

Factors Associated with Neonatal Mortality: A Case Study of the Luebo Health Zone Hospitals in the Democratic Republic of Congo

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Abstract: *Introduction:* Neonatal mortality is a worldwide problem. About 2.7 million newborns died in 2015. The under-five mortality rate was 127 per 1,000 in 2011 in Africa and 97 per 1,000 in the Democratic Republic of Congo. In Kasai Occidental, it was 23 per 1,000 during the period covered by the 2010 MICS survey. The objective of this study is to identify the risk factors associated with neonatal mortality in the Luebo Health Zone in the Democratic Republic of Congo. *Materials and methods:* We used a retrospective and cross-sectional study. The population included all births in 2016 in three maternity wards. Data were collected from birthing records, prenatal consultation records (PNC), partographs and annual reports. The EPI Info 6 software was used for data analysis. The Chi-square and the odd ratio test were calculated and the logistic regression was applied. *Results:* The study revealed 32 deaths out of 683 newborns registered in the three maternity hospitals in 2016, which represents a rate of 47%. The main factors associated with neonatal mortality in the Luebo Health Zone are, less than 5 surviving infants from mothers ($p < 0.001$), low birth weight ($p < 0.001$), gestational age less than 36 weeks ($p < 0.001$), pregnancy anemia ($p = 0.002$), caesarean delivery, pregnancy malaria ($p = 0.012$), antenatal visits numbers less than 3 ($p < 0.001$). *Conclusions:* An improved management of malaria in pregnant women, adherence to antenatal care during pregnancy, and better awareness of pregnant women on the prevention of anemia, malaria and family planning are priorities in the strategy for reducing neonatal mortality.

Keywords: Determinants, neonatal mortality, Luebo, Kasai, Democratic Republic of Congo

1. Background

Neonatal mortality is a worldwide problem. 2005 WHO report on global health indicated that nearly 11 million children under five would die from causes that are largely preventable and that among those children, 4 million newborns would not exceed the first month of their lives [1]. About 2.7 million newborns died in 2015 and 2.6 million were stillbirths [2]. Global Health Strategy for Women, Children, and Adolescents aims to end preventable deaths among all these children and significantly improve their health and well-being [1].

Studies conducted in Pakistan, Bangladesh, and Vietnam have identified several factors associated with neonatal mortality, including preterm birth, cesarean deliveries, intrapartum complications, and infections [3] and household poisoning [4]; intrapartum asphyxia, prematurity or low birth weight, sepsis or meningitis, respiratory distress syndrome and pneumonia [5, 6].

In studies conducted in Africa from 2008 to 2017, the mortality rate varied between 39 and 283‰ [7-13]. The various factors associated with this phenomenon in West Africa, Algeria, Madagascar, Chad, Cameroon and Côte d'Ivoire were pre- and perpartum hemorrhages, peripartum arterial hypertension, dystocia and amniotic infection [8]; advanced maternal age greater than 35, multiparity, genital infection, prematurity, low birth weight, jaundice, and acute fetal distress [10]; Apgar score less than 7, low birth weight, prematurity, fetal distress, neonatal infection, interval

between birth of less than two, absence or irregular follow-up of prenatal consultations, fact being a stay-at-home mother [12] or premature rupture of membranes [9].

In the Democratic Republic of Congo, the final report of the MICS-2010 (Multiple Indicator Cluster) surveys shows an infant mortality rate of 97‰ [14]. The Demographic Sanitary Health Survey conducted in 2013-2014 in the Democratic Republic of Congo notes that the neonatal mortality rate was 28‰ during the five years covered by this survey [15]. In the city of Bukavu, at Dr. Rau/Ciriri Hospital, the study conducted by Mansuka, *et al*, 2015 showed that the prevalence of perinatal mortality was 32‰. Other mortality study results of risk associated factors among newborns transferred at the neonatology department of Jason Sendwe Hospital in Lubumbashi [16], showed that the mortality was significantly related to the mother's Profession, her high educational level, gestational age < 37 AS, vaginal delivery, to the male sex of the newborn, to birth weight < 1500 grams and to prematurity. In another study conducted in Lubumbashi, Ntambue, *et al*, 2013 noted a perinatal mortality rate of 27‰, with associated factors such as delivery from unmarried mother, home delivery, complications of delivery, vaginal delivery in dystocia, cesarean, multiple pregnancies, low birth weight and prematurity. The underlying causes of that mortality rate were respiratory distress, neonatal infections, complications of prematurity, neonatal tetanus, congenital malformations and all other unknown causes [17]. In the Kasai Occidental province, the MICS report shows a prevalence of infant mortality of 99‰ [14]. The Demographic and Health Survey showed for this Democratic Republic of

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Congoprovence a neonatal mortality rate of 23 % during the ten years preceding this survey[15]. As presented in the preceding lines, neonatal mortality constitutes a public health problem in our environment and requires special attention from healthcare providers.

The present study aims to identify the predominant neonatal mortality risk factors in the Luebo Health Zone in order to collect solid evidence-based information to lead health managers in taking actions and to likely contribute to the reduction of neonatal mortality.

2. Methodology

Framework of study

This study was carried out in the three main hospitals of the Luebo Health Zone, Kasai province, in the Democratic Republic of Congo, namely, Luebo General Reference Hospital, CPC Luebo Hospital and Kabemba Hospital Center. They serve a total of 25,341 inhabitants and are considered as primary reference hospitals of this Health Zone.

Type and period of study

This is an analytical cross-cutting study meant to allow us to establish links between neonatal mortality and the underlying factors. The study covers the period from January 1st to December 31st, 2016.

Material / Study Population

The population of the study was composed of the births occurred during the year of 2016, in the three reference hospitals of the Health Zone.

Sampling

We reviewed all records of mother-child "couples" admitted for delivery at the primary referral maternity centers in the Health Zone. This gives us a comprehensive idea of the births in those three maternities as the information was collected on the basis of birth records analysis. Antenatal consultation cards, partograms, prenatal consultation records and birth registers were used for the purpose.

Variables studied

Neonatal mortality was the dependent variable of the study. Neonatal mortality is defined in our study as any infant's death occurring during their first 29 days of life. The independent variables were grouped according to their association with maternal characteristics and those of the newborn. Maternal characteristics included maternal age, infection during pregnancy, marital status, residence, parity, inter-reproductive space, number of antenatal care visits, anemia and the size of the mother. Newborn characteristics included sex, birth weight, and presence of neonatal infection. Any positive case of malaria confirmed by thick smear test or any other rapid diagnostic test in the newborn from 0 to 12 days old was considered a case of congenital malaria.

Data collection techniques

In order to systematically obtain the necessary information, data were collected in the local health information system, including birth weight, mother's age, mother's size, parity,

interstitial space, reproductive status, residence, presence or absence of infection, anemia, neonatal infection, sex of the newborn, gestational age, marital status, number of CPN visits and caesareans. Data was collected from maternity registers, NPC registers, partographs, and annual hospital reports using previously developed data collection grids.

Collection of data

To ensure the data quality, a team of 9 interviewers, 3 encoders, and 3 supervisors was established based on the level of education and experience. The enumerators were responsible for completing the data collection forms using collection tools such as maternity registers, prenatal consultation records, partographs, neonatal consultation forms and annual structure reports. All this was done under the supervision of a supervisor. The ability to use the data collection tools of this team was then reinforced by the principal investigator through a training session. The completeness of the data collected in maternity wards has been regularly checked. The collection forms were systematically numbered and the data were encoded in an Excel file. The resulting database was saved on a Compact Disc (CD).

Data analysis

The data collected in relation to the newborn infants were separated from the data from the newborns who were alive, to facilitate comparison between the two groups. The data quality control was done at two levels, first in the field during the collection to check completeness, accuracy and correct recording of data. Then before the data processing to check the coherence of the data (by making use of the investigators). The files were automatically discarded when it was not possible to correct the inconsistent data. To process the data, the categorization was done in two, one group of data corresponding to the closed questions and another group corresponding to the open questions.

The EPI Info 6 software was used for data analysis. The Chi-square has been calculated to compare the proportions. The ratio of odds (the odds ratio) was used to estimate or compare risks. Logistic regression (OR adjustment) was applied to identify trends in variables. Some statistical parameters were measured including low birth weight, mean (central tendency measure), standard deviation. (dispersion measurement), the 95% confidence intervals (between different proportions (a measure of statistical inference)). Frequency tables for the variables and contingency tables have been developed. Association measures were calculated between the different independent variables and the death of the newborn.

Ethical considerations

A written authorization to carry out the study in each of the three maternities (the Luebo General Referral Hospital, the CPC Luebo Hospital, and the Kabemba Hospital Center) was obtained from the medical and health authorities. The information was anonymously collected, that is, without mentioning the names of the respondents on the questionnaires. Only the persons involved in the study had access to the completed questionnaires. The names of the newborns in our study and their mothers were not collected during the data collection. The data sheets used were kept in

a private place, locked in the safe of department head's office.

Among women who have more than 5 children alive, 43.8% lost their newborn versus 15.9% of those whose newborns survived. The difference in proportions is statistically significant. It is the same with those who are less than 18 years old but without any statistical difference.

3. Results

1) General characteristics of mothers

Table I: General characteristics of mothers surveyed at three Luebo maternity homes in 2016.

		Deceased		Survivors		OR	P
		n(32)	%	n(651)	%		
Mother's age (Year)	<18 years	2	6,3	44	6,8	1,13(0,26-4,95)	0,8493
	18 à 35 years	22	68,8	545	83,7	1	
	> 35 ans	8	0,3	62	9,5	0,90(0,32-2,55)	
Mother's weight (Kg)	<50 Kg	2	6,3	66	10,1	0,57(0,13-2,46)	
	50 à 80 Kg	30	93,7	569	87,4	1	0,2761
	Higher than 80kg	0	0,0	16	2,5	0,46(0,11-1,93)	
Mother's height(cm)	Less than 150	0	0,0	6	0,9	0,00(0,00-13,51)	0,5854
	Higher than 149	32	100	645	99,1	1	
Mother's level of education of	Primary	0	0,0	24	3,7	--	--
	Secondary	0	0,0	95	14,6	--	--
	Post secondary	0	0,0	2	0,3	--	--
Parents Occupation	Ménagère	20	62,5	468	71,9	0,65(0,31-1,36)	0,2509
	other	12	37,5	183	28,1	1	
Number of children alive	Less than 5	18	56,2	547	84,0	1	0,0000
	Higher than 5	14	43,8	104	15,9	4,09(1,97-8,48)	

2) General characteristics of newborns

Of the 32 infants who died during the first 6 weeks of life, 6% had low birth weight, compared to 2.3% of those who survived with the same weight. The difference noted

between these two proportions is statistically significant. This difference was also significant with gestational age, whereas this is not the case for the sex of the newborn as shown in Table II.

Table II: General characteristics of newborns surveyed at three Luebo maternity clinics in 2016

		Deceased		Survivors		OR	P
		n(32)	%	n(651)	%		
Baby gender	M	20	62,5	355	54,5	1,38(0,67-2,89)	0,3764
	F	12	37,5	296	45,5	1	
Birthweight (grams)	<2500	6	18,8	15	2,3	9,78(3,51-27,26)	0,0000
	≥2500	26	81,2	636	97,7	1	
Gestational age (weekdays)	<36	10	31,2	23	3,5	12,41(5,28-29,20)	0,0000
	≥36	22	68,8	628	96,5	1	

3) Mortality rate in the surveyed hospitals

The overall neonatal mortality rate in maternity wards in Luebo Health Zone was 47 % in 2016 for a total of 683 registered births.

4) The frequency of factors associated with neonatal mortality

The following table shows that the factors associated with neonatal mortality vary between the number of neonatal visits, less than 3 ((93.8%)) and maternal infections (0.0%).

Table III: The frequency of factors associated with neonatal mortality in three Luebo maternity homes in 2016

Factors (n=683)	Frequency (%)
Mother's Anemia	18,8
Maternal infection	0,0
Maternal death	0,0
Malaria in pregnancy	12,5
Cesarean	43,8
CPN visits less than 3	93,8
Congenital malaria	0,0
Newborn Asphyxia	0,0
Neonatal infection	0,0

5) Maternal factors in the death of the newborn

Of all mothers who attended antenatal clinics less than three times, 93.8% lost their newborns within 6 weeks of birth compared to 21.0% of those whose newborns survived. The difference noted is statistically significant. The difference in proportions is also significant for mothers who had anemia during pregnancy, for those who delivered by cesarean and for mothers who had malaria during pregnancy.

Table IV: Maternal factors in the death of the newborn in three maternity homes in Luebo

		Deceased		Survivors		OR	P
		n(32)	%	n(651)	%		
Mother'sanemia	Yes	6	18,8	36	5,5	3,94(1,53-10,18)	0,0023
	No	26	81,2	615	94,5	1	
Maternal Infection	Yes	0	0,0	6	0,9	0,00(0,00-13,50)	0,5854
	No	32	100	645	99,1	1	
Caesarian	Yes	14	43,8	80	12,3	5,55(2,65-11,59)	0,0000
	No	18	56,2	571	87,7	1	
Maternaldeath	Yes	0	0,0	2	0,3	0,00(0,00-71,44)	0,7535
	No	32	100	649	99,7	1	
Malaria in pregnancy	Yes	4	12,5	220	33,8	0,29(0,09-0,80)	0,0122
	No	28	87,5	431	66,2	1	
Visits CPN	< 3	30	93,8	137	21,0	56,28(13,28-238,41)	0,0000
	≥3	2	6,2	514	79,0	1	

6) Characteristics of the newborn in neonatal death:

No cases of congenital malaria and neonatal infection were reported during the study period.

Table V: Newborn characteristics of neonatal death in three Luebo maternity homes in 2016

		Deceased		Survivors		OR	P
		n(32)	%	n(651)	%		
Congenital malaria	Yes	0	0,0	0	0,0	--	--
	No	32	100,0	651	100,0	1	
Asphyxia	Yes	0	0,0	16	2,5	1	
	No	32	100,0	635	97,5	0,0(0,0-4,3)	0,3694
Neonatal Infection	Yes	0	0,0	0	0,0	1	
	No	32	100,0	651	100,0	--	--

7) Factors associated with the death of the newborn:

In multivariate analysis, maternal anemia during pregnancy, cesarean delivery, and malaria during pregnancy were associated with neonatal death (p <0.05).

Paramètres	O.R.	C.I. at 95%	P.
Mother'sanemia	0,2537	0,0982 0,6553	0,0046
Gestationalage	502933,9632	0,0000 >1,0012	0,9682
Caesarian	0,1801	0,0862 0,3763	0,0000
Number of children alive	0,6033	0,2641 1,3783	0,2306
Malaria in Pregnancy	3,5731	1,2384 10,3092	0,0185
Birthweight	493354,2687	0,0000 >1,0012	0,9746
Number of NPC visits	0,5590	0,2118 1,4755	0,2402

4. Discussion

The study was conducted in three referral maternity hospitals in the Luebo Health Zone. Its objective was to determine the neonatal mortality rate in Luebo maternity hospitals and its most important determinants during 2016. The main limitations of the study were: (1) the difficulty in making a clear separation between malaria and anemia in pregnant women, anemia is one of the complications of malaria; (2) Among the number of children alive, the distinction is not made between parity and household size; (3) The sample size not allowing us to point out and clearly identify congenital malaria, neonatal infections and asphyxia in the newborn. This aspect is to be taken into account in subsequent studies.

The study revealed a death rate of 47‰ births recorded during the surveyed period in the three maternities visited. In

Pakistan and Bangladesh, this rate was respectively 47.4% and 32.3% between 2003 and 2004. In this study, this neonatal mortality rate could be explained by several associated factors, including the high number of children alive, low birth weight, gestational age less than 36 weeks, pregnancy anemia, caesarean delivery, malaria during pregnancy, the number of visits CPN less than 3, maternal age below 18 years, and the sex of the newborn (male) as we note in the following lines. Although the sex of the newborn being a male is predominant (51.3%), we did not note any statistically significant difference between newborn deaths frequency and their sex. However, Katamea *et al* [16] noted that mortality was significantly related to newborn male sex in their study of risk factors for mortality in neonates transferred to the neonatology department of Jason Sendwe Hospital in Lubumbashi (OR = 2.43 (1, 08 to 5.46)). There is no sufficient explanation to justify this phenomenon.

Low birth weight is associated with neonatal mortality (p <0.0001). In their study of the determinants of early neonatal mortality in the Befelatanana maternity ward, Antananarivo, Raobijaona and Rakotomanga [12] also noted this association (RR = 6.14 (4.20-8.98)). In fact, the low weight is generally linked to unbalanced nutritional state and could constitute a ground for infections, with a weakened immune system that can easily lead to the newborn's death. mortality is correlated to gestational age. In Lubumbashi, Ntambwe *et al* [17] found that complications of prematurity were associated with perinatal mortality (9.0%). The maturity of all newborn organs or even their immune system depends on gestational age. There is an association between neonatal mortality and maternal anemia during pregnancy. No previous studies have mentioned anemia during pregnancy. Poor intrauterine growth in relation to a disturbance of the fetoplacental blood circulation that reduces micronutrient and oxygen supply could explain this phenomenon. (any reference which can support this statement ?)

No correlation was found between neonatal infections and newborn death during our study period. However, Noria *et al* [10] reported an association between genital infection and the newborn's death in Algeria in 2015 (OR = 5.3, 95% CI (2.5-6.7), p = 0.001).

Through our study, we found a significant association between cesarean and neonatal mortality. Ntambwe A. *et al* also noted this correlation in their study mentioned above[17]. The correlation between neonatal mortality and cesarean would be explained by the often late decision of the clinician to perform the cesarean section in the three medical care facilities surveyed. This finding is corroborated Panchabhai *et al*[18] in their global survey on Neonatal mortality is associated with Malaria during pregnancy. It has been recognized as a leading cause of infant morbidity and mortality in Africans[19]. Some studies have shown an association between neonatal mortality and pregnancy-related diseases in general, as noted by P. Mulongo Mbarambara *et al* ($p < 0.05$) [20] and the association between neonatal mortality and malaria in particular, as noted by Danielle Christiane Kedy Koumet *et al* (7%, $p = 0.03$) [21]. Placental malaria alters the placental structure and disrupts mother exchange child, thus leading to a state of malnutrition in the newborn with the susceptibility related to this condition.

There is a correlation between neonatal mortality and pregnancy anemia. There is also an association between neonatal mortality and a number of antenatal visits less than three. Raobijaona *et al* also noted that neonatal mortality was associated with absence or irregularity of ANC follow-up ($p < 0.0001$) in Antananarivo[12]. Antenatal care is used to identify problems during pregnancy and also to prepare for delivery. These preventive measures aim to optimize the course and the outcome of the pregnancy and would ensure the newborn survival.

In the multi-varied analysis, maternal anemia, malaria in pregnancy, and the number of prenatal visits were associated with neonatal mortality ($p < 0.05$).

5. Conclusion

Neonatal mortality is a public health problem in the Luebo Health Zone. The study conducted in three maternity wards in this area made it possible to determine the factors associated with this phenomenon. The number of children under 5, low birth weight, gestational age less than 36 weeks, anemia in pregnancy, cesarean delivery, malaria in pregnancy, and number of NPC visits less than These have been noted as predominant factors associated with neonatal mortality. The link between neonatal mortality and factors such as maternal age below 18 years or the female sex of the newborn has not been demonstrated. From all the above reasons, there is an urgent need to educate pregnant women. Health Education is one of the essential elements in the delivery of Primary Health Care to avoid early pregnancy before the age of majority of 18 years, to prevent and treat anemia and malaria by regularly attending antenatal clinic services and to practice family planning to avoid large births. It is also important for clinicians to take a timely decision to perform cesareans. In perspective, studies will have to be conducted to dissociate the neonatal-neonatal mortality-correlation and malaria-neonatal mortality correlation; out of the number of children alive, the share of household size and parity. A larger sample would highlight the correlation with congenital malaria, asphyxia, and neonatal infections.

What is already know on this topic

- High Neonatal mortality in Africa
- Neonatal mortality risk factors for in the world

What this study adds

Predominant Risk factors for neonatal mortality in the Luebo Health Zone are the number of children under 5, low birth weight, gestational age less than 36 weeks, anemia in pregnancy and malaria in pregnancy, cesarean delivery and number of prenatal visits less than 3.

6. Competing Interests

All authors declare that they do not have any competing interests.

7. Authors' Contributions

CM developed the software, carried out most of the testing and analyzed the results. WK and HK helped with the analysis of results. CM and WK wrote the manuscript with continuous support from HK. All authors read and approved the final manuscript version.

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