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Determinants and Hospital Outcome of Perinatal Asphyxia in Three Health Facilities in the Limbe Health District, Cameroon

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ABSTRACT

Background: *Neonatal asphyxia (NA) remains a major global health concern, especially in low-income settings. With the goal to prevent its occurrence, our objective was to determine predictors and hospital outcomes of NA within a Cameroonian context.*

Methods: *A case-control study was conducted among pregnant women attending three major health-facilities of the Southwest Region of Cameroon, from January-April 2023. Cases were defined as neonates at 5th minute with Apgar-score<7 versus controls with Apgar-score≥7. Logistic regression was performed to determine predictors of NA, with 95% confidence interval [CI].*

Results: *Incidence of NA was 75.5 per 1000 live births, and predictors of NA were prolonged labor (AOR=4.01 [1.19-13.55]), premature rupture of membranes (AOR=8.98 [2.97-27.14]), acute foetal distress (AOR=33.91 [9.29-29.68]), gestational-age >42 weeks (AOR=5.99 [1.37-26.32]), (n<4) of ANC-visits (AOR=12.76 [5.49-123.72]) and neonatal resuscitation (AOR=86.99 [29.16-259.47]). The most common outcome was hypoxic-ischemic encephalopathy (88.7%); mean duration of hospitalization was 6.58 days; and 77.4% asphyxiated were discharged without any apparent neurologic sequelae, while 21% (13) of asphyxiated neonates died during hospitalization.*

Conclusion: *Incidence of NA is high, driven by acute foetal distress, premature rupture of membranes, prolonged gestational-age and labour, with the most common hospital outcome being hypoxic-ischemic encephalopathy.*

Keywords

Neonate, Asphyxia, Determinants, Hospital outcome.

Background

Perinatal asphyxia is defined by the World Health Organization (WHO) as failure to initiate breathing at birth [1]. According to international classification of disease (ICD 11) perinatal asphyxia is diagnosed when APGAR score at the 5th minute is less than seven [2]. Perinatal asphyxia is caused by a lack of blood flow or gas exchange to the fetus during the late pregnancy, during, or after birth as a neonate [3]. In 2019, UNICEF indicates that perinatal asphyxia is the second leading cause of neonatal deaths after preterm birth worldwide [4]. According to the WHO, 3.6 million babies suffer from perinatal asphyxia globally, with approximately one million deaths (23%) per year [5]. Though the prevalence of perinatal asphyxia varies across the globe, African countries contribute close to 50% of its global burden [6]. In Sub-Saharan countries, the prevalence of perinatal asphyxia is still unacceptably high, which ranges from 21.3% to 56.9% [7]. This high prevalence is due to inaccessibility to health facilities, socio-cultural beliefs, illiteracy, and shortage in health staff. In Cameroon, the prevalence of perinatal asphyxia from neonatal units varies from 8.5% to 35% [8-10].

Determinants for perinatal asphyxia are multifactorial and can be divided into antepartum, intrapartum, and fetal. The antepartum factors associated with perinatal asphyxia were young maternal age (<19 years), delivery at health centers, maternal ethnicity (mixed race), single mothers, primiparity, maternal diseases (gestational diabetes, preeclampsia, anemia, antepartum hemorrhage), and maternal infections [9,10,11-13]. Prolonged labor, vaginal assisted deliveries, meconium-stained amniotic fluid, failure to use partograph, premature rupture of membranes, emergency caesarean section, acute fetal distress were substantial intrapartum determinants [11,13]. Important fetal determinants were non-cephalic presentation, cord prolapse, low birth weight, prematurity, cord round neck decelerations of fetal heart, gestational age greater than 42 completed weeks [10,11]. Identifying these determinants of perinatal asphyxia is crucial to achieve Sustainable Development Goal 3 which says to ensure healthy lives and promote wellbeing for all at all ages [14]. Unfortunately, perinatal asphyxia has a poor outcome leading to both short term and long- term complications. Short term complications of perinatal asphyxia include hypoxic ischemic encephalopathy (HIE), septicemia, hypoglycemia, respiratory distress, and feeding problems [10]. Its long-term sequelae include cerebral palsy, epilepsy, hearing impairment, visual impairments [15]. The management of these infants is usually complex and expensive [16].

Perinatal deaths accounts for 43.5% of all under-five deaths in the Southwest Region of Cameroon with neonatal asphyxia (66%) being the first cause [17]. So, we undertook this study to evaluate the incidence, determinants and hospital outcome of perinatal asphyxia so that appropriate interventions and management strategies could be undertaken to help reduce its huge morbidity and mortality.

Material and Methods

We carried out a hospital based prospective case-control study at the maternities and neonatology units of the Limbe Regional Hospital, Bota District Hospital and the Subdivisional Health Center Down Beach Limbe from 15th January 2023 to 15th April 2023. All live term newborns delivered in the above health facilities during our study period were enrolled. In this study, subjects were categorized into cases and controls. Cases were term newborns alongside their mothers with Apgar scores <7 at the fifth minute of life. Controls were term neonates alongside their mothers with an Apgar score ≥7 in the fifth minute of life. For each case, we took two controls, a 1: 2 unmatched case-control study. Consecutive sampling method was used in selecting both the cases and controls and controls were selected consecutively within 48 hours after the birth of the asphyxiated newborn in the same maternity. Newborns with major congenital malformations such as hydrocephalus, anencephaly and cyanotic congenital heart defects, preterm newborns, still births and those who refused to give their consent were excluded from the study.

The minimum sample size (N) was calculated by using the Kelsey formula adapted for case-control studies. The computed results gave a final minimum sample size of 171 (57 cases and 114 controls).

After obtaining all administrative authorizations we gained access to the maternities and neonatology units of each hospital. Pretested structured questionnaires were used to collect information from the mothers and medical records. Before administering the questionnaire, each mother was given a summary of what the study was all about, its inconvenience and its benefits before obtaining written consent. Once consent was obtained, there was a one-on-one interview with the mother. Information about the antenatal, obstetric history, medical history of the mother was obtained from the medical records and antenatal cards. If the study participant could not provide all information regarding the newborn, the information was then obtained from the neonate medical record. Following the recruitment of a case, 2 controls were recruited from the same maternity within 48 hours after delivery of the case. The diagnosis of neonatal asphyxia was an Apgar score less than 7 at the 5th minute of life. All cases from both Bota District hospital and Subdivisional Hospital Down Beach Limbe were referred immediately after birth and resuscitation to the LRH for further management. Cases were then followed up at the Limbe Regional Hospital daily, clinical assessment and detailed neurological examination were carried out. The Sarnat Score was used to evaluate neurological function and to indicate the presence and severity of HIE. At the end of each hospitalization, duration of hospitalization and outcome were recorded.

Data collected each day was coded and entered into Epi Info version 7.2. Data was analyzed using Statistical Package for Social Sciences version 26.0. Categorical variables were presented as frequencies and percentages while continuous variables were presented as means and standard deviation. The various determinants of perinatal asphyxia were grouped into antepartum, intrapartum and neonatal variables. These variables were analyzed in two separate models. Firstly, bivariate analysis was used to determine factors associated with perinatal asphyxia. Factors that were statistically significant at bivariate level were further analyzed at the multivariate level. This was done using logistic regression fitting models to determine factors that are statistically and independently associated with neonatal asphyxia. The adjusted Odds ratio (AOR) was calculated and factors with a p-value of < 0.05 at 95% confidence interval were considered statistically significant.

Results

A total number of 830 neonates were born during our study period. 375 in the LRH, 323 in BDH and 132 in Subdivisional Hospital Down Beach Limbe. 9 were stillbirths and 821 live births amongst whom 92 were premature, 1 was born with congenital abnormalities and 4 mothers did not give their consent. With the 821 live births 62 were asphyxiated giving an incidence of 75.5 per 1000 live births (7.6%) and we included 124 Controls (Non-asphyxiated neonates).

The mean maternal age was 27.2±6.26. Majority of mothers in both groups were between the age of 21-29 years. 52(83.9%) of cases and 93(75.0%) of controls resided in urban areas. Most mothers were married and had attained at least a secondary level of education (Table 1a). Amongst the 62 cases, 36(58.1%) were males while 26(41.9%) were females giving a male to female ratio of 1.4:1. While out of the 124 controls, 69(55.6%) were males and 55(44.4%) were females giving a male to female ratio of 1.3:1. With regards to birth weight, 11(17.7%) cases and 13(10.5%) controls were macrosomic while 5(8.1%) of cases and 9(7.3%) of controls had a low birth weight. 11(17.7%) of cases and 11(8.9%) of controls were born after 42 complete weeks of gestation (Table1b).

Table 1a: Sociodemographic characteristics of mothers.

Variable	Cases (n=62)	Percent (%)	Control (n=124)	Percent (%)
Age				
≥40	2	3.2	2	1.6
≤20	13	21.0	13	10.5
21-29	34	54.8	63	50.8
30-39	13	21.0	46	37.1
Occupation				
Employed	39	62.9	76	61.3
Unemployed	23	37.1	48	40.7
Religion				
Christian	58	93.5	117	94.4
Muslim	4	6.5	7	5.6
Marital status				
Cohabitating	7	11.3	9	7.3
Married	36	58.1	80	64.5
Single	19	30.6	35	28.2
Level of education				
Primary school	4	6.5	13	8.9
Secondary school	40	64.5	52	41.9
University	18	29.0	59	47.6
Residence				
Rural	10	16.1	31	25.0
Urban	52	83.9	93	75.0

Table 1b: Sociodemographic characteristics of asphyxiated babies.

Variable	Cases (n=62)	Percent (%)
Birthweight		
Low birth weight	5	8.1
Macrosomia	11	17.7
Normal	46	74.2
Baby gender		
Female	26	41.9
Male	36	58.1
Gestational age		
>42 weeks	11	17.7
37-40 weeks	38	61.3
>40-42 weeks	13	21.0

Among the mothers, 37(59.9%) of cases attended ANC visits less than 4 times while 22(35.5%) attended ANC visits 4 or more times. Majority of mothers attended ANC visits in hospitals with 33(53.2%) of cases and 85(68.5%) of controls. 36(58.1%) cases and 50(40.3%) of controls had malaria in pregnancy while 36(58.1%) of cases and 18(14.5%) of controls developed anemia in pregnancy. There was a history of hospitalization during pregnancy in 22(35.5%) of cases and 24(19.4%) of controls. Just 2(3.2%) cases and 6(4.8%) controls developed pre-eclampsia in pregnancy. Results found out that labor was prolonged in 33(53.2%) of cases and 11(8.9%) of controls. Prolong Rupture of Membranes (PROM) occurred in 28(45.2%) of cases and in 113(91.1%) of controls. Also, the amniotic fluid was meconium stained in 36(58.1%) of cases and 10(8.1%) controls. Acute fetal distress was seen in 43(69.4%) of cases and 6(4.8%) of controls. The most frequent mode of delivery was vaginal in both cases and controls (Table 2).

Table 2: Distribution of intrapartum related characteristics.

Variable	Cases (n=62)	Percent (%)	Control (n=124)	Percent (%)
Place of delivery				
Subdivision Hospital	10	16.1	20	16.1
District Hospital	17	27.4	34	27.4
Regional Hospital	35	56.5	70	56.5
Duration of labor				
Normal	25	40.3	110	88.7
Precipitated	4	6.5	3	2.4
Prolonged	33	53.2	11	8.9
Color of amniotic fluid				
Blood	5	8.1	3	2.4
Clear	21	33.9	111	89.5
Meconium stained	36	58.1	10	8.1
Mode of delivery				
Vaginal	42	67.7	104	83.9
Emergency CS	11	17.7	4	3.2
Elective CS	6	9.8	15	12.1
Instrumental	3	4.8	1	0.8
Fetal presentation				
Breech	5	8.1	5	4.0
Others	2	3.2	0	0.0
Vertex	55	88.7	119	96.0
Delivery conducted by				
Interns	8	12.9	4	3.2
Midwifes	27	43.5	80	64.5
Nurses	10	16.1	21	16.9
Obstetrician	17	27.4	19	15.3
Premature Rupture of membrane				
Yes	28	45.2	113	91.1
No	34	54.8	11	8.9
Obstructed labor				
No	60	96.8	124	100.0
Yes	2	3.2	0	0.0
Acute fetal distress				
No	19	30.6	118	95.2
Yes	43	69.4	6	4.8

The different sociodemographic, antepartum, intrapartum and neonatal variables were tested for their association with the occurrence of perinatal asphyxia. All 14 variables that were statistically significant at the bivariate level were then fitted in a multiple logistic regression in multivariate analysis. During the

Table 3: Multivariate logistic regression analysis of factors associated with perinatal asphyxia at the Limbe Health District.

Variable	Cases n (%)	Controls n (%)	COR (95%CI)	AOR (95%CI)	P-value
Residence					
Rural	10(16.1)	31(25.0)	0.577(0.26-1.271)	2.633(0.962-7.206)	0.059
Urban	52(83.9)	93(75.0)	1		
Place of ANC visits					
Health center	29(46.8)	39(31.5)	1.915(1.024-3.584)	0.908(0.396-2.081)	0.820
Hospital	33(53.2)	85(68.5)	1		
Number of ANC visits <4 ≥4	 40(64.5) 22(35.5)	 16(12.9) 108(87.1)	 12.109(0.312-1.492) 1	 **12.765(5.490-29.678)**	 **0.000**
Gestational diabetes Yes	 3(4.8)	 1(0.8)	 6.254(0.637-61.413)	 9.110(0.580-145.987)	 0.116
No	59(95.2)	123(99.2)	1		
Malaria in pregnancy					
Yes	36(41.9)	50(40.3)	2.049(1.103-3.806)	1.465(0.649-3.308)	0.358
No	26(58.1)	74(59.7)	1		
Bleeding during third trimester					
Yes	36(58.1)	18	2.503(0.803-7.798)	2.728(0.571-13.042)	0.279
No	26(41.9)	106(85.5)	1		
History of hospitalization during third trimester					
Yes	22(35.5)	18(14.5)	2.292(1.155-4.546)	1.681(0.656-4.302)	0.279
No	40(64.5)	106(85.5)	1		
Duration of labor					
Prolonged	33(53.2)	11(8.9)	13.200(5.879-29.638)	**4.007(1.185-13.552)**	**0.026**
Precipitated	4(6.5)	3(2.4)	3.867(1.234-17.881)	7.794(1.200-50.609)	0.310
Normal	25(40.3)	110(88.7)	1		
Color of amniotic fluid					
MSAF	36(58.1)	10(8.1)	19.02(8.201-44.150)	**11.19(2.530-49510)**	**0.001**
Blood	5(8.1)	3(2.4)	5.810(1.955-29.696)	8.489(0.988-72.909)	0.051
Clear	21(33.9)	111(89.5)	1		
Fetal presentation					
Breech	5(8.1)	5(4.0)	3.818(1.073-13.586)	1.345(0.127-14.220)	0.805
Vertex	55(88.7)	119(96.0)	1		
PROM					
Yes	28(45.2)	11(8.9)	12.474(5.628-27.647)	**8.982(2.972-27.14)**	**<0.001**
No	34(54.8)	113(91.1)	1		
Acute fetal distress					
Yes	43(69.4)	6(4.8)	44.509(16.671-118.829)	**33.90(9.293-123.714)**	**<0.000**
No	19(30.6)	118(95.2)	1		
Birth weight					
Macrosomia	11(17.7)	13(10.5)	1.876(0.782-4.502)	1.735(0.367-8.213)	0.487
Low birth weight	5(8.1)	9(7.3)	1.232(0.391-3.880)	1.350(0.206-8.851	0.754
Normal	46(41.9)	102(82.3)	1		
Gestational age					
>42 weeks	11(17.7)	11(8.9)	2.216(0.902-5.443)	**5.99(1.365-26.315)**	**0.018**
40-42 weeks	13(21.0)	17(13.7)	2.034(0.813-4.890)	2.007(0.543-13.678)	0.321
37-40 weeks	38(61.3)	96(77.4)	1		

multivariate logistic regression, 6 variables were found to be significantly associated with the occurrence of perinatal asphyxia. These were: ANC visits < 4, prolong labor, meconium-stained amniotic fluid, premature rupture of membranes, acute fetal distress and gestational age >42 weeks. Attending ANC visits < 4 times significantly increased the odds of perinatal asphyxia 12.76 times (AOR= 12.765 95%CI: 5.490-29.678 p=0.000). Women with prolonged labor had increased odds of having babies with perinatal asphyxia compared to those whose duration of labor was normal (AOR: 4.00; 95%CI: 1.185-13.552; p=0.002). Also, PROM significantly increased the occurrence of perinatal asphyxia 8.98 times (AOR: 8.982; 95%CI: 2.972-27.144; p=<0.001). Furthermore, neonates who experienced acute fetal distress were 33.90 times more likely to develop perinatal asphyxia than those who didn't (AOR: 33.907; 95%CI: 33.907-123.718; p<0.000). In mother where the amniotic liquor was meconium stained, there was 11.19 times more likelihood for the occurrence of perinatal asphyxia (AOR: 11.191; 95%CI: 2.530-49.510; p=0.001). Newborns with gestational age > 42 weeks were 5.99 times more likely to develop perinatal asphyxia compared to term babies (AOR: 5.993; 95%CI: 1.37-26.32; p=0.018) (Table 3).

Nine complications were assessed. Complications such as HIE (88.7%), seizures (33.8%), feeding difficulties (61.3%), sepsis (87.1%), respiratory distress (82.3%) were common in neonates with neonatal asphyxia. 77.4% of neonates were discharged with a stable neurologic status while 21.0% of neonates died (Table 4).

Table 4: Hospital complications of perinatal asphyxia among asphyxiated newborns.

Variable	Frequency (n=62)	Percent (%)
Hypoxic ischemic encephalopathy		
No	7	11.3
Yes	55	88.7
Feeding difficulties		
No	24	38.7
Yes	38	61.3
Seizures		
No	41	66.1
Yes	21	33.8
Hypoglycemia		
No	49	79.0
Yes	13	21.0
Respiratory distress		
No	11	17.7
Yes	51	82.3
Necrotizing enterocolitis		
No	58	93.5
Yes	4	6.5
Sepsis		
No	8	12.9
Yes	54	87.1
Discharged without any apparent neurologic sequelae		
No	14	22.6
Yes	48	77.4

Amongst the asphyxiated babies 55(88.7%) developed HIE and among those babies 28(60%) developed mild encephalopathy, 19(34.5%) moderate encephalopathy while 8(14.5%) developed severe encephalopathy. With regards to the duration of hospital stay of asphyxiated babies, the mean duration of hospitalization was 6.58 days (2.88) with a range of 1 to 19days. In our study a total of 13(21%) asphyxiated babies died. Among those who died, 7(53.8%) had an Apgar score of 0-3, 4(30.8%) had an Apgar score of 4-5 while 2(15.4%) had an Apgar score of 6 (Figure 1).

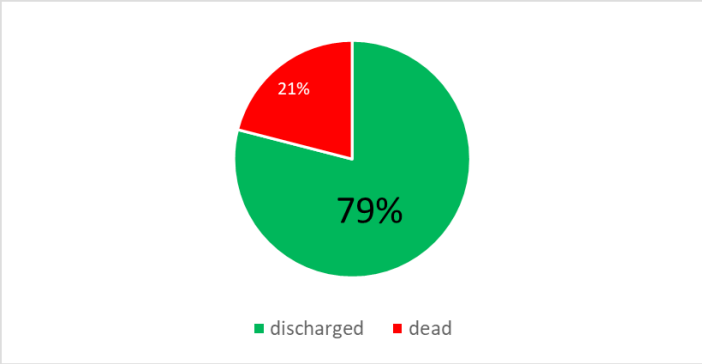

Figure 1: Total mortality amongst asphyxiated neonates.

Discussion

In our study, the incidence of neonatal asphyxia was found to be 75.5 per 1000 (7.6%). This result was similar to 6.6% obtained in South India [18]. Our incidence was however lower than 23.1% obtained in Nigeria [19]. This variation could be explained by the difference in socio-demographic characteristics as in our study most women had at least a secondary level of education as compared to the other study where women had no formal education, hence have little decision-making ability with respect to ANC follow up. Furthermore, this variation in incidence could be because this study included all live births while we included only live term or post term babies. In contrast, our finding was higher than that obtained in Colombia 4% [20]. These differences in incidence could be explained by advanced health care systems present in this country.

The number of ANC was found to be significantly associated with asphyxia. Women who attended ANC less than 4 times had increase odds of having a baby with birth asphyxia. This finding was similar to studies done in Nigeria [21]. Attending ANC frequently aids in detecting maternal diseases and fetal distress early enough to anticipate the occurrence of birth asphyxia. Also, during ANC, mothers are informed of the dangers signs to watch out for during pregnancy ensuring good well-being for both the mother and fetus. However, this was contrary to a study in Rwanda in which mothers who attended ANC less than 4 times had a lower birth asphyxia rate [22]. Maternal pathologies; malaria, urinary tract infection, and anemia were not found to be significantly associated with perinatal asphyxia. Similar results were found in studies done in Central Ethiopia and Rwanda [12,22]. Nevertheless, it is crucial to insist on educating women on the danger signs of these pathologies during pregnancy. Contrarily, these maternal pathologies were

however significantly associated to neonatal asphyxia in studies carried out in Bamenda, Cameroon and Colombia [13,20].

Premature rupture of membranes (PROM), prolong labor, acute fetal distress and meconium-stained amniotic fluid, and acute fetal distress were significantly associated with neonatal asphyxia. These findings were similar to studies done in Cameroon, Ethiopia and India [9,11,23]. PROM was associated with perinatal asphyxia. A consistent finding was obtained from studies in Yaounde Cameroon and Central Ethiopia [9,24]. This could be explained by the fact that, when fetal membranes rupture before the onset of labor, spontaneous gush of fluid happens alongside umbilical cord incidents such as cord compression and cord prolapse which will lead to hypoxia and subsequently asphyxia [24]. Moreover, premature rupture of membranes, if prolonged, often facilitates feto-maternal systemic infections which is usually followed by neonatal asphyxia. Neonates of mothers who had prolonged labor were more likely to develop neonatal asphyxia than those with normal labor. This finding is similar to studies done in Cameroon and Sweden [13,25]. When labor is prolonged, the risk of birth trauma is increased and any attempt to speed up delivery using uterotonics, forceps delivery or vacuum extraction increases the chances of fetal distress [12]. Moreso, these uterotonics cause powerful uterine contractions that cause reduced blood flow to the placenta and consequently to the fetus leading to fetal distress, hypoxia and asphyxia [26]. Our finding was in contrast to those from a study in Rwanda where normal duration of labor was found to be associated with neonatal asphyxia [22]. Acute fetal distress was found to be strongly associated with neonatal asphyxia in this study. Similar results were found in Southern Ethiopia and Colombia [3,11]. The possible reason for this might be that acute fetal distress mainly results from insufficient placenta perfusion or any factor during labor that will impair fetal oxygenation and can further cause difficulty to initiate and sustain breathing at birth thus resulting to asphyxia [27].

Meconium-stained amniotic fluid was found to increase the odds of neonatal asphyxia up to 11 times. Similar results were found in Cameroon [10]. A possible explanation of this is that the presence of meconium in the amniotic fluid leads to aspiration of meconium in to the lungs. This results in chemical pneumonitis with inflammation of the pulmonary tissue, mechanical narrowing of the airways, and pulmonary air leakage, ultimately leading to anoxia or hypoxia [28]. This emphasizes on the importance of the aspiration and resuscitation technique in the delivery room of such cases. We found no association between mode of delivery nor conductor of delivery and neonatal asphyxia. This finding was similar with studies done in Ngaoundere Cameroon [10]. However, studies carried out in Nepal revealed that instrumental delivery increases the risk of perinatal asphyxia while a study in Togo revealed caesarean section to be a protective factor against neonatal asphyxia [29,23]. In addition, we found no association between fetal presentation and neonatal asphyxia. This was however in contrast with other studies in Cameroon where fetal malpresentation was found to increase the risk of neonatal asphyxia [9].

There was increased risk of neonatal asphyxia in neonates born at gestational age greater than 42 complete weeks. This finding was in line with other studies done in Cameroon [10]. Post-term infants may have a higher risk of perinatal complications due to placental insufficiency [30]. As gestational age goes beyond 42 weeks, the amount of oxygen and nutrients delivered by the placenta to the fetus decreases. The longer pregnancy continues above term, the greater the risk of developing placental insufficiency, fetal development retardation, and hypoxia-anoxia as the placenta calcifies [31]. However, a study in Northwest Ethiopia revealed that the age of the newborn had no significant association with neonatal asphyxia [32]. In our study however, there was no significant association between gender and neonatal asphyxia which was similar with a study in Rwanda [22]. This was however in contrast to a study carried out in Nepal where higher risk of neonatal asphyxia was observed in male babies [29]. The possible explanation of this could be that sex hormones, particularly estrogens, are thought to protect females more effectively against anoxo-ischemic lesions [33]. There was no association between birth weight and neonatal asphyxia in our study. This was not in line with studies in Rwanda where babies who had a normal birth weight had increased risk of birth asphyxia [22].

The most frequent complication of neonatal asphyxia was HIE (88.7%) with 60% having mild encephalopathy, 34.5% with moderate encephalopathy and 14.5% with severe encephalopathy. Similar results were found in studies in Senegal where 80.4% had HIE with 77% at Sarnat I, 22.0% at Sarnat II and 0.8% at Sarnat III [34] and Cameroon where 88.8% had HIE with 54.69% at Sarnat I, 15.63% at Sanart II and 29.69% at Sanart III [13]. In another study in Congo Brazzaville, 100% neonates had HIE [35]. However, in contrast to our results, in Tanzania, 10.8% had HIE with 50.8% having mild HIE, 39.0% with moderate HIE and 10% with severe HIE [36] and another study in Uganda reported 3% of patients with HIE, 43.5% with mild HIE, followed by 34.8%, and 21.7% that had moderate and severe HIE respectively [37]. These results stated above were lower compared to what was found in our study. Differences could be due to the higher sample size used in each study. Other complications were respiratory distress 82.3%, neonatal sepsis 87.1%, feeding difficulties 61.3%, seizures 33.8%, hypoglycemia 21%, and necrotizing enterocolitis 6.5%. Similar results were found in studies done in Ngouandere, Cameroon [10]. Furthermore, studies done in Allahabad and Bangalore India reported encephalopathy (58%), abnormal cry (66%), convulsion (46%), feeding difficulties (65%), hyperbilirubinemia (40%), respiratory distress (33%), apnoea (23%), shock (20%), acute renal failure (6%), necrotizing enterocolitis (6%), disseminated intravascular coagulation (13%), HIE (31.66%) and septicaemia as short-term outcome [38,39].

The mean duration of hospitalization of asphyxiated neonates in our study was 6.58 days (range 1 to 19 days). This was similar to studies carried out in Yaounde, Cameroon where the mean duration

of hospitalization was 6 days (range 1 to 20 days) [9]. This result was however higher than a mean duration of hospitalization of 4.7 days in a study in Bangladesh [40]. The majority (77.4%) of neonates in our study were discharged with an apparently normal neurologic status. In our study, the mortality rate was 21.0% which was slightly lower to a mortality of 23% in Allahabad, India [38], and higher than 17.8% in Nepal [29].

Strengths

Standard scores such as the Sarnat score were used to classify the severity of HIE. To the best of our knowledge, this is one of the few studies to be carried out on the determinants and hospital outcome in the Limbe health district.

Limitations

The Apgar score was a subjective tool used to diagnose neonatal asphyxia. Confirmatory tests such as umbilical artery cord blood pH were not done. This study was hospital-based and thus did not include neonates who were delivered at home and were not brought to the hospital.

Conclusion

Our findings concluded that the incidence of neonatal asphyxia was 75.5% per 1,000 (7.6%) with modifiable determinants such as antenatal visits < 4, prolong labor, PROM, MSAF, acute fetal distress, and gestational age >42 complete weeks. The most common hospital outcome of neonatal asphyxia was HIE. The mean duration of hospitalization was 6.58 days and majority (77.7%) of the asphyxiated neonates were discharged with no apparent neurologic sequelae while 21.0% died. We strongly recommend effective monitoring of maternofetal conditions during pregnancy and labor to detect any intrapartum emergency early and thus prompt intervention. Preventive measures during antenatal visits through informing and communicating with the pregnant women should be re-emphasized.

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STUDY QUESTIONNAIRE

DATE…….

Patient's code……

Part I Socio demographic data of mother

Age(years)	□ ≤20 □ 21-29 □30-39 □≥40
Occupation	□ Employed □ Unemployed □ Strenuous □ not strenuous
Religion	□ Christian □ Muslim □ Others
Marital Status	□ Single □ Married □ Cohabitating □ Divorced
Level of education	□ Primary school □ Secondary school □ University □ None
Residence	□ Rural □ Urban

PART II Maternal past history

ı) Medical and social history

Hypertension	□ Yes □ No
Diabetes	□ Yes □ No
HIV	□ Yes □ No
Have you been operated on before	□Yes □ No
Smoking	□ Yes □ No If yes how many pack years
Alcohol	□ Yes □ No if yes how many units per week

ıı) Obstetric history

When was your last menstrual period	
Miscarriage	□ Yes □ No
Still birth	□ Yes □ No
Intrauterine fetal death	□ Yes □ No
Do you have a baby who suffered from birth asphyxia before?	□ Yes □ No

PART III DETERMINANTS

ı) Antepartum determinants

Place of ANC	□ Hospital □ Health center
Number of ANC	□ 0 □ < 4 □≥4
Gestational diabetes	□ Yes □ No
Malaria	□ Yes □ No
Urinary tract infection	□ Yes □ No
Preeclampsia	□ Yes □ No
Anemia in pregnancy	□ Yes □ No
Bleeding in the third trimester	□ Yes □ No
Were you hospitalized during the third trimester?	□ Yes □ No

ıı) Intrapartum determinants

Place of delivery	□ Regional Hospital □ District hospital □ Subdivisional hospital
Duration of labor	□ Normal □ Prolonged □ Precipitated
Color of amniotic fluid	□ Meconium stained □ Blood □ Clear

Mode of delivery	□ Vaginal □ CS (Elective or Emergency) □ Instrumental
Fetal presentation	□ Vertex □ Breech □ Others
Delivery was conducted by?	□ Midwives □ Nurses □ Interns □ Obstetrician
Premature rupture of membranes	□ Yes □ No
Obstructed labor	□ Yes □ No
Cord prolapse	□ Yes □ No
Acute Fetal distress	□ Yes □ No

iii) Neonatal determinants

Resuscitation at birth	□ Yes □ No
Birth weight	□< 2500g □2500-4000g □>4000g
Baby's gender	□ Male □ Female
Gestational age	□ 37-40 weeks □ 40-42 weeks □> 42 weeks
Apgar score at the 5th minute	□ 0-3 □ 4-5 □ 6 □7-10

PART IV Hospital outcome of asphyxiated babies

Hypoxic ischemic Encephalopathy	□ Yes □ No If yes then SANART Stage I □ SANART Stage II □ SANART Stage III □	
Feeding difficulties	□Yes	□ No
Seizures	□Yes	□No
Sepsis	□Yes	□No
Hypoglycemia	□Yes	□No
Respiratory distress	□Yes	□No
Necrotizing enterocolitis	□Yes	□No
Discharge without neurological sequalae (Normal)	□Yes	□No
Duration of hospital stay		
Dead	□Yes	□No