MEDDOCS
Open Access Publisher

ISSN: 2637-9627

Annals of Pediatrics

Open Access | Research Article

Part 1: Epidemiological Facies, Clinical Profile

Perinatal Asphyxia in a Hospital Setting in a Developing Country

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Received: Nov 15 2023
Accepted: Jan 17, 2024
Published Online: Jan 24, 2024
Journal: Annals of Pediatrics
Publisher: MedDocs Publishers LLC
Online edition: http://meddocsonline.org/

Keywords: Obstructed labour; Newborn; Neonatal resuscitation; Hypoxic-ischemic encephalopathy.

Abbreviations: AEEG: Amplified Electroencephalogramm; ANCS: Antenatal Care Visit; CHUP-CDG: Centre Hospitalier Universitaire Charles De Gaulle; CPAP: Continuous Positive Airway Pressure; EEG: Electroencephalogramm; HIE: Hypoxic-Ischemia Encephalopathy; LBW: Low Birth Weight; MRI: Magnetic Resonance Imaging; PNA: Perinatal Asphyxia; TORCH: Toxoplasmosis, Others, Rubella, Cytomegalovirus, Herpes Simplex; WA: Weeks of Amenorrhea; WHO: World Health Organization.

Abstract

Background: Perinatal asphyxia is one of the three leading causes of neonatal morbidity and mortality, along with prematurity and neonatal sepsis and the burden of these diseases is greatest in nations with limited resources. With this objective, the present study was conducted to describe the epidemiological and clinical aspects of perinatal asphyxia in a developing country to reduce neonatal morbidity and mortality linked to this major public health problem.

Methods: A descriptive cross-sectional study was conducted from January 1, 2019, to October 31, 2021, in the neonatology unit of the Centre hospitalier universitaire pédiatrique Charles de Gaulle, Ouagadougou, Burkina Faso (West Africa). All newborns, with an Apgar score less than 7 at the 5th minute of birth, were included. **Results:** The records of 331 newborns were analyzed in which, the frequency of perinatal asphyxia was 22.3%. Hypoxic-ischemic encephalopathy was mild in 57.7% of cases, moderate in 25.4% of cases, and severe in 16.9% of cases. Sequelae were observed in 26.7% of cases.

Conclusion: The burden of perinatal asphyxia is high in our UN with a high mortality rate and sequelae. This neonatal concern can be decreased using the continuum of care by strengthening the "Pregnancy monitoring-codified management of childbirth-postnatal care" system.

Cite this article: Nagalo K, Toguyeni L, Douamba S, Konaté B, Porgo S, et al. Perinatal Asphyxia in a Hospital Setting in a Developing Country. Ann Pediatr. 2024; 7(1): 1135.

Introduction

Perinatal Asphyxia (PNA), often referred to as neonatal asphyxia, occurs due to insufficient blood flow and oxygen to the foetus before, during, or shortly after birth. According to the World Health Organization (WHO), PNA is defined as a state of newborn suffering linked to an insufficient supply of oxygen to the organs, before, during, or immediately after birth, or even more commonly as the inability to breathe normally during birth and for an extended period of time [1,2].

From a pathophysiological point of view, when utero-placental (prenatal) or pulmonary (immediate postnatal) gas exchange is compromised or completely ceases, the vital organs are deprived of oxygen, leading either to partial (hypoxia) or complete (anoxia) oxygen deprivation resulting in progressive hypoxemia and hypercapnia. When hypoxemia is severe enough, vital tissues and organs (muscles, liver, heart, kidneys, and ultimately the brain) become oxygen-deficient leading to anaerobic glycolysis and lactic acidosis [3]. The neurological consequences of all these metabolic disorders include Hypoxic-Ischemic Encephalopathy (HIE) and/or multiorgan failure.

PNA is a global public health problem with an incidence of 2 per 1000 births in developed countries but the incidence is multiplied by ten times in developing countries. Among children affected by asphyxia, 15 to 20% die during the neonatal period, while 25% of survivors will retain permanent neurological deficits [4]. PNA is responsible for 40% and 34% of neonatal deaths in South Asia and sub-Saharan Africa, respectively [5]. In Burkina Faso, the data is still patchy and hospitable. A previous study showed that PNA was the second leading cause of neonatal death responsible for 10% of neonatal deaths [6], while another study claims that PNA was among the top five newborn pathologies with a frequency of 9.4% and was responsible for 20.9% of neonatal mortality [7]. A recent study reports a frequency of 17.9% in Ouagadougou [8].

With this context, the present research was conducted with an aim to throw light on the epidemiological, clinical, para clinical, therapeutic, and outcomes aspects of PNA. The information collected in this study will help to better understand this condition in order to contribute to improve its management and reduce neonatal morbidity and mortality in Burkina Faso and in other countries with limited resources.

Material and methods

Study design

A cross-sectional retrospective study was conducted in the Neonatology Unit (NU) of the Centre hospitalier universitaire pédiatrique Charles de Gaulle (CHUP-CDG) in the city of Ouagadougou, the capital of Burkina Faso.

Type and period of study

A descriptive cross-sectional study using retrospective data was conducted over the period from January 1st, 2019to October 31, 2021.

Sampling

The study population consisted of all newborns hospitalized in the neonatal unit from January 1st, 2019 to October 31, 2021.

All newborns with an Apgar score of less than 7 at the 5th minute of life and admitted within the first 24 hours of life during the study period were included, whereas, the newborns suffering from any type of congenital defects were excluded from the study.

Data collection and analysis

The data were collected retrospectively using the clinical files of the patients, the admission registers, and the monthly and annual reports.

A standardized and anonymized data collection form was designed for this study. The data extracted from the sources of information were collected on this sheet and analyzed using the Epi-info® software (CDC, Atlanta). For categorical variables, frequency distributions were generated and expressed in percentage terms. For quantitative variables, the mean was calculated with the standard deviation.

The epidemiological, clinical, outcomes variables studied are presented in **Table 1.**

Table 1: Variables studied in perinatal asphyxia, Ouagadougou, Burkina Faso, 2021.

Variables studied	
Epidemiological	• Frequency • Sociodemographic characteristics of the newborn: gender • Sociodemographic characteristics of the mother: age, occupation
Clinical	• Mode of admission, means of transfer
	• Obstetrical data: pregnancies, parity, monitoring of pregnancy (antenatal care visits, prenatal investigations, maternal conditions)
	• Labour and birth: duration of labour, state of membranes, colour of amniotic fluid, fever, route of delivery, place of delivery, Apgar score, resuscitation, gestational age, birth weight
	• Family history: rank among siblings
	• Clinical signs: vital parameters, physical examination
Outcome	• Survival • Death

Definitions

The term of birth expressed in Weeks of Amenorrhoea (WA) made it possible to classify newborns as premature (less than 37 WA), at term (37-40 WA), and post-term (41 WA and beyond).

According to birth weight, newborns with low birth weight (LBW, less than 2,500 g), normal weight (2,500-3,999 g), and macrosomic (4,000 g and more) were distinguished.

Labour duration was considered long if it exceeded 12 hours.

Respiratory distress was said to be mild if the Silverman score was equal to 1 or 2, moderate if the score was equal to 3 or 4, and severe if the score was equal to or greater than 5.

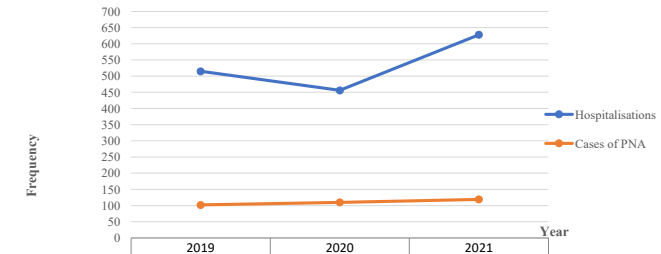
HIE was measured by the modified Sarnat score and classified into stages of increasing severity: Sarnat 1 (or mild), Sarnat 2 (or moderate), and Sarnat 3 (or severe) [9].

Results

Epidemiological

During the study duration of 34 months, 1,599 neonates were hospitalized in the neonatal unit, of which 331 newborns

were hospitalized for PNA, giving a frequency of 20.7%. Over the respective years, PNA accounted for 19.8%, 24.1%, and 18.9% of hospitalizations in 2019, 2020, and 2021, respectively.



	2019	2020	2021
Hospitalisations	515	456	628
Cases of PNA	102	110	119

Figure1: Frequency of perinatal asphyxia, 2018, Burkina Faso

Figure 1: Illustrates the annual evolution of the PNA during the period studied.

Of the 331 newborns, 187 were male, giving a sex ratio of 1.3.

The average age of the mothers was 26.24 years ± 5.9 [16, 44]. The majority of mothers (78.5%) were aged between 20 and 35 years, followed by under 20 (14.5%), and above 35 years (7%).

Table 2 shows the occupation of the mother of asphyxiated newborn.

Table 2: Distribution of asphyxiated newborns according to the main occupation of the mother, Ouagadougou 2021, Burkina Faso (n = 331).

Mother's occupation	Frequency	%
Housewife	203	61.3
Student	40	12.1
Employee	35	10.5
Trader	30	9.1
Other	23	7.0

Clinical

In 97% of cases, newborns were referred from another health facility, whereas, only 3% of cases were brought directly from home.

The means of transfer used was ambulance (70.5%) followed by motorcycle (17.2%), private vehicle (11.5%), and bicycle (0.8%).

Table 3 shows the obstetric characteristics of the mothers of the asphyxiated newborns.

The average number of pregnancies per mother was 2.39±1.57 [1,7]. The average parity was 2.23±1.43 [1,7] and the average number of abortions was 1.49 ± 0.70 [1,4]. The mean number of ANCs performed was 3.46 ANCs±1.39 [0,7].

The mean duration of labour was 35.31±29.96 [4,120]. It was longer than 12 hours in 93.7% of the mothers. Premature Rupture of Membranes (PROM) was noted in 10.6% of cases. In 56% of cases, the Amniotic Fluid (AF) was stained, meconium in 40% of cases, and clear in 4% of cases. Fever was present during labour in 3.6% of cases.

Table 3: Distribution of asphyxiated newborns according to maternal obstetric variables, Ouagadougou 2021, Burkina Faso (n = 331).

Obstetric variable	Frequency	%
Parity		
Primiparous	145	43.8
Pauciparous (2-3)	122	36.8
Multiparous (4-6)	61	18.4
Grand multiparous (≥ 7)	3	1.0
Abortion		
Yes	61	18.4
No	270	81.6
Number of ANCs*		
Normal (≥ 4)	184	55.6
Low (< 4)	147	44.4
Prenatal infection assessment (TORCH §)		
Yes	5	1.6
No	309	98.4
Pathology during pregnancy		
Malaria	14	38.9
Blood disorder (anaemia, bleeding)	8	22.2
Preeclampsia	6	16.7
Urogenital infection	4	11.1
Pathology during childbirth		
Dystocia (scarred uterus, forehead presentation)	4	11.1

The mean term of pregnancy was 38.71 weeks±3.08 [26,46]. In 75.2% of cases, newborns were born at term, while 16% and 8.8% of cases were preterm and post-term, respectively.

In 85.5% of cases, delivery was vaginal. Instrumental extraction (vacuum) was necessary in three cases. Caesarean section was performed in 14.6% of cases, the main indications were fetal distress (59.5%) and pre-eclampsia/eclampsia (26.2%). In 99.7% of cases, newborns were born in a maternity ward. One case (0.3%) was born at home. The mean Apgar score at the 5th min. was 5.33±1.18 [1, 6], whereas, the mean resuscitation time was 12.97 min.±9.13 [5, 90]. The mean birth weight was 2,752.57 g±751.73 [700, 4,800]. In 70.9% of the cases, the birth weight was normal, 26.1% of the cases had a LBW, and 3% of the cases were macrosomics.

The asphyxiated newborn was the first of the siblings in 44.7% of cases, the second in 19.3% of cases, the third in 15.7% of cases, the fourth in 11.2% of cases, and fifth and more in 9.1% of cases.

Cyanosis, pallor, and jaundice were noted in 25.1%, 7.3%, and 6% of cases, respectively. Respiratory distress was noted in 8.8% of cases and the mean Silverman score was 3.8±1.7 [1, 8]. This distress was mild in 43.7% of cases, moderate in 31.6% of cases, and severe in 24.7% of cases.

Table 4 presents the vital parameters (temperature, respiratory and heart rates, pulsed peripheral oxygen saturation) of newborns on admission.

Table 4: Distribution of asphyxiated newborns according to vital parameters, Ouagadougou 2021, Burkina Faso (n = 331).

Vital parameter	Frequency	%
Temperature (°C)		
Fever (> 37.5)	160	52.1
Normal (36.5-37.5)	106	34.1
Hypothermia (< 36.5)	41	13.8
Heart rate (bpm)		
Normal (100-150)	227	82.8
Tachycardia (> 150)	28	10.2
Bradycardia (< 100)	19	7.0
Respiratory rate (c/min)		
Normal (40-60)	105	47.7
Tachypnea (≥ 60)	88	37.3
Bradypnea (< 60)	33	15.0
Oxygen saturation (SpO_2)		
Hypoxia (< 95%)	155	57.2
Normal (≥ 95%)	116	42.8

The newborns were having an average temperature of 36.6°C±1.73 [25,44.8], mean heart rate of 134.05 bpm±22.84 [30,196], mean respiratory rate of 54.9 c/min.±18 [0.134], and mean peripheral pulse oxygen saturation of 87%±15 [36, 99] on room air.

All newborns presented with HIE. According to the severity, 57.7% of newborns were at Sarnat stage 1, 25.4% at stage 2, and 16.9% at stage 3.

In 69.5% of cases, the newborns were normally discharged home. There were 99 deaths, giving a case fatality rate of 29.9%. The specific mortality rate was 6.2% (99/1,599). During the period studied, a total of 355 deaths were recorded, representing a proportional mortality rate due to PNA of 27.9% (99/355).

Discussion

In this study, PNA accounted for 20.7% of hospitalisations, with no real variation in frequency over the years which is higher than previous studies carried out in Burkina Faso by Makoura *et al.* 2019 [10] (15.1%) and Yaméogo *et al.* 2020 [8] (17.9%) respectively. Our NU has a greater capacity for patients which explains the higher rate of incidence of PNA as compared to those reported by our predecessors, whereas, the prevalence of PNA is relatively low in developed countries where a surveillance system exists, the health systems are efficient, and the sociol-economic level is high. In France, the incidence of PNA is 3/1000 live births in the Pas-de-Calais region [11]. Conversely, in developing countries, this rate is high with 28/1000 live births in Nigeria [12]. The incidence of PNA varies considerably from one country to another ranging from 9.7% in Turkey [13] to 49% in Bangladesh [14]. Between these two extremes, intermediate rates of 10.9% [15] and 30.1% [16] were reported in Nigeria, 20.6% in Senegal [17], and 21.2% in India [18]. In Ethiopia, a meta-analysis indicates a prevalence of 19.3% [19] with variations from 12.5% [20] to 32.8% [21] from one region to another. In most of the countries cited here, PNA represents more than 10% of hospitalisations, which makes it a major public health problem. Several factors, such as differences in childbirth practices, levels of health system development, infant mortality rates, socioeconomic conditions, and lifestyles could be the reasons for such variations in the prevalence of PNA between countries.

Ultimately, this study highlights the importance of monitoring the prevalence of PNA in different countries and working toward the prevention of this serious condition for the survival of newborns.

In the present study, male newborns were in the majority which is similar to several other previous studies present in the literature [12,20,22-26]. On the contrary, few studies report a preponderance of girls [16]. There is no direct link between the PNA and the sex of the newborn, the over-representation of males in the PNA undoubtedly reflects a higher birth rate in favour of this sex.

In this study, PNA was more common among those newborns whose mothers were between 20 and 35 years old which is in agreement with most African studies. The prevalence of PNA varies by maternal age, with higher rates seen in women aged 18–35 years [17], 25–34 years [24], 26–35 years [27], and 25 to 29 years old [21,26]. In these age groups, women are in full sexual activity and have a high fertility rate, which increases the probability of deliveries with PNA.

Most mothers were housewives, a finding that corroborates that of other authors from sub-Saharan Africa [26-31]. This result seems to us to reflect the occupational situation of women in Burkina Faso where women are mainly responsible for household chores [32]. The similarity of the result with that of the African authors seems to indicate that the realities are not different in our countries in Africa south of the Sahara.

Due to the absence of a maternity ward, all newborns who suffered from PNA were born outside our hospital. Hence, a proper maternity ward equipped with machines should be constructed within the CHUP-CDG which will, in turn, allow adjacency between the NU and the delivery room to reduce neonatal mortality as transferring the newborn to another unit after birth increases the risk of death [33]. Ambulances, when available, are not medicalized, which makes transfer conditions precarious. To make up for the insufficiency of ambulances, motorcycles, or bicycles are used in the context of a low-income country.

The majority of asphyxiated newborns in this study were born to pauciparous mothers. This result is like that of certain authors [24,29,30]. Who report that primiparous mothers were more likely to give birth to asphyxiated newborns. However, other authors [21,25,34] have shown that newborns to multiparous women are more frequently affected. According to Woday [29], primiparous mothers are also the youngest and are more prone to abnormal presentations and prolonged deliveries. PNA is therefore likely to be higher in these primiparous mothers than in multiparous mothers.

In this study, newborns with asphyxia were mostly born from pregnancies followed by a number of ANCs as recommended by the WHO which is similar to several previous studies [16,17,25]. The PNA is an unpredictable drama that unfolds in three acts. It can occur during pregnancy (antenatal), during childbirth (per natal), or immediately after birth (postnatal). Even if adequate ANCs have been performed, asphyxiation can still occur. Surprisingly, the women performed few examinations during the follow-up of their pregnancy, such as TORCH infection assessment and ultrasound, which undoubtedly led to insufficient screening for pathologies during pregnancy. Improving the quality of

ANCs would make it possible to detect high-risk pregnancies.

During pregnancy, malaria was the most frequent pathology constituting 38.9% of cases. This result is not surprising because Burkina Faso is a malaria-endemic country. Intermittent preventive treatment based on sulfadoxine-pyrimethamine alone is sometimes not enough to prevent malaria in pregnant women if other individual and collective vector control measures are not combined. Maternal anemia which is responsible for hypoxia in the fetus is common in our sub-Saharan African tropical countries [17,21,25-27]. Iron deficiency anemia [24] caused either due to nutritional deficiencies or digestive parasites is very common in our population and is further aggravated by malaria. To fight against this multi factorial condition, iron and folic acid supplementation for pregnant women is already in force in the country, but the fight against other causes will help stem this scourge.

In this study, hypertensive disorders such as pre eclampsia were noted in 16.7% of women, which is higher than the frequencies reported by some authors [17,21,24,25] (10 to 12 %). On the other hand, the frequency observed in this study is lower than that reported by other authors [16,26,27] (28 to 36%). This variation is likely due to differences in the prevalence of hypertension and its risk factors in the populations studied.

This study revealed that the duration of labor was prolonged in 93.7% of mothers which is higher than the frequencies reported in Ethiopia which are 15% [26], 19.4% [25], and 46% [24]. This difference in frequency could no doubt be explained by better management of the different phases of labor in the latter country. According to one study, a second stage of labor of 3 hours or more is associated with low 5-minute Apgar scores in first-born deliveries [35]. Careful use of the partograph by midwives to monitor the progress of labor should allow appropriate decisions to be made in the event of obstructed labor and thus avoid complications for the newborn.

The rate of 10.6% of PROM observed in this study is higher than that reported by some authors [21]. Who found a rate of 6%, but lower than that reported by other authors [17,24,26,28]. Who found rates that varied between 15% and 32%. PROM, by increasing the risk of infection and increased stress, can cause asphyxia in the newborn [36,37].

In this study, newborns with asphyxia were born vaginally in 82.2% of cases and cesarean section was used only in a few cases which is comparable to that reported by many authors [24-26,28-30]. In contrast to this, a few studies report greater use of cesarean section [17,18].

Almost all newborns with asphyxia were born in the maternity ward, which confirms the result of other authors [38]. Although PNA is unpredictable, there are many questions about where and when it occurs. Improving women's access to maternity facilities in developing countries is crucial for reducing the rate of preventable maternal and neonatal mortality and morbidity by creating closer maternity care centers, providing transportation facilities, making women aware of the importance of regular prenatal follow-up, building capacities of service providers in the field of obstetrics and neonatology in particular with regard to the resuscitation of newborns, availability of necessary equipment and materials in the delivery rooms, encouraging pregnant women to go to the maternity ward at the first signs of labor, to ensure timely and appropriate management in case of complications, and to raise public awareness regarding the importance of hygiene and the prevention of infections during pregnancy and childbirth in order to reduce the risk of complications.

While the majority (75.2%) of newborns in this study were born at term, there were frequent cases of preterm births in this study which is consistent with many previous studies [17,24-27,30]. who report a greater frequency (53 to 86%) of full-term newborns subject to asphyxia. This suggests that this tragic event occurred during the intra partum period. It is therefore essential to strengthen the skills of midwives and to sensitize them to the use of the partograph for monitoring childbirth, as well as, to resort to cesarean section when necessary, in order to reduce the frequency of asphyxia.

In this study, 82.2% of asphyxiated newborns were delivered vaginally. This result is consistent with those reported by several authors [24-26,28-30], whereas, a few studies reported controversial results with the above-mentioned studies as they found a greater frequency of cases of asphyxia born by cesarean section [17,18].

This study found that the majority (70.9%) of newborns who suffered from asphyxia had normal birth weight, a result consistent with the findings of several authors [18,21,25-28,34]. Since normal weight births are more common, it is not surprising that the likelihood of an event such as asphyxia is higher in this weight group during childbirth. For example, in cases of fetal - pelvic disproportion, it is normal weight newborns (and macrosomes) that are more likely to suffer from asphyxia, unlike LBW newborns. This result, however, contradicts that of Berhe [31]. Who found a preponderance of LBW. This difference could be methodological.

In this study, the asphyxiated newborn was more frequently the first born of the siblings then the asphyxia was less frequent as the date increased. This result is in flagrant contradiction with that of other studies which suggest that there may be a link between the rank of the child in the siblings and perinatal asphyxia. A study looked at birth data of more than 900,000 infants in Australia between 2001 and 2010 found that the newborns born as second children had a higher risk of PNA than first born. Infants born as third or subsequent infants also had a higher risk than first infants, but this risk was slightly lower than for second infants [39]. Another study looked at data from more than 500,000 births in Sweden between 2009 and 2016 also found that the risk of perinatal asphyxia increased with the child's rank in the sibling. Newborns born as the second child had a higher risk than firstborns, and newborns born as the third or subsequent children had an even higher risk [40].

It is important to note that these studies do not conclusively prove that there is a causal link between the rank of the child in the sibling and perinatal asphyxia. Other factors may also play a role, such as the mother's age, the baby's birth weight, and complications during pregnancy or delivery. The results of these studies, however, suggest that it is important to take into account the rank of the child in the sibling when assessing the risk of perinatal asphyxia.

In this study, more than half (51.2%) of asphyxiated newborns were febrile, suggesting a possible neonatal infection of maternal-fetal origin. This hypothesis is supported by the presence of several diagnostic criteria for neonatal infection such as fever during delivery, prolonged duration of labor, PROM, and amniotic fluid abnormalities reported in the present study.

Of the asphyxiated neonates, 13.8% were hypothermic, which may also be related to infection, as well as fever, thermoregulation problems common in premature infants who made up 16% of the sample, or poor conditions of transfer of newborns observed in current practice in our context from the various maternities to our neonatal unit.

In addition, 8.8% of asphyxiated newborns suffered from respiratory distress, which differs from the result of Thiam's study [17] which reported a higher frequency of 31.1%. This difference may be explained by the higher rate of preterm and cesarean births in the latter study. Indeed, preterm newborns are more likely to suffer from respiratory problems related to hyaline membrane disease due to surfactant deficiency. The transient respiratory distress observed in newborns born by cesarean section is caused by a delay in the resorption of pulmonary fluid, which is rare in newborns born vaginally.

In this study, all newborns with asphyxia had developed an HIE of decreased severity (according to the stages of Sarnat). This result is similar to that of a study conducted by Thiam [17] (80.3%) and close to that of Padayachee study [41] (77.1%) in whom stage 2 was the most frequent. It is important to assess the degree of severity of HIE using Sarnat scoring system in order to establish the vital and functional neurological prognosis of affected newborns.

Limits and constraints of the study

In a context of developing country having limited resources and the lack of biochemical investigations (cord pH, lactacidemia), we defined the PNA using the Apgar score which has its own limitations. Since this retrospective hospital study was based on the medical records of the patient, it lacked precision. Also, the data to accurately analyze the HIE is lacking and the post-hospitalization follow-up of children who suffered from HIE has not been done, hence a prospective study should be conducted in order to overcome these limitations.

Conclusion

This study showed that perinatal asphyxia is a significant public health problem in the neonatology unit of a hospital, especially in a developing country. Given the implications and potential consequences of perinatal asphyxia, rigorous monitoring of pregnancy and childbirth should be done to identify high-risk cases and provide optimal management. To ensure the best possible management, significant diagnostic and therapeutic resources such as advanced laboratory facilities, medical imaging technologies, and therapeutic interventions are required in the neonatology unit.

Conflicts of interest: The authors declare no conflicts of interest regarding the publication of this paper.

Authors' contributions

KN designed the study, analyzed the data, and drafted the manuscript.

BK participated in designing the study and writing the manuscript.

SP participated in data collection, data entry, data analysis, and drafting of manuscript.

LT, SD, AB, MS, CK contributed to the drafting of the manuscript.

DY critiqued and revised the manuscript.

All the authors read and approved the final version of the manuscript.

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