Determinants of obstructed labour and associated outcomes in 54 referral hospitals in Nigeria

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Abstract

Objective: To estimate the prevalence of obstructed labour, associated risk factors, and outcomes across a network of referral hospitals in Nigeria.

Design: Retrospective observational study.

Setting: 54 referral level hospitals across the six geopolitical regions of Nigeria.

Population: Pregnant women who were diagnosed with obstructed labour during childbirth and subsequently underwent an emergency caesarean section between 1 September 2019 and 31 August 2020.

Methods: Secondary analysis of routine maternity care datasets. Random effects multivariable logistic regression was used to ascertain the factors associated with obstructed labour.

Main outcome measures: Risk factors for obstructed labour and related postpartum complications, including intrapartum stillbirth, maternal death, uterine rupture, postpartum haemorrhage, and sepsis.

Results: Obstructed labour was diagnosed in 1186 (1.7%) women. Among these women, 31 (2.6%) resulted in maternal death, and 199 (16.8%) experienced postpartum complications. Women under 20 years of age (OR: 2.03; 95% CI: 1.50 - 2.75), those who lacked formal education (OR: 1.88; 95% CI: 1.55 - 2.30), were unemployed (OR: 1.94; 95% CI: 1.57 - 2.41), nulliparous (OR: 2.11; CI: 1.83 - 2.43), did not receive antenatal care (OR: 3.34; 95% CI: 2.53 - 4.41), or received antenatal care in an informal healthcare setting (OR: 8.18; 95% CI: 4.41 - 15.14) were more likely to experience obstructed labour. Ineffective referral systems were identified as a major contributor to maternal death.

Conclusions: Modifiable factors contributing to the prevalence of obstructed labour and associated adverse outcomes in Nigeria can be addressed through targeted policies and clinical interventions.

Tweetable abstract: Obstructed labour affects 2% of labours in referral-level facilities across Nigeria. Improving referral pathways will reduce morbidity associated with obstructed labor.

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Introduction

Obstructed labour, also referred to as labour dystocia, is a condition in which the progression of labour is hindered by a mismatch between the size of the presenting part of the fetus and the woman's pelvis, despite the presence of adequate uterine contractions. This often occurs because of the disparity between the fetal presenting part and the maternal pelvis [1]. Globally, obstructed labour affects approximately 5% of pregnancies and accounts for substantial long-term complications, such as vesicovaginal fistula and 8% of maternal deaths [2, 3]. In low- and middle-income countries, including Nigeria, obstructed labour continues to be a major cause of maternal morbidity and mortality [4-6]. For instance, a recent national cross-sectional study of maternal near-misses found that uterine rupture resulting from obstructed labour accounted for 11% of severe maternal outcomes and 10% of maternal deaths in Nigeria [6].

Due to widespread poverty and poor nutrition in low-resource settings, such as Nigeria, many women have a poorly developed pelvis which is a risk factor for obstructed labour [3]. Furthermore, Many pregnant women in Nigeria give birth at home without the assistance of skilled professionals [7]. When complications arise during delivery, the lack of an effective referral system makes it challenging for women to receive prompt medical attention, resulting in severe consequences such as uterine rupture, maternal death, and long-term disabilities like vesicovaginal fistula, gynaetresia, and secondary infertility in those who survive. Additionally, newborns may experience complications, such as stillbirth, severe birth asphyxia, neonatal death, cerebral palsy, and developmental disabilities.

Due to the absence of a coordinated maternity care data collection process across the country, estimates of obstructed labour and its associated risk factors in Nigeria have primarily been based on data from individual health facilities with varying data collection procedures. The current study provides a comprehensive estimate of obstructed labour using the Maternal and Perinatal Database for Quality, Equity, and Dignity Programme (MPD-4-QED) from referral hospitals spread across the 36 states and six geopolitical zones of Nigeria. This is the first study to report the prevalence and risk factors of obstructed labour using a routinely collected nationwide electronic database in Nigeria. The MPD-4-QED

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harmonised database allows for a systematic examination of the prevalence, associated risk factors, and outcomes of obstructed labour across a national sample of tertiary facilities. The findings of this study will help address the critical gap in knowledge regarding the burden of obstructed labour at referral-level health facilities in Nigeria and identify factors that can be targeted to reduce its occurrence and complications.

METHODS

Study design and population

This study involved a secondary analysis of the MPD-4-QED database, a maternity care dataset routinely collected from 54 referral-level hospitals across six geopolitical zones of Nigeria. Of these, 48 were public hospitals and 6 were private health facilities. The MPD-4-QED population comprises 76,563 women who were admitted to these hospitals between 1 September 2019 and 31 August 2020 for childbirth or due to postpartum complications arising within 42 days of childbirth. The database, data collection process, and quality assurance procedures have been previously described [8].Briefly, the MPD-4-QED Programme uses a custom-built District Health Information Software (DHIS-2) platform that is employed in the collection of maternity care data from referral hospitals in Nigeria. The database records maternal sociodemographic information, medical and antenatal care history, labour and delivery details, the baby's clinical conditions within the first seven days of life, and the mother's postpartum observations until hospital discharge, 42 days after giving birth, or death (whichever occurred first).

Our analysis focused on women who were at least 28 weeks pregnant at the time of delivery and who delivered in the participating in the facilities (women who were admitted after birth were not included in the current study population). We defined obstructed labour based on clinical diagnosis and followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in reporting the study.

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Outcomes of interest

The main outcome of interest were prevalence of obstructed labour and sociodemographic and clinical factors associated with obstructed labour. The secondary outcomes were postpartum complications such as ruptured uterus, postpartum haemorrhage, sepsis, intensive care unit admission, and length of hospital stay following obstructed labour. Other outcomes of interest were adverse perinatal outcomes, such as intrapartum stillbirth, early neonatal death, Neonatal Intensive Care Unit admission, and the identification of contributing factors for maternal death.

Covariates

In our analysis, we considered various variables from the dataset known to influence pregnancy outcomes. These were classified into three categories: *sociodemographic factors* (maternal age, marital status, level of education, occupation, and the partner's occupation), *past medical and obstetric history* (parity, previous caesarean section, previous miscarriage, and chronic medical conditions), and *index obstetric history* (registration for antenatal care, referral status from lower levels of care, number of gestations, pregnancy-induced hypertension, gestational diabetes, antepartum haemorrhage, continuous monitoring during labour, and birth weight of the child).

Statistical analysis

We described the characteristics of women with and without obstructed labour and the corresponding maternal and perinatal outcomes. Mixed effects multilevel logistic models with random intercepts by hospital were constructed to examine the odds of obstructed labour relative to those without obstructed labour. Initially, a bivariate model was employed to identify associated factors, which were subsequently used to build a hierarchical multivariate model. The conceptual model proposes that more distant determinants, such as sociodemographic characteristics, may influence outcomes either directly or indirectly through other proximate determinants, such as obstetric history, current pregnancy care, or complications. Therefore, three levels were adopted: sociodemographic factors, past medical and obstetric

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history, and current pregnancy history. Model 1 comprised of all sociodemographic variables. Model 2 retained statistically significant variables from Model 1 and was further controlled for past medical and obstetric history. Similarly, Model 3 retained all variables that were statistically significant in Model 2 and further adjusted for index pregnancy history. Bivariate and adjusted odds ratios of the final multilevel model, along with 95% confidence intervals, are presented. The level of statistical significance was set at 0.05, using a 2-sided alternative hypothesis.

Results

Between 1 September 2019 and 31 August 2020, a total of 69,698 women were admitted to the referral hospitals for labour. Among these, 1186 (1.7%) had obstructed labour. 48.5% of the women with obstructed labour were referred from lower levels of care..

The characteristics of the study population are summarised in Table 1. Women who were younger than 20 years of age, single, lacking formal education, and unemployed were more likely to experience obstructed labour. Similarly, obstructed labour was more prevalent among nulliparous women, those without antenatal care, those referred from informal healthcare settings, and those with a birthweight of 4000 grams or more. Among the 1186 women with obstructed labour, 31 (2.6%) had a maternal death and 199 (16.8%) had maternal morbidity (Table 2). Postpartum anaemia was the most common morbidity (39.7%). Fifteen (7.5%) women had ruptured uteri, 23 (11.6%) had anaemia diagnosed after birth, and 22 (11.1%) had postpartum sepsis. Approximately 10% of the women were admitted to the intensive care unit and more than half of the women had a hospital stay longer than 5 days after delivery.

Of the 1213 total births, 233 (19.2%) were stillbirths (Table 3). Of these, 144 (61.8%) occurred during labour. Among the 980 live births, 83 (8.5%) experienced early neonatal death and approximately one-third were admitted to the neonatal intensive care unit, with birth asphyxia as the most common indication for admission. Birth asphyxia and sepsis were the commonest causes neonatal death. Table 4 shows the odds of obstructed labour based on women's characteristics. Women who were under 35 years had

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increased odds of obstructed labour as compared to women over 35 years of age (<20 years old aOR: 2.03; 95% CI: 1.50 - 2.75; 20 to 35 years (aOR1.41, 95%CI 1.2-1.66)), lacked formal education (aOR: 1.88; 95% CI: 1.55 - 2.30) or had primary education only (aOR 1.85 95%CI: 1.43-2.37), were unemployed (aOR: 1.94; 95% CI: 1.57 - 2.41) or had a sales/trading job (aOR: 1.46 95%CI:1,23-174), and were nulliparous (aOR: 2.11; CI: 1.83 - 2.43) or grand-multipara (aOR: 1.23 95%CI: 0.97-1.55) had increased odds of obstructed labour. In addition, obstructed labour was associated with a no antenatal care (aOR: 3.34; 95% CI: 2.53 - 4.41) or receiving antenatal care in an informal healthcare setting ie traditional birth attendants or other informal setting (aOR: 8.18; 95% CI: 4.41 - 15.14). Furthermore, fetal macrosomia (aOR: 3.38; 95% CI: 2.48 - 4.61) and the absence of continuous labour monitoring (aOR: 2.36; 95% CI: 1.90 - 2.94) increased the likelihood of obstructed labour as well as having a chronic medical condition (aOR1.79 95%CI: 1.31-2.45).

The most frequent contributing factors to maternal death among those with obstructed labour were delays in seeking medical assistance (83.9%), delays in appropriate referrals (70.0%), and delays in receiving care from medical staff (29.0%). In addition, a lack of necessary equipment or consumables at healthcare facilities was identified as a contributing factor in 22.6% of cases (Table 5).

Discussion

Main findings

We found that around two percent of labours in referral-level hospitals in Nigeria were obstructed, with most of the women referred. Teenagers, first-time pregnant women, women without formal education, women who were unemployed, women who did not receive antenatal care or received pregnancy care from informal healthcare settings, fetal macrosomia, and women who were not continuously monitored during labour had increased odds of experiencing obstructed labour. Furthermore, our study revealed a higher prevalence of maternal death, perinatal death, and maternal and perinatal morbidity among women

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with obstructed labour. Lack of an effective referral system was identified as the primary contributor to maternal death.

Strengths and Limitations

The strength of this study lies in the involvement of a substantial number of pregnant women and accurate representation of referral level (tertiary) hospitals across Nigeria's geopolitical regions. This study represents the first multi-centre estimate of obstructed labour in referral-level hospitals across Nigeria based on routinely collected maternity datasets. The meticulous analysis and harmonisation of data across hospital sites lends credibility to our findings, providing a reliable portrait of the national situation within the highest echelon of healthcare services in Nigeria. However, this study does have some limitations. The diagnosis of obstructed labour was based solely on the clinical assessment made by the attending physician and the subsequent decision to perform a caesarean section. We acknowledge that there may be variations in the threshold for diagnosing obstructed labour among clinicians and that some women might have been misdiagnosed or misclassified.

Interpretation

Previous studies conducted in single Nigerian tertiary hospitals have reported a prevalence of obstructed labour ranging from 1.5% to 3.4% [9-12]. However, our findings, which showed a prevalence of 1.7% for obstructed labour, represent referral hospitals across Nigeria. The prevalence of obstructed labour and associated maternal morbidity and mortality in this study were lower than population based studies in low-to-middle-income countries [13, 14]. This may be due to the focus of this study on referral-level hospitals.

Teenage pregnancy imposes a great physiological burden on young mothers, which can be exacerbated by inadequate dietary intake and poor antenatal care. This can result in complications during childbirth. In addition, women who lack formal education may come from families with lower socioeconomic

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187 background and may marry earlier before their pelvis is fully developed. Teenagers may also have
188 challenges accessing contraception. In contrast, women who have received formal education are more
189 likely to marry later, have greater access to contraception and take advantage of the available antenatal
190 care and hospital delivery services [15, 16]. Therefore, it is important to provide equitable access to formal
191 education and reduce barriers for young women to education.

192 First-time mothers are prone to labour anxiety and fetal malpositioning (such as occipito-posterior head
193 position), which can predispose to labour obstruction [17]. In the current study, on-third of women with
194 obstructed labour did not receive antenatal care. Women who did not receive antenatal care were three
195 times more likely to experience obstructed labour. This underscores the importance of focusing on
196 improving antenatal care attendance as an intervention to prevent prolonged obstructed labour. The
197 absence of antenatal care during pregnancy deprives women of vital information regarding her pregnancy
198 such as multiple pregnancies, macrosomia, fetal anomalies, and other risk factors for obstructed labour.
199 However, it is worth noting that most women who experienced obstructed labour received some form of
200 antenatal care. Those who received antenatal care in an informal setting were eight times more likely to
201 experience obstructed labour. This is similar to observations in Ethiopia [15], suggesting that the quality of
202 antenatal care is just as crucial.

203 The likelihood of obstructed labour increases two-fold in women referred. Many women seek pregnancy
204 care and delivery at primary or secondary healthcare facilities because of their proximity to their homes
205 and affordability of these services. With effective referral pathways in place women who are at risk of
206 obstructed labour can be referred to facilities where caesarean section can be performed, however the
207 absence of timely recognition of poor labour progress can result in delays in referring women, leading to
208 prolonged obstructed labour. Fantu et al. also indicated that referral from lower levels of care is a
209 significant risk factor for obstructed labour [15].

210 Women who had macrosomic babies (birthweight > 4 kg) were three times more likely to experience
211 obstructed labour. Macrosomia, a major cause of cephalopelvic disproportion, has been widely recognised

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as a common contributor to obstructed labour [16]. Women can be screened for macrosomia by attending antenatal care, allowing for intervention before labour. Skilled personnel during labour and continuous labour monitoring (to detect failure to progress) can also result in early intervention [3, 18]. Notably, the absence of continuous labour monitoring with a partograph doubled the likelihood of obstructed labour, and one-third of women with obstructed labour fell into this category.

Postpartum anaemia was the most prevalent morbidity, which aligns with a prior observation from a tertiary health facility in Northern Nigeria [7]. This may be attributed to the presence of anaemia prior to pregnancy. Many women enter pregnancy with chronic anaemia caused by malnutrition and infections [19]. Additionally, this finding may also be due to an underestimation of blood loss following surgical intervention for obstructed labour. The occurrence of postpartum sepsis may be heightened by factors such as history of anaemia, prolonged labour, multiple vaginal examinations, and surgical interventions. The risk of uterine rupture increases with multiparity, previous uterine scarring, and abnormal fetal lie [20]. The prevalence of perinatal morbidity such as birth asphyxia can lead to complications including visual impairment, seizure disorders, and learning difficulties, posing a significant social and economic burden on families, the healthcare system, and the nation as a whole.

To improve maternal and perinatal outcomes in Nigeria, it is necessary to establish an effective referral system that connects lower-level care to tertiary health facilities. Moreover, enhancing the capacity for emergency obstetric care is crucial. Previous research on maternal near-misses in Nigeria has revealed that some tertiary hospitals lack the necessary equipment to provide emergency obstetric care [21]. In our analysis, delays in receiving care after arriving at referral health facilities were found to be contributing factors to maternal death. By improving the capacity to provide emergency obstetric services, the incidence of adverse outcomes in women with obstructed labour can be reduced.

Conclusion

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Obstructed labour is a critical obstetric complication that can result in significant maternal and perinatal morbidity and mortality. The results of this study suggest that several interventions can be optimised to improve the quality of care for women with obstructed labour. These interventions include increasing access to quality antenatal care, ensuring continuous labour monitoring for all women in labour, improving referral pathways from lower-level facilities, and providing improved emergency obstetric care with a focus on preventing sepsis. Addressing the underlying contributing factors for obstructed labour, such as increasing women's empowerment and autonomy through access to free education, requires a multifactorial approach. The implementation of these measures can significantly reduce obstructed labour and the associated morbidities and mortality.

DECLARATIONS

Ethics approval and consent to participate

The scientific content of the study was approved by the WHO Human Reproduction Programme (HRP) Research Project Review Panel (protocol ID, A65930, 06 May 2018). The WHO Ethics Review Committee (ID A65930, 05 June 2018) and Nigerian National Health Research and Ethics Committee approved the study (ID NHREC/01/01/2007, 05 September 2018). Authorities from all participating hospitals granted written institutional approval to participate in the program's data collection, periodic analyses, and reporting.

Consent for publication

Individual-level written consent was not required, as the study did not involve direct interaction with women or their babies, or interviews with medical staff.

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Availability of data and materials

All relevant data are available in the manuscript and the Supporting Information files.

Competing interests

The authors declare no competing interests in the conduct of this research.

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Authors' contributions

All individuals listed as authors of this article participated fully in data collection, literature search, preparation of the draft manuscript, review of the draft, and final approval of the manuscript for publication.

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Data Sharing

All data are available in Supplementary materials.

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Table 1. Characteristics of the study population by obstructed labour occurrence

	Obstructed labour (N=1186)		No Obstructed labour (N=68512)	
SOCIODEMOGRAPHIC CHARACTERISTICS	n/N	%	n/N	%
Age				
<20 years	104/1186	8.8%	2356/68512	3.4%
20-35 years	958/1186	80.8%	55813/68512	81.5%
>35 years	124/1186	10.5%	10343/68512	15.1%
Marital status				
Single	27/1184	2.3%	732/68289	1.1%
Married/cohabitating	1156/1184	97.6%	67459/68289	98.8%
Separated/divorced	0/1184	0.0%	91/68289	0.1%
Widowed	1/1184	0.1%	7/68289	0.0%
Woman's educational level				
No formal education	269/1089	24.7%	6334/63773	9.9%
Completed Primary education	84/1089	7.7%	2366/63773	3.7%
Completed Secondary education	450/1089	41.3%	26310/63773	41.3%
Completed post-secondary education	286/1089	26.3%	28763/63773	45.1%
Woman's occupation				
Not gainfully employed	533/1154	46.2%	24883/66965	37.2%
Professional/technical/managerial	126/1154	10.9%	16210/66965	24.2%
Sales/trading	249/1154	21.6%	15707/66965	23.5%
Manual labour/other	246/1154	21.3%	10165/66965	15.2%
Husband's occupation				
Not gainfully employed	19/1119	1.7%	737/65728	1.1%
Professional/technical/managerial	282/1119	25.2%	29082/65728	44.2%
Sales/trading	304/1119	27.2%	17310/65728	26.3%
Manual labour/other	514/1119	45.9%	18599/65728	28.3%
PAST OBSTETRIC CHARACTERISTICS				
Parity				
Nullipara	555/1186	46.8%	20456/68510	29.9%
Multipara (1-4)	498/1186	42.0%	42190/68510	61.6%
Grand multipara (5 or more)	133/1186	11.2%	5864/68510	8.6%
Women who had previous caesarean section				
Nuliparous	555/1161	47.8%	20456/66986	30.5%
No	474/1161	40.8%	36960/66986	55.2%
Yes	132/1161	11.4%	9570/66986	14.3%
Woman who had previous miscarriage				
No	925/1163	79.5%	49128/67451	72.8%
Yes	238/1163	20.5%	18323/67451	27.2%
Chronic medical disorders (pre-pregnancy) [a]				
No	1138/1184	96.1%	62034/67624	91.7%
Yes	46/1184	3.9%	5590/67624	8.3%

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Table 1 continue.

	Obstructed labour (N=1186)		No Obstructed labour (N=68512)	
INDEX PREGNANCY CHARACTERISTICS	**n/N**	**%**	**n/N**	**%**
Antenatal care booking (ANC)				
No antenatal care	359/1185	30.3%	6942/67858	10.2%
ANC at the same facility	355/1185	30.0%	50758/67858	74.8%
ANC at another health facility	443/1185	37.4%	9907/67858	14.6%
ANC with traditional birth attendant or informal setting	28/1185	2.4%	251/67858	0.4%
Referral Status				
Not referred or self-referred	611/1186	51.5%	59494/68509	86.8%
Referred from public or private hospital	496/1186	41.8%	8575/68509	12.5%
Referred from informal setting	79/1186	6.7%	440/68509	0.6%
Multiple Pregnancy				
Yes	26/1186	2.2%	2358/68511	3.4%
No	1160/1186	97.8%	66153/68511	96.6%
Continuous labour monitoring [b]				
Yes	467/697	67.0%	43877/52356	83.8%
No	230/697	33.0%	8479/52356	16.2%
Pregnancy induced hypertension				
Yes	29/1181	2.5%	2567/67516	3.8%
No	1152/1181	97.5%	64949/67516	96.2%
Gestational Diabetes				
Yes	3/1181	0.3%	273/67516	0.4%
No	1178/1181	99.7%	67243/67516	99.6%
Antepartum hemorrhage				
Yes	8/1181	0.7%	1393/67516	2.1%
No	1173/1181	99.3%	66123/67516	97.9%
Birth weight				
< 2499	97/1174	8.3%	10656/69940	15.2%
2500-3999	937/1174	79.8%	55579/69940	79.5%
>= 4000	140/1174	11.9%	3705/69940	5.3%

[a] Diabetes, asthma, sickle cell anaemia, tuberculosis, HIV, hepatitis, cardiac disease, renal disease, thyroid disease, epilepsy, or other medical disorder

[b] Missing data on n=16645

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Table 2. Maternal outcome following obstructed labour.

Maternal Outcome	n/N	%
Death	31/1186	2.6%
Morbidity after birth[2]	199/1186	16.8%
Complication between delivery and hospital discharge:		
• Ruptured uterus	15/199	7.5%
• Pre-eclampsia	10/199	5.0%
• Eclampsia	11/199	5.5%
• PPH	23/199	11.6%
• Retained placenta	0/199	0.0%
• Sepsis	22/199	11.1%
• Wound infection	31/199	15.6%
• Thromboembolic disease	3/199	1.5%
• Anaemia	79/199	39.7%
• Acute renal failure	4/199	2.0%
• Disseminated intravascular coagulopathy	0/199	0.0%
• Stroke	1/199	0.5%
• Anaesthetic complication	0/199	0.0%
• Pulmonary edema	3/199	1.5%
• Cardiac arrest	10/199	5.0%
• Hepatic failure	0/199	0.0%
• Other	66/199	33.2%
Prolonged hospital stay[3]	539/1064	50.7%
Women admitted to ICU	19/191	9.9%

[2]Maternal complication between delivery and hospital discharge
[3]Prolonged stay is defined as more than 5 days between date of admission and date of discharge

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Table 3. Perinatal outcome following obstructed labour.

Perinatal Outcome	n/N	%
Alive at birth	980/1213	80.8%
Still Birth:	233/1213	19.2%
• Intrapartum stillbirth	144/233	61.8%
• Antenatal stillbirth	89/233	38.2%
Neonatal death[1]	83/980	8.5%
Admission to NICU		
• No	653/979	66.7%
• Yes	326/979	33.3%
Indication for NICU admission		
• Birth Asphyxia	169/326	51.8%
• Trauma	6/326	1.8%
• Jaundiced	16/326	4.9%
• Congenital anomaly	4/326	1.2%
• Prematurity	14/326	4.3%
• Presumed Neonatal Sepsis	38/326	11.7%
• Hypoxic ischemia encephalopathy	18/326	5.5%
• Other	110/326	33.7%

[1]baby died before discharge from hospital. n=1213 babies

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Table 4. Sociodemographic and clinical factors associated with obstructed labour

	Unadjusted Odds Ratio (95% CI)	p value*	Adjusted Odds Ratio (95% CI)	p value*
SOCIODEMOGRAPHIC CHARACTERISTICS				
Age				
<20 years	3.13 (2.39 - 4.11)		2.03 (1.5 - 2.75)	
20-35 years	1.4 (1.16 - 1.69)	<0.001	1.41 (1.2 - 1.66)	<0.001
>35 years	1		1	
Marital status				
Single/Separated/Divorced/Widowed	1.84 (1.25 - 2.7)	0.02	-	-
Married/cohabitating	1		-	
Woman's educational level				
No formal education	2.89 (2.4 - 3.47)		1.88 (1.55 - 2.3)	
Completed Primary education	2.68 (2.12 - 3.4)	<0.001	1.85 (1.43 - 2.37)	<0.001
Completed Secondary education or more	1		1	
Woman's occupation				
Professional/technical/managerial	1		1	
Sales/trading	2.1 (1.69 - 2.6)	<0.001	1.68 (1.34 - 2.12)	<0.001
Not gainfully employed/Manual labour/other	2.82 (2.32 - 3.43)		1.94 (1.57 - 2.41)	
Partner's occupation				
Professional/technical/managerial	1		1	
Sales/trading	1.84 (1.56 - 2.17)	<0.001	1.46 (1.23 - 1.74)	<0.001
Not gainfully employed/Manual labour/other	3.1 (2.66 - 3.61)		2.17 (1.85 - 2.56)	
PAST OBSTETRIC CHARACTERISTICS				
Parity				
Nullipara	2.34 (2.07 - 2.64)		2.11 (1.84 - 2.43)	
Multipara (1-4)	1	<0.001	1	<0.001
Grand multipara (5 or more)	1.52 (1.25 - 1.86)		1.23 (0.97 - 1.55)	
Previous caesarean section				
No	1	0.520	-	-
Yes	1.07 (0.88 - 1.3)		-	
Previous miscarriage				
No	1.57 (1.36 - 1.82)	<0.001	1.37 (1.17 - 1.61)	<0.001
Yes	1		1	
Chronic medical disorders (pre-pregnancy) [a]				
No	2.14 (1.59 - 2.88)	<0.001	1.79 (1.31 - 2.45)	<0.001
Yes	1		1	
INDEX PREGNANCY				
Antenatal care booking (ANC)				
No antenatal care	6.99 (5.96 - 8.2)		3.34 (2.53 - 4.41)	
ANC at the same facility	1		1	
ANC at another health facility	6.81 (5.84 - 7.93)	<0.001	3.26 (2.46 - 4.33)	<0.001
ANC with traditional birth attendant or informal setting	15.66 (10.39 - 23.62)		8.18 (4.41 - 15.14)	
Referral Status				
Not referred or self-referred	1		1	
Referred from public or private hospital	5.98 (5.24 - 6.82)	<0.001	2.2 (1.72 - 2.82)	<0.001
Referred from informal setting	13.37 (10.13 - 17.66)		2.37 (1.55 - 3.62)	
Multiple Pregnancy				
Yes	1	0.012	1	0.045
No	1.65 (1.12 - 2.45)		1.65 (1.01 - 2.7)	
Continuous labor monitoring				
Yes		<0.001	1	<0.001
No	3.55 (2.92 - 4.32)		2.36 (1.9 - 2.94)	
Pregnancy induced hypertension				
Yes	1		1	0.003
No	1.84 (1.27 - 2.67)		2.25 (1.31 - 3.85)	
Gestational diabetes	1	0.426	-	-
Yes			-	

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No	1.51 (0.55 - 4.19)			
Antepartum hemorrhage				
Yes	1	<0.001	1	<0.001
No	4.28 (2.17 - 8.44)		4.26 (2 - 9.08)	
At least one baby whose birthweight was more than 4000 g				
Yes	2.63 (2.12 - 3.27)	<0.001	3.38 (2.48 - 4.61)	<0.001
No	1		1	

*P-value obtained from the GLMM model

[a] Diabetes, asthma, sickle cell anaemia, tuberculosis, HIV, hepatitis, cardiac disease, renal disease, thyroid disease, epilepsy or other medical disorder

[b] Missing data on n=16645

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Table 5. Contributing factors to maternal death following obstructed labour, N=31.

Contributing Factor*	n/N	%
Delay in woman seeking medical help	26/31	83.9%
Delay in appropriate referral	21/30	70.0%
Lack / Delay of transport from home to health care facility	4/29	13.8%
Lack of facilities, equipment or consumables	7/31	22.6%
Delay in receiving care from medical staff	9/31	29.0%
Health services and communication breakdown	4/30	13.3%
Lack of medical expertise, training or education	0/30	0.0%
Patient's refusal of treatment or admission	2/29	6.9%
Lack of human resources	1/30	3.3%

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