hours before delivery. Macerated stillbirths are always associated with poor quality antepartum care, and fresh stillbirths are associated with poor quality intrapartum care (Bedwell, Blaikie, Danna, Sutton, Laisser, Kasengele, Wakasiaka, Victor & Lavender, 2020).

In 2019, Mhlophe examined the factors contributing to the occurrence of stillbirths in a tertiary hospital in the eMalahleni sub-district, Mpumalanga province, South Africa, and found an increased percentage of macerated stillbirths. The study found that 80% of the demised foetuses were confirmed intrauterine deaths on admission and 50% of the stillbirths were unexplained and were delivered by women from the local eMalahleni sub-district. About 56% initiated their antenatal care in the second trimester (Mhlophe, 2019).

- **Partogram use**

Of the participants, 83**%** (n=74) were not monitored on the partogram and 17**%** (n=15) were monitored with the partogram.

In 2011, the Department of Health introduced the Strategic Plan for Maternal, Newborn, Child and Women's Health (MNCWH) and Nutrition. The purpose was to accelerate the reduction of maternal and child morbidity and mortality through the implementation of evidence-based interventions aimed at improving maternal health and child survival. The strategies included the correct use of the partogram and standard protocols for the management of obstetrics emergencies (ESMOE). According to the Department of Health (2016), all women in labour, whether spontaneous or induced, should be monitored with a partogram to observe the maternal condition and progress of labour. There is an increased risk of intrapartum stillbirth when the foetal heart rate is inadequately monitored by not using a partogram (Bedwell, Blaikie, Danna, Sutton et al., 2020).

- **Attendant at delivery**

Of the participants, 71% (n=63) were attended by a midwife and 29% (n=26) were attended by a midwife and doctor.

According to the Department of Health (2016), all women in labour should be attended to by skilled and experienced birth attendants and be seen by a doctor at least every four hours if they have high-risk conditions. In South Africa, an attendant is a competent health professional who provides quality, human rights-based, culturally sensitive and dignified care to pregnant women and their newborns during childbirth. The training of birth attendants includes the following programmes: ESMOE and Helping Babies Breathe.

### 4.2.4 Section D: Status of the baby

Of the stillborn neonates, 55% (n=49) were males and 45% (n=40) were females. A study in Northern Tanzania found an increased prevalence of male stillborn neonates (Lema, Mremi, Amsi, Pyuza et al., 2020). Blackwell, Landon, Mele, Reddy et al., (2015) attributed male excess stillbirths to increased foetal plasma testosterone during pregnancy, which has a significantly high pro-inflammatory response to infection.

Figures 4.2 and 4.3 display the sex and the birth weights of the stillbirths.

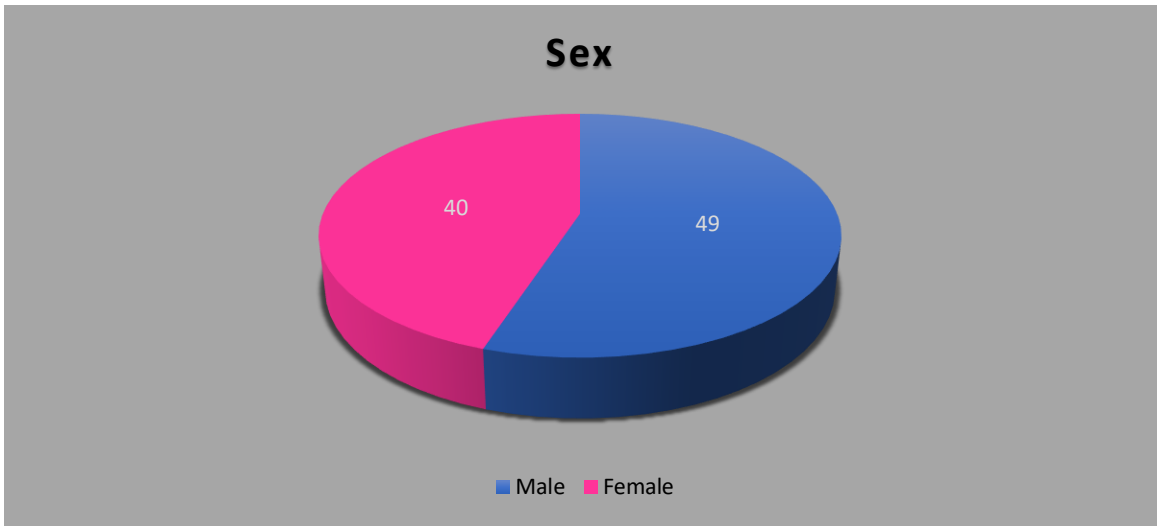


**Figure 4.2 Summary of sex of the stillbirths**

#### 4.2.4.1 Birth weight

The birth weights of the participants' stillborn babies were as follows: 59**%** (n=53) were 1100-2400g, 31% (n=28) were 2500-3500g, 3**%** (n=3) were 3600-4000g, 3**%** (n=3) were >4000g and 2**%** (n=2) were 500-1000g (see Figure 4.3).

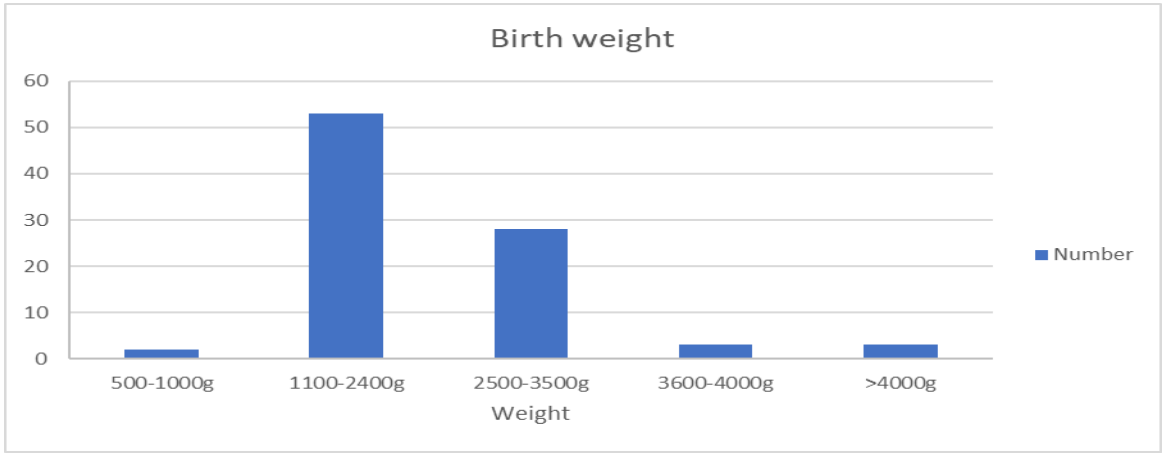


**Figure 4.3 Summary of the birth weights**

**Discussion**

In this study, the birth weights were significantly lower for gestational age, which indicated the presence of intrauterine growth restriction which may have been due to maternal conditions (Stevens, Odell & Wadee, 2023). Intrauterine growth restriction should be discovered during antenatal care visits. According to the Department of Health (2016) a measurement of less than the 10th percentile for gestational age as noted on the antenatal symphysis-fundal graph or failure of the symphysis fundal height to increase on serial measurement should raise suspicion of intrauterine growth restriction and the woman should be referred for an ultrasound.

- **Type of stillbirth**

Of the stillbirths, 75% (n=67) were macerated stillbirths. In macerated stillbirths, foetal death occurs more than 12 hours before delivery and the viable foetus is born with no sign of life and born with peeling skin or autolytic changes. Macerated stillbirths reflect the quality of antenatal care (Michalow, Chola, McGee, Tungendraft et al., 2015). Lack of antenatal care, infrequent antenatal care visits, inadequate assessment of women, and lack of appropriately trained staff are contributory factors to antepartum stillbirths (macerated stillbirths) (National Perinatal Morbidity and Mortality Committee, 2016). Fresh stillbirth implies that foetal death occurred within 12 hours of labour or during the intrapartum phase. Fresh stillbirths are an indication of substandard intrapartum care (Shanker, Saini & Gupta, 2020).

### 4.2.5 Section E: Placental findings

#### 4.2.5.1 Gross/macroscopic placental findings

Of the gross placental findings, 65% (n=58) had <35cm cord length (short cords), 30% (n=27) had normal cord lengths (36-69cm) and 2% (n=2) had long cords (>70cm). Of the cords, 65% (n=58) were blood stained, 20% (n=18) were meconium stained, and 15% (n=13) were clear. No knots were observed in 93% (n=83) cases, 3% (n=3) cases had the cord around the neck, 2% (n=2) cases had false knots, and 1% (n=1) case had a true knot that was very tight. Of the cases, 96% (n=85) cases had normal cord coiling (<3 coils in 10cm) and 4% (n=4) had hypercoiling (>3 coils in 10cm). Of the cases, 1% (n=1) had a cord diameter of <0.5cm, 81% (n=72) had 0.6cm to 0.8cm diameter, 7% (n=6) had 0.9 to 2cm diameter, and 11% (n=10) had >2cm to 3cm diameter. On the placental disc, 15% (n=13) had retroplacental clot, 49% (n=44) cases had infarcts and 2% (n=2) had a succenturiate lobe; 20% (n=18) had meconium stained membranes, 12% (n=11) had white patches, 56% (n=50) had dusky membranes and 11% (n=10) had opaque membranes; 64% (n=57) had placental weights of <3rd to 5$^{th}$ percentile, 17% (n=15) had placental weight of 10th to 25th percentile, 15% (n=13) had 50th to 75th

percentile and 4% (n=4) had 90th to 97th percentile. Table 4.6 lists the gross/macroscopic findings.

**Table 4.6 Gross/macroscopic placental findings**

| Gross/macroscopic findings | | N=89 | Percentage % |
|---|---|---|---|
| Cord length | >70cm long | 4 | 5 % |
| | <35cm short | 58 | 65 % |
| | 36-69 cm normal | 27 | 30% |
| Cord colour | Bloodstained | 58 | 65% |
| | Meconium stained | 18 | 20 % |
| | Clear | 13 | 15% |
| Cord knots | True knots | 1 | 1% |
| | False knots | 2 | 2 % |
| | Cord around the neck | 3 | 3 % |
| | No knots | 83 | 93% |
| Cord coiling | Hypercoiling | 4 | 4% |
| | Normal coiling | 85 | 96% |
| Cord diameter | <0.5cm (extremely thin) | 1 | 1% |
| | 0.6-0.8cm (thin) | 72 | 81% |
| | 0.9-2cm (normal) | 6 | 7% |
| | >2-3com (thick) | 10 | 13% |

**Discussion**

Gross placental findings are placental findings after an orderly and meticulous physical examination of the placenta, including the umbilical cord, membranes and disc (Tiwari, Gupta & Jain, 2021). In South Africa, it is mandatory to physically examine the placenta following stillbirth to exclude placental insufficiency, abruptio placentae, infections and other abnormalities (NDoH, 2016).

Short and blood-stained cords are often found (Kulkarni, Palanianppan & Evans, 2017). Thin cords are associated with intrauterine growth restriction (Salafia & Misra, 2020). Infarcts are common lesions associated with stillbirths (Salafia & Misra, 2020; Donthi, Malik, Mohamed et al. 2020). A high prevalence of dusky membranes indicated the presence of infection (chorioamnionitis) (Tiwari, Gupta & Jain, 2021). Most placentas were below the 10th percentile which indicated intrauterine growth restriction (Stevens, Odell & Wadee, 2023).

**4.2.5.2 Foetal surface and cord**

The normal foetal surface of the placental is grey in colour, shiny, with visible blood vessels and the umbilical cord is attached to this surface. During gross placental examination, the length of the cord and diameter are measured. Cord insertion is observed. Normal cord insertion should be medial or mediolateral. The normal length of the cord is 36cm to 69cm and the normal diameter is 0.9cm to 2cm (Kulkarni, Palanianppan & Evans, 2017). The colour of the cord and cord insertion are observed. Cord coiling and the presence of true knots are

noted. Normal cord coiling should be 3 coils in 10cm and no true knots. Any abnormalities on the foetal surface may lead to adverse pregnancy outcomes. The cord is summarised in Table 4.7 and Figure 4.4.

**Table 4.7 Cord**

| **Length** | **Frequency** | **Percentage** |
|---|---|---|
| Long >70cm | 4 | 5% |
| Short <35cm | 58 | 65% |
| Normal cord 36-69cm | 27 | 30% |
| **Colour** | **Frequency** | **Percentage** |
| Blood stained | 58 | 65% |
| Meconium stained | 18 | 20% |
| Clear | 13 | 15% |
| **Coiling** | **Frequency** | **Percentage** |
| Hypercoiling | 4 | 5% |
| Normal coiling | 85 | 95% |
| **Diameter** | **Frequency** | **Percentage** |
| <0.5cm | 1 | 1% |
| 0.5cm-0.8cm | 72 | 81% |
| 0.9cm- 2cm | 6 | 7% |
| >2cm-3cm | 10 | 11% |

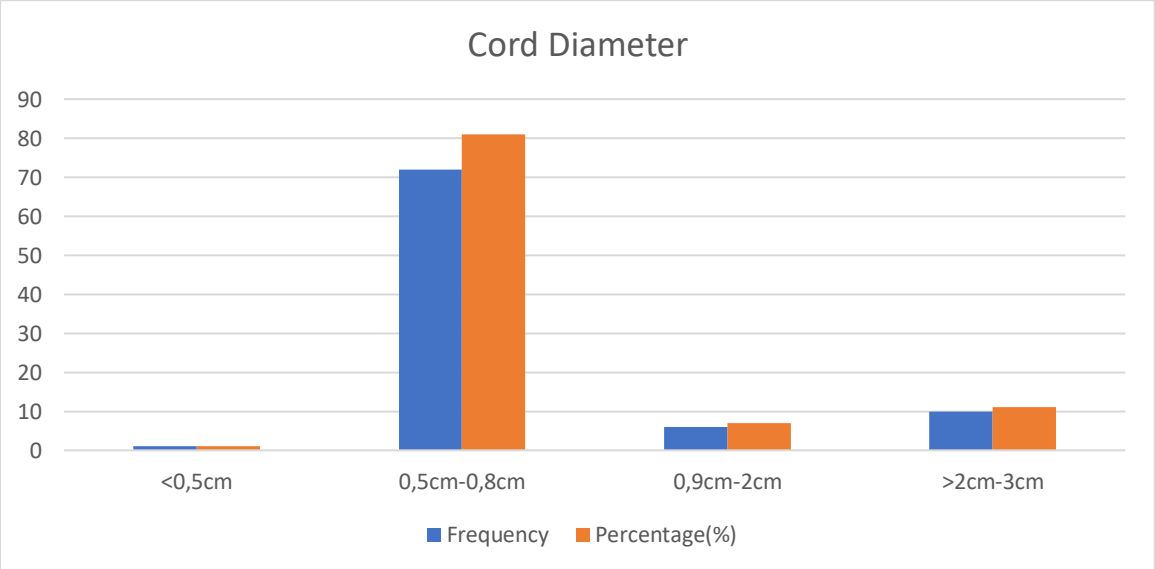


**Figure 4.4 Summary of the cord diameter**

The umbilical cord diameter is associated with foetal growth, wellbeing, and perinatal outcome. In this study, 81% (n=72) of the cases had a cord diameter between 0.5 cm and 0.8cm (thin cords), 11% (n=10) had a diameter above 2cm to 3cm (big cords), 7% (n=6) had a diameter between 0.9cm and 2cm (normal) and 1% (n=1) had a diameter less than 0.5cm (extremely thin). An average cord diameter for a term neonate is 1.5 to <2cm. Thin cords are associated with pathological placental findings and with adverse perinatal outcomes which include foetal loss, preterm births, and intrauterine growth retardation (Wu, Ren, Zhu, Peng, Zhang & Li, 2021). A decrease in the Wharton's jelly area is responsible for thin cords which may result in restricted foetal growth. Maternal factors such as poor obstetric history may be associated with thick or thin umbilical cord diameters, and the cord diameter correlates with birth weight (Blackwell, Landon, Mele, Reddy et al., 2016).

- **Maternal surface**

The maternal surface of the normal placenta is disk-shaped and maroon in colour. It has visible lobules called cotyledons which are usually 15-20 in number. The maternal surface is attached to the maternal endometrium (decidua) during pregnancy. It is sometimes called the placental disc. Table 4.8 summarises the findings on the placental disc.

**Table 4.8 Summary of placental disc findings**

| Placental disc | Frequency | Percentage |
|---|---|---|
| Retroplacental clot | 13 | 15% |
| Infarcts | 44 | 49% |
| Succenturiate lobe | 2 | 2% |
| **Colour** | **Frequency** | **Percentage** |
| Meconium stained | 18 | 20% |
| White patches | 11 | 8% |
| Dusky | 50 | 56% |
| Opaque | 10 | 11% |
| **Placental weight** | **Frequency** | **Percentage** |
| >3$^{rd}$-5$^{th}$ | 57 | 64% |
| 10$^{th}$-25$^{th}$ | 15 | 17% |
| 50$^{th}$ -75$^{th}$ | 13 | 15% |
| 90$^{th}$ -97$^{th}$ | 4 | 4% |

Of the placentas, 49% (n=44) had infarcts, 15% (n=13) had retroplacental clots, and 2% (n=2) had succenturiate lobes. Infarcts are placental parenchymal lesions that have undergone

ischaemic necrosis due to reduced placental maternal blood flow (Roland, Hu, Ren, Chen, Li & Varvoutis, 2020). Infarcts reduce the transportation of oxygen and nutrients to the foetus and therefore may lead to intrauterine growth retardation and adverse perinatal outcomes which include stillbirth (Scalise, Falcone, Avruscio et al., 2022). Of the placentas, 56% (n=50) had dusky placental membranes, 20% (n=18) were meconium stained, 12% (n=11) had white patches, and 11% (n=10) were opaque. Dusky, opaque, and white patches on the placental membranes are an indication of ascending infection and chorioamnionitis which is classified under maternal inflammatory response (Tiwari, Gupta & Jain, 2021).

- **Placental weights**

Of the placentas, 64% (n=57) had placental weights between the >3rd and 5th percentile (very small for gestational age), 17% (n=15) were between the 10th and 25th percentile (small for gestational age), 15% (n=13) were between the 50th and 75th percentile (appropriate for gestational age), and 4% (n=4) were between the 90th and 97th percentile (large for gestational age).

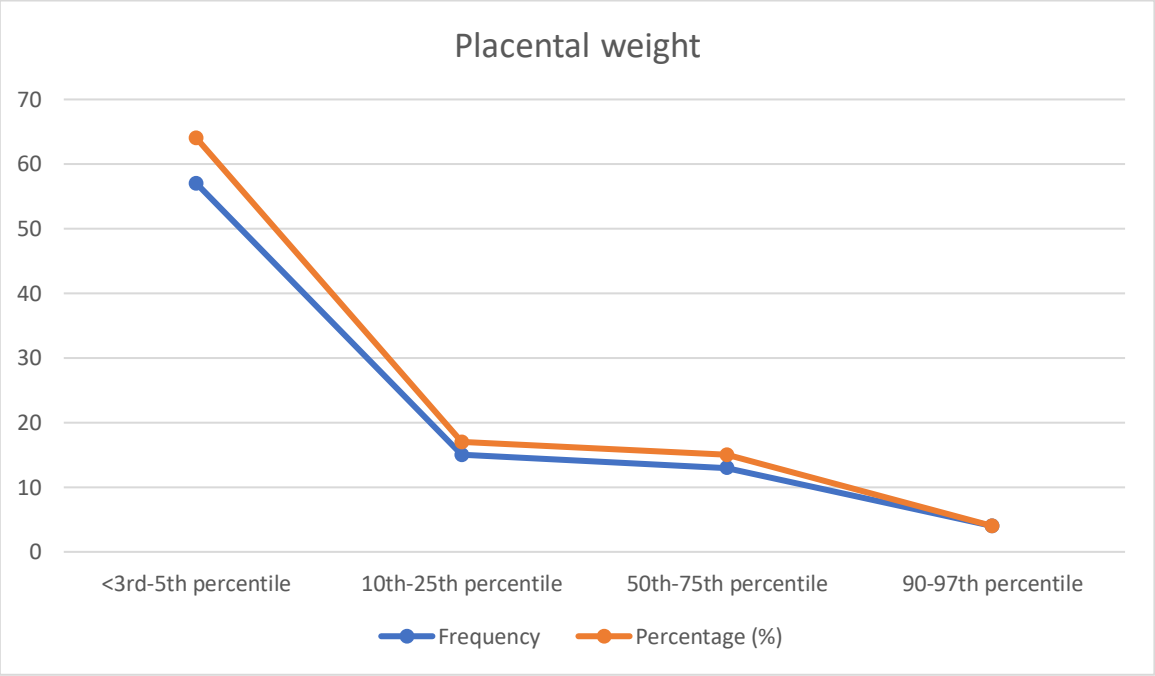


**Figure 4.5 Summary of the placental weights**

**Discussion**

Low placental weight affects foetal and neonatal outcomes (Ikumi, Malaba, Pillay, Cohen, Mdlala et al. 2021; Weckman, Ngai, Wright et al., 2019). Abnormal fetoplacental weight ratio is a risk factor for poor pregnancy outcomes including foetal death (Sathasivam, Selliah, Sivalingarajah et al. 2023; Carrasco-Wong, Moller, Giachini, Lima et al., 2020). A placenta

weighing less than 400g at term is regarded as a small placenta and any placenta weighing more than 600g is a large placenta (Jarmuzek, Wielgos & Bomba-Opon, 2015). Excessive growth of the placenta (placentomegaly) was associated with multiple maternal and foetal conditions such as gestational diabetes, maternal anaemia, foetal anaemia, congenital syphilis, and toxoplasmosis (Reijnders, Mulders, van der Windt et al., 2018; Jarmuzek, Wielgos & Bomba-Opon, 2015). Placental hypoplasia (low placental weight) was associated with maternal cardiovascular diseases, hypertensive disorders, and diabetes mellitus (DeRoo, Skjaerven, Wilcox et al., 2016).

#### 4.2.5.3 Micro/histological findings

Microscopic histological placental findings refer to findings of the placenta through sectioning, staining and examination of the placenta and the umbilical cord under a microscope (Bishop & Matich, 2020). Histological findings include proliferative vascular changes, chronic villitis, villous immaturity, acute and chronic villitis necrotizing funisitis, and the presence of spirochetes (Bishop & Matich, 2020). The micro/histological findings are summarised in Table 4.9 and Figure 4.6.

**Table 4.9 Summary of the micro/histological findings**

| Findings | Frequency | Percentage |
|---|---|---|
| Maternal vascular malperfusion (MVM) | 30 | 34% |
| Maternal inflammatory response (MIF) | 25 | 28% |
| Meconium histiocytes | 13 | 15% |
| Abruptio (pathological) | 10 | 11% |
| Foetal inflammatory response (FIR) | 8 | 9% |
| Foetal vascular malperfusion (FVM) | 2 | 2% |
| Chronic histiocytic villitis | 1 | 1% |

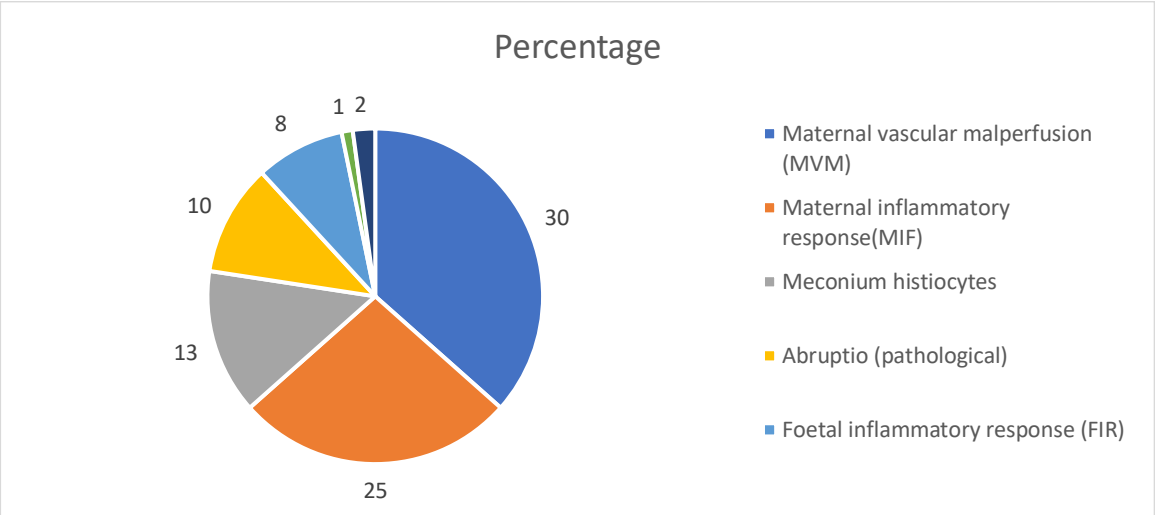


**Figure 4.6 Summary of the histological placental findings**

- **Maternal vascular malperfusion**

Maternal vascular malperfusion (MVM) is defined as gross and microscopic findings that present with abnormal perfusion through the maternal decidual vessels (Khong, Mooney, Ariel, Balmus, Boyd et al., 2016). Maternal vascular malperfusion reflects abnormal spiral artery remodelling which can lead to abnormal placental perfusion and may result in adverse perinatal outcomes (Ernst, 2018). A summary of the maternal vascular malperfusion is provided in Figure 4.7.

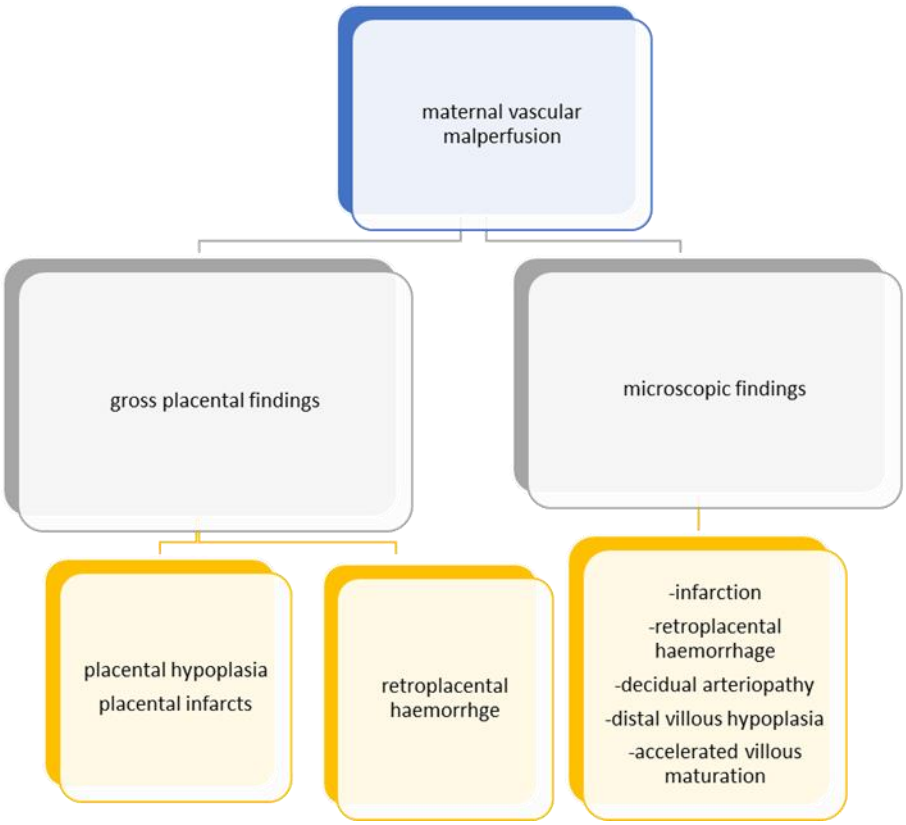


**Figure 4.7 Summary of maternal vascular malperfusion findings on both gross and histological examination**

**Discussion**

Maternal vascular malperfusion was the most significant placental finding in this study, which included placental hypoplasia (placental weight of <10 percentile), placental infarcts, retroplacental haemorrhage, decidual arteriopathy, distal villous hypoplasia and accelerated villous maturation. Maternal vascular malperfusion is frequently observed in placentas from pregnancies impacted by preeclampsia and intrauterine growth restriction (Melchiorre, Giorgione & Thilaganathan, 2021). Maternal vascular malperfusion is associated with HIV infection (Hoque, Hoque, van Hal & Buckus, 2021; Graham & Heazell, 2020).

- **Maternal inflammatory response**

Maternal inflammatory response was the second significant placental finding statistically associated with stillbirth. Maternal obesity increases the risk for maternal inflammatory response (Tabacu, Istrate-Ofiteru, Manolea, Dijmarescu et al., 2022; Amark, Westgren & Persson, 2018). Chronic and acute chorioamnionitis is associated with stillbirth because it can happen with intact membranes and is sometimes asymptomatic (Wylie, Matechi, Kishashu, Fawzi, Premii et al., 2017).

- **Meconium histiocytes**

Meconium histiocytes suggest foetal stress, which is manifested in hypoxia as foetal response to placental hypoxia irrespective of its cause (Redline, 2014). Meconium causes umbilical vasospasm and degeneration of vascular smooth muscle cells and results in ischaemic foetal damage (Salafia & Misra, 2020). Acute maternal and foetal inflammatory response may be attributed to meconium histiocytes (Jacques & Qureshi, 2020). The study found meconium histiocytic placental lesions.

- **Pathological abruption**

Placental abruption is a serious obstetrical complication associated with maternal and foetal morbidity and mortality (Kovo & Schreiber, 2021). Placental abruption is the separation of the placenta from the uterine wall prior to delivery which may be due to defective remodelling of the spiral arteries or defective deep placentation (Kovo & Schreiber, 2021). Maternal hypertensive disorders and maternal vascular malperfusion of the placenta are associated with placental abruption (Graham & Heazell, 2019; Ravishankar, 2021) and were also prevalent in the study.

- **Foetal inflammatory response**

Exposure to multiple organisms such as bacteria, viruses, fungi, and protozoa of the foetus may lead to foetal inflammatory response, which may include exposure to meconium-stained amniotic fluid and be manifested in the following placental lesions: vasculitis (inflammation of the umbilical cord vessel), funisitis (inflammation within the cord substance), arteritis (inflammation involving an umbilical artery) and phlebitis (inflammation involving the umbilical vein) (Salafia & Misra, 2020).

- **Foetal vascular malperfusion**

In this study, foetal vascular malperfusion was statistically significant. Foetal vascular malperfusion indicates a reduced or absent perfusion to the foetus or obstructed umbilical blood flow (Redline, 2023; Ravishankar, 2018). Obstruction may lead to vascular stasis which

may result in vascular thrombosis and adverse perinatal outcomes (Redline, 2023). Maternal vascular malperfusion may lead to foetal vascular malperfusion. Short cords, long cords, thin cords true knots, abnormal cord coiling, abnormal cord insertion, preeclampsia and gestational diabetes may lead to chronic foetal circulatory obstruction and stillbirth (Heider, 2017).

- **Chronic histiocytic villitis**

Chronic histiocytic intervillositis refers to the diffuse infiltration of monocytes into the intervillous space often leading to poor perinatal outcomes, which include recurrent intra-uterine growth restriction, miscarriage, and foetal death (Benachi, Rabant, Martinovic, Bouchghoul et al. 2021). In this study, few histiocytic placental lesions were found.

### 4.3 CORRELATION OF DATA ANALYSIS BETWEEN VARIABLES

Correlation of data analysis between variables was done. The Chi-square test was used to determine relationships between variables. The variables comprised stillbirth vs maternal age, stillbirth vs parity, stillbirth vs contraceptive use, stillbirth vs number of antenatal care visits, birth weight vs mid-upper arm circumference, birth weight vs maternal vascular malperfusion, birth weight vs birth attendant, type of stillbirth vs previous obstetrical history, cord insertion vs smoker/substance abuse, cord insertion vs haemoglobin, cord length vs meconium hystiocytes, cord diameter vs syphilis, placenta weight vs onset of labour, placental weight vs maternal malperfusion, colour of membrane vs maternal inflammatory response, and colour of membrane vs meconium histiocytes, and colour of membranes vs syphilis. A Chi-square value of $p< 0.05$ was considered significant while a $p>0.05$ level was not significant.

- **Correlation between foetal heart parity and gravidity**

Table 4.10 presents the results between foetal heart parity and gravidity. There was no significant association between the foetal heart parity and gravidity with p-value (1.000).

**Table 4.10 Correlation between foetal heart parity and gravidity**

*Crosstab*

| | | | Parity and Gravidity | | | Total |
|---|---|---|---|---|---|---|
| | | | Primigravida | Multigravida | Grandemultipara | |
| Fetal heart on admission | No | Count | 17 | 57 | 4 | 78 |
| | | % within Parity and Gravidity | 89,5% | 86,4% | 100,0% | 87,6% |
| | Yes | Count | 2 | 9 | 0 | 11 |
| | | % within Parity and Gravidity | 10,5% | 13,6% | 0,0% | 12,4% |
| Total | | Count | 19 | 66 | 4 | 89 |
| | | % within Parity and Gravidity | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | .722[a] | 2 | 0,697 | 0,892 |
| Likelihood Ratio | 1,214 | 2 | 0,545 | 0,810 |
| Fisher-Freeman-Halton Exact Test | 0,243 | | | 1,000 |
| N of Valid Cases | 89 | | | |

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .49.

- **Correlation between foetal heart and the number of antenatal care visits**

Table 4.11 presents the results between foetal heart and the number of antenatal care visits. There is a significant association between the foetal heart on admission and the number of antenatal care visits with p-value (0.035).

**Table 4.11 Correlation of number of antenatal visits and foetal heart on admission**

*Crosstab*

| | | | Number of antenatal visits | | | Total |
|---|---|---|---|---|---|---|
| | | | 0 | 1-3 | 4-7 | |
| Fetal heart on admission | No | Count | 11 | 30 | 37 | 78 |
| | | % within Number of antenatal visits | 100,0% | 96,8% | 78,7% | 87,6% |
| | Yes | Count | 0 | 1 | 10 | 11 |
| | | % within Number of antenatal visits | 0,0% | 3,2% | 21,3% | 12,4% |
| Total | | Count | 11 | 31 | 47 | 89 |
| | | % within Number of antenatal visits | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 7.389[a] | 2 | 0,025 | 0,030 |
| Likelihood Ratio | 9,087 | 2 | 0,011 | 0,016 |
| Fisher-Freeman-Halton Exact Test | 6,431 | | | **0,035** |
| N of Valid Cases | 89 | | | |

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.36.

- **Correlation of birth weight and mid-upper arm circumference**

Table 4.12 presents the results of the relationship between the birth weight and the mid-upper arm circumference. The findings indicated a significant association between birth weight and mid-upper arm circumference with the p-value (0.015).

**Table 4.12 Correlation of birth weight and mid-upper arm circumference**

*Crosstab*

| | | | MUAC | | | | |
|---|---|---|---|---|---|---|---|
| | | | <23 | Normal | Not done | Overweight | Total |
| Birth weight | Extremely small | Count | 0 | 0 | 0 | 1 | 1 |
| | | % within MUAC | 0,0% | 0,0% | 0,0% | 14,3% | 1,1% |
| | Normal | Count | 2 | 9 | 11 | 3 | 25 |
| | | % within MUAC | 100,0% | 31,0% | 21,6% | 42,9% | 28,1% |
| | Small | Count | 0 | 20 | 40 | 3 | 63 |
| | | % within MUAC | 0,0% | 69,0% | 78,4% | 42,9% | 70,8% |
| Total | | Count | 2 | 29 | 51 | 7 | 89 |
| | | % within MUAC | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 19.423[a] | 6 | 0,004 | 0,026 |
| Likelihood Ratio | 12,833 | 6 | 0,046 | 0,021 |
| Fisher-Freeman-Halton Exact Test | 14,369 | | | 0,015 |
| N of Valid Cases | 89 | | | |

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .02.

- **Correlation of birth weight and birth attendant**

Table 4.13 presents the results of the relationship between birth weight and birth attendant. The findings indicated a significant association between birth weight and birth attendant with the p-value (0.034).

**Table 4.13 Correlation of birth weight and birth attendant**

*Crosstab*

| | | | Attendant | | |
|---|---|---|---|---|---|
| | | | midwife | midwife/doctor | Total |
| Birth weight | Extremely small | Count | 1 | 0 | 1 |
| | | % within Attendant | 1,6% | 0,0% | 1,1% |
| | Normal | Count | 13 | 12 | 25 |
| | | % within Attendant | 20,6% | 46,2% | 28,1% |
| | Small | Count | 49 | 14 | 63 |
| | | % within Attendant | 77,8% | 53,8% | 70,8% |
| Total | | Count | 63 | 26 | 89 |
| | | % within Attendant | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 6.169[a] | 2 | 0,046 | 0,034 |
| Likelihood Ratio | 6,161 | 2 | 0,046 | 0,045 |
| Fisher-Freeman-Halton Exact Test | 5,933 | | | 0,034 |
| N of Valid Cases | 89 | | | |

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .29.

- **Correlation of birth weight and maternal vascular malperfusion**

Table 4.14 presents the results of the relationship between birth weight and maternal vascular malperfusion. The findings indicated a significant association between birth weight and maternal vascular malperfusion with p-value (0.001).

**Table 4.14 Correlation between birth weight and maternal vascular malperfusion**

*Crosstab*

| | | | maternal vascular malperfusion | | | |
|---|---|---|---|---|---|---|
| | | | no | present | yes | Total |
| Birth weight | Extremely small | Count | 1 | 0 | 0 | 1 |
| | | % within maternal vascular malperfusion | 2,3% | 0,0% | 0,0% | 1,2% |
| | Normal | Count | 19 | 0 | 3 | 22 |
| | | % within maternal vascular malperfusion | 43,2% | 0,0% | 8,8% | 25,9% |
| | Small | Count | 24 | 7 | 31 | 62 |
| | | % within maternal vascular malperfusion | 54,5% | 100,0% | 91,2% | 72,9% |
| Total | | Count | 44 | 7 | 34 | 85 |
| | | % within maternal vascular malperfusion | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 15.948[a] | 4 | 0,003 | 0,008 |
| Likelihood Ratio | 18,613 | 4 | 0,001 | 0,000 |
| Fisher-Freeman-Halton Exact Test | 16,320 | | | 0,001 |
| N of Valid Cases | 85 | | | |

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is .08.

- **Correlation of type of stillbirth and previous obstetric history**

Table 4.15 presents the results of the relationship between type of stillbirth and previous obstetric history. The findings indicated a significant association between previous stillbirth and previous obstetric history with p value (0.038).

**Table 4.15 Correlation between type of stillbirth and previous obstetric history**

*Crosstab*

| | | | Previous obstetric history | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Abortion | molar pregnancy | neonatal death | none | Stillbirth | Total |
| Type of stillbirth | fresh | Count | 5 | 1 | 0 | 14 | 3 | 23 |
| | | % within Previous obstetric history | 31,3% | 100,0% | 0,0% | 20,9% | 75,0% | 25,8% |
| | macerated | Count | 11 | 0 | 1 | 53 | 1 | 66 |
| | | % within Previous obstetric history | 68,8% | 0,0% | 100,0% | 79,1% | 25,0% | 74,2% |
| Total | | Count | 16 | 1 | 1 | 67 | 4 | 89 |
| | | % within Previous obstetric history | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 9.361[a] | 4 | 0,053 | 0,034 |
| Likelihood Ratio | 8,652 | 4 | 0,070 | 0,054 |
| Fisher-Freeman-Halton Exact Test | 8,444 | | | 0,038 |
| N of Valid Cases | 89 | | | |

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .26.

- **Correlation of type of stillbirth and birth attendant**

Table 4.16 presents the results of the relationship between the type of stillbirth and birth attendant. The findings indicated a significant association between the type of stillbirth and birth attendant with p-value (0.012).

**Table 4.16 Correlation between type of stillbirth and birth attendant**

*Crosstab*

| | | | Attendant | | |
|---|---|---|---|---|---|
| | | | midwife | midwife/doctor | Total |
| Type of stillbirth | fresh | Count | 12 | 11 | 23 |
| | | % within Attendant | 19,0% | 42,3% | 25,8% |
| | macerated | Count | 51 | 15 | 66 |
| | | % within Attendant | 81,0% | 57,7% | 74,2% |
| Total | | Count | 63 | 26 | 89 |
| | | % within Attendant | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 63.135[a] | 12 | 0,000 | 0,004 |
| Likelihood Ratio | 19,013 | 12 | 0,088 | 0,016 |
| Fisher-Freeman-Halton Exact Test | 25,377 | | | 0,012 |
| N of Valid Cases | 89 | | | |

a. 17 cells (85.0%) have expected count less than 5. The minimum expected count is .02.

- **Correlation between cord insertion and maternal haemoglobin**

Table 4.17 presents the results of the relationship between cord insertion and maternal haemoglobin. The findings indicated a significant association between cord insertion and maternal haemoglobin with p-value (0.029).

**Table 4.17 Correlation between cord insertion and maternal haemoglobin**

*Crosstab*

| | | | HB | | | |
|---|---|---|---|---|---|---|
| | | | Anemic | Not Anemic | not done | Total |
| Cord insertion | battledore | Count | 1 | 0 | 2 | 3 |
| | | % within HB | 7,7% | 0,0% | 6,3% | 3,4% |
| | circumvallate | Count | 0 | 1 | 0 | 1 |
| | | % within HB | 0,0% | 2,3% | 0,0% | 1,1% |
| | lateral | Count | 3 | 4 | 2 | 9 |
| | | % within HB | 23,1% | 9,1% | 6,3% | 10,1% |
| | medial | Count | 6 | 24 | 25 | 55 |
| | | % within HB | 46,2% | 54,5% | 78,1% | 61,8% |
| | mediolateral | Count | 3 | 15 | 3 | 21 |
| | | % within HB | 23,1% | 34,1% | 9,4% | 23,6% |
| Total | | Count | 13 | 44 | 32 | 89 |
| | | % within HB | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 13.759[a] | 8 | 0,088 | 0,075 |
| Likelihood Ratio | 15,298 | 8 | 0,054 | 0,055 |
| Fisher-Freeman-Halton Exact Test | 14,445 | | | 0,029 |
| N of Valid Cases | 89 | | | |

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .15.

### Correlation between cord length and meconium

Table 4.18 presents the results of the relationship between the cord length and meconium. The findings indicated a significant association between cord length and meconium with the p-value (0.031).

**Table 4.18 Correlation between cord length and meconium**

*Crosstab*

| | | | meconium | | Total |
|---|---|---|---|---|---|
| | | | no | yes | |
| Cord length | Abnormal | Count | 1 | 4 | 5 |
| | | % within meconium histiocytes | 1,5% | 16,7% | 5,6% |
| | Normal | Count | 27 | 7 | 34 |
| | | % within meconium histiocytes | 41,5% | 29,2% | 38,2% |
| | Short cord | Count | 37 | 13 | 50 |
| | | % within meconium histiocytes | 56,9% | 54,2% | 56,2% |
| Total | | Count | 65 | 24 | 89 |
| | | % within meconium histiocytes | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 7.866[a] | 2 | 0,020 | 0,022 |
| Likelihood Ratio | 6,876 | 2 | 0,032 | 0,036 |
| Fisher-Freeman-Halton Exact Test | 6,661 | | | 0,031 |
| N of Valid Cases | 89 | | | |

a. 2 cells (33.3%) have expected count less than 5. The minimum expected

- **Correlation between cord diameter and smoking/substances**

Table 4.19 presents the results of the relationship between the cord diameter and smoking/substances. The findings indicated a significant association between the cord diameter and smoking/substances with p-value (0.017).

**Table 4.19 Correlation between cord diameter and smoking/substances**

*Crosstab*

| | | | Smoker /substances | | | | |
|---|---|---|---|---|---|---|---|
| | | | active | no | no /alcohol yes | passive | Total |
| Cord diameter | Normal | Count | 2 | 72 | 0 | 4 | 78 |
| | | % within Smoker /substances | 100,0% | 90,0% | 0,0% | 80,0% | 87,6% |
| | Thick | Count | 0 | 3 | 2 | 0 | 5 |
| | | % within Smoker /substances | 0,0% | 3,8% | 100,0% | 0,0% | 5,6% |
| | Thin | Count | 0 | 5 | 0 | 1 | 6 |
| | | % within Smoker /substances | 0,0% | 6,3% | 0,0% | 20,0% | 6,7% |
| Total | | Count | 2 | 80 | 2 | 5 | 89 |
| | | % within Smoker /substances | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 36.076[a] | 6 | 0,000 | 0,004 |
| Likelihood Ratio | 14,133 | 6 | 0,028 | 0,009 |
| Fisher-Freeman-Halton Exact Test | 15,598 | | | 0,017 |
| N of Valid Cases | 89 | | | |

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .11.

- **Correlation between cord diameter and syphilis**

Table 4.20 presents the results of the relationship between cord diameter and syphilis. The findings indicated a significant association between the cord diameter and syphilis with p-value (0.030).

**Table 4.20 Correlation between cord diameter and syphilis**

*Crosstab*

| | | | Syphylis | | | Total |
|---|---|---|---|---|---|---|
| | | | negative | not done | positive | |
| Cord diameter | Normal | Count | 62 | 14 | 2 | 78 |
| | | % within Syphylis | 88,6% | 100,0% | 40,0% | 87,6% |
| | Thick | Count | 4 | 0 | 1 | 5 |
| | | % within Syphylis | 5,7% | 0,0% | 20,0% | 5,6% |
| | Thin | Count | 4 | 0 | 2 | 6 |
| | | % within Syphylis | 5,7% | 0,0% | 40,0% | 6,7% |
| Total | | Count | 70 | 14 | 5 | 89 |
| | | % within Syphylis | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 13.432[a] | 4 | 0,009 | 0,029 |
| Likelihood Ratio | 10,342 | 4 | 0,035 | 0,018 |
| Fisher-Freeman-Halton Exact Test | 9,541 | | | 0,030 |
| N of Valid Cases | 89 | | | |

a. 7 cells (77.8%) have expected count less than 5. The minimum expected count is .28.

- **Correlation between placental weight and onset of labour**

Table 4.21 presents the results of the relationship between the placenta weight and the onset of labour. Findings indicated a significant association between placental weight and the onset of labour with p-value (0.012).

**Table 4.21 Correlation between placental weight and onset of labour**

*Crosstab*

| | | | Onset of labour | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | C/S | emergency | induction | Self induced | spontaneous | Total |
| Placental weight | Abnormal | Count | 0 | 0 | 1 | 1 | 8 | 10 |
| | | % within Onset of labour | 0,0% | 0,0% | 3,8% | 50,0% | 13,8% | 11,2% |
| | Inadequate Placenta | Count | 0 | 1 | 23 | 0 | 35 | 59 |
| | | % within Onset of labour | 0,0% | 50,0% | 88,5% | 0,0% | 60,3% | 66,3% |
| | Normal | Count | 1 | 1 | 2 | 1 | 15 | 20 |
| | | % within Onset of labour | 100,0% | 50,0% | 7,7% | 50,0% | 25,9% | 22,5% |
| Total | | Count | 1 | 2 | 26 | 2 | 58 | 89 |
| | | % within Onset of labour | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 15.766[a] | 8 | 0,046 | 0,060 |
| Likelihood Ratio | 16,362 | 8 | 0,037 | 0,020 |
| Fisher-Freeman-Halton Exact Test | 16,254 | | | 0,012 |
| N of Valid Cases | 89 | | | |

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .11.

- **Correlation between placental weight and foetal vascular malperfusion**

Table 4.22 presents the results of the relationship between placental weight and foetal vascular malperfusion with p-value (0.004).

**Table 4.22 Correlation between placental weight and foetal vascular malperfusion**

*Crosstab*

| | | | foetal vascular | | Total |
|---|---|---|---|---|---|
| | | | no | yes | |
| Placental weight | Abnormal | Count | 10 | 0 | 10 |
| | | % within foetal vascular malperfusion | 12,0% | 0,0% | 11,2% |
| | Inadequate Placenta | Count | 58 | 1 | 59 |
| | | % within foetal vascular malperfusion | 69,9% | 16,7% | 66,3% |
| | Normal | Count | 15 | 5 | 20 |
| | | % within foetal vascular malperfusion | 18,1% | 83,3% | 22,5% |
| Total | | Count | 83 | 6 | 89 |
| | | % within foetal vascular malperfusion | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 13.718[a] | 2 | 0,001 | 0,003 |
| Likelihood Ratio | 11,317 | 2 | 0,003 | 0,004 |
| Fisher-Freeman-Halton Exact Test | 9,878 | | | 0,004 |
| N of Valid Cases | 89 | | | |

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .67.

- **Correlation between the colour of the membranes and maternal inflammatory response**

Table 4.23 presents the results of the relationship between the colour of the membranes and maternal inflammatory response. The findings indicated a significant association between the colour of the membranes and maternal inflammatory response with p-value (0.002).

**Table 4.23 Correlation between colour of the membranes and maternal inflammatory response**

*Crosstab*

| | | | maternal | | Total |
|---|---|---|---|---|---|
| | | | no | yes | |
| Colour of membranes | clear | Count | 7 | 0 | 7 |
| | | % within maternal inflammatory response | 12,1% | 0,0% | 7,9% |
| | cloudy | Count | 0 | 4 | 4 |
| | | % within maternal inflammatory response | 0,0% | 12,9% | 4,5% |
| | dusky | Count | 6 | 7 | 13 |
| | | % within maternal inflammatory response | 10,3% | 22,6% | 14,6% |
| | meconium stained | Count | 14 | 3 | 17 |
| | | % within maternal inflammatory response | 24,1% | 9,7% | 19,1% |
| | opaque | Count | 31 | 16 | 47 |
| | | % within maternal inflammatory response | 53,4% | 51,6% | 52,8% |
| | white patches | Count | 0 | 1 | 1 |
| | | % within maternal inflammatory response | 0,0% | 3,2% | 1,1% |
| Total | | Count | 58 | 31 | 89 |
| | | % within maternal inflammatory response | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 17.391[a] | 5 | 0,004 | 0,002 |
| Likelihood Ratio | 20,986 | 5 | 0,001 | 0,001 |
| Fisher-Freeman-Halton Exact Test | 16,325 | | | 0,002 |
| N of Valid Cases | 89 | | | |

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .35.

- **Correlation between colour of the membranes and meconium histocytes**

Table 4.24 presents the results of the relationship between the colour of the membranes and meconium histiocytes. The findings indicated a significant association between membranes and meconium histiocytes with p-value (0.000).

**Table 4.24 Correlation between colour of membranes and meconium histiocytes**

*Crosstab*

| | | | meconium histiocytes | | Total |
|---|---|---|---|---|---|
| | | | no | yes | |
| Colour olour of membranes | clear | Count | 7 | 0 | 7 |
| | | % within meconium histiocytes | 10,8% | 0,0% | 7,9% |
| | cloudy | Count | 4 | 0 | 4 |
| | | % within meconium histiocytes | 6,2% | 0,0% | 4,5% |
| | dusky | Count | 9 | 4 | 13 |
| | | % within meconium histiocytes | 13,8% | 16,7% | 14,6% |
| | meconium stained | Count | 3 | 14 | 17 |
| | | % within meconium histiocytes | 4,6% | 58,3% | 19,1% |
| | opaque | Count | 41 | 6 | 47 |
| | | % within meconium histiocytes | 63,1% | 25,0% | 52,8% |
| | white patches | Count | 1 | 0 | 1 |
| | | % within meconium histiocytes | 1,5% | 0,0% | 1,1% |
| Total | | Count | 65 | 24 | 89 |
| | | % within meconium histiocytes | 100,0% | 100,0% | 100,0% |

*Chi-Square Tests*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 35.818[a] | 5 | 0,000 | 0,000 |
| Likelihood Ratio | 35,968 | 5 | 0,000 | 0,000 |
| Fisher-Freeman-Halton Exact Test | 31,327 | | | 0,000 |
| N of Valid Cases | 89 | | | |

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .27.

**Summary**

The Fisher-Hamilton Exact Test was done to test the association between the variables. Statistical association and significance were found between the following variables: stillbirth and number of antenatal care visits (0.0035); birth weight and mid-upper arm circumference (0.013); birth weight and maternal vascular malperfusion (0.001); birth weight and birth attendant (0.034); type of stillbirth and birth attendant (0.033); type of stillbirth and previous obstetric history (0.038); cord insertion and smoking/substance abuse (0.012); cord insertion and haemoglobin (0.029); cord length and meconium histiocytes (0.031); cord diameter and syphylis (0.030); placental weight and onset of labour (0.012); placental weight and foetal vascular malperfusion (0.004); colour of membranes and maternal inflammatory response (0.002); colour of membranes and meconium histiocytes (0.000), and colour of membranes and syphilis (0.053).

This study observed the following placental lesions: maternal vascular malperfusion (Ernst, 2018); maternal inflammatory response (Blackwell, Landon, Mele, Reddy et al. 2016; Amark, Westgren, Sirotkina, et al. 2021); meconium histiocytes (Redline, 2014; Salafia & Misra, 2020); pathological abruptio (Kovo & Shreiber, 2021); foetal inflammatory response (Salafia & Misra, 2020), and foetal vascular malperfusion (Redline, 2023). Placental lesions in term stillbirths were associated with maternal characteristics, such as fewer or no antenatal visits (Lema, Mremi, Amsi et al. 2020); previous obstetric history (Tesema, Gezie & Nigatu, 2020); anaemia (Gebremeskel, Mulu, Kumbi & Ergete, 2020); syphilis (Yu, Wei, Duan, Schmitz, Sakurai et al. 2021); mid-upper arm circumference (Beneventi, Bellingeri, De Maggio, Cavagnoli et al. 2023), and smoking and substance abuse (Reijnders, Mulders, van der Windt et al. 2018). Intrauterine growth retardation was confirmed by placental weights and birth weights, that were below the 10$^{th}$ percentile for gestational age, and the cord diameters were 0.5 to 0.8cm (Sharma & Shukla, 2017).

## 4.4 CONCLUSION

This chapter discussed the data analysis and findings of the study. Data was collected from the records to obtain the macroscopic and microscopic placental findings. Chapter 5 concludes the study, briefly describes the findings and limitations, and makes recommendations for practice and further research.

# CHAPTER 5 FINDINGS, LIMITATIONS AND RECOMMENDATIONS

## 5.1 INTRODUCTION

Chapter 4 presented the data analysis, interpretation, and results. This chapter concludes the study, summarises the findings, describes the limitations, and makes recommendations for midwifery education and practice, and further research.

## 5.2 AIM AND OBJECTIVES OF THE STUDY

During the monthly presentations of the perinatal morbidity and mortality statistics in the selected public hospital in the eMalahleni sub-district in Mpumalanga Province, the researcher observed that the stillbirth rate, as well as unexplained stillbirths, remained high, with no improvement plan. Accordingly, the study aimed to assess and describe the placental findings of macroscopic and microscopic placenta examinations in singleton-term stillbirths in the selected public hospital. To achieve the aim, the objectives were to:

- Examine placentas of term singleton stillbirths macroscopically and microscopically for placental findings related to stillbirths in the selected public hospital.
- Describe the characteristics and trends of the placental lesions of the stillbirths.

## 5.3 RESEARCH DESIGN AND METHODOLOGY

In this study, the researcher used a quantitative, prospective, observational and descriptive research design. Data was collected from the maternal clinical records and maternity registers of the selected public hospital and a sample of 89 placentas from women who delivered stillborn neonates in the maternity ward were examined.

## 5.4 FINDINGS

The findings of the study are summarized under participants' demographic data, antenatal care, labour and delivery, and placental findings.

### 5.4.1 Participants' demographic data

Most of the participants were aged between 18 and 35, were single, Black, and had a secondary or high school education. In addition, most had been referred from local clinics and district hospitals.

### 5.4.2 Antenatal care

Multigravidas were more affected than primigravidas and grande multiparas. Stillbirth occurred more frequently in the participants who had an obstetric history of previous stillbirths and

abortions than in those without. Some participants without any maternal medical conditions (healthy pregnancies) had stillbirths. Although most of the pregnancies were unplanned and no contraceptives were used, there was no statistical association between unplanned pregnancy and stillbirth. A decreased MUAC (mid-upper arm circumference) of below 23cm was associated with low placental weight and the majority of the placental weights were below the 10th percentile which indicated that there was intra-uterine growth restriction. In addition, the study found that participants with fewer or no antenatal care visits had stillbirths.

### 5.4.3 Labour and delivery

In most cases, the onset of labour was spontaneous and the method of delivery was mostly a normal vertex delivery. Most of the participants had no foetal heart rate detectable on admission and all were attended by midwives. There were more male than female stillborn neonates. In addition, 90% of the stillbirths were macerated stillbirths which reflected the quality of antepartum care and most could have been prevented. No partogram was used in 70% of the cases.

### 5.4.4 Placental findings

The placental findings are presented under gross/macroscopic and micro/histology findings.

#### 5.4.4.1 Gross/macroscopic findings

Most of the placentas had short cords that were blood and meconium stained. Only a few true and false knots were observed, and three babies had cords around the neck. Normal cord coiling was observed except in 4 cases. In addition, cords with a thin diameter of less than the 10th percentile were found, which signified the presence of intra-uterine growth retardation. The colour of the placental membranes was mostly meconium stained, had white patches and was dusky, indicating the presence of maternal inflammatory response or chorioamnionitis. The placental weights were mostly below the 10th percentile, which confirmed intra-uterine growth restriction.

#### 5.4.4.2 Micro/histology findings

Maternal vascular malperfusion, maternal inflammatory response, meconium histiocytes, pathological placental abruptio, foetal inflammatory response, foetal vascular malperfusion and chronic histiocytic villitis were the most observed placental lesions according to the sequence of their prevalence.

Placental lesions were associated with stillbirth. Macro- and microscopic placental examination permits the study of the foetus, and the foetal responses to maternal diseases were associated with infections, lifestyle, previous obstetric complications, maternal diseases and environmental pollutants. Macro- and microscopic examination should continue to be

used as part of the investigations following stillbirths to reduce unexplained stillbirths and litigation of health institutions.

## 5.5 STRENGTH AND LIMITATIONS OF THE STUDY

The study had strengths and limitations.

### 5.5.1 Strength

The sample size of 89 placentas was adequate for statistical conclusion. The placental histology reports that were authorised by senior pathologists and discussed by the Perinatal Morbidity and Mortality Committee about the probable cause of stillbirths assisted the bereaved parents during counselling and assisted in reducing the number of unexplained stillbirths. The study observed the statistical significance and association of the mid-upper arm circumference (MUAC) and not body mass index (BMI) with birth weight. The study created awareness and improved knowledge of placental pathology.

### 5.5.2 Limitations

The study was limited to placental findings in singleton-term stillbirths at one selected public hospital. The researcher observed that the second and early third trimesters were the most vulnerable periods, especially for placental lesions, such as maternal vascular malperfusion and maternal inflammatory response which might lead to preterm labour and other perinatal adverse pregnancy outcomes. If the second and early third-trimester stillbirths are included in future studies to cover all stillbirths, the stillbirth rate may decrease. Paternal lifestyles were not investigated because they were not included in the maternity case record book and the data collection tool. It is known that the mother's health has an impact on the foetus, but paternal metabolic syndrome (diabetes, high blood pressure and obesity) has recently been found to increase the risk for stillbirths. The placental histology reports were not standardised as the pathologists used different formats for reporting.

## 5.6 RECOMMENDATIONS

Based on the findings, the researcher makes the following recommendations for midwifery education, midwifery care, and further research.

### 5.6.1 Midwifery education

Nursing education institutions should include:

- Placental pathology in the midwifery curriculum to assist in the identification of different lesions for the prevention of stillbirths in first and subsequent pregnancies.

### 5.6.2 Midwifery care

Health care facilities and midwives should

- Provide counselling on maternal obesity, which is one of the most important modifiable risk factors for stillbirth. Adequate preconception counselling should emphasise maternal and paternal lifestyle modification because an increased MUAC has been associated with maternal inflammatory response. Umbilical cord abnormalities increase in the presence of maternal obesity, which accounts for the increased risk of stillbirth at term as maternal vascular malperfusion is also associated with maternal obesity.
- Encourage regular and consistent antenatal care visits and include screening for risk factors.
- Improve the skills of birth attendants through intensifying ESMOE, BANC PLUS, partogram use and Helping Babies Breathe (HBB) training and drills to assist in decreasing perinatal mortality.
- Provide quality antenatal care to improve perinatal outcomes. All pregnant women must be properly assessed, including fundal height monitoring, proper plotting against gestational age, comparing the findings with the 10th, 50th and 90th percentile and interpretation of the foetal growth curve and foetal movement monitoring because of the high prevalence of intrauterine growth restriction which is evidenced by low birth and placental weights under the 10th percentile.
- In this study, most of the participants who delivered a stillbirth had no previous obstetric history and were classified as low risk. Early detection of placental pathology is needed. A new South African technological device called the Umbi flow has been invented, tested, and piloted in primary settings and proved to be very effective in detecting placental lesions during pregnancy. This low-cost mobile and portable device can be used in primary health care settings by primary health providers, including midwives. The device requires one week's training, detects the flow of blood to the placenta, and foetuses at risk can be detected early and the women can be referred in time, which may reduce the number of unexplained foetal deaths.
- Provide family planning and contraceptive use counselling and offer a variety of contraceptives to meet the needs of all women, including women with high-risk conditions. In this study, most of the pregnancies were unplanned, and no contraceptives were used.
- Provide proper management of preeclampsia and prompt referral. Administration of low-dose prophylaxis aspirin before 16 weeks to prevent or delay the onset of preeclampsia in high-risk mothers as a result of several maternal, physical and intra-uterine factors which

may lead to adverse perinatal outcomes. This may have a protective effect on inflammation-related placental pathology as a result of maternal pathology.

- Screen pregnant women routinely for maternal infections such as TORCH and B-Streptococcus as they may be associated with maternal inflammatory response. TORCH screening is presently done only following a stillbirth.
- Intensify screening and treating of syphilis. The World Health Organization (2017) suggests a single-site rapid syphilis test should be used to screen all pregnant women during their first antenatal visit and the provision of first dose treatment if the test is found to be positive whilst waiting for the rapid plasma reagent test from the laboratory.
- Treat maternal anaemia, which is associated with placental pathological lesions. Treatment of anaemia is critical to assist with the normal function of the placenta.
- Encourage thorough and proper gross examination of the placentas to assist in the identification of placental lesions which will lead to treatment options in subsequent pregnancies.

### 5.6.3 Further research

Further research should be conducted on the following topics:

- An examination of placental findings in neonates affected by hypoxic ischaemic encephalopathy and low birth weight.
- An investigation of the effect of chronic intra-uterine hypoxia on perinatal mortality and morbidity
- The relationship between paternal lifestyles and the risk of stillbirths

## 5.7 CONCLUSION

This chapter summarised the findings of the study, described the limitations, and made recommendations for midwifery education and practice, and further research. The findings of the study should contribute to improvement in the antenatal care and intrapartum care of pregnant women and thereby reduce the number of preventable stillbirths.

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**Annexure A: Letter to obtain permission from the hospital to conduct a study**

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

November 2021

Chief Executive Officer (Mrs KAP Madonsela)
Private Bag x 7206
Witbank
1035

Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

My name is Joanna Ouma Vilane, and I am a master's student at the University of Pretoria. The research I wish to examine placentas in term singleton stillbirths for my master's dissertation titled PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN EMALAHLENI SUB-DISTRICT IN MPUMALANGA PROVINCE - A DESCRIPTIVE STUDY. The findings will assist in developing educational information on the phenomenon and assist in reductive and preventative measures. This research project will be conducted under the supervision of Prof. M. Yazbek and co-supervisor Ms M Musie from the University of Pretoria.

I hereby seek your consent to access patient information of women who gave birth to a term singleton stillbirth from their files and maternity registers and to examine the placenta after birth and send placentas to the laboratory for histology. A statistician at the University of Pretoria will assist to analyse the findings. Upon completion of the study, I undertake to provide the institution with a copy of the full research report. For further information feel free to contact me on the following number: 0832322894 e-mail: oumavee@gmail.com.

Kind regards

Joanna Ouma Vilane

## 5 Declaration

**Declaration by Applicant:**

I Mr/Ms/Dr/Prof/Adv. J.O. VILANE agree to submit/present the result of this study back to the CEO/Institution/District.

Estimated date of feedback: November 2021

**Comment by CEO/~~DM/PM~~:** **Supported / Not Supported**

Approved - To be present the results to the Management.

**Signature:** RMadonsela **Date:** 19/01/2021

**Name:** RAP Madonsela

DEPARTMENT OF HEALTH
WITBANK HOSPITAL
2021 -01- 19
PRIVATE BAG X7206 WITBANK
MPUMALANGA PROVINCE

**A duly signed form can be uploaded on the website by the researcher or emailed to:**
**JerryS@mpuhealth.gov.za or ThembaM@mpuhealth.gov.za**

Please note that this letter is not an approval to undertake a study, but a support letter from identified facility/district.
i.e. the CEO/District Manager acknowledges to have been consulted on the study

**Annexure B: Consent form**

# PARTICIPANT'S INFORMATION & INFORMED CONSENT DOCUMENT

**STUDY TITLE: PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN EMALAHLENI SUB-DISTRICT IN MPUMALANGA PROVINCE- DESCRIPTIVE STUDY**

**Sponsor: None**

**Principal Investigators: JO Vilane**

**Institution: University of Pretoria**

**DAYTIME AND AFTER-HOURS TELEPHONE NUMBER(S):**

**Daytime number/s: 013 653 2473**

**Afterhours number: 083 232 2894**

**DATE AND TIME OF FIRST INFORMED CONSENT DISCUSSION:**

| | | | | |
|---|---|---|---|---|
| | | | | : |
| **Date** | **month** | **year** | | **Time** |

**Dear Prospective Participant**

**Dear Mr. / Mrs. .....**

## 1) INTRODUCTION

You are invited to volunteer for a research study. I am doing research for a master's degree purpose at the University of Pretoria. This information in this document is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. If you have any questions, which are not fully explained in this document, do not hesitate to ask the researcher. You should not agree to take part unless you are completely happy about all the procedures involved.

## 2) THE NATURE AND PURPOSE OF THIS STUDY

The aim of this study is to examine the placentas and obtain clinical information from the maternity case record book. By doing so we wish to learn more about abnormal placental lesions and maternal conditions that may be associated with stillbirths.

## 3) EXPLANATION OF PROCEDURES AND WHAT WILL BE EXPECTED FROM PARTICIPANTS.

This study involves answering some questions regarding your pregnancy, any clinical information relating to the pregnancy, examination of the placenta after delivery, and when necessary, send the placenta to be examined under a microscope in the laboratory. This will be done for the purpose of the research.

## 4) POSSIBLE RISKS AND DISCOMFORTS INVOLVED

There are no medical risks associated with the study. The only possible risks and discomfort involved are sensitive questions about your lifestyle and habits. You need not answer them if you feel uncomfortable.

## 5) POSSIBLE BENEFITS OF THIS STUDY

Although you may not benefit directly. The study may describe the characteristics and trends of the abnormal placental lesions which may assist with treatment options in subsequent pregnancies

## 6) COMPENSATION

You will not be paid to take part in the study. There are no costs involved for you to be part of the study.

## 7) YOUR RIGHTS AS A RESEARCH PARTICIPANT

Your participation in this research is entirely voluntary and you can refuse to participate or stop at any time without stating any reason. Your withdrawal will not affect your access to other medical care.

## 8) ETHICS APPROVAL

This Protocol was submitted to the Faculty of Health Sciences Research Ethics Committee, University of Pretoria, telephone numbers 012 356 3084 / 012 356 3085 and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2013), which deals with the recommendations guiding doctors in biomedical research involving human/subjects. A copy of the Declaration may be obtained from the investigator should you wish to review it.

## 9) INFORMATION

If you have any questions concerning this study, you should contact:

Prof. M. Yazbek Tel:012 356 3158 Cell:082 576 3558

## 10) CONFIDENTIALITY

All information obtained during the course of this study will be regarded as confidential. Each participant that is taking part will be provided with an alphanumeric coded number e.g. A001. This will ensure confidentiality of information so collected. Only the researcher will be able to identify you as a participant. Results will be published or presented in such a fashion that patients remain unidentifiable. The hard copies of all your records will be kept in a locked facility at the Department of Nursing Science, HW Snyman North, Prinshof Campus, Pretoria.

## 11) CONSENT TO PARTICIPATE IN THIS STUDY

- I confirm that the person requesting my consent / consent for my child to take part in this study has told me about the nature and process, any risks or discomforts, and the benefits of the study.
- I have also received, read and understood the above written information about the study.
- I have had adequate time to ask questions and I have no objections to participate in this study.
- I am aware that the information obtained in the study, including personal details, will be anonymously processed and presented in the reporting of results.
- I understand that I will not be penalized in any way should I wish to discontinue with the study and that withdrawal will not affect my further treatments.
- I am participating willingly.
- I have received a signed copy of this informed consent agreement.

_____ _____

Participant's name (Please print) Date

_____ _____

Participant's signature Date

_____ _____

Researcher's name (Please print) Date

_____ _____

Researcher's signature Date

**Annexures C: Consent form for placenta examination and disposal**

Patient's name and Surname:_____

Adress:_____

Patient's date of birth:_____

_____

a) It is compulsory for the placenta to be examined virtually by midwives and doctors after delivery in order to exclude problems related to the placenta.
-If after the virtual examination problems are identified, it is important and not compulsory that the placenta be send to the laboratory for examination under the microscope.
I consent to the virtual examination of the placenta. Yes/No
I consent to the examination of the placenta under the microscope. Yes/No

b) I have been offered information relating to the disposal of the placenta.
I consent for the hospital/laboratory to dispose the placenta as a clinical waste. Yes/No
I choose to make my own arrangement relating to the disposal. Yes/No

Patient's name: _____ Signature_____Date:_____

Doctor/midwife's name:_____Signature_____Date:_____

Witness: _____Signature_____Date:_____

## Annexure D: Letter of statistical support

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

DEPARTMENT OF STATISTICS

### LETTER OF STATISTICAL SUPPORT

Date: *16/05/2022*

This letter is to confirm that **Ms. J.O. Vilane,** studying at the University of Pretoria discussed the project with the title **"PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN EMALAHLENI SUB-DISTRICT IN MPUMALANGA PROVINCE - DESCRIPTIVE STUDY"** with me.

I hereby confirm that I am aware of the project and undertake to assist with the statistical analysis of the data generated from the project.

The following program, IBM SPSS Statistics version 28 will be used to perform the analysis. The data analysis will consist of the frequency tables: (counts and percentages) for categorical data, means, and standard deviations for continuous data. If the data is skewed, the median and the interquartile range will be presented to describe the data.

The Pearson chi-square test will be performed to test for association between the placenta findings and maternal medical conditions.

The non-probability purposive method will be used to select approximately 100 women who delivered term stillbirths meets the inclusion criteria.

**NAME :**

*A. Masenge*

Mr. Andries Masenge

Department of Statistics
Internal Consultation Service
Tel 012 420 3645

**Annexure E: Data collection Tool**

Study code …….. Date of enrolment……

**Part A**

**1 Demographics**

1.1 Maternal age:

| | | | |
|---|---|---|---|
| <18yrs | 18-24 yrs. | 25-34 yrs. | ≥35 yrs. |

1.2 Residential address:

| |
|---|
| |

1.3 Education:

| | | | |
|---|---|---|---|
| None | Primary | Secondary | Tertiary |

1.4 Marital status:

| | | | | |
|---|---|---|---|---|
| Single | Married | Separated | Divorced | cohabitation |

1.5 Race/ethnicity:

| | | | |
|---|---|---|---|
| Black | Coloured | Indians | White |

1.6 ANC facility/district

| | |
|---|---|
| | |

1.7 Referral:

| | |
|---|---|
| referred | Self referral |

**Part B**

**2. Antenatal care**

2.1 Parity and gravidity:

| | |
|---|---|
| | |

2.2 Previous obstetric history:

| | | |
|---|---|---|
| Abortion | Stillbirth | Neonatal death |

2.3 Gestational age at 1st ANC visit:

| | | | | |
|---|---|---|---|---|
| ≤ 20 wks. | 20-28 wks | 29-36 wks | 37-40 wks | >40 wks |

2.4 Pregnancy planned:

| | |
|---|---|
| Yes | No |

2.5 Contraception used:

| | | | | |
|---|---|---|---|---|
| Implant | Injection | IUCD | Oral | None |

2.6 Number of antenatal care visits:

| | | | | |
|---|---|---|---|---|
| ≥4 | 3 | 2 | 1 | No visit |

2.7 Nutritional status:

2.7.1 BMI

| | | | |
|---|---|---|---|
| <18 | 19-25 | 26-34 | ≥35 |

2.7.2 MUAC

| | | |
|---|---|---|
| <23 | 23-32 | >32 |

2.8 Exposure to environmental factors:

| | | |
|---|---|---|
| Active smoker | Passive smoker | Not smoking |

2.9 Mental health screening:

| | | |
|---|---|---|
| Yes | No | Score: |

2.10 Lifestyle habits:

| | | |
|---|---|---|
| alcohol | substances | none |

2.11 History of intimate partner violence/domestic violence/ sexual abuse:

| | |
|---|---|
| Yes | No |

2.12 Use of herbal/over the counter medication:

| Yes | No |
|---|---|

2.13 Covid-19 infection:

| Yes | No |
|---|---|

2.14 Vaccinated against Covid-19:

| Yes | No |
|---|---|

2.15 HIV status:

| HIV positive | HIV negative | unknown |
|---|---|---|

1.16 On ARV/PrePP:

| Yes | No |
|---|---|

1.17 Syphilis status

| Negative | Positive | Not done | unknown |
|---|---|---|---|

1.18 Haemoglobin at booking:

| Done | Not done | unknown |
|---|---|---|

1.19 Rhesus factor:

| Negative | Positive | Not done |
|---|---|---|

1.20 Anti- D given:

| Yes | No |
|---|---|

1.21 Maternal comorbidities

| Chronic hypertension | PET | Heart disease | Diabetes | TB | Other: specify |
|---|---|---|---|---|---|

**PART C:**

**2. Labour and delivery**

2.1 Onset of labour:

| Spontaneous | Induction |
|---|---|

2.2 Date and time of delivery:

| | |
|---|---|
| | |

2.3 Method of delivery:

| NVD | Assisted NVD | C/S |
|---|---|---|

2.4 Gestational age:

| 28-36 wks. | 37-42 wks. | >42 wks. | Unknown |
|---|---|---|---|

2.5 Attendant at delivery:

| Midwife | Doctor | Other: specify |
|---|---|---|

2.6 Foetal heart sound on admission:

| Yes | No |
|---|---|

2.7 Partograph used:

| Yes | No |
|---|---|

**PART D:**

**3. Status of the baby**

3.1 Sex

| Male | Female | Unknown |
|---|---|---|

3.2 Birth weight:

| 1000g | 1000-2500g | 2500-3500g | ≥4000g |
|---|---|---|---|

3.3 Type of stillbirth

| Fresh | Macerated |
|---|---|

**Part E**

**4.Gross placental examination findings**

**4.1 Foetal surface:**

4.1.1 cord insertion……

4.1.2 cord length……..

4.1.3 cord diameter……..

4.1.4 cord vessels……

4.1.5 cord colour……

4.1.6 cord knots……

4.1.7 cord coiling……

**4.2 Maternal surface:**

4.2.1 colour……..

4.2.2 retroplacental clot……

4.2.3 cotyledons complete……..

4.2.4 infarcts……

4.2.5 calcifications……

4.2.6 oedema……

**4.3 Membranes**:

4.3.1 amnion and chorion complete……..

4.3.2 colour of the membranes……..

4.3.3 placenta weight……..

4.3.4 compare the placental weight with weight of the baby……..

**4.4 Remarks:** …….

…….

…….

**Annexure F: Declaration for storage of research information**

**Protocol No.** _____

**Principal Investigator(s) Declaration for the storage of research data and/or documents**

I, the Principal Investigator(s), JOHANNAH OUMA VILANE

of the following trial/study titled

PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL AT EMALAHLENI SUB-DISTRICT IN MPUMALANGA PROVINCE - DESCRIPTIVE STUDY.

will be storing all the research data and/or documents referring to the above mentioned trial/study at the following address: ____DEPT OF NURSING SCIENCE, HW SNYMAN NORTH 8TH FLOOR, PRINSHOF CAMPUS, PRETORIA_____

**I understand that the storage for the abovementioned data and/or documents must be maintained for a minimum of 15 years from the commencement of this trial/study.**

START DATE OF TRIAL/STUDY: 01/02/2022

END DATE OF TRIAL/STUDY: 31/01/2023

UNTIL WHICH YEAR WILL DATA WILL BE STORED: 2037

**Name** JOHANNAH OUMA VILANE

**Signature** _____

**Date** 01 SEPTEMBER 2022

## Annexure G: Declaration for Helsinki Ethical Principles for medical research involving human subjects



Special Communication

# World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects

World Medical Association

Adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964, and amended by the: 29th WMA General Assembly, Tokyo, Japan, October 1975
35th WMA General Assembly, Venice, Italy, October 1983 41st WMA General Assembly, Hong Kong, September 1989
48th WMA General Assembly, Somerset West, Republic of South Africa, October 1996 52nd WMA General Assembly, Edinburgh, Scotland, October 2000
53rd WMA General Assembly, Washington, DC, USA, October 2002 (Note of Clarification added) 55th WMA General Assembly, Tokyo, Japan, October 2004 (Note of Clarification added)
59th WMA General Assembly, Seoul, Republic of Korea, October 2008 64th WMA General Assembly, Fortaleza, Brazil, October 2013

## Preamble

1. The World Medical Association (WMA) has developed the Dec- laration of Helsinki as a statement of ethical principles for medi- cal research involving human subjects, including research on identifiable human material and data.

   The Declaration is intended to be read as a whole and each of its constituent paragraphs should be applied with consider- ation of all other relevant paragraphs.

2. Consistent with the mandate of the WMA, the Declaration is ad- dressed primarily to physicians. The WMA encourages others who are involved in medical research involving human subjects to adopt these principles.

## General Principles

3. The Declaration of Geneva of the WMA binds the physician with the words, "The health of my patient will be my first consider- ation," and the International Code of Medical Ethics declares that, "A physician shall act in the patient's best interest when provid- ing medical care."

4. It is the duty of the physician to promote and safeguard the health, well-being and rights of patients, including those who are involved in medical research. The physician's knowledge and con- science are dedicated to the fulfilment of this duty.

5. Medical progress is based on research that ultimately must in- clude studies involving human subjects.

6. The primary purpose of medical research involving human sub- jects is to understand the causes, development and effects of diseases and improve preventive, diagnostic and therapeutic in- terventions (methods, procedures and treatments). Even the

   best proven interventions must be evaluated continually through research for their safety, effectiveness, efficiency, accessibility and quality.

7. Medical research is subject to ethical standards that promote and ensure respect for all human subjects and protect their health and rights.

8. While the primary purpose of medical research is to generate new knowledge, this goal can never take precedence over the rights and interests of individual research subjects.

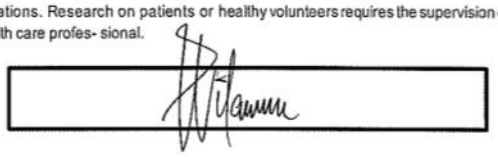
9. It is the duty of physicians who are involved in medical research to protect the life, health, dignity, integrity, right to self- determination, privacy, and confidentiality of personal informa- tion of research subjects. The responsibility for the protection of research subjects must always rest with the physician or other health care professionals and never with the research subjects, even though they have given consent.

10. Physicians must consider the ethical, legal and regulatory norms and standards for research involving human subjects in their own countries as well as applicable international norms and stan- dards. No national or international ethical, legal or regulatory re- quirement should reduce or eliminate any of the protections for research subjects set forth in this Declaration.

11. Medical research should be conducted in a manner that mini- mises possible harm to the environment.

12. Medical research involving human subjects must be conducted only by individuals with the appropriate ethics and scientific edu- cation, training and qualifications. Research on patients or healthy volunteers requires the supervision of a competent and appropriately qualified physician or other health care profes- sional.





## Annexure H: Ethical clearance

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences

**Institution:** The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.
- FWA 00002567, Approved dd 18 March 2022 and Expires 18 March 2027.
- IORG #: IORG0001762 OMB No. 0990-0279 Approved for use through June 30, 2025 and Expires 07/29/2026.

Faculty of Health Sciences **Research Ethics Committee**

9 November 2023

**Approval Certificate**
**Annual Renewal**

Dear Johannah Ouma Vilane,

**Ethics Reference No.: 175/2020 – Line 1**
**Title: Placental findings in term singleton stillbirths in a selected public hospital in eMalahleni sub-district in Mpumalanga province - descriptive study**

The **Annual Renewal** as supported by documents received between 2023-10-13 and 2023-11-08 for your research, was approved by the Faculty of Health Sciences Research Ethics Committee on 2023-11-08 as resolved by its quorate meeting.

Please note the following about your ethics approval:

- Renewal of ethics approval is valid for 1 year, subsequent annual renewal will become due on 2024-11-09.
- The Research Ethics Committee (REC) must monitor your research continuously. To this end, you must submit as may be applicable for your kind of research:
  a) annual reports;
  b) reports requested *ad hoc* by the REC;
  c) all visitation and audit reports by a regulatory body (e.g. the HPCSA, FDA, SAHPRA) within 10 days of receiving one;
  d) all routine monitoring reports compiled by the Clinical Research Associate or Site Manager within 10 days of receiving one.
- The REC may select your research study for an audit or a site visitation by the REC.
- The REC may require that you make amendments and take corrective actions.
- The REC may suspend or withdraw approval.
- Please remember to use your protocol number (175/2020) on any documents or correspondence with the Research Ethics Committee regarding your research.

**Ethics approval is subject to the following:**

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

**Yours sincerely**

**On behalf of the FHS REC, Dr R Sommers**
MBChB, MMed (Int), MPharmMed, PhD
***Deputy Chairperson** of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria*

*The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes, Second Edition 2015 (Department of Health).*

Research Ethics Committee
Room 4-60, Level 4, Tswelopele Building
University of Pretoria, Private Bag X323
Gezina 0031, South Africa
Tel +27 (0)12 356 3084
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Fakulteit Gesondheidswetenskappe
Lefapha la Disaense tša Maphelo

**Annexure I: Language editing**

Cell/Mobile: 073-782-3923

53 Glover Avenue

Doringkloof

0157 Centurion

16 May 2024

**TO WHOM IT MAY CONCERN**

I hereby certify that I have edited Ouma Vilane's master's dissertation, PLACENTAL FINDINGS IN TERM SINGLETON STILLBIRTHS IN A SELECTED PUBLIC HOSPITAL IN MPUMALANGA PROVINCE – DESCRIPTIVE STUDY, for language and content.

IM Cooper

Iauma M Cooper

192-290-4