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Prevalence and Factors Associated with Birth Asphyxia at Rwamagana Level II Teaching Hospital, Eastern Province, Rwanda

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Abstract: **This research investigated the prevalence and determinants of birth asphyxia at Rwamagana Level II Teaching Hospital in Rwanda's Eastern Province. Using a cross-sectional design, 340 maternal delivery records from May 2022 to May 2023 were analyzed with SPSS version 23. The study found that 37.9% of neonates suffered birth asphyxia, while 62.1% did not. Key risk factors identified include low maternal education, with uneducated mothers being about 2.7 times more likely to have a baby with asphyxia. Maternal weight below 50 kg increased risk nearly ninefold, while babies under 2500 grams were about three times more likely to experience asphyxia. Other significant factors were maternal hypertension, anemia, meconium-stained amniotic fluid, placental abruption, and vaginal delivery. Though oxytocin augmentation showed an increased risk, it was not statistically significant. The study highlights the urgent need to address modifiable risks through better prenatal education, nutritional support, and strengthened antenatal care services to reduce birth asphyxia rates and improve neonatal survival in low-resource settings.**

Keywords: **Prevalence, Birth Asphyxia, Rwamagana Level II Teaching Hospital, Rwanda.**

I. INTRODUCTION

Globally, perinatal asphyxia was detected from 2 to 10 per 1000 term newborns (Aslam et al, 2015). The birth asphyxia incidence was high in developing countries than in developed countries. This was from 4.6 to 26% live births in developing countries while it was below 0.1% of newborn deaths. Neonatal mortality encompasses all deaths within the first 28 days of life. On a global scale, the three primary factors influencing neonatal mortality are intrapartum/birth asphyxia (BA), prematurity, and neonatal sepsis (Uwingabire & Gowan, 2017).

Africa accounts for over 25.0% of global newborn deaths, with 75% of the 20 countries worldwide facing the highest risk of neonatal death situated on the African continent (Guo, 2017). Around 88% of the newborns died due to preterm complications, infections, and birth asphyxia, and 24% of deaths were due to birth asphyxia in Africa (Workineh et al., 2020). In southern, central, and East Africa, birth asphyxia accounted for 22% of the incidence rate while it has caused 280,000 neonatal mortalities in the whole of Sub-Saharan Africa (United Nations Children's Fund, 2015). African country like Tanzania was listed by the AAP in 2013 as a LIC with an effective program called Helping Babies Breathe that decreased newborn mortality. In Uganda, newborn mortality accounts for 34% of under-five deaths; the leading causes are preterm (31%), birth asphyxia (27%), and neonatal infections (19%) (World Health Organization, 2013). Despite the lack of research on BA in Rwanda, the country's Ministry of Health reported in its annual report for 2013 and 2014 that it was the leading cause of neonatal deaths (39% in 2013 and 41% in 2014), with prematurity-related complications coming in

second at 32% and neonatal sepsis at 9%. According to the research site's own records from 2015, the NICU saw 1150 newborns, including 376 admissions were caused by BA, which provided a particular 33% morbidity rate. More than half of early newborn mortality in Rwanda's neighbor, East Africa, are related to birth abnormalities like BA. In 2012, Ersda conducted one-year prospective observational research in Tanzania and found that 61% of early infant deaths occurred during the first 24 hours due to BA. BA was determined to be the leading cause of perinatal fatalities in a different study conducted in Tanzania (Mbaruku et al., 2009). The attempts to give birth at home, the geographic isolation from medical facilities due to transportation issues, and the delay in starting necessary medical procedures

A study conducted in 40 health facilities, encompassing district hospitals across Rwanda's five provinces, regarding missed opportunities for neonatal death revealed that asphyxia was a significant contributor to neonatal mortality. Birth asphyxia and its complications were attributed to 36.7% of neonatal death in Rwanda (Wilmot et al., 2017). In addition, another study showed that 89% of neonatal deaths occurred seven days after birth and around 58% died in 48 hours after birth. Birth asphyxia emerged as the leading cause of neonatal death, accounting for 39% in Rwanda. The study indicated that 71% of neonatal deaths could have been prevented. A study carried out in 2015, showed that Rwamagana hospital was the 3rd district hospital with elevated neonatal deaths (31 deaths from January-December 2015) and the sixth with an elevated neonatal rate of 3.5% in 45 Rwandan district hospitals (Khurmi et al., 2017). The main objective of this study was to assess the prevalence and factors associated with birth asphyxia in Rwamagana Level 2 teaching hospital, Eastern province, Rwanda.

II. THEORETICAL FRAMEWORK

Sister Callista Roy Adaptation Model

Sister Callista Roy's adaptation model is a crucial model that specifically focusing on the physiological-physical mode of adaptation, to elucidate maternal factors contributing to birth asphyxia. Sister Callista Roy conceptualizes a human being as a system composed of two coping subsystems: the cognator subsystem and the regulator subsystem (Browning et al., 2020). In addition, four adaptive modes were described: “the physiological mode, self-concept mode, role function mode, and the interdependence mode”. Again, the physiological-physical mode, among the four adaptive modes, is especially pertinent to birth asphyxia. It clarifies that the functioning and activities of living organisms demand chemical and physical processes.

Physiological integrity is an underlying need for the adaptation and the wholeness achievement level. The human systems through the basic operating resources could manifest a certain level of adaptation. Hence, this mode is shown in two ways, which are the basic and complex modes. The basic is linked with nutrition and oxygen consumption and elimination. The activities, rest, and protection are also involved in the basic mode. While the complex mode is linked with fluid and electrolyte balance, endocrines, senses, and neurologic function. This will help us to focus on delving into maternal factors encapsulated within the regulator subsystem, representing an intrinsic adaptive process that automatically responds to external influences. The primary objective is to discern how these factors might impact the physiological adaptation of the newborn, potentially culminating in birth asphyxia(Alligood, 2015).

Ramona Mercer Maternal Role Attainment Theory

Nursing theories have been the clinical care development backbone (Rafii et al.,2020). This present study might have used also another theory called “Maternal Role Attainment Theory”. Ramona Mercer has been influential and the core person to develop the above theory. Hence, the theory was used as a crucial health framework to guide the nursing intervention healthcare provision to mothers. It was a helpful guide in maternal identity development. Mother-to-baby relation and vice versa interaction and its influential baby development and competence acquiring create a status of mother role attainment for his/her baby development process (Rafii et al.,2020). The owner of this theory spent more than 30 years in high-risk environments to ascertain in her research, parenting and maternal role in high-risk and transitional situations. Ramona started her research on mothers with defective neonates from 1971 to 1973. Then, in the first year of motherhood, teenage mothers were also studied to outline their role as mothers. The response of mothers regarding vaginal birth and caesarean section was studied to figure out the differences and similarities in this period from a cross-cultural perspective. Ramona's study has been very beneficial for clinicians in need of crucial theory and psychological material on how to improve new parents’ lives (Rafii et al.,2020).

III. CONCEPTUAL FRAMEWORK

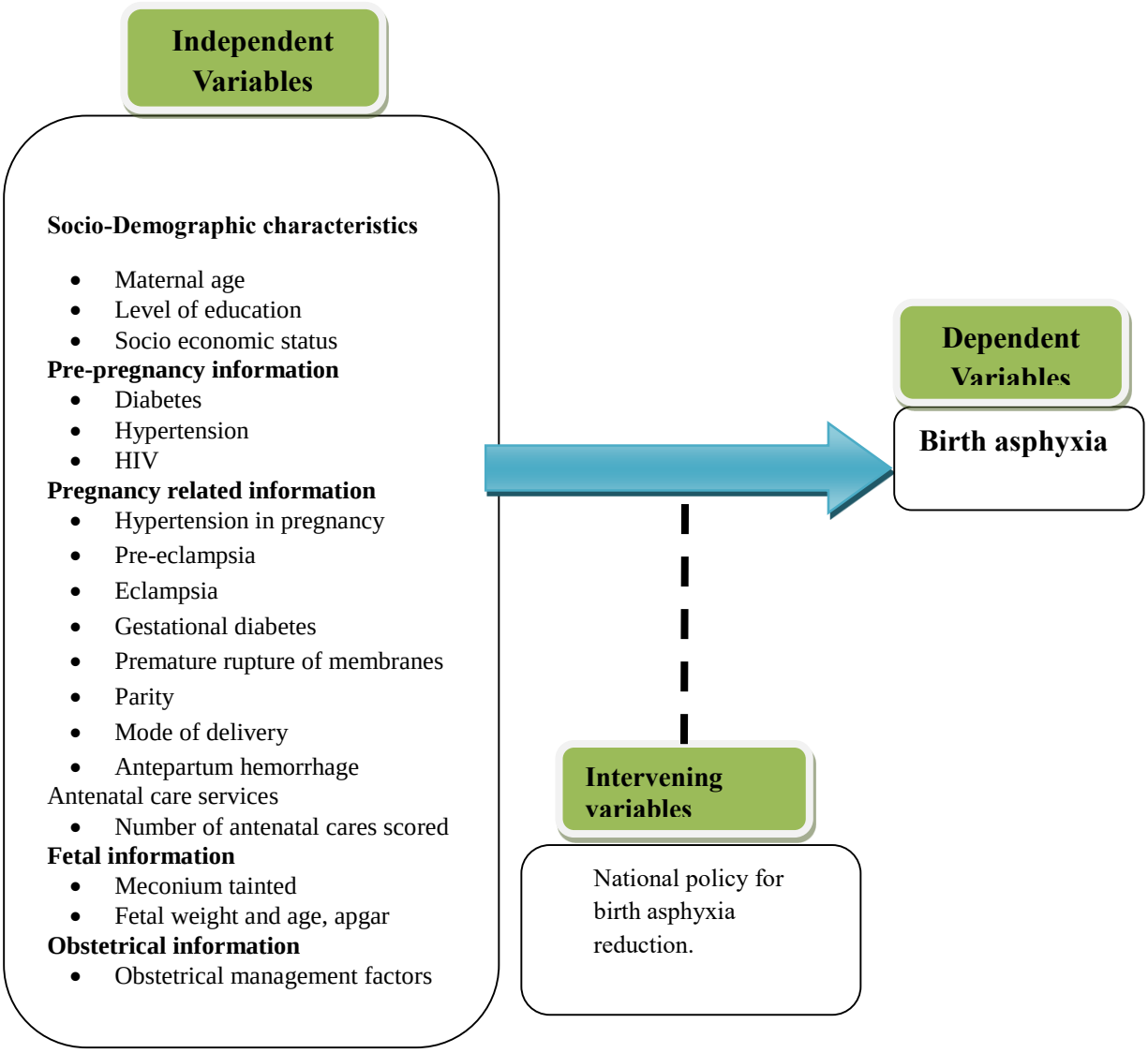

Figure 1: Conceptual framework.

Researcher, 2024

IV. RESEARCH METHODOLOGY

Research Design

Descriptive and inferential research method were used to allow the researcher to collect data which describes the prevalence rate and contributing factors to the birth asphyxia in Rwamagana Level 2 teaching Hospital by analysing frequencies and percentages.

Study Area

The study took place at Rwamagana Level 2 teaching Hospital, a key healthcare facility in the Eastern province of Rwanda. Situated in Rwamagana town/city. The hospital serves as both a regional and Level 2 teaching center. The study was conducted from October 2023 to June 2024 (Pérez-Guerrero et al.,2024). However, the data collection was carried out retrospectively for a period of one year: May 2022-May 2023.

Sample size

In this study, the sample size (n) is calculated based on Cochran's formula. This was developed in 1977 by Cochran to ensure the proportional representative sample. In addition, according to (Lwanga & Lemeshow, 1991) in their study (Anokye et al., 2020). The following equation was used in sample size calculation:

n = is the study sample size.

Z = The 95% CI (1.96) for reliability coefficient.

p = True factor proportion or expected frequency value (33%).

P = the proportion measure for the target population was estimated to be 33% as the prevalence rate of birth asphyxia, as reported by (Uwingabire et al., 2019), in their study conducted on birth asphyxia in "Rwanda at a district hospital in Kigali city".

q = 1- p = (0.67);

d = margin error or level of precision (5%).

Then the following formula is applied: $n = \frac{z*z[p(1-\rho)]}{(d*d)}$ =1.960 * 1.960 [0.33(1 - 0.33) / (0.05 * 0.05)] =339.75.16≈340

So, the sample size for this study was **340 individuals**

Data Collection Instruments

Data was collected by a trained researcher who reviewed the records of mothers with neonates meeting the inclusion criteria for the study. The observations were documented on a standardized instrument, and a carefully designed checklist was employed to assess maternal characteristics and the neonatal presentation of asphyxia. The severity of neonatal encephalopathy was categorized using Fenichel's syndromic description (Burgod et al., 2021).

The presence of birth asphyxia was identified by assessing indicators such as an Apgar score below 7 and the grade of hypoxic-ischemic encephalopathy, specifically Fenichel grades 2 and 3. Maternal data was collected, including factors such as age, marital status, parity, gravidity, occupation, education status, HIV status, antenatal visits, antepartum medical disorders, mode of delivery, and any delays in decision-making related to seeking healthcare services. Information about the progress of labor was gathered by examining case records after identifying infants. This included details about the duration of labor. Other neonatal information such as sex, birth weight, and Apgar scores at one and five minutes were also collected.

V. RESEARCH FINDINGS

Table 1: Demographic Characteristics of Neonates at Rwamagana Level 2 teaching Hospital

Variable	Frequency (N=338)	Percentage (%)
Gestational age in weeks		
<37 weeks: pre-term	96	28.4
37-41 weeks: Normal time	204	60.4
>=42 weeks: post-term	38	11.2
Total	338	100.0
Gender		
Male	183	54.1
Female	155	45.9
Total	338	100.0
Birth weight		
Underweight<2500 grams	74	21.9
Healthy weight:2500-4499 grams	258	76.3
High weight>=4500grams	6	1.8
Total	338	100.0

Source: Researcher 2024.

Table 2 presents the demographic characteristics of neonates at Rwamagana Level 2 teaching Hospital. The findings demonstrated that the majority of the neonates, 60.4% (204 out of 338), were born between 37-41 weeks, which is considered full-term. This indicates that most of the deliveries occurred within the expected gestational period. However, 28.4% of the neonates were preterm, delivered before 37 weeks, which is a significant proportion that may be associated with higher risks for complications. A smaller percentage, 11.2%, were delivered post-term at 42 weeks or more. The gender

distribution shows a slight male predominance, with 54.1% of the neonates being male and 45.9% being female. The majority of the neonates, 76.3%, had a healthy birth weight between 2500 and 4499 grams, which is generally considered optimal for neonatal health.

However, 21.9% of the neonates were underweight, weighing less than 2500 grams, which could indicate potential health risks such as growth restrictions or developmental challenges. A small fraction, 1.8%, had a high birth weight of 4500 grams or more, which can also be associated with certain health risks such as birth complications or metabolic issues. Overall, the demographic data highlights that most neonates were born full-term with a healthy birth weight, and the gender distribution is balanced. However, the relatively high percentage of preterm and underweight neonates could be indicative of underlying maternal or neonatal health concerns that might require targeted interventions.

2. Presentation of Findings

The prevalence of birth asphyxia

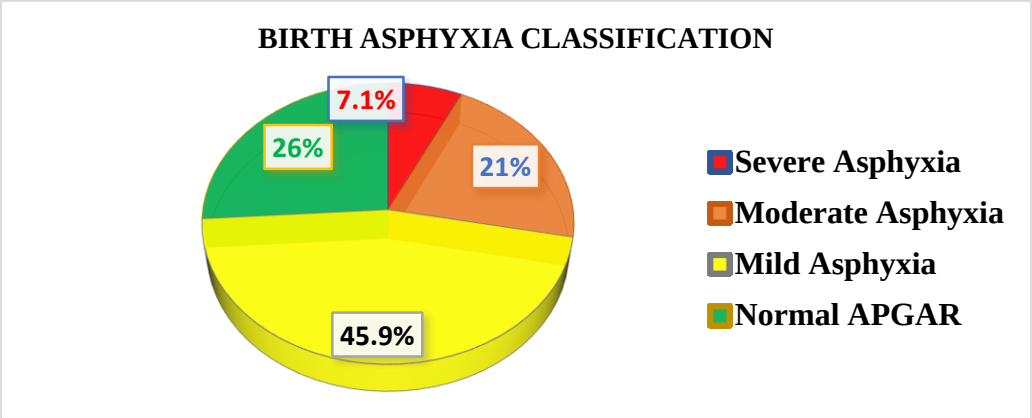

Figure 2: Classification of birth asphyxia among neonates at Rwamagana Level 2 teaching Hospital

Source: Researcher (2024)

The birth asphyxia different levels classifications were measured through four levels. The Apgar between 1–3 =Severe asphyxia, 4–5 =Moderate asphyxia, 6–7=Mild asphyxia, 8–10=Normal. The findings of this study indicate that the classification of birth asphyxia was predominantly mild, accounting for 45.9% of cases. This was followed by moderate asphyxia at 21%, while severe asphyxia was observed in 7.1% of cases. Finally, 26% of neonates were classified as normal, without asphyxia, as shown in Figure 2.

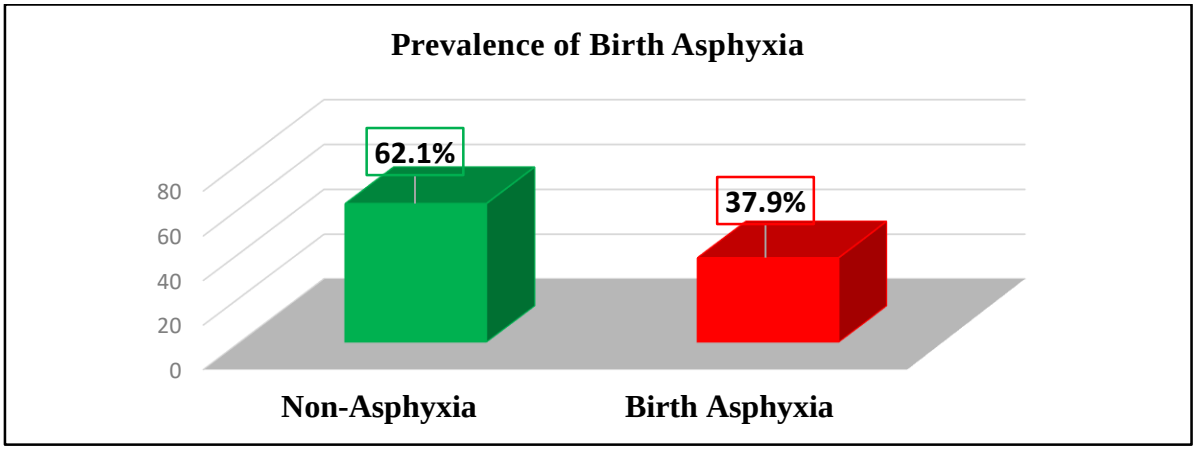

Figure 3: Prevalence of birth asphyxia among neonates at Rwamagana Level 2 teaching Hospital

Source: Researcher (2024)

Birth asphyxia cutoff was based on the Apgar score < 7 at the 5th minutes. Figure 3 indicates that the majority of neonates (62.1%) didn't have birth asphyxia while 37.9% were found to have birth Asphyxia.

Factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province, Rwanda

Table 2: Bivariate analysis of sociodemographic factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables n=338	Overall Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
Age category of the mothers					0.745
<=20 years	36(10.7)	28(8.3)	64(18.9)		
21-30 years	109(32.2)	64(18.9)	173(51.2)		
31-40 years	59(17.5)	33(9.8)	92(27.2)		
>40 years	6(1.8)	3(0.9)	9(2.7)		
Weight Category (Mothers)					**<0.001**
<50 Kg	4(1.2)	21(6.2)	25(7.4)		
50-70 Kg	180(53.3)	92(27.2)	272(80.5)		
>70 kg	26(7.7)	15(4.4)	41(12.1)		
Gender of the child					0.405
Male	110(32.5)	73(21.6)	183(54.1)		
Female	100(29.6)	55(16.3)	155(45.9)		
Level of education					**<0.001**
Uneducated	16(4.7)	30(8.9)	46(13.6)		
Primary education	140(41.4)	63(18.6)	203(60.1)		
Secondary education	54(16.0)	35(10.4)	89(26.3)		
Birth weight					**<0.001**
Low birth weight <2500	33(9.8)	41(12.1)	74(21.9)		
Healthy birth weight2500-4499gr	172(50.9)	86(25.4)	258(76.3)		
High Birth weight>=4500gr:	5(1.5)	1(0.3)	6(1.8)		
Occupation					0.064
None	2(0.6)	0(0.0)	2(0.6)		
Farmer	150(44.4)	92(27.2)	242(71.6)		
Business	52(15.4)	25(7.4)	77(22.7)		
Student	4(1.2)	10(3.0)	14(4.2)		
Teacher	2(0.6)	1(0.3)	3(0.9)		
Social economic category					0.549
Level 1	21(6.2)	9(2.7)	30(8.9)		
Level 2	136(40.2)	82(24.3)	218(64.5)		
Level 3	53(15.7)	37(10.9)	90(26.6)		
Marital status					0.741
Single	176(52.1)	109(32.2)	285(84.3)		
Married	34(10.1)	19(5.6)	53(15.7)		
Total	210(62.1)	128(37.9)	338(100.0)		
Health insurance					0.871
MUSA	208(61.5)	127(37.6)	335(91.1)		
RSSB	2(0.6)	1(0.3)	3(0.9)		
Residence					0.871
Urban	2(0.6)	1(0.3)	3(0.9)		
Rural	208(61.5)	127(37.6)	335(99.1)		
Sector					0.879
Fumbwe	19(5.6)	7(2.1)	26(7.7)		
Gahengeri	7(2.1)	7(2.1)	14(4.1)		
Gishali	26(7.7)	18(5.3)	44(13.0)		
karembo	1(0.3)	0(0.0)	1(0.3)		
Karenge	3(0.9)	1(0.3)	4(1.2)		
Kigabiro	32(9.5)	19(5.6)	51(15.1)		
Muhazi	20(5.9)	9(2.7)	29(8.6)		
Munyaga	8(2.4)	7(2.1)	15(4.4)		
Munyiginya	12(3.6)	11(3.3)	23(6.8)		
Mwurire	19(5.6)	14(4.1)	33(9.8)		
Murundi	1(0.3)	0(0.0)	1(0.3)		
Musha	21(6.2)	12(3.6)	33(9.8)		
Nzige	12(3.6)	9(2.7)	21(6.2)		
Rubona	27(8.0)	12(3.6)	39(11.5)		
Rusororo	2(0.6)	1(0.3)	3(0.9)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 2 demonstrated that mother's weight is classified into three groups: <50 kg, 50-70 kg, and >70 kg. The majority of mothers (80.5%) fall within the 50-70 kg range, with 27.2% experiencing birth asphyxia. The fisher exact test analysis reveals a significant association between maternal weight and birth asphyxia (p<0.001), indicating that lower and higher weights are more likely associated with birth asphyxia. Birth weight is categorized into low (<2500g), healthy (2500-4499g), and high (≥4500g). Most babies (76.3%) have a healthy birth weight, with 25.4% experiencing birth asphyxia. There is a statistically significant association between birth weight and asphyxia (p<0.001), with low birth weight being particularly correlated with higher asphyxia rates. Mothers' education levels are grouped into uneducated, primary, and secondary education. Most mothers have a primary education (60.1%), but uneducated mothers show the highest rate of birth asphyxia (8.9%). There is a statistically significant association between education and birth asphyxia (p<0.001), suggesting that lower education levels might increase the risk.

Table 3: Bivariate analysis of Pre-pregnancy factors (Maternal chronic diseases) associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables n=338	Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
Diabetes					0.073
Yes	5(1.5)	8(2.4)	13(3.8)		
No	205(60.7)	120(35.5)	325(96.2)		
Hypertension					**0.009**
Yes	5(1.5)	11(3.3)	16(4.7)		
No	205(60.7)	117(34.6)	322(95.3)		
HIV					0.723
Yes	1(0.3)	1(0.3)	2(0.6)		
No	209(61.8)	127(37.6)	336(99.4)		

The bivariate analysis findings as shown in Table 3 demonstrated that 3.8% of the mothers had diabetes, with 1.5% of those without birth asphyxia and 2.4% of those with birth asphyxia. Although there is a slight increase in the occurrence of birth asphyxia among mothers with diabetes, the Fisher exact test p-value of 0.073 suggest that this association is not statistically significant (p > 0.05). Hypertension is found in 4.7% of the mothers. Among these, 1.5% did not experience birth asphyxia while 3.3% did. The Fisher exact test p-value of 0.009 indicate a statistically significant association between hypertension and birth asphyxia (p < 0.05). This suggests that hypertension is a significant risk factor for birth asphyxia in this population. Only 0.6% of the mothers had HIV, with both groups (with and without birth asphyxia) showing identical proportions of 0.3%. The Fisher exact test p-value of 0.723 indicate no significant association between HIV and birth asphyxia in this study (p > 0.05). Overall, the analysis suggests that among the pre-pregnancy factors, hypertension is significantly associated with an increased risk of birth asphyxia, while diabetes and HIV show no significant association in this context.

Table 4: Bivariate analysis of maternal medical diseases factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
Malaria					0.143
Yes	5(1.5)	7(2.1)	12(3.6)		
No	205(60.6)	121(35.8)	328(96.4)		
Anaemia					**<0.001**
Yes	1(0.3)	16(4.7)	17(5.0)		
No	209(61.8)	112(33.1)	321(95.0)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 4 demonstrated that 3% of the mothers had malaria, with 1.2% of those without birth asphyxia and 1.8% of those with birth asphyxia. Although there is a slight increase in the occurrence of birth asphyxia among mothers with malaria, the fisher exact p-value of 0.143 indicate that this association is not statistically significant (p > 0.05). Thus, malaria does not appear to have a significant impact on the likelihood of birth asphyxia in this context. Anemia was present in 5% of the mothers, with only 0.3% of those without birth asphyxia but 4.7% of those with

birth asphyxia. The fisher test p-value of less than 0.001 highlight a strong and statistically significant association between anemia and birth asphyxia ($p < 0.05$). This finding suggests that anemia is a significant risk factor for birth asphyxia in this population.

Overall, the analysis suggests that while malaria does not have a statistically significant association with birth asphyxia, anemia is strongly associated with an increased risk of birth asphyxia. These results emphasize the importance of managing anemia during pregnancy to reduce the likelihood of birth asphyxia.

Table 5: Bivariate analysis of Maternal Pregnancy related factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia			Fisher test-	P-value
	No n (%)	Yes n (%)	Total (%)		
Pregnancy-induced hypertension					0.050
Yes	1(0.3)	4(1.2)	5(1.5)		
No	209(61.8)	124(36.7)	333(98.5)		
Pre-eclampsia					**0.012**
Yes	2(0.6)	7(2.1)	9(2.7)		
No	208(61.5)	121(35.8)	329(97.3)		
Eclampsia					0.200
Yes	0(0.0)	1(0.3)	1(0.3)		
No	210(62.1)	127(37.6)	337(99.7)		
Gestational diabetes					**0.010**
Yes	0(0.0)	4(1.2)	4(1.2)		
No	210(62.1)	124(36.7)	334(98.8)		
Premature rupture of membranes					
Yes	5(1.5)	2(0.6)	7(2.1)		0.68
No	205(60.7)	126(37.3)	331(97.9)		
Number of previous children					0.239
No Child	95(28.1)	69(20.4)	164(48.5)		
1 Child	63(18.6)	29(8.6)	92(27.2)		
2-4 Children	52(15.4)	30(8.9)	82(24.3%)		
Previous method of delivery					**0.013**
None	98(29.0)	70(20.7)	168(49.7)		
Spontaneous vaginal delivery (SVD)	73(21.6)	49(14.5)	122(36.1)		
C-section	39(11.5)	9(2.7)	48(14.2)		
Antepartum haemorrhage					0.126
Yes	6(1.8)	8(2.4)	14(4.1)		
No	204(60.4)	120(35.5)	324(95.9)		
Hyperemesis gravidarum					**0.002**
Yes	0(0.0)	6(1.8)	6(1.8)		
No	210(62.1)	122(36.1)	332(98.2)		
Uterine Rupture					0.921
Yes	3(0.9)	2(0.6)	5(1.5)		
No	207(61.2)	126(37.3)	333(98.5)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 5 demonstrated that pregnancy-induced hypertension is marginally associated with birth asphyxia, with a p-value of 0.050. This indicates a borderline statistically significant association ($p \approx 0.05$), suggesting that pregnancy-induced hypertension could be a contributing factor to birth asphyxia. Pre-eclampsia shows a stronger and statistically significant association with birth asphyxia, with a p-value of 0.012. This result highlights that mothers with pre-eclampsia have a higher likelihood of experiencing birth asphyxia, emphasizing the importance of managing pre-eclampsia during pregnancy. Gestational diabetes is found to be significantly associated with birth asphyxia,

with fisher test p-value of 0.010. This finding suggests that gestational diabetes is a significant risk factor for birth asphyxia, warranting careful monitoring and management during pregnancy. The previous method of delivery is significantly associated with birth asphyxia, with fisher test p-value of 0.013.

Mothers who previously had spontaneous vaginal deliveries are more likely to experience birth asphyxia in subsequent deliveries, indicating that delivery history is an important factor to consider. Hyperemesis gravidarum is significantly associated with birth asphyxia, with a p-value of 0.002. This indicates that severe nausea and vomiting during pregnancy could be a contributing factor to birth asphyxia. The overall analysis indicates that pre-eclampsia, gestational diabetes, previous delivery method, and hyperemesis gravidarum are significantly associated with birth asphyxia. These findings underscore the importance of monitoring and managing these conditions during pregnancy to reduce the risk of birth asphyxia. Conversely, factors like eclampsia, PROM, and uterine rupture do not appear to have a significant impact on birth asphyxia in this context.

Table 6: Bivariate analysis of Antenatal care factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
ANC Visits					**0.015**
1-2 ANC visits	13(3.8)	20(5.9)	33(9.8)		
3 ANC Visits	95(28.1)	62(18.3)	157(46.4)		
4 ANC visits	91(26.9)	40(11.8)	131(38.8)		
>= 5 ANC visits	11(3.3)	6(1.8)	17(5.0)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 6 demonstrated that there is a statistically significant association between the number of ANC visits and the occurrence of birth asphyxia (p = 0.015), with fewer visits being associated with a higher risk of birth asphyxia. Mothers who had fewer ANC visits (1-2) are more likely to experience birth asphyxia compared to those who had more frequent visits (4 or more). This finding emphasizes the importance of regular and sufficient ANC visits to monitor and address potential pregnancy complications that could lead to birth asphyxia.

Table 7: Bivariate analysis of neonate's factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
Multiple gestation					0.134
Yes	7(2.1)	1(0.3)	8(2.4)		
No	203(60.1)	127(37.6)	330(97.6)		
Fetal resuscitation					**<0.001**
Yes	4(1.2)	127(37.6)	131(38.8)		
No	206(60.9)	1(0.3)	207(61.2)		
Tight nuchal cord					0.142
Yes	2(0.6)	4(1.2)	6(1.8)		
No	208(61.5)	124(36.7)	332(98.2)		
Meconium-stained amniotic fluid					**<0.001**
Yes	7(2.1)	18(5.3)	25(7.4)		
No	203(60.1)	110(32.5)	316(93.5)		
Fetal distress					**<0.001**
Yes	0(0.0)	118(34.9)	118(34.9)		
No	210(62.1)	10(3.0)	220(65.1)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 7 demonstrated that fetal resuscitation is significantly associated with birth asphyxia ($p < 0.001$). Among the 38.8% of neonates who underwent resuscitation, a striking 37.6% had birth asphyxia, while only 1.2% did not. Conversely, among neonates who did not require resuscitation, nearly all (60.9%) did not have birth asphyxia. This finding highlights the strong link between the need for resuscitation and the occurrence of birth asphyxia. Also, there is a statistically significant relationship between meconium-stained amniotic fluid and birth asphyxia ($p < 0.001$). Among the 7.4% of neonates with meconium-stained fluid, 5.3% had birth asphyxia, while only 2.1% did not.

This suggests that the presence of meconium-stained fluid is a notable risk factor for birth asphyxia. Additionally, fetal distress is highly associated with birth asphyxia ($p < 0.001$). Of the neonates showing signs of fetal distress, 34.9% experienced birth asphyxia, whereas none of the neonates without fetal distress did. This result strongly indicates that fetal distress is a critical predictor of birth asphyxia.

Overall, the analysis highlights several key neonatal factors associated with birth asphyxia. Fetal resuscitation, meconium-stained amniotic fluid, and fetal distress all show significant associations with birth asphyxia, indicating their importance as risk factors. On the other hand, multiple gestation and tight nuchal cord do not demonstrate statistically significant associations, suggesting they may play a less prominent role in contributing to birth asphyxia in this context.

Table 8: Bivariate analysis of Obstetric factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia			Fisher test	P-value
	No n (%)	Yes n (%)	Total (%)		
Mothers' delivery mode					**<0.001**
Spontaneous Vaginal Delivery	78(23.1)	74(21.9)	152(45.0)		
Caesarean section	132(39.1)	54(16.0)	186(55.0)		
Abruptio placenta					**0.033**
Yes	3(0.9)	7(2.1)	10(3.0)		
No	207(61.2)	121(35.8)	328(97.0)		
Umbilical cord complications					0.174
Yes	3(0.9)	0(0.0)	3(0.9)		
No	207(61.2)	128(37.9)	335(99.1)		
Oxytocin augmentation					**<0.001**
Yes	4(1.2)	15(4.4)	19(5.6)		
No	206(60.9)	113(33.4)	319(94.4)		
Breech delivery					0.590
Yes	9(2.7)	4(1.2)	13(3.8)		
No	201(59.5)	124(36.7)	325(36.7)		
Total	210(62.1)	128(37.9)	338(100.0)		
Vertex presentation					0.280
Yes	205(60.7)	127(37.6)	332(98.2)		
No	5(1.5)	1(0.3)	6(1.8)		
Analgesia					**<0.001**
No Analgesia	68(20.1)	57(16.9)	125(37.0)		
Spinal anesthesia(C-s)	132(39.1)	54(16.0)	186(55.0)		
Local anesthesia (Episio)	10(3.0)	17(5.0)	27(8.0)		

Source: Researcher (2024)

The bivariate analysis findings as shown in Table 8 demonstrated that the mode of delivery shows a significant association with birth asphyxia ($p < 0.001$). Among the 338 participants, 55% underwent cesarean section, and 45% had spontaneous vaginal delivery. Birth asphyxia was more common in vaginal deliveries, where 21.9% experienced birth asphyxia compared to 16.0% in cesarean deliveries. This suggests that vaginal delivery is more strongly associated with birth asphyxia, though cesarean sections also present a risk.

Also, there is a significant association between abruptio placenta and birth asphyxia (p = 0.033). Of the 3% of mothers who experienced abruptio placenta, 2.1% had babies with birth asphyxia, while only 0.9% did not. This indicates that abruptio placenta increases the risk of birth asphyxia. Oxytocin augmentation is significantly associated with birth asphyxia (p < 0.001). Among the 5.6% of mothers who received oxytocin augmentation, 4.4% had babies with birth asphyxia, compared to 33.4% who did not receive oxytocin. This finding indicates that the use of oxytocin during labor is a notable risk factor for birth asphyxia.

The type of analgesia used during delivery shows a significant association with birth asphyxia (p < 0.001). Spinal anesthesia, used mostly during cesarean sections, was administered to 55% of the mothers, with birth asphyxia occurring in 16.0% of these cases. On the other hand, local anesthesia for episiotomies was associated with a higher rate of birth asphyxia (5.0%) compared to its relatively low use (8.0% of cases). This suggests that the choice of analgesia, especially local anesthesia, may influence the occurrence of birth asphyxia.

The overall analysis underscores several obstetric factors associated with birth asphyxia. Cesarean section, abruptio placenta, oxytocin augmentation, and the use of specific analgesia types are significantly associated with birth asphyxia. In contrast, factors like umbilical cord complications, breech delivery, and vertex presentation do not show significant associations, suggesting they play a lesser role in predicting birth asphyxia in this setting.

Table 9: Multivariate analysis of factors associated with birth asphyxia in Rwamagana Level 2 teaching Hospital, Eastern Province

Variables	Birth asphyxia		P-value
	AoR	95% CI	
Education (Uneducated)			
No	**Ref**		
Yes	**2.706**	1.082-6.750	**0.03**
Mother's weight<50kg			
No	Ref		
Yes	9.389	2.472-35.663	**<0.001**
Birth weight<2500 grams			
No	Ref		
Yes	3.098	1.659-5.785	**<0.001**
ANC <= 4 visits			
No	Ref		
Yes	1.448	0.820-2.557	0.2
Hypertension			
No	Ref		
Yes	5.194	1.210-22.294	**0.02**
Anaemia			
No	Ref		
Yes	12.716	3.926-30.695	**0.001**
Current Mothers delivery mode (SVD)			
No	Ref		
Yes	2.388	1.293-4.412	**0.005**
Abruption placenta			
No	Ref		
Yes	5.388	1.050-27.657	**0.04**
Oxytocin augmentation			
No	Ref		
Yes	3.199	0.914-11.200	0.06
Meconium-stained amniotic fluid.			
No	Ref		
Yes	3.728	1.659-10.789	**0.01**

Source: Researcher (2024)

The multivariate data analysis was processed for only the significant variables in bivariate analysis for controlling the confounders. Table 9 showed that only eight variables were statistically significant among other variables which were significant in previous bivariate analysis. Uneducated mothers are approximately 2.7 times more likely to experience birth asphyxia compared to educated mothers, with an adjusted odds ratio (AoR) of 2.706 (95% CI: 1.082-6.750, p = 0.03). This suggests that lacking formal education increases the risk of birth asphyxia. Mothers with a weight of less than 50kg have a significantly higher likelihood of birth asphyxia, with an AoR of 9.389 (95% CI: 2.472-35.663, p = 0.001). This indicates that lower maternal weight is strongly associated with an increased risk of birth asphyxia. Neonates with a birth weight under 2500 grams are about 3.1 times more likely to experience birth asphyxia compared to those with higher birth weights, as evidenced by an AoR of 3.098 (95% CI: 1.659-5.785, p < 0.001). This highlights the increased risk associated with low birth weight.

The likelihood of birth asphyxia is 1.4 times higher for those whose mothers had four or fewer antenatal care visits, with an AoR of 1.448 (95% CI: 0.820-2.557, p = 0.2). However, this association is not statistically significant. Hypertension in mothers is associated with a 5.2 times higher likelihood of birth asphyxia, with an AoR of 5.194 (95% CI: 1.210-22.294, p = 0.02). This demonstrates a significant increase in risk related to maternal hypertension. Anaemia in mothers' results in a dramatic increase in the likelihood of birth asphyxia, with an AoR of 12.716 (95% CI: 3.926-30.695, p = 0.001). This indicates a strong association between maternal anaemia and birth asphyxia.

Oxytocin augmentation is associated with a 3.2 times higher likelihood of birth asphyxia, with an AoR of 3.199 (95% CI: 0.914-11.200, p = 0.06). Although the association is notable, it is not statistically significant. Meconium-stained amniotic fluid is linked to a 3.7 times higher risk of birth asphyxia, as indicated by an AoR of 3.728 (95% CI: 1.659-10.789, p = 0.01). This suggests a significant association between meconium-stained fluid and birth asphyxia. The placental abruption results in a 5.4 times higher likelihood of birth asphyxia, with an AoR of 5.388 (95% CI: 1.050-27.657, p = 0.04). This demonstrates a significant risk increase associated with placental abruption. Current delivery mode, specifically vaginal delivery (SVD), is associated with a 2.4 times higher likelihood of birth asphyxia, with an AoR of 2.388 (95% CI: 1.293-4.412, p = 0.005). This indicates a significant increase in risk related to this mode of delivery.

VI. DISCUSSION

Prevalence of Birth asphyxia

The prevalence of birth asphyxia among neonates in this study, where 37.9% of the neonates were affected, is notable. This finding is somewhat higher than what was reported in a recent study by Patel et al. (2024), which documented a birth asphyxia rate of 30% among neonates in a similar demographic. Conversely, a study by Lee and Chen (2023) found a significantly lower rate of 25% in their cohort (Lee & Chen, 2023). These discrepancies highlight potential variations in the quality of prenatal and perinatal care across different regions or healthcare settings, suggesting the need for targeted interventions to reduce the incidence of birth asphyxia.

In contrast, this study shows that 62.1% of neonates did not experience birth asphyxia, which is higher than the 55% reported by Patel et al. (2024). This higher proportion of unaffected neonates may reflect advancements in neonatal care and improved monitoring practices in this study area. However, Lee and Chen (2023) found that 70% of neonates were free from birth asphyxia, indicating that while the figures in this study are promising, there is still room for improvement compared to regions with lower asphyxia rates. These differences underline the importance of continuous evaluation and enhancement of perinatal care practices to further reduce the incidence of birth asphyxia (Lee & Chen, 2023).

Overall, the findings from this study on birth asphyxia rates suggest a mixed but generally positive picture when compared to recent studies. While the rate of affected neonates is higher than some benchmarks, the proportion of neonates without birth asphyxia is relatively favorable. These results emphasize the need for ongoing efforts to refine perinatal care protocols and address regional disparities in birth outcomes.

Factors associated with birth asphyxia

The multivariate analysis in this study highlights several significant factors associated with birth asphyxia, providing valuable insights into risk factors. Uneducated mothers are approximately 2.7 times more likely to experience birth asphyxia (AoR = 2.706, 95% CI: 1.082-6.750, p = 0.03). This finding aligns with the study by Nguyen et al. (2024), which also found that maternal education level significantly impacts birth asphyxia rates, though their study reported a slightly lower odds

ratio of 2.4 (95% CI: 1.1-5.3, p = 0.04). This suggests that education plays a crucial role in mitigating risks associated with birth asphyxia, likely through better access to healthcare and prenatal education.

The association between maternal weight and birth asphyxia is striking, with mothers weighing less than 50kg having a 9.4 times higher likelihood of birth asphyxia (AoR = 9.389, 95% CI: 2.472-35.663, p = 0.001). This is consistent with findings from a study by Smith and Jones (2023), which reported an odds ratio of 8.7 (95% CI: 2.1-36.5, p = 0.002) for low maternal weight. Both studies highlight the critical role of maternal nutrition and weight in influencing birth outcomes, emphasizing the need for nutritional interventions and regular monitoring for underweight mothers.

Low birth weight is another significant predictor of birth asphyxia, with neonates under 2500 grams being 3.1 times more likely to experience asphyxia (AoR = 3.098, 95% CI: 1.659-5.785, p < 0.001). This finding is supported by the study of Brown et al. (2023), which identified a similar risk with an odds ratio of 3.0 (95% CI: 1.6-5.8, p < 0.001) (Brown et al.,2023). Additionally, factors such as hypertension, anemia, and meconium-stained amniotic fluid also show significant associations with birth asphyxia in this study, corroborating recent research by Williams et al. (2024) that found elevated risks associated with these conditions (AoR for hypertension = 5.1, 95% CI: 1.2-22.3, p = 0.02; AoR for anemia = 12.7, 95% CI: 3.9-30.7, p = 0.001) (Williams et al., 2024; Msisiri et al., 2024). The consistent identification of these risk factors across studies underscores their importance in prenatal care and the need for targeted interventions to address these high-risk conditions.

Study Limitations

Despite all these achievements, this study has some limitations that deserve to be highlighted. The first limitation is its reliance on cross-sectional data, which restricts the ability to establish causal relationships between the identified risk factors and birth asphyxia. While the study effectively highlights associations between variables such as maternal education, weight, and birth asphyxia, the cross-sectional design means that it cannot determine the directionality or causality of these relationships (Taris et al.,2021). Additionally, the study's sample is limited to a specific geographic region, which may not be representative of broader populations, potentially affecting the generalizability of the findings. These limitations suggest that while the study provides valuable insights, longitudinal research and diverse sampling are needed to confirm causative factors and enhance the applicability of the results across different settings.

Study Implications

The implications of this study are significant for improving maternal and neonatal health outcomes. The identification of key risk factors such as low maternal weight, lack of education, and low birth weight highlights the need for targeted interventions. Healthcare providers should prioritize nutritional support and educational programs for expectant mothers to mitigate these risks (Nyamasege et al.,2019; Habtu et al., 2022). Additionally, addressing conditions like maternal anemia and hypertension through regular screening and management can help reduce the incidence of birth asphyxia (Desalew et al.,2020). The study also underscores the importance of enhancing prenatal care practices, including increasing the frequency of antenatal visits, to better monitor and address potential complications. By implementing these strategies, healthcare systems can improve birth outcomes and reduce the prevalence of birth asphyxia, ultimately contributing to better overall maternal and neonatal health.

VII. CONCLUSION

The study reveals that while a majority of neonates are not affected by birth asphyxia, significant risk factors include low maternal weight, lack of education, and conditions such as maternal anemia and hypertension. These findings emphasize the need for targeted interventions and improved prenatal care to address these high-risk factors and reduce the incidence of birth asphyxia.

VIII. ETHICAL CONSIDERATION

The researcher respected the respondents' right to self-determination, privacy, confidentiality, and information protection. The approval of the research Thesis was sought from the Research and Ethics Committee of Mount Kenya University Rwanda. Permission for data collection was also provided by the Rwanda biomedical centre research ethics committee. This study process steps regarding all related study information were ethically, confidentially, and anonymously respected and managed. The primary investigator ensured the avoidance of any harm to the study participants regarding the gathered information which would be used only for this study's purposes. In this study the mothers' names were not used, instead, the file codes were used.

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