

Placental Findings in Term Singleton Stillbirths in a Public Hospital in Emalahleni Sub-District in Mpumalanga Province: A Descriptive Study

Ouma Vilane | Mariatha Yazbek  | Maurine Musie

University of Pretoria, Pretoria, South Africa

Correspondence: Mariatha Yazbek (mariatha.yazbek@up.ac.za)

Received: 23 June 2024 | **Revised:** 20 November 2024 | **Accepted:** 12 February 2025

Keywords: placental findings | placental lesions | term singleton stillbirths | unexplained stillbirths

ABSTRACT

Objective: This study was carried out to investigate the macroscopical and microscopical placental findings in term singleton stillbirths at a selected public hospital.

Methods: A quantitative non-experimental observational descriptive study was conducted by examining the placentas of 89 term singleton stillbirth babies in the labor ward for macroscopic lesions. A data collection tool was used to capture clinical data from patient files on variables of interest related to placental lesions for stillbirth cases. The IBM SPSS Statistics version 28 package was used to analyze the data.

Results: A significant relationship was found between the following variables ($p < 0.05$): stillbirth and number of antenatal care visits ($p = 0.0035$); birth weight and mid-upper arm circumference ($p = 0.013$); birth weight and maternal vascular malperfusion (MVM) ($p = 0.001$); birth weight and birth attendant ($p = 0.034$); type of stillbirth and birth attendant ($p = 0.033$); type of stillbirth and previous obstetric history ($p = 0.038$); cord insertion and smoking/substance abuse ($p = 0.012$); cord insertion and hemoglobin ($p = 0.029$); cord length and meconium histiocytes ($p = 0.031$); cord diameter and syphilis ($p = 0.030$); placental weight and onset of labor ($p = 0.012$); placental weight and fetal vascular malperfusion (FVM) ($p = 0.004$); color of membranes and maternal inflammatory response (MIF) ($p = 0.002$); color of membranes and meconium histiocytes ($p = 0.000$), and color of membranes and syphilis ($p = 0.053$).

Conclusion: The study provides essential insights into the placental findings associated with term singleton stillbirths in the Emalahleni Sub-District. Examination of the placenta may help to define the causes in more than 90% of stillbirth cases, inform the research, and decrease stillbirth rates.

1 | Introduction

Stillbirth, defined as the death of a fetus at 28 weeks' gestation or later, remains a significant public health concern, particularly in low- and middle-income regions (Pinar et al. 2014). Examination of the complex pathogenic interplay among the mother, fetus, and placenta that leads to stillbirth has generally focused on maternal

and fetal disorders. With that said, placental pathology has been identified as a crucial factor in understanding the causes of stillbirths, given its role in fetal nourishment, oxygenation, and waste elimination. For normal growth and survival, the fetus depends on the placenta (Gualdoni et al. 2022, 2). The placenta is an organ of fetal adaptation to maternal environment and provides oxygen nourishment and waste disposal (dos Reis et al. 2020, 1). The

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2025 The Author(s). *Public Health Nursing* published by Wiley Periodicals LLC.

placenta acts as a barrier against most infections (Yong et al. 2021, 2) and is called the “chronicle of intrauterine life” because it provides intrauterine events. Maternal diseases and infections are reflected in the placenta which may result in abnormal placentation, malperfusion, and inflammation of the placenta (Goldstein et al. 2020, 1). Uninterrupted blood flow of maternal and fetal blood circulation is very important for normal placental functioning and to support fetal growth (Ernst 2018, 551).

Studies suggest that placental abnormalities such as infarctions, infections, and vascular insufficiency are often implicated in term stillbirths and may provide vital clues for prevention and early intervention of stillbirths (Gibbins et al. 2020, 2). These are a result of impaired placental circulation causing lesions, and dysfunction of the placenta which may result in adverse perinatal outcomes (Gibbins et al. 2020, 2). Some of the placental abnormalities that may be denoted on placenta pathology are associated with many potentially modifiable disorders such as demographic, environmental, nutritional, and lifestyle factors (Reinebrandt et al. 2018, 289). Undernutrition, overweight, and obesity are associated with poor pregnancy outcomes (Symington et al. 2018, 9). Placental lesions in maternal obesity and gestational diabetes are abnormal cord insertion, umbilical cord knots, hypercoiling, umbilical cord thrombosis, and placental infarcts (Wright et al. 2019, 11). Maternal vascular malperfusion (MVM) is associated with pre-eclampsia and other hypertensive disorders (Kulkarni et al. 2017, 180; Paules et al. 2019, 614).

Severe anemia in pregnancy may lead to placental abruption and stillbirth (Shi et al. 2022, 9) and tuberculosis may result in inflammation of the placenta (Tiwari and Kumar 2017, 2). Placental findings in perinatal tuberculosis include chronic necrotizing granulomas and villitis (Goldstein et al. 2020, 9). Maternal caffeine intake is associated with uteroplacental vasoconstriction (Reijnders et al. 2019, 74), and a high daily caffeine intake of >300 mg per day may increase the incidence of stillbirths (WHO 2020, 14). Placental lesions from previous obstetric history of stillbirths are low placental weight, infarcts, calcifications, and abnormal cord insertion (Bedwell et al. 2020, 1211).

Physical or sexual intimate partner violence against pregnant women accounted for a 30% increase in the chances of stillbirth (Lawn et al. 2016, 598). Fetal death following placenta abruption with no maternal condition or without clear reason may be associated with intimate partner violence (Oche et al. 2020, 2). Advanced maternal age (>35) is associated with a variety of pregnancy complications and placental pathology related to pregnancy-induced hypertension, gestational diabetes, and increased BMI (Zhang et al. 2022). Maternal smoking and passive smoking in Ethiopia contributed to unexplained stillbirths (Tesema et al. 2020, 193). Maternal cigarette smoking, passive smoking, and substance abuse cause damage to the placenta (vasoconstriction) which results in fetal lesions and low placental weight (Gibbins et al. 2020, 8; Wright et al. 2019, 11).

Maternal exposure to indoor and ambient air pollution may lead to placenta lesions such as fetal vascular malperfusion (FVM) (Khan et al. 2017, 2). Air pollutants reduce the oxygen-carrying capacity of blood to the body tissue of the fetus and the fetus is then deprived of oxygen leading to intra-uterine growth retardation and stillbirth (Khan et al. 2017, 2). The Covid-19

pandemic has had a profound effect on the healthcare system worldwide and has resulted in an increase in socio-economic challenges. The direct effect of Covid-19 infection on the fetus may be Covid placentitis (inflammation of the placenta) which may cause stillbirth (Gebremeskel et al. 2020: 263; Linehan et al. 2021, 263; O’Sullivan 2021). Covid-19-related placental lesions are thrombosis and placental necrosis which may lead to fetal demise (Bouachba et al. 2021, 1; Schwartz et al. 2020, 1).

Figure 1 is a conceptual framework that describes how physical, maternal/paternal, and social factors affect the placenta and may lead to placental lesions and adverse perinatal outcomes which include stillbirths.

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 stillbirth rate, as well as unexplained stillbirths, remained high, with no improvement plan. The study therefore aimed to assess and describe the placental findings of macroscopic and microscopic placenta examinations in singleton-term stillbirths in the selected public hospital.

2 | Materials and Methods

2.1 | Study Design and Participants

A quantitative observational descriptive study was conducted using the “Strengthening the reporting of observational studies in Epidemiology (STROBE)” checklist. The study was conducted between October 2022 and the end of July 2023 in a selected public hospital. In this study, 89 term singleton stillbirth placentas were examined. There were 105 placentas for the period of study of which 16 placentas were excluded because of various reasons. Some of the consent forms were incomplete and others did not meet the inclusion criteria.

The unit of analysis were placentas of term singleton stillbirths. The sampling method used was non-probability purposive sampling. Pregnant women admitted in labor ward were approached by the investigator after confirmation of an intrauterine fetal death, and after counseling for eligibility, most of them indicated a need to know the probable cause of the fetal demise. 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 was given a consent form to sign. Women who were ≥37–40 weeks of gestation by calculations from the first day of the last normal menstrual period which was confirmed by sonar were approached. Women who voluntarily gave informed consent to participate in the study were enrolled and were given consent forms to sign for placenta disposal. For women who were below 18 years, guardians had to consent for the study and for disposal of the placenta. Women admitted with fetal heart sounds who delivered fresh stillborn were approached after delivery and were recruited as the first group. Cultural believes of the women and their families regarding the handling and disposal of the placentas were considered.

Only singleton placentas of women with confirmed intra-uterine fetal death and fresh stillbirths with a gestation of 37–40 weeks

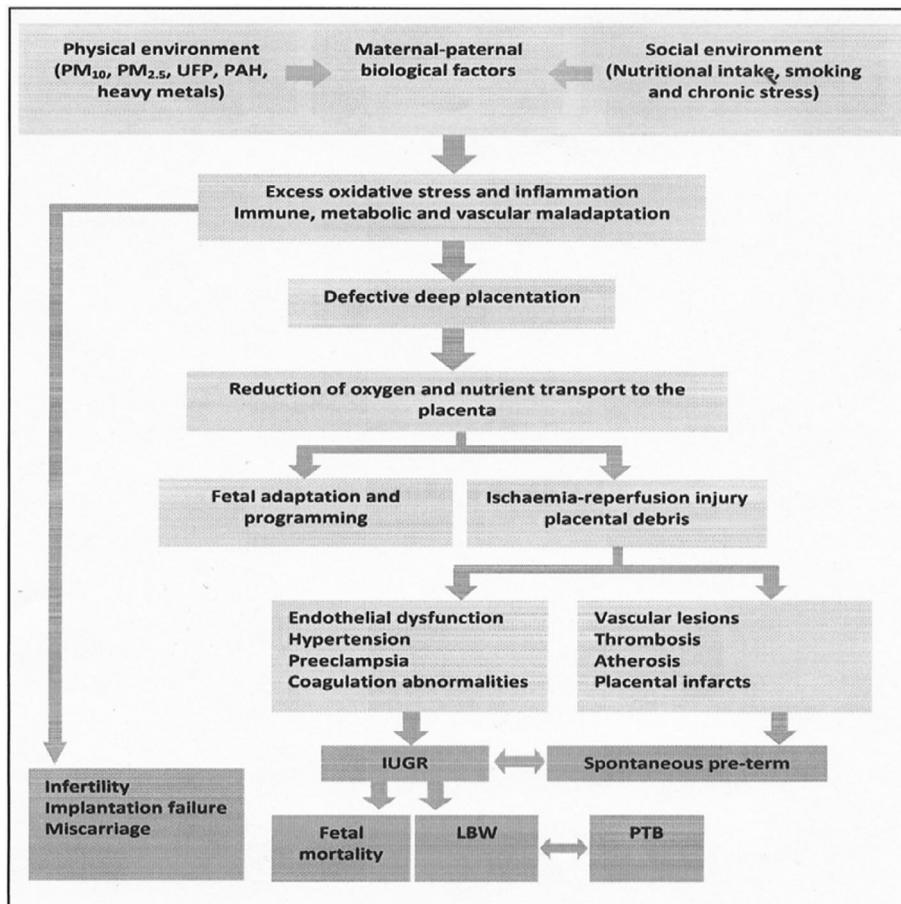


FIGURE 1 | The effect of the physical environment, maternal-paternal biological factors, and social environment on the placenta. *Source:* (Ahmad 2020).

who delivered in the labor ward of the selected public hospital were included in the study. The selected public hospital functions as a referral hospital for two districts, which are Nkangala and Gert Sibande, with 6 sub-districts, 89 Primary Health Care facilities, and 22 mobile clinics, and is surrounded by many informal settlements and coal mines which attracts lots of immigrants from neighboring countries like Mozambique, Zimbabwe, Swaziland, Lesotho, and others. The population of Nkangala district is about 1,357,744. The informal settlements have no electricity supply and rely on coal for fuel. The pregnant women inhale the polluted air from the mines. The stillbirth rate varied between 16 and 30 per month during 2021 in the selected hospital.

2.2 | Data Collection Tools

A self-administered measuring tool was adapted from the WHO Making Every Baby Count (2016:17). The following sections were included in the tool, Section A Demographical Data, Section B Antenatal Care, Section C Labor and Delivery, Section D Status of the Baby, and Sections E Placental findings.

2.3 | Data Collection

The clinical history was collected from the patient's 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 hematoma, meconium staining, infarcts, calcifications, cord for knots, hypercoiling, and the presence of three blood vessels. The placentas were weighed and compared with the placenta weight for the gestational age chart. The placental diameter and cord thickness were measured and recorded according to the standard operational procedure of the selected hospital. After the macroscopic examination, placentas were put in placenta buckets. Formalin 10% was added to preserve them. The placentas were then labeled and sent for histology. Histology results were received after 4–6 weeks, already interpreted, and authorized by a senior pathologist in an easy-to-read format. The results were discussed in the monthly perinatal meetings of the selected hospital. Figure 2 depicts the data collection process.

2.4 | Data Analysis

Descriptive statistical analysis was done using the International Business Machines Statistical Package for the Social Sciences Statistics Version 28 (IBM SPSS) software. In the evaluation of the data, descriptive statistics such as percentage, frequency, and mean values were used. Correlation of data analysis between different variables was done. The Chi-square test was used to

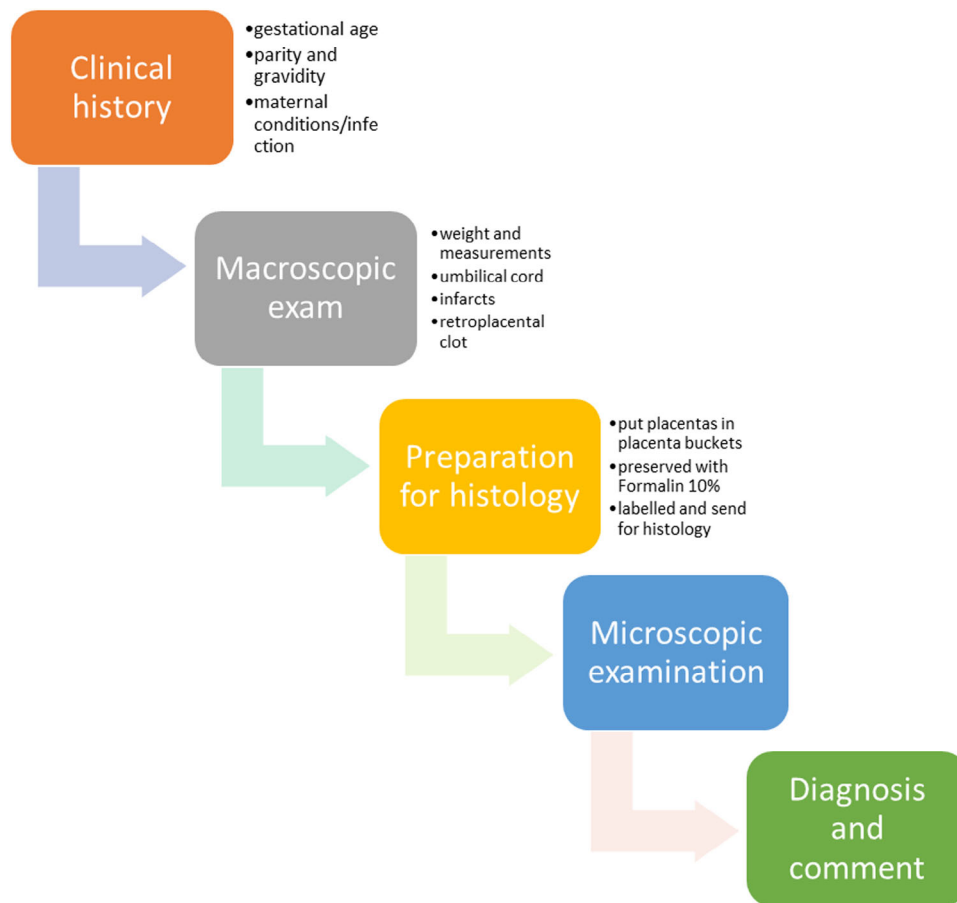


FIGURE 2 | Data-collection procedure. [Color figure can be viewed at wileyonlinelibrary.com]

determine a relationship between variables, and the Fisher-Free-Hamilton Exact test to determine the association. The Pearson Chi-square test was used to perform tests if there was any association between the placenta findings and maternal medical conditions. Excel 2016 was used to capture the data. The research only indicated the summary of the correlation tables of the variables that had significant associations. The statistical significance level was accepted as $p < 0.05$.

2.5 | Ethical Considerations

2.5.1 | Ethical Clearance

Ethical approval was obtained from University of Pretoria Ethics Committee, approval number (175/2020). The study was also carried out in accordance with the ethical rules specified in the Declaration of Helsinki principles.

3 | Results

The sample consisted of 89 placentas from women who delivered term singleton stillbirths in the labor ward of the selected public hospital. The study variables included were the maternal demographic profile, antenatal care, labor and delivery, the status of the baby, and the gross macroscopic placental findings (Tables 1–3). The maternal clinical history was collected from the maternity

case record book and the maternity register. The macroscopic examination included the placental weight, disk dimensions, and the descriptions of the umbilical cord (Table 4).

3.1 | Section A Demographical Data

Of the participants, 78%, ($n = 69$) were 18–35 years old, 22% ($n = 20$) were older than 35, and none were younger than 18. 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. The majority of the participants (91%, $n = 81$) were single, 7% ($n = 6$) were married, and 1% ($n = 1$) were divorced. The majority of the participants (91%, $n = 81$) were single, 7% ($n = 6$) were married, and 1% ($n = 1$) were divorced. Of the participants, 96% ($n = 85$) were Black and 4% ($n = 4$) were White. Of the participants, 75% ($n = 67$) were referred from the district hospitals and clinics for risk factors 25% ($n = 22$) were self-referrals who presented to the selected hospital with either antepartum bleeding, reduced or absence of fetal movements. See Table 1.

3.2 | Section B Antenatal Care

The antenatal care is depicted in Table 2. Parity and gravidity are associated with increased risk of adverse perinatal outcomes. Of the participants, 64% ($n = 57$) were multigravida, 21%

TABLE 1 | Participants' demographic profile.

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

(*n* = 19) were primigravida, and 15% (*n* = 13) were grande multipara. 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 molar pregnancy. 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. Of the participants, 53% (*n* = 47) had more than four antenatal care visits, 35% (*n* = 31) had 1-3 visits and 12% (*n* = 11) did not attend antenatal clinic at all. Of the participants, 93% (*n* = 83) did not use contraceptives and 54% (*n* = 48) pregnancies were not planned. 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. 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* = 1) had no recorded score. Of the participants, 90% (*n* = 80) did not smoke, 6% (*n* = 5) were passive smokers, and 4% (*n* = 4) were active smokers. 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. 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.

Maternal comorbidities/infections associated with an increased risk of stillbirth were found. Of the participants, 21% (*n* = 19)

TABLE 2 | 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	30
>20 wks	51	57
Unbooked	11	12
Number of antenatal visits		
0	11	12
1-3 visits	31	35
4-7 visits	48	54
Contraceptives used		
Yes	6	8
No	83	93
BMI/MUAC		
Healthy	12	13
Overweight	14	16
Obese	31	35
Underweight	1	1
Not done	31	35
Mental health screening		
Done	26	29
Not done	63	71
Exposure to environmental factors		
Active smoker	4	4
Passive smoker	5	5
Not smoking	80	90
Lifestyle habits		
Alcohol	8	9
Substances	1	1
None	80	90
Rhesus factor		
Positive	63	71
Not done	24	27
Negative	2	2

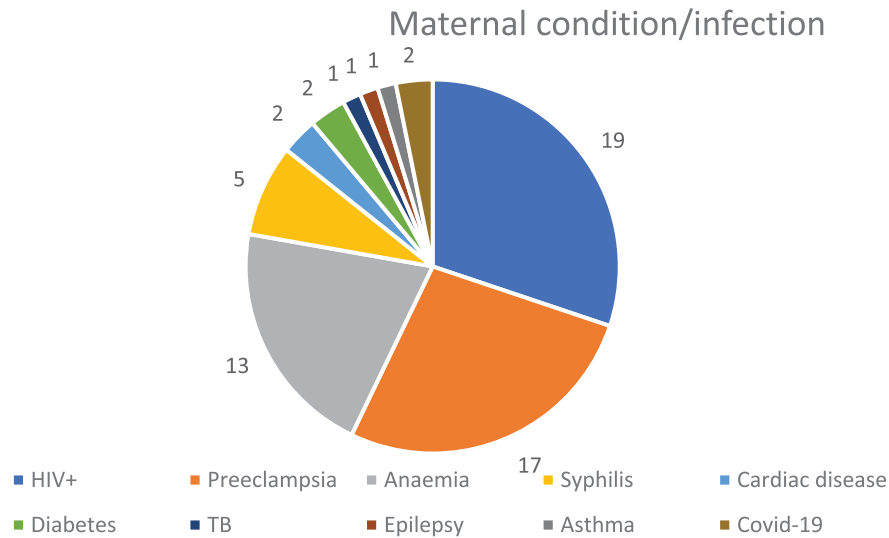


FIGURE 3 | Summary of participants' maternal comorbidities/infections. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 | Participants' labor and delivery.

Labor and delivery	N = 89	Percentage (%)
Onset of labor		
Induction	26	29
Spontaneous	58	65
Self-induced	2	2
Method of delivery		
Normal vertex delivery	75	84
Cesarean section	14	16
Gestational age at delivery		
37–40 wks	87	98
41–42 wks	2	2
Fetal 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 and doctor	26	29

were HIV positive, 19% ($n = 17$) had preeclampsia, 15% ($n = 13$) had anemia, 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. Figure 3 summarizes the participants' maternal comorbidities/infections. Of the participants, 71% ($n = 63$) had maternal medical diseases or conditions as summarized in Figure 3.

3.3 | Section C Labor and Delivery

Of the participants, 65% ($n = 58$) had spontaneous onset of labor, 29% ($n = 26$) had induction, and 2% ($n = 2$) had self-induction of labor through backstreet insertion of Cytotec tablets, 84% ($n = 75$) had normal vertex deliveries and 16% ($n = 14$) had cesarean 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 fetal heart sounds on admission and 10% ($n = 9$) had fetal heart sounds on admission. The partogram was used on 17% ($n = 15$) of the participants in labor 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 attendant by midwives and doctors. Of the participants, 84% ($n = 75$) had normal vertex deliveries and 16% ($n = 14$) had cesarean section deliveries. Of the participants, 90% ($n = 80$) had no fetal heart sounds on admission and 10% ($n = 9$) had fetal heart sounds on admission. Of the participants, 83% ($n = 74$) were not monitored on the partogram and 17% ($n = 15$) were monitored with the partogram. Table 3 summarizes the participants' labor and delivery.

3.4 | Section D Status of the Baby

Of the stillborn neonates, 55% ($n = 49$) were males and 45% ($n = 40$) were females. The birth weights of the participants' stillborn babies were as follows: 59% ($n = 53$) were 1100–2400 g, 31% ($n = 28$) were 2500–3500 g, 3% ($n = 3$) were 3600–4000 g, 3% ($n = 3$) were >4000 g and 2% ($n = 2$) were 500–1000 g. Of the stillbirths, 75% ($n = 67$) were macerated stillbirths.

3.5 | Section E Placental Findings

Of the gross placental findings depicted in Table 4, 65% ($n = 58$) had <35 cm cord length (short cords), 30% ($n = 27$) had normal cord lengths (36–69 cm) and 2% ($n = 2$) had long cords (>70 cm). Of the cords, 65% ($n = 58$) were blood stained, 20% ($n = 18$) were

TABLE 4 | Gross/macroscopic placental findings.

Gross/macroscopic findings	N = 89	Percentage (%)
Cord length		
>70 cm long	2	2
<35 cm short	58	65
36–69 cm normal	27	30
Cord color		
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		
<0.5 cm (extremely thin)	1	1
0.6–0.8 cm (thin)	72	81
0.9–2 cm (normal)	6	7
>2–3cm (thick)	10	13
Placental disk		
Retroplacental clot	13	15
Infarcts	44	49
Succenturiate lobe	2	2
Membrane color		
Meconium stained	18	20
White patches	11	12
Dusky	50	56
Opaque	10	11
Placental weight		
<3rd–5th percentile	57	64
10th–25th percentile	15	17
50th–75th percentile	13	15
90th–97th percentile	4	4

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 10 cm) and 4% ($n = 4$) had hypercoiling (>3 coils in 10 cm). Of the cases, 1% ($n = 1$) had a cord diameter of <0.5 cm, 81% ($n = 72$) had 0.6–0.8 cm diameter, 7% ($n = 6$) had 0.9–2 cm diameter, and 11% ($n = 10$) had >2–3 cm diameter. On the placental disc, 15% ($n = 13$) had

TABLE 5 | Summary of placental disc findings.

	Frequency	Percentage (%)
Placental disc		
Retroplacental clot	13	15
Infarcts	44	49
Succenturiate lobe	2	2
Color		
Meconium stained	18	20
White patches	11	8
Dusky	50	56
Opaque	10	11
Placental weight		
>3rd–5th	57	64
10th–25th	15	17
50th–75th	13	15
90th–97th	4	4

retroplacental clot, 49% ($n = 44$) cases had infarcts and 2% ($n = 2$) had 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 5th 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.

Examination of the maternal surface of the placenta revealed the following. Of the placentas, 49% ($n = 44$) had infarcts, 15% ($n = 13$) had retroplacental clots, and 2% ($n = 2$) had succenturiate lobes. 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. A summary of the placental disc findings is provided in Table 5.

Placental weight can affect the fetal and neonatal outcomes. 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). A summary of the placental weights is provided in Figure 4.

The microscopic histological findings of the placental refer to sectioning, staining, and examination of the placenta and the umbilical cord under a microscope. The histological findings include proliferative vascular changes, chronic villitis, villous immaturity, acute and chronic villitis necrotizing funisitis, and the presence of spirochetes which are summarized in Table 6.

MVM was the most significant placental finding in this study, which included placental hypoplasia (placental weight of <10 percentile), placental infarcts, retroplacental hemorrhage, decidual arteriopathy, distal villous hypoplasia, and accelerated villous maturation. MVM is summarized in Figure 5.

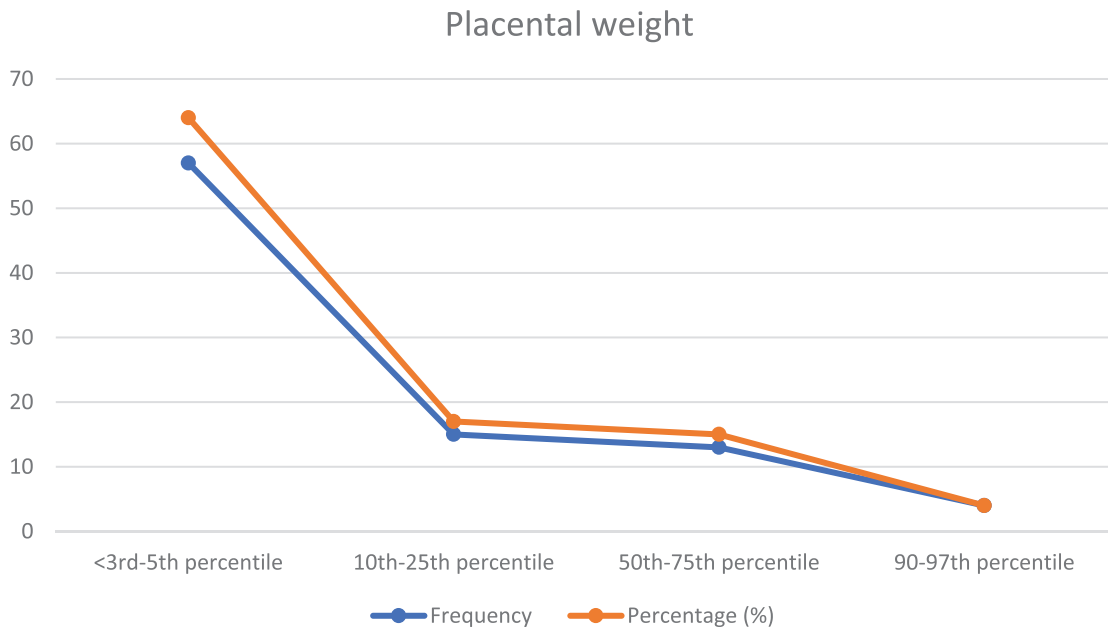


FIGURE 4 | Summary of the placental weights. [Color figure can be viewed at wileyonlinelibrary.com]

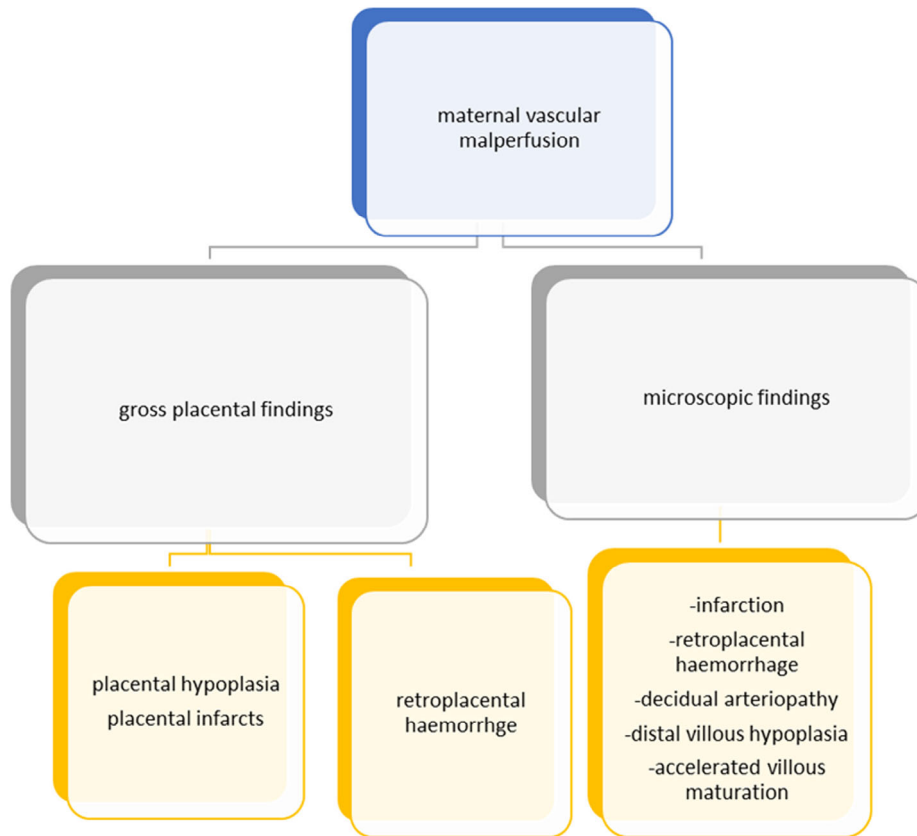


FIGURE 5 | Summary of maternal vascular malperfusion findings on both gross and histological examination. [Color figure can be viewed at wileyonlinelibrary.com]

3.6 | Correlation of Data Analysis between Variables

Correlation between variables in maternal behavior and stillbirth was done to find the possibility of predicting causal relation-

ships. The Chi-square test relies on approximations that were used to determine relationships between the variables which comprised stillbirth versus maternal age, stillbirth versus parity, stillbirth versus contraceptive use, stillbirth versus number of antenatal care visits, birth weight versus mid-upper arm

TABLE 6 | 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
Fetal inflammatory response (FIR)	8	9
Fetal vascular malperfusion (FVM)	2	2
Chronic histiocytic villitis	1	1

circumference, birth weight versus MVM, birth weight versus birth attendant, type of stillbirth versus previous obstetrical history, cord insertion versus smoker/substance abuse, cord insertion versus hemoglobin, cord length versus meconium histiocytes, cord diameter versus syphilis, placenta weight versus onset of labor, placental weight versus maternal malperfusion, color of membrane versus maternal inflammatory response (MIF), and color of membrane versus meconium histiocytes and color of membranes versus syphilis. A Chi-square value of $p < 0.05$ was considered significant while $p > 0.05$ level was not significant. The Fisher Hamilton Exact Test was added to calculate the exact probability of observing the data under the assumption (Table 7).

A significant relationship was found between the following variables ($p < 0.05$): stillbirth and number of antenatal care visits ($p = 0.0035$); birth weight and mid-upper arm circumference ($p = 0.013$); birth weight and MVM ($p = 0.001$); birth weight and birth attendant $p = (0.034)$; type of stillbirth and birth attendant ($p = 0.033$); type of stillbirth and previous obstetric history ($p = 0.038$); cord insertion and smoking/substance abuse ($p = 0.012$); cord insertion and hemoglobin ($p = 0.029$); cord length and meconium histiocytes ($p = 0.031$); cord diameter and syphilis ($p = 0.030$); placental weight and onset of labor ($p = 0.012$); placental weight and FVM ($p = 0.004$); color of membranes and MIF ($p = 0.002$); color of membranes and meconium histiocytes ($p = 0.000$), and color of membranes and syphilis ($p = 0.053$).

4 | Discussion

The study assessed and described the findings of macroscopic and microscopic placenta examinations in singleton-term stillbirths in a selected public hospital using a self-administered measuring tool adapted from the WHO Making Every Baby Count (2016:17). Characteristics and trends of the placental lesions of the stillbirths were then described.

4.1 | Section A Demographical Data

Most of the participants were between 18 and 35 years old, were single, Black, and had a secondary or high school education.

In addition, most had been referred from local clinics and district hospitals. Advanced maternal age is associated with poor implantation and poor placental perfusion because of the reduced hormones responsible for the implantation process (Mondal et al. 2017). In India, stillbirths were associated with teenage pregnancy and with advanced maternal age (Tiwari et al. 2021). In China, advanced and very advanced maternal age >40 years was associated with an increased risk of adverse perinatal outcomes, including stillbirths (Wu et al. 2021). In Ethiopia, maternal education had an impact on maternal knowledge about health issues, the utilization of antenatal care services and stillbirth (Tesema et al. 2020). 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 for stillbirth due to socio-economic insecurity and lack of psychological support (Bedwell et al. 2020). Maternal race is associated with increased risk of stillbirth due to socio-economic discrepancies (Mhlophe 2019).

4.2 | Section B Antenatal Care

The World Health Organization (2016) and Seebregts et al. (2016) stress the importance of antenatal care and regular attendance for positive birth outcomes. 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. A study in Northern Tanzania found that fewer antenatal visits were associated with stillbirths (Lema et al. 2020). In Durban, Natal, an increased number of antenatal visits was associated with less adverse perinatal outcomes, including stillbirths (Hoque et al. 2022). Antenatal visits present opportunities for reaching pregnant women with interventions Hoque et al. 2022). Inappropriate timing of the first antenatal booking is associated with poor pregnancy outcomes, including perinatal deaths, and stillbirths (Tesema et al. 2020).

In South Africa, the goal of antenatal care is 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 2011). In this study, multigravidas were more affected than primigravidas and grande multiparas. In their study on maternal and fetal risk factors for stillbirths, Gardosi et al. (2013) found that zero (0) parity and parity of three (3) and more were at increased risk for stillbirths. Previous obstetric history of abortions and stillbirths is a risk factor for stillbirth (Lema et al. 2020). 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.

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 et al. 2016). The United Nations (2015) sustainable goals 2030 target is for 63% of women in sexual relationships to be on contraceptives. Although most of the pregnancies in this study were unplanned and no contraceptives were used, there was no statistical association between unplanned pregnancy and stillbirth.

TABLE 7 | Correlation of data analysis between variables.

Correlation of data analysis between variables					
	Yes	No	Total	p value (<0.05)	Test
Correlation of number of antenatal visits and fetal heart on admission			89	0.035	F
0 visits	0	11			
1-3 visits	1	30			
4-7 visits	10	37			
Correlation of birth weight and mid-upper arm circumference			89	0.015	F
Extremely small	2				
Small	0				
Normal	29				
Overweight					
Not done	51				
Correlation of birth weight and birth attendant			89	0.034	F
Extremely small	1				
Small	25				
Normal	63				
Correlation between birth weight and maternal vascular malperfusion			85	0.001	F
Extremely small	0	1			
Small	31	24			
Normal	3	19			
Present	7				
Correlation between type of stillbirth and previous obstetric history			89	0.038	F
Fresh	23				
Macerated	66				
Correlation between type of stillbirth and birth attendant			89	0.012	F
Fresh	23				
Macerated	66				
Correlation between cord insertion and maternal hemoglobin			89	0.029	F
Battledore	3				
Circumvallate	1				
Lateral	9				
Medial	55				
Mediolateral	21				
Correlation between cord length and meconium			89	0.031	F
Abnormal	5				
Normal	34				
Short cord	50				
Correlation between cord diameter and smoking/substances			89	0.017	F
Normal	78				
Thick	5				
Thin	6				

(Continues)

TABLE 7 | (Continued)

Correlation of data analysis between variables					
	Yes	No	Total	p value (<0.05)	Test
Correlation between cord diameter and syphilis			89	0.030	F
Normal	2	62			
Thick	1	4			
Thin	1	4			
Not done	14	0			
Correlation between placental weight and onset of labor			89	0.012	F
Cesarean section	1				
Emergency cesarean section	2				
Induction	26				
Self-induced	2				
Spontaneous	58				
Correlation between placental weight and fetal vascular malperfusion			89	0.004	F
Abnormal	0	10			
Inadequate placenta	1	58			
Normal	5	15			
Correlation between color of the membranes and maternal inflammatory response			89	0.002	F
Clear	0	7			
Cloudy	4	0			
Dusky	7	6			
Meconium stained	3	14			
Opaque	16	31			
White patches	1	0			
Correlation between color of membranes and meconium histiocytes			89	0.000	F
Clear	0	7			
Cloudy	0	4			
Dusky	4	9			
Meconium stained	14	3			
Opaque	6	41			
White patches	0	1			

Note: F denotes Fisher Hamilton Exact Test.

Maternal nutrition has an impact on fetal development and gestational outcomes. In Brazil, Miele et al. (2021) assessed the nutritional status of 1165 nulliparous pregnant women by body mass index and mid-upper arm circumference 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 et al. 2021). A study in Romania found that obesity was associated with other risk factors such as gestational diabetes and hypertensive disorders, fetal macrosomia, and late stillbirths in pregnancy, which are associated with MIF, abnormal and malperfusion of the placenta, with an increase in maternal and

perinatal morbidity and mortality (Tabacu et al. 2022). In this study, a decreased MUAC (mid-upper arm circumference) of below 23 cm 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.

The placenta plays a very important role as an endocrine organ regulating hormones that impact the well-being of the mother and the fetus. The placenta in mental health is to regulate maternal mood (Thomas 2020). The maternal mental health status is assessed and a score between zero and three is 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 2011).

Most of the participants in this study 90% ($n = 80$) did not smoke. 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 and Arbour 2014). Smoking cigarettes actively or passively and using drugs during pregnancy are associated with an increased risk of fetal growth restriction, which is a major cause of stillbirths (Gardosi et al. 2013). 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 et al. 2018). Alcohol intake during pregnancy increases the risk of placental abruption and abnormal placentation (Gualdoni et al. 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 incompatibility has been an important cause of neonatal morbidity and mortality, including stillbirth (Aliyo et al. 2023). To reduce Rhesus incompatibility that may cause hemolytic disease of the newborn (HDN), the government encourages communities and pregnant women through health education as they follow antenatal care (ANC) to screen for Rh-D types (Aliyo et al. 2023).

Maternal medical diseases were found in 71% ($n = 69$) of the women. Maternal diseases such as hypertensive disorders and diabetes are mostly associated with an increased risk of stillbirth (Tesema et al. 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 center in India, Tiwari et al. (2021) found that more than half of the women who had stillbirths had medical disorders or conditions. In their study in South Africa, Ikumi et al. (2021) found that HIV-positive women were at increased risk of developing placental pathology such as MVM and increased chronic and acute MIF (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).

4.3 | Section C: Labor and Delivery

The section on labor and delivery examined the onset of labor, method of delivery, gestational age at delivery, fetal heart sound on admission, partogram use, and attendant at delivery. In most cases, the onset of labor was spontaneous and the method of delivery was mostly a normal vertex delivery. Most participants had no fetal heart rate detectable on admission and all were attended by midwives. Vaginal delivery is recommended for spontaneous labor or following an induction of labor. In Ethiopia, Tesema et al. (2020) found that most women had a vaginal delivery after a fetal death. Induction of labor can be performed soon or within 24 h after fetal death is confirmed (Brosens

et al. 2019). Maternal preferences, gestational age, and previous obstetric history should be taken into consideration. An elective and emergency cesarean section can be performed depending on the indications, for example, antepartum, or intrapartum bleeding in case of placenta abruption or two previous cesarean sections (Kovo and Schriber 2021). Delivery should be expedited in the presence of sepsis or rupture of membranes. Delivery must not be prolonged after confirmation of fetal death to prevent complications associated with coagulation (disseminated intravascular coagulopathy) (Kovo and Schriber 2021).

In labor, there is an increased risk of intrapartum stillbirth when the fetal heart rate is inadequately monitored by not using a partogram (Bedwell et al. 2020). No partogram was used in 70% of the cases. In addition, 90% of the stillbirths were macerated stillbirths which reflected the quality of antepartum care. In 2019, Mhlophe examined the factors contributing to the occurrence of stillbirths in a tertiary hospital in Emalahleni sub-district, Mpumalanga province, South Africa, and found an increased percentage of macerated stillbirths. Macerated stillbirths reflect the quality of antenatal care (Michalow 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 macerated stillbirths (National Perinatal Morbidity and Mortality Committee 2016). Fresh stillbirths are an indication of substandard intrapartum care (Shanker et al. 2020). This study found that 80% of the demised fetuses were confirmed intrauterine deaths on admission and 50% of the stillbirths were unexplained and were delivered by women from the local eMalahleni sub-district.

4.4 | Section D Status of the Baby

In this study, there were more male than female stillborn neonates. A study in Northern Tanzania found an increased prevalence of male stillborn neonates (Lema et al. 2020). Blackwell et al. (2016) attributed male excess stillbirths to increased fetal plasma testosterone during pregnancy, which has a significantly high pro-inflammatory response to infection. 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 et al. 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.

4.5 | Sections E Placental Findings

In South Africa, it is mandatory to physically examine the placenta following stillbirth to exclude placental insufficiency, abruptio placentae, infections, and other abnormalities (NDoH 2011). Short and blood-stained cords are often found (Kulkarni et al. 2017). Thin cords are associated with intrauterine growth restriction (Salafia and Misra 2020). Infarcts are common lesions associated with stillbirths (Salafia and Misra 2020; Donthi

et al. 2020). A high prevalence of dusky membranes indicated the presence of infection (chorioamnionitis) (Tiwari et al. 2021). Most placentas were below the 10th percentile which indicated intrauterine growth restriction (Stevens et al. 2023). The umbilical cord diameter is associated with fetal growth, well-being, and perinatal outcome. 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 fetal loss, preterm birth, and intrauterine growth retardation (Wu et al. 2021). Dusky, opaque, and white patches on the placental membranes are an indication of ascending infection and chorioamnionitis which is classified under MIF (Tiwari et al. 2021).

Low placental weight affects fetal and neonatal outcomes (Ikumi et al. 2021; Weckman et al. 2019). Abnormal fetoplacental weight ratio is a risk factor for poor pregnancy outcomes including fetal death (Sathasivam et al. 2023; Carrasco-Wong et al. 2020). A placenta weighing less than 400 g at term is regarded as a small placenta and any placenta weighing more than 600 g is a large placenta (Jarmuzek et al. 2015). Excessive growth of the placenta was associated with multiple maternal and fetal conditions such as gestational diabetes, maternal anemia, fetal anemia, congenital syphilis, and toxoplasmosis (Reijnders et al. 2018; Jarmuzek et al. 2015). Low placental weight was associated with maternal cardiovascular diseases, hypertensive disorders, and diabetes mellitus (DeRoo et al. 2015).

MVM was the most significant placental finding in this study, which included placental hypoplasia (placental weight of <10 percentile), placental infarcts, retroplacental hemorrhage, decidual arteriopathy, distal villous hypoplasia, and accelerated villous maturation. MVM is frequently observed in placentas from pregnancies impacted by preeclampsia and intrauterine growth restriction (Melchiorre et al. 2021). MVM is associated with HIV infection (Hoque et al. 2021; Graham and Heazell 2020).

4.6 | Limitations and Strengths

The limitations of the study are that the findings placental findings in singleton stillbirths are limited to the context of the Emalahleni sub-district in Mpumalanga Province. Additionally, the researcher observed that the second and early third trimesters were the most vulnerable periods, especially for placental lesions, such as MVM and MIF which might lead to preterm labor and other perinatal adverse pregnancy outcomes. If 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 are not included in the maternity case record book and in the data collection tool. It is known that the mother's health has an impact on the fetus, 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 standardized as the pathologists used different formats for reporting.

One of the strengths is that this study is the first of its nature to report on the placental findings in singleton stillbirths in South Africa. The recommendations for future studies to incorporate placental pathology in midwifery healthcare facilities and midwives should provide counseling on maternal obesity, which is

one of the most important modifiable risk factors for stillbirth. Adequate preconception counseling should emphasize maternal and paternal lifestyle modification because an increased MUAC has been associated with MIF. Umbilical cord abnormalities increase in the presence of maternal obesity, which accounts for the increased risk of stillbirth at term as MVM is also associated with maternal obesity.

4.7 | Implications for Public Health Nursing

Stillbirths account for three-quarters of perinatal deaths globally, yet the cause of most stillbirths remains unknown. Examination of the placenta may help to determine the cause of stillbirth as abnormal placental structure and function are associated with stillbirth. The trends of placental lesions described in this article may lead to future studies determining relationships between the placental lesions in term singleton stillbirths and maternal medical conditions, socio-economic status, environmental, season, and BMI/nutritional status as factors that may have contributed to stillbirths. The findings of this study may indicate treatment options in subsequent pregnancies and a decline 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 (WHO Every New-born Baby, 2014: 8).

5 | Conclusion

Placental lesions were associated with stillbirths. Macroscopic and microscopic placental examination permitted the study of the fetuses, and the fetal response to maternal diseases, infections, lifestyle, previous obstetric complications, maternal diseases, and environmental pollutants. MVN, maternal and fetal inflammatory response (FIR) were the most prevalent placental lesions identified which were associated with maternal characteristics and conditions. Pre-pregnancy antenatal screening for maternal conditions should form part of routine antenatal care. Women with a high-risk obstetric history must be referred early. Diagnosis of fetal intra-uterine growth restriction through fundal height measurement and fetal growth curve monitoring must be mandatory. Early detection of placental dysfunction during the antenatal period of all low-risk pregnancies through the use of the Umbiflow (a sophisticated portable continuous wave Doppler with bi-directional indication of blood flow velocity in the umbilical cord) should be done in all primary health care settings, and midwives must be trained on how to use it. Screening of all pregnant women for TORCH and B-Streptococcus infection should be mandatory. Health education should be provided on nutrition to prevent obesity as well as intensive counseling and provision of a variety of contraceptives. Macro- and microscopic examination of the placenta should continue to be used as part of the investigations following stillbirths in order to reduce the occurrence of unexplained stillbirths, in litigation cases of health institutions, and to prevent stillbirths in subsequent pregnancies.

Author Contributions

All authors (Ouma Vilane, Mariatha Yazbek, and Maurine Musie) contributed to the study conception and design. The material preparation and

data collection were performed by Ouma Vilane and the data analysis by Ouma Vilane and Mariatha Yazbek. The first draft was written by Ouma Vilane. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Consent

Informed consent was obtained from all participants of the included placenta for examination.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request of the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

References

- Ahmad, N. B. 2020. "Air Pollution and Placental Function." In *Health Services Research & Primary Care*. PhD thesis, University of Manchester. <https://research.manchester.ac.uk>.
- Aliyo, A., G. Ashenafi, M. Abduselam. (2023). "Rhesus Negativity Prevalence and Neonatal Outcomes amongst Pregnant Women Delivered at Bule Hora University Teaching Hospital, West Guji Zone, South Ethiopia." *Clin Med* 17: 11795565221145598. <https://doi.org/10.1177/11795565221145598>.
- Blackwell, S. C., M. B. Landon, L. Mele, et al. 2016. "Relationship between Excessive Gestational Weight Gain and Neonatal Adiposity in Women with Mild Gestational Diabetes Mellitus." *Obstetrics & Gynecology* 128, no. 6: 1325–1332. <https://doi.org/10.1097/aog.0000000000001773>.
- Bouachba, A., F. Allias, B. Nadaud, et al. 2021. "Placental Lesions and SARS-Cov-2 Infection: Diffuse Placenta Damage Associated to Poor Foetal Outcome." *Placenta* 112: 97–104. <https://doi.org/10.1016/j.placenta.2021.07.288>.
- Bedwell, C., K. Blaikie, V. A. Danna, et al. 2020. "Understanding the Complexities of Unexplained Stillbirth in Sub-Saharan Africa: A Mixed Methods Study." *BJOG: An International Journal of Obstetrics & Gynaecology* 128, no. 7: 1206–1214. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8248405/pdf/BJO-128-1206.pdf>.
- Brosens, I., P. Puttemans, and G. Benagiano. 2019. "Placental Bed Research: I. The Placental Bed: From Spiral Arteries Remodeling to the Great Obstetrical Syndromes." *American Journal of Obstetrics and Gynecology* 221, no. 5: 437–456. <https://doi.org/10.1016/j.ajog.2019.05.044>.
- Carrasco-Wong, I., A. Moller, F. R. Giachini, et al. 2020. "Placental Structure in Gestational Diabetes Mellitus." *Biochimica Et Biophysica Acta (BBA)—Molecular Basis of Disease* 1866, no. 2: 165535. <https://doi.org/10.1016/j.bbadis.2019.165535>.
- dos Reis, H. L. B., N. A. T. Boldrini, A. F. R. Rangel, V. F. Barros, P. R. Mercon de Vargas, and A. E. Miranda. 2020. "Placental Growth Disorders and Perinatal Adverse Outcomes in Brazilian HIV-Infected Pregnant Women." *PLoS ONE* 15, no. 4: e0231938. <https://doi.org/10.1371/journal.pone.0231938>.
- DeRoo, L., R. Skjærven, A. Wilcox, et al. 2015. "Placental Abruption and Long-term Maternal Cardiovascular Disease Mortality: A Population-based Registry Study in Norway and Sweden." *European Journal of Epidemiology* 31, no. 5: 501–511. <https://doi.org/10.1007/s10654-015-0067-9>.
- Donthi, D., P. Malik, A. Mohamed, A. Kousar, R. A. Subramanian, and U. K. Manikyam. 2020. "An Objective Histopathological Scoring System for Placental Pathology in Pre-Eclampsia and Eclampsia." *Cureus* 12, no. 10: e11104. <https://doi.org/10.7759/cureus.11104>.

- Erickson, A. C., and L. Arbour. 2014. "The Shared Pathoetiological Effects of Particulate Air Pollution and the Social Environment on Fetal-Placental Development." *Journal of Environmental and Public Health* 2014: 1–20. <https://doi.org/10.1155/2014/901017>.
- Ernst, L. M. 2018. "Maternal Vascular Malperfusion of the Placental Bed." *Apmis*. 126, no. 7: 551–560. <https://doi.org/10.1111/apm.12833>.
- Gardosi, J., V. Madurasinghe, M. Williams, A. Malik, and A. Francis. 2013. "Maternal and Fetal Risk Factors for Stillbirth: Population Based Study." *Bmj* 346 no. 3: f108–f108. <https://doi.org/10.1136/bmj.f108>.
- Gebremeskel, T., A. Mulu, S. Kumbi, and W. Ergete. 2020. "Histopathological Change of Placenta Associated With Maternal Anaemia in Northeast Ethiopia: A Comparative Study." *Ethiopian Journal of Health Sciences* 30, no. 5: 777–784.
- Gibbins, K. J., H. Pinar, U. M. Reddy, et al. 2020. "Findings in Stillbirths Associated With Placental Disease." *American Journal of Perinatology* 37, no. 7: 708–715.
- Goldstein, J. A., K. Gallagher, C. Beck, R. Kumar, and A. D. Gernand. 2020. "Maternal-Foetal Inflammation in the Placenta and the Developmental Origins of Health and Disease." *Frontiers in Immunology* 11: 531543. <https://doi.org/10.3389/fimmu.2020.531543>.
- Graham, N., and A. E. P. Heazell. 2020. "When the Foetus Goes Still and the Birth Is Tragic: The Role of the Placenta in Stillbirths." *Obstetrics and Gynecology Clinics of North America* 47, no. 1: 183–196.
- Gualdoni, G. S., P. V. Jacobo, C. Barril, M. R. Ventura, and E. Cebral. 2022. "Early Abnormal Placentation and Evidence of Vascular Endothelial Growth Factor System Dysregulation at the Foeto-Maternal Interface After Periconceptional Alcohol Consumption." *Frontiers in Physiology* 12: 815760.
- Ikumi, N. M., T. R. Malaba, K. Pillay, et al. 2021. "Differential Impact of Antiretroviral Therapy Initiated Before or During Pregnancy on Placenta Pathology in HIV-Positive Women." *Aids* 35, no. 5: 717–726.
- Jarmuzek, P., M. Wielgos, and D. Bomba-Opon. 2015. "Placental Pathologic Changes in Diabetes Mellitus." *Neuro Endocrinology Letters* 36, no. 2: 101–105.
- Khan, N., C. Zhang, M. Islam, R. Islam, and M. Rahman. 2017. "Household Air Pollution From Cooking and Risk of Adverse Health and Birth Outcomes in Bangladesh: A Nationwide Population-Based Study." *Environmental Health* 16, no. 1: 57.
- Kovo, M., and L. Schriber. 2021. "Placental Histopathology and Pregnancy Outcome in Placental Abruption." *Thrombosis Update* 5, no. 3: 100087. <https://doi.org/10.1016/J.TRU.2021.100087>.
- Kulkarni, A. D., N. Palanianppan, and M. J. Evans. 2017. "Placental Pathology and Stillbirth: A Review of the Literature and Guidelines for the Less Experienced." *Journal of Fetal Medicine* 4: 177–185. <https://doi.org/10.1007/s40556-017-0133-3>.
- Lawn, J. E., H. Blencowe, P. Waiswa, et al. 2016. "Stillbirths, Rates Risk Factors and Acceleration towards 2030: Ending Preventable Stillbirths." *Lancet* 387, no. 2: 587–593. [https://doi.org/10.1016/S0140-6736\(15\)00837-5](https://doi.org/10.1016/S0140-6736(15)00837-5).
- Lema, G., A. Mremi, P. Amsi, et al. 2020. "Placental Pathology and Maternal Factors Associated With Stillbirth: An Institutional Based-Control Study in Northern Tanzania." *PLoS ONE* 15, no. 12: e0243455. <https://doi.org/10.1371/journal.pone.0243455>.
- Linehan, L., K. O'Donoghue, S. Dineen, J. White, J. R. Higgins, and B. Fitzgerald. 2021. "SARS-CoV-2 Placentitis: An Uncommon Complication of Maternal Covid-19." *Placenta* 104: 261–266. <https://doi.org/10.1016/j.placenta.2021.01.012>.
- McGee, S. A., L. Chola, A. Tugendhaft, et al. 2016. "Strategic Planning for Saving the Lives of Mothers, Newborns and Children and Preventing Stillbirth in KwaZulu-Natal Province, South Africa: Modelling Using the Lives Saved Tool (LiST)." *BMC Public Health [Electronic Resource]* 16: 140.
- Melchiorre, K., V. Giorgione, and B. Thilaganathan. 2021. "The Placenta and Preeclampsia: Villain or Victim?" *American Journal of Obstetrics and*

- Gynecology 226, no. 2S: S954–S962. <https://doi.org/10.1016/j.ajog.2020.10.024>.
- Mhlophe, C. 2019. “Factors Contributing to the Occurrence of Stillbirths in a Tertiary Hospital.” Master’s dissertation, University of Pretoria.
- Michalow, J., L. Chola, S. McGee, et al. 2015. “Triple Return on Investment: the Cost and Impact of 13 Interventions That Could Prevent Stillbirths and Save the Lives of Mothers and Babies in South Africa.” *BMC Pregnancy and Childbirth* 15, no. 1:39. <https://doi.org/10.1186/s12884-015-0456-9>.
- Miele, M. J., R. T. Souza, I. M. Calderon, et al. 2021. “Maternal Nutrition Status Associated With Pregnancy-Related Adverse Outcomes.” *Nutrients* 13, no. 7: 2398. <https://doi.org/10.3390/nu13072398>.
- Mondal, G. C., A. Baske, and S. Biswas. 2017. “Morphological Changes of Placenta Associated With Maternal Anaemia.” *International Journal of Life-Sciences Scientific Research* 3, no. 5: 1400–1407. <https://doi.org/10.21276/ijlssr.2017.3.5.23>.
- National Department of Health (NDOH). 2011. *Strategic Plan for Maternal, Newborn, Child and Women’s Health (MNCWH) and Nutrition*. DOH.
- National Department of Health. 2016. *Guidelines for Maternity Care in South Africa*. DOH.
- National Perinatal Morbidity and Mortality Committee. 2016. *Saving Babies, 2014–2016. Report on Perinatal Mortality in South Africa*. DOH. <https://www.westerncape.gov.za/assets/departments/health/napemmco>.
- O’Sullivan, K. 2021. “Covid-19 and Stillbirth: What Does the Latest Research Say About Possible Complications?” *Irish Times*, 5 March, 1.
- Oche, M. O., H. Adamu, A. Abubakar, M. S. Aliyu, and A. S. Dogondaji. 2020. “Intimate Partner Violence in Pregnancy: Knowledge and Experiences of Pregnant Women and Controlling Behaviour of Male Partners in Sokoto, Northwest Nigeria.” *International Journal of Reproductive Medicine* 2020: 7626741.
- Paules, C., L. Youssef, C. Rovira, et al. 2019. “Distinctive Patterns of Placental Lesions in Pre-Eclampsia vs Small-for-Gestational Age and Their Association With Fetoplacental Doppler.” *Ultrasound Obstetrics and Gynecology* 54, no. 5: 609–616.
- Pinar, H., R. L. Goldenberg, M. A. Koch, et al. 2014. “Placental Findings in Singleton Stillbirths.” *Obstetrics & Gynecology* 123, no. 2 PART 1: 325–336.
- Reijnders, I. F., A. G. M. G. J. Mulders, M. van der Windt, E. A. P. Steegers, and R. P. M. Steegers-Theunissen. 2018. “The Impact of Periconceptional Maternal Lifestyle on Clinical Features and Biomarkers of Placental Development and Function: a Systematic Review.” *Human Reproduction Update* 25, no. 1: 72–94. <https://doi.org/10.1093/humupd/dmy037>.
- Reijnders, I. F., A. Mulders, M. van der Windt, E. A. P. Steegers, and R. P. M. Steegers-Theunissen. 2019. “The Impact of Periconceptional Maternal Lifestyle on Clinical Features and Biomarkers of Placental Development and Function: A Systematic Review.” *Human Reproduction Update* 25, no. 1: 72–94. <https://doi.org/10.1093/humupd/dmy037>.
- Reinebrandt, H. E., S. H. Leisher, M. Coory, et al. 2018. “Making Stillbirths Visible: A Systematic Review of Globally Reported Causes of Stillbirth.” *BJOG: An International Journal of Obstetrics and Gynaecology* 125, no. 2: 212–224.
- Salafia, C. M., and D. P. Misra. 2020. “Histopathology of Foetal Inflammatory Response to Intra-Amniotic Pathogens.” *Seminars in Fetal and Neonatal Medicine* 25, no. 4: 101128. <https://doi.org/10.1016/j.siny.2020.101128>.
- Sathasivam, R., P. Selliah, R. Sivalingarajah, U. Mayorathan, and B. M. Munasinghe. 2023. “Placental Weight and Its Relationship With the Birth Weight of Term Infants and Body Mass Index of the Mothers.” *Journal of International Medical Research* 51, no. 5: 3000605231172895. <https://doi.org/10.1177/03000605231172895>.
- Schwartz, D. A., M. Baldewijns, A. Benachi, et al. 2020. “Chronic Histiocytic Intervillositis with Trophoblast Necrosis Is a Risk Factor Associated with Placental Infection from Coronavirus Disease 2019 (COVID-19) and Intrauterine Maternal-Fetal Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Transmission in Live-Born and Stillborn Infants.” *Archives of Pathology & Laboratory Medicine* 145, no. 5: 517–528. <https://doi.org/10.5858/arpa.2020-0771-sa>.
- Seebregts, C. P. Barron G. Tanna P. Benjamin, and T. Fogwill. 2016. “MomConnect: an Exemplar Implementation of the Health Normative Standards Framework in South Africa.” *South African Health Review (SAHR)* 2016: 125–136.
- Shanker, O., V. Saini, and M. Gupta. 2020. “Stillbirths: Incidence, Causes and Surrogate Markers of Intrapartum and Antepartum Fetal Deaths.” *International Journal of Innovative Research in Medical Science* 5, no. 08: 289–295. <https://doi.org/10.23958/ijirms/vol05-i08/927>.
- Shi, H., L. Chen, Y. Wang, et al. 2022. “Severity of Anaemia During Pregnancy and Adverse Maternal and Foetal Outcome.” *JAMA Network Open* 5, no. 2: e2147046.
- Stevens, R., N. Odell, and R. Wadee. 2023. “The Clinical Significance of Placental Histopathological Evaluation in the Management of High-Risk Obstetric Patients: A Cross-Sectional Retrospective Study.” *South African Journal of Obstetrics and Gynaecology* 29, no. 1: e2019.
- Symington, E. A., J. Baumgartner, J. Malan, L. Zandberg, C. Ricci, and C. M. Smuts. 2018. “Nutrition During Pregnancy and Early Development (NuPED) in Urban South Africa: A Study Protocol for a Prospective Cohort.” *BMC Pregnancy and Childbirth* 18, no. 1: 308.
- Tabacu, M. C., A. M. Istrate-Ofteru, M. M. Manolea, et al. 2022. “Maternal Obesity and Placental Pathology in Correlation With Adverse Pregnancy Outcome.” *Romanian Journal of Morphology and Embryology* 63, no. 1: 99–104.
- Tesema, G. A., L. D. Gezie, and S. G. Nigatu. 2020. “Trends of Stillbirth Among Reproductive-Age Women in Ethiopia Based on Ethiopian Demographic and Health Surveys: A Multivariate Decomposition Analysis.” *BMC Pregnancy and Childbirth* 20: 193. <https://doi.org/10.1186/s12884-020-02880-5>.
- Thomas, L. 2020. *The Role of the Placenta in Maternal Mental Health*. News Medicine Life Sciences.
- Tiwari, L., and R. Kumar. 2017. “Congenital Tuberculosis With Possible Placental Transmission and Paradoxical Reaction to Tuberculosis Treatment.” *Lung Breathing Journal* 1, no. 2: 1–2. <https://doi.org/10.15761/LBJ.1000111>.
- Tiwari, P., M. M. Gupta, and S. L. Jain. 2021. “Placental Findings in Singleton Stillbirths: a Case-control Study From a Tertiary-care Center in India.” *Journal of Perinatal Medicine* 50, no. 6: 753–762. <https://doi.org/10.1515/jpm-2021-0179>.
- United Nations (UN). 2015. *Sustainable Development Goals, 2030*. UN.
- Weckman, A. M., M. Ngai, J. Wright, C. R. McDonald, and K. C. Kain. 2019. “The Impact of Infection in Pregnancy on Placental Vascular Development and Adverse Birth Outcomes.” *Frontiers in Microbiology* 10: 1924. <https://doi.org/10.3389/fmicb.2019.01924>.
- World Health Organization (WHO). 2014. *Every Newborn: An Action Plan to End Preventable Deaths*, 11–12. WHO.
- World Health Organization (WHO). 2016. *Making Every Baby Count*. WHO. <https://www.who.int/publications/i/item/9789241511223>.
- World Health Organization (WHO). 2020. *Recommendations on Antenatal Care for Positive Pregnancy Experience*, 14. WHO.
- Wright, R. G., C. Macindoe, and P. Green. 2019. “Placental Abnormalities Associated with Childbirth.” *Academic Forensic Pathology* 9, no. 1–2: 2–14. <https://doi.org/10.1177/1925362119851113>.
- Wu, J. N., Y. Y. Ren, C. Zhu, T. Peng, B. Zhang, and M. Q. Li. 2021. “Abnormal Placental Perfusion and the Risk of Stillbirth: A Hospital-Based Retrospective Cohort Study.” *BMC Pregnancy and Childbirth* 21: 308. <https://doi.org/10.1186/s12884-021-03776-8>.
- Yong, H. E. J., S.-Y. Chan, A. Chakraborty, et al. 2021. “Significance of the Placental Barrier in Antenatal Viral Infections.” *Biochimica Et Biophysica*

Acta (BBA)—Molecular Basis of Disease 1867, no. 12: 166244. <https://doi.org/10.1016/j.bbadis.2021.166244>.

Zhang, P., T. Haymar, F. Al Sayyed, et al. 2022. “Placental Pathology Associated With Maternal Age and Maternal Obesity in Singleton Pregnancy.” *Journal of Maternal-Fetal Neonatal Medicine* 35, no. 25: 9517–9525.