

Neonatal mortality and risk factors in the University Hospital of the Mother and Child Lagoon in Cotonou, Benin, 2015-2016

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ABSTRACT

Introduction: The neonatal period is one of the most vulnerable periods for a child's survival because of the various attacks and infections, majority of which are avoidable mainly through preventive measures. We assessed neonatal hospital mortality and associated factors in a specialized hospital neonatal center. **Methods:** We conducted a retrospective descriptive study and then a case-control study from January 1, 2015 to December 31, 2016 at the Mother and child University Hospital in Cotonou, Benin. We considered all children hospitalized for any condition in the neonatal unit from January 1, 2015 to December 31, 2016 to conduct the descriptive study. From this population, we selected cases and controls for the case-control study. A case was defined as any newborn hospitalized for any condition in the University Hospital of the Mother and Child Lagoon (CHU MEL) neonatal unit, and who died before the 28th day of life and control was defined as any newborn hospitalized for any affection in the neonatal unit of CHU MEL and discharged alive during the period from January 1, 2015 to December 31, 2016. Socio-demographic, clinical and hospital-related data were recorded. We calculated the proportion and ratio. We conducted univariate, stratified, and logistic regression analysis and calculated odds ratio (ORs), adjusted odds ratios (aOR) and 95% confidence interval to identify risk factors associated with neonatal mortality. **Results:** We included 2,235 infants in the descriptive study and 828 for the case-control study. The sex ratio Male to female (HF) was 1.2. Mortality was 19% CI (17.08% -20.35%). The main diseases were neonatal jaundice at 33%, neonatal infections (NNI) (30%), prematurity (25%), perinatal asphyxia and other respiratory distress (19%). The risk factors for neonatal death were neonatal infections (aOR = 1.76 95% CI [1.09-2.85], p = 0.020), vaginal delivery (aOR = 1.68 95% CI [1.04-2.71] p = 0.031), preterm birth (aOR = 2.51 95% CI [1.28-3.60], p = 0.003), perinatal asphyxia (aOR = 2.78 95% CI [1.62-4.79] p = 0.0012), low birth weight (aOR = 9.35 95% CI [5.19-16.83] p < 0.01), other health center origin (aOR = 1.80 95% CI [1.10-2.94] p = 0.018), resuscitation (aOR = 2.15 95% CI [1.34-3.45] p = 0.001) and malformation (aOR = 28.86 95% CI [7.92-105.15] p < 0.01). **Conclusion:** Neonatal mortality is high at CHU MEL. In the neonatal period, 80% of deaths occurred. Improvement in the follow-up of newborns, especially those exposed to its factors, will reduce this mortality. The health workers should consider these factors in care management of newborns.

KEYWORDS

neonatal death, perinatal asphyxia, prematurity, risk factors

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Introduction

A neonatal death is death of any baby showing signs of life at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown, that occurs up until midnight of the 27th day of life (neonatal period) [1]. A neonatal death is defined as a death during the first 28 days of life (0-27 days) [2]. Globally approximately one million babies died on the first day of life in 2015, and neonatal deaths accounted for 45% of total under five mortality in the same year). In sub-Saharan Africa newborn deaths accounted for approximately one-third of deaths among children under 5 years [3] The first 28 days of life - the neonatal period - is the most vulnerable time for a child's survival. Children face the highest risk of dying in their first month of life at an average global rate of 18 deaths per 1,000 live births in 2017. Regionally, neonatal mortality was highest in sub-Saharan Africa and South Asia, with each estimated at 27 deaths per 1,000 live births in 2017. A child born in sub-Saharan Africa or in South Asia is nine times more likely to die in the first month than a child born in a high-income country. Across countries, the risk of dying in the first month of life was about 50 times higher in the highest mortality country than in the lowest mortality country [4].

Despite progress made in improving maternal and child health, approximately 4 million neonatal deaths still occur annually; 75% of which happen in the first week with the highest risk of death being on the first day of life. High levels of neonatal deaths occur in countries in East and South-Central Asia, however the highest neonatal mortality rates are generally recorded in sub-Saharan Africa [5].

Globally, the main direct causes of neonatal death are estimated to be preterm birth (28%), severe infections (26%), and asphyxia (23%). Low birth weight is an important indirect cause of death. Maternal complications during labor increase the risk of neonatal death, and poverty has been strongly associated with an increased risk of neonatal mortality [5]. Approximately 450 newborn babies die every hour, mainly from preventable causes; it is therefore imperative to understand the causes in order to put in place effective preventive and control measures [5].

In 2015, the global neonatal mortality was 19.2 ‰ with regional disparities; [6] 28% in sub-Saharan Africa, 26.6% in the Mediterranean region , 24.3%

in South-East Asia, 7.7% in the Americas, 6.7% in the Western Pacific and 6% in Europe [6]. In Benin, neonatal mortality dropped from 40 deaths per 1,000 live births in 1990 to 28 deaths per 1,000 live births in 2012. However, neonatal mortality increased to 31.8 deaths per 1,000 live births in 2015 [6]. The hospital neonatal mortality rate is much higher than the global one [7-10].

One of the targets of the three goals of the Sustainable Development Goals is the reduction of neonatal mortality to less than 12 per 1000 [11]. If for most cases the causes are known, it is important to analyze in different contexts, the risk factors associated with these deaths. Several factors have been associated with neonatal mortality in different studies in Africa [12-17]. In Benin, studies conducted at the Parakou Regional Hospital Center in 2013 only focused on perinatal and early neonatal period [18], and were more relevant to perinatal and early neonatal mortality. We conducted a study to determine the factors associated with neonatal mortality at the University Hospital of the Mother and Child Lagoon in Cotonou in Benin.

Methods

Study Design

First, we conducted a retrospective descriptive study and then a case-control study from January 1, 2015 to December 31, 2016.

Study site and Study Population

We conducted this study at the Mother and Child University Hospital in Cotonou (CHU MEL). Cotonou, is the administrative capital city of Benin, located in the southern part of the country. The population of Cotonou is cosmopolitan and was estimated to be 752833 in 2016. Cotonou has two national referral hospitals, four private hospitals, and 318 public and private health centers. CHU MEL is a hospital with various services focused on the health of the mother and the child. It has a gynecology-obstetrics department; a pediatrics department that hosts the neonatology unit; a laboratory service, a pediatric surgery unit, radiology, social affairs, and pharmacy services.

The neonatal unit is manned by three pediatricians, 20 nurses, 11 caregivers, and three

support/maintenance workers. The neonatal unit admits newborns referred from the gynecology-obstetrics unit of the hospital as well as newborns referred from other health centers. The neonatal unit has a breastfeeding room to allow mothers of children to breastfeed children at the facility.

The study population consisted of newborns from 0 to 27 days old admitted at the neonatal unit of CHU MEL from January 1, 2015 to December 31, 2016.

Data Collection

We defined a case and a control for a case-control study. We defined a case as any neonate hospitalized for any condition in the CHU MEL neonatal unit and who died before the 28th day of life during the period January 1, 2015 to December 31, 2016. A control was defined as any newborn hospitalized for any condition in the neonatal unit of CHU MEL and discharged alive during the period January 1, 2015 to December 31, 2016. **Inclusion criteria:** We included all neonates whose files were available and complete.

Exclusion criteria: We excluded all children who went through the neonatal unit for a systematic examination only.

Sampling (Figure 1) : For the descriptive study, we conducted exhaustive sampling of all children's files that were completely filled. For the case control study, we calculated the sample size for the case-control study with the Statcalc utility of the Epi info software using 95% confidence interval, 80% power, unmatched 1 case for 1 control, and 30% of exposed controls to prematurity and an OR of 1.55, we considered the lowest value of OR that would make our study of public health interest. The minimum estimated sample size was 764.

Selection of cases: We conducted an exhaustive census of all the cases of neonatal deaths that occurred from January 1, 2015 to December 31, 2016. All the 414 deaths that had occurred at the neonatal unit were included in the study.

Sampling of controls: We generated a list of controls and selected 414 controls from the list of files corresponding to the definition of controls. For each cases, we selected every newborns that had been admitted on the same day and was discharged

as alive. If there were more than one controls we randomly selected among the identified controls.

Data collection tools: We used a data extraction form to capture data from hospital records (i.e. registers and patient files).

Study variables: The dependent variable was either dead or alive. The independent variables were newborn related factors including gestational age at birth, birth weight, and final diagnosis recorded at discharge. We also abstracted variable on maternal factors including age, occupation; parity, conditions during pregnancy, mode of delivery, place of delivery, and type of pregnancy.

Data management

We entered and cleaned the data in Excel, and imported in Epi Info 7.1.1.14 for analysis. We performed bivariate and multivariate analysis using logistic regression and calculated odds ratio (ORs), adjusted odds ratios (aOR) and 95% confidence interval to identify risk factors. We carried out stratified analysis to control for confounding and assess for effect modification. All the factors whose $p \leq 0.20$ in bivariate analysis were included in the logistic regression model.

Statistical analysis

Used Epi info 7.1.1.we calculated proportions and ratios for characteristics of newborns and causes of death and mortality rate. We compared proportions using the Pearson chi square test. We conducted bivariate and multivariate analysis using logistic regression to obtain associated factors. For stratified analysis, we performed crude analysis by calculating crude OR for each factor with confidence interval and p-value; we stratified the data by potential confounders and effect modifiers including age group and place of delivery , multiple pregnancy, resuscitation performed at birth, birth weight, delivery mode, diagnosed of infection, malformation and asphyxia.

We calculated stratum-specific OR; age groups <7 days and ≤ 7 days of age were considered. We evaluated for effect modification by comparing stratum-specific OR. Where effect modification was present, we reported stratum-specific OR. Where effect modification was absent, we assessed and

controlled for confounding by comparing the stratum-specific OR with the crude OR. If the crude OR value did not fall within the range of the smallest and the largest stratum-specific OR, confounding was present; we then calculated the weighted average of stratum-specific OR (Mantel-Haenszel summary OR) and compared the adjusted OR with the crude OR to see if they were “appreciably different”.

For multivariate analysis, we introduced a logistic regression model and included the variables whose p values were less than or equal to 0.20 to look for confounding factors. We used Odds ratios (OR) and their 95% confidence interval (95% CI) to estimate the strength of the association. The threshold meaning was at 5% and the adequacy of the final model was tested by the Hosmer and Lemeshow test.

Ethical considerations

We obtained approval from the Ministry of Health. We ensured anonymity by not extracting identification details such as names from files at the Neonatology Unit of CHU MEL hospital. Confidentiality was assured and maintained throughout the study.

Results

Characteristics of newborns hospitalized in CHU MEL neonatal unit, Cotonou Benin from January 2015 to December 2016

We recorded 2235 files of neonates who had been hospitalized for any condition from January 1, 2015 to December 31, 2016. The ratio of male to female was 1.2: 1. More than half 1419/2216 (64%) of these neonates came from maternity CHU MEL. Of all the newborns reviewed, 1570/2234 (70%) were admitted on the day of their birth. Few of them 301/2235 (13%) were a result of twin pregnancy. Very low birth weight children formed 329/2206 (13%) of the hospitalized newborns. The number of deaths was 417 and the mortality rate was 18.7%. Neonatal deaths occurred in the early neonatal period at 331/414 (79.4%) of dead newborns.

Causes of neonatal death in CHU MEL neonatal unit, Cotonou, Benin from January 2015 to December 2016

The conditions that caused the highest number deaths were prematurity 241/417 (57.8%), followed by perinatal asphyxia 54/417 (37%) and neonatal infections 111/417 (26.6%). Others conditions that caused death were injuries and malnutrition. ([Table 1](#))

Characteristics of newborn cases and controls hospitalized in CHU MEL neonatal unit, Cotonou Benin from January 2015 to December 2016

The ratio of males to females was 1.2:1 for both cases and controls. More newborns were admitted at birth among the newborn cases (316/414; 76.33%) as compared to the controls (301/414; 72.7%). The proportion of cases that had birth weight less than 1500 g was 43% (178/410) while proportion of controls having birth weight less than 1500 is 8 % (35/414). More of controls come from CHU MEL (73.7%; 283/384) ([Table 2](#))

Neonatal mortality factors in the CHU MEL neonatal unit, Cotonou Benin, January 2015 to December 2016

Very low birth weight (OR: 8.28 CI [5.61-12.46]), resuscitation at birth (OR:3.26 CI [2.44-4.36]), twin pregnancy (OR: 2.81 CI [1.89-4.21]), other health center origin (OR:2.05 CI[1.55-2.73]), prematurity (OR: 3.81 CI [2.80-5.19]), and malformations (OR: 7.77 CI [3.20-22.56]) were the conditions that increase the risk of death of the newborn. Vaginal delivery (OR: 2.53 CI [1.88-3.43]) was a maternal risk factor for neonatal death compared to caesarean delivery ([Table 3](#)).

Stratified analysis

Factors associated with neonatal mortality were stratified by age to assess for possible confounding and effect modification. Age appeared to be an effect modifier of resuscitation. Newborns who were less than 7 days old and had been resuscitated were 4.51 times more likely to die compared to newborns who were more than 7 days old and had been resuscitated. This effect was also found in newborns of preterm birth and those who had been diagnosed

with asphyxia. Age less than 7 days old appeared to be factor of very low birth weight ([Table 4](#)).

Multivariate analysis

Multivariate logistic regression analysis was performed to study the factors associated with neonatal mortality while controlling for other factors. At multivariate analysis, the risk factors for neonatal death were neonatal infections (aOR = 1.76 95% CI [1.09-2.85], $p = 0.020$), vaginal delivery (aOR = 1.68 95% CI [1.04-2.71] $p = 0.031$), preterm birth (aOR = 2.51 95% CI [1.28-3.60], $p = 0.003$), perinatal asphyxia (aOR = 2.78 95% CI [1.62-4.79] $p = 0.0012$), the very low birth weight (aOR = 9.35 95% CI [5.19-16.83] $p < .01$), other health center origin (aOR = 1.80 95% CI [1.10-2.94] $p = 0.018$), resuscitation (aOR = 2.15 95% CI [1.34-3.45] $p = 0.001$), and malformation (aOR = 28.86 95% CI [7.92-105.15] $p < 0.01$) ([Table 5](#)).

Discussion

We found that the neonatal mortality rate was high in the hospital. The hospital based mortality founded in our study was 18.7% which was higher compared to neonatal mortality at the national level estimated at 3.18% in 2015[6]. This could be explained by the fact that in this study only newborns with a condition were considered for the total population. In addition, not all neonates had been admitted to the neonatal unit. Our hospital based mortality are close to those found by other authors, including FLA Kouéta (15,3%) in Ouagadougou (Burkina), Mukhtar in Kano (16,9%) in Nigeria, Yenan (19,9%) in Bouaké (Ivory Coast)[7,8,19]. However, our results were contrary to those reported in a study by Harir Noria (5,3%) at the Gynecology-Obstetrics Hospital Sidi Bel Abbes in Algeria which estimated mortality at 5.3%, and those of Kedy Koum (8%) which estimated the neonatal mortality rate in Douala, Cameroon at 8 % [12,20]. The mortality in our study was also lower than that found by Imoudou (25,9%) at the Azare hospital in Nigeria[9]. These differences can be explained by the ways in which these studies were conducted and the places of study. Kedy Koum[20] worked in a resource-limited hospital where only newborns weighing 1500g or over were admitted and the birth term was greater than 32 weeks whereas in our study we included newborns

with very low birth weight and premature babies. The difference in results could also be due to the fact that Harir Noria [12] considered the denominator as the number who were born in the hospital, which is different from our study where we considered only children who had been hospitalized for a condition similar to the cases but were discharged alive. Imoudou [9] worked in an area where the majority of deliveries were done at home before the newborns were transferred to hospital; in our study, little newborn came from home.

We also found that the most common conditions in our study were neonatal jaundice (32.62%), neonatal infections (NNI) (29.93%), prematurity (25.01%), and perinatal asphyxia and other respiratory distress (APN) (19.33%) These conditions are similar to those found by Yenan (NNI 30%, prematurity 22.5%) at the Bouake hospital[19], Mukhtar (APN 27%, NNI 25, 3%, prematurity 16%) at Aminu hospital in Kano[8] and Kisito (NNI 23.5%, prematurity 17.9%) at El Fateh Suka hospital in Ouagadougou[21], Ingrid Kirsten (NNI, APN, prematurity) [13].

Neonatal deaths occurred in the early neonatal period in high proportion. This proportion is close to that of Yenan at the University Hospital of Bouaké, Bezzaoucha at Blida University Hospital in Algeria [19,22]. Others studies had higher proportions: Azoumah at Kara University Hospital, Harir Noria at the hospital Sidi Bel Abbes in Algeria [12,23]. This is explained by the fact that the early neonatal period is one of the delicate periods of the child's life and that if the care at this period is done according to the standards (asepsis), and without a rigorous follow-up to detect early the problems of the newborn, he may die.

We also found factors such as prematurity, very low birth weight, vaginal delivery, having a congenital malformation, perinatal asphyxia and neonatal infection were significantly associated with neonatal death.

Prematurity is one of the causes of neonatal deaths often found in the literature. In our study, prematurity was significantly associated with neonatal death. Koum et al. ($p < 0.0001$), in a referral hospital in Douala [15], Tina at the Jason Sendwe Hospital in Lubumbashi, DRC (OR: 3.21, CI: 1.46-7.06) [14], Harir Noria in a study at the Gynecology-

Obstetrics Hospital Sidi Bel Abbes, Algeria (OR: 10.08 CI 3.45-20.20) [12]. This can be explained by the fact that, in our environment, as in most developing countries which are characterized by impoverishment and under-equipment of the health structures, the birth of the premature child poses serious problems, associated with a high rate of neonatal death. The high case-fatality rate associated with premature birth found in our study is explained by the fact that from birth to admission to the neonatal unit, the premature baby does not benefit from any continuous care as he deserves according to the physiological immaturity of all organs. Very low birth weight is often associated with prematurity. In our study, it is associated with neonatal mortality. Kedy et al at a referral hospital in Douala ($p < 0.005$) [15], Ingrid et al, at Dili National Hospital in Timor [13], Tina at Jason Sendwe Hospital in Lubumbashi, DRC (OR 15, 3 CI: 1.08-5.46) [14], also found it as risk factors for death. Bobossi at the pediatric Bangui complex used low birth weight which was also related to death (OR 4.98, CI 3.63-6.83) [17], Harir Noria in a study at Gynecology-Obstetrics Hospital Sidi Bel Abbes, Algeria also used low weight and found that it was related to death (OR: 4.5 CI 1.6-10.5) [12]. The very low birth weights in our environment cause serious problems for the health worker staff from their medical care. Also the lack of equipment does not allow adequate and effective treatment. Their care being delicate, it will be necessary that our hospitals are well equipped to ensure a good follow-up.

The vaginal delivery may be normal, obstructed, forceps or episiotomy and it is significantly associated with death. Kisito at El Fateh Suka hospital in Ouagadougou found this as a risk factor (OR = 6.57, CI 1.33-32.29) [19,8], Lasme at Yopougon Teaching Hospital ($p = 1,910^{-5}$) in Ivory Coast in 2003 [16] found the same factor. Tina at the Jason Sendwe Hospital in Lubumbashi, DRC, found obstructed labor (OR: 7.5 CI 1.54-27.38) [14]. During vaginal delivery, several complications can occur and be a source of morbidity in the newborn. Moreover, without proper surveillance, early detection of complications for decision-making without delay leads to newborn childbirth with morbidities that can lead to death. The presence of malformation is associated with death in our study. Fla described it as a major condition leading to death, but did not have a significant association [7]. Malformed newborns often have multiple

malformations, making their management difficult, hence the majority of deaths observed. The asphyxia is one of the top three causes of death worldwide. It is related to death in our study. Michel K.N. at the Kolwezi Hospital (DRC) (OR 7.86, IC2.02-30.64) [10] also found it. Neonatal infections were with prematurity and asphyxia, the three leading causes of death in 2015 globally. Associated with death in our study, and although most studies have described it as one of the leading causes of death, they have not been able to demonstrate a significant association. Neonatal infections have several causes that can be of antenatal, perinatal or post-natal origin. The diagnosis of certainty is made by laboratory examinations, the costs of which are borne by the parents, sometimes resulting in a clinical diagnosis. In some cases, the treatment must be precise, which is still not the case.

Limitations

In this study, some of the case and control patient files had some missing data. However, the missing data was very low at about 5% and would minimally change the overall findings.

Conclusion

Neonatal mortality is high at CHU MEL. In the neonatal period, 80% of deaths occurred. The most common conditions found in deaths are, prematurity followed by birth asphyxia and other respiratory distress and neonatal infection. Several factors are related to this mortality. Improvement in the follow-up of newborns, especially those exposed to these factors, will reduce this mortality. The health workers should consider these factors in care management of newborns.

What is known about this topic

- Neonatal mortality remains high
- Conditions leading to death in newborns are infections, prematurity and perinatal asphyxia

What this study adds

- Malformations and low delivery are also factors related to neonatal mortality
- Mortality will be reduced at the Hospital by taking account the factors detected by health workers in care management of newborns

Competing interests

The authors declare that they have no competing interests.

Consent to publish

Consent to publish was sought from all the authors and was obtained.

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Availability of data and materials

The dataset for this study can be availed upon request. The dataset is an Excel dataset.

Authors' contributions

MAH, BS, SA, MS, YAGH developed the protocol, collected the data. MAH, BS, YAGH, LO, BS, SA, MS analyzed the data and interpreted the data and wrote the manuscripts. MAH, BS, SA, YAGH reviewed several drafts and made a substantial contribution to the writing of the manuscripts. All authors read and approved the final manuscript.

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Tables and figures

Table 1: Causes of neonatal death in CHU MEL neonatal unit, Cotonou, Benin from January 2015 to December 2016.

Table 2: Characteristics of newborn case and control hospitalized in CHU MEL neonatal unit; Cotonou; Benin from January 2015 to December 2016

Table 3: Neonatal mortality factors in the CHU MEL neonatal unit, Cotonou, Benin, January 2015 to December 2016

Table 4: Neonatal mortality factors stratified by age in the CHU MEL neonatal unit, Cotonou, Benin, January 2015 to December 2016

Table 5: Independent risk factors for neonatal mortality in the CHU MEL Neonatal Unit Cotonou, Benin from January 2015 to December 2016

Figure 1: Flow chart of participant selection

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Table 1: Causes of neonatal death in CHU MEL neonatal unit, Cotonou, Benin from January 2015 to December 2016

Causes (n=417)	Number of deaths	Percent (%)
Prematurity	241	57.80
Perinatal Asphyxia and other distress	154	37.00
Neonatal infection	111	26.62
Neonatal jaundice	45	10.79
Anemia	44	10.55
Malformations	36	8.63
Hemorrhage	11	2.64
Others	27	6.47

Table 2: Characteristics of newborn case and control hospitalized in CHU MEL neonatal unit; Cotonou; Benin from January 2015 to December 2016

Characteristics		Case		controls	
		Number	Percent	Number	Percent
Age	At birth	316	76.33	301	72.70
	1-7 days	77	18.60	98	23.68
	> 7 days	21	5.07	15	03.62
Sex	M	226	54.72	227	55.00
	F	187	45.28	185	45.00
Birthweight	< 1500 g	178	45.41	35	08.46
	≥ 1500g	232	56.59	379	91.54
Resuscitation	Yes	228	55.00	113	27.30
	No	186	45.00	301	72.70
Origin	CHU MEL	212	51.20	283	73.70
	Others	202	48.80	101	26.30

Table 3: Neonatal mortality factors in the CHU MEL neonatal unit, Cotonou, Benin, January 2015 to December 2016

Variables		Case	Control	OR (CI 95%)	P value
Newborns factors					
Other health center origin	Yes	202	131	2.05(1.55-2.73)	<0.01
Twin pregnancy	Yes	95	40	2.81(1.89-4.21)	<0.01
Resuscitation	Yes	228	113	3.26(2.44-4.36)	<0.01
Sex	M	226	227	0.98(0.74-1.29)	0.484
Very low birth weight <1500g	Yes	178	35	8.28(5.61-12.46)	<0.01
Perinatal asphyxia	Yes	154	94	2.01(1.48-2.73)	<0.01
Preterm birth<37 week of amenorrhea	Yes	241	133	3.81(2.80-5.19)	<0.01
Malformation	Yes	36	5	7.77(3.20-22.56)	<0.01
NNI	Yes	111	141	0.70 (0.52-0.95)	0.014
Maternal factors					
Vaginal delivery	Yes	298	208	2.53(1.88-3.43)	<0.01
Diseases during pregnancy	Yes	203	200	1.15(0.84-1.52)	0.198
Official occupation	Yes	67	80	0.84(0.58-1.20)	0.194
Mother's Age	≤25	146	158	0.90(0.68-1.21)	0.281
Parity	1	105	117	0.89(0.64-1.23)	0.265

Table 4: Neonatal mortality factors stratified by age in the CHU MEL neonatal unit, Cotonou, Benin, January 2015 to December 2016

Factors	Age	Case	Control	Crude OR (95%CI)	Stratum specific OR (95%CI)	MH Adjusted OR (95%CI)
Other health center origin	≤7 days	152	72	2.05 (1.55-2.73)	2.60 (1.85-3.66)	
	>7 days	50	58		1.54 (0.87-2.72)	
Twin pregnancy	≤7 days	70	23	2.81 (1.88-4.19)	3.18 (1.93-5.26)	3.01(2.00-4.53)
	>7 days	25	17		2.67 (1.32-5.37)	
Resuscitation	≤7 days	197	73	3.26(2.44-4.36)	4.51 (3.19-6.35)	NA
	>7 days	31	40		1.14 (0.63-2.06)	
Very low birthweight	≤7 days	136	13	2.01 (1.48-2.73)	15.44 (2.40-28.13)	NA
	>7 days	42	22		4.53 (2.40-8.55)	
APN	≤7 days	146	73	2.01(1.48-2.73)	2.42 (1.72-3.40)	NA
	>7 days	8	21		0.48 (0.20-1.16)	
Preterm birth	≤7 days	193	88	3.81(2.80-5.19)	4.26(2.99-6.8)	NA
	>7 days	48	45		2.99(1.57-5.70)	
Malformation	≤7 days	25	3	7.79 (3.02-20.06)	8.00 (2.39-26.80)	8.26 (3.18-21.45)
	>7 days	11	2		8.78 (1.89-40.78)	
Vaginal delivery	≤7 days	243	133	2.53(1.88-3.43)	2.57 (1.85-3.57)	NA
	>7 days	65	65		2.83 (1.49-5.36)	

Table 5: Independent risk factors for neonatal mortality in the CHU MEL Neonatal Unit Cotonou, Benin from January 2015 to December 2016

Variables	Adjusted OR	CI 95 %	P value
Malformation	28.86	7.92-105.15	<0.01
Very low birth weight	9.35	5.19-16.83	<0.01
Perinatal asphyxia and other respiratory distress	2.78	1.62-4.79	<0.01
Preterm birth	2.15	1.28-3.60	0.003
Low birth delivery	1.68	1.04-2.71	0.031
Neonatal infection (NNI)	1.76	1.09 -2.85	0.020
Other health center origin	1.80	1.10-2.94	0.018
Resuscitation	2.15	1.34-3.45	0.001
Mother official	1.31	0.76-2.85	0.323
Pathology during pregnancy	0.79	0.50-1.26	0.332
Twin pregnancy	1.38	0.76-2.52	0.284
Log likelihood = -270.0251 Pseudo R2 = 0.2902; test de Hosmer- Lemeshow			

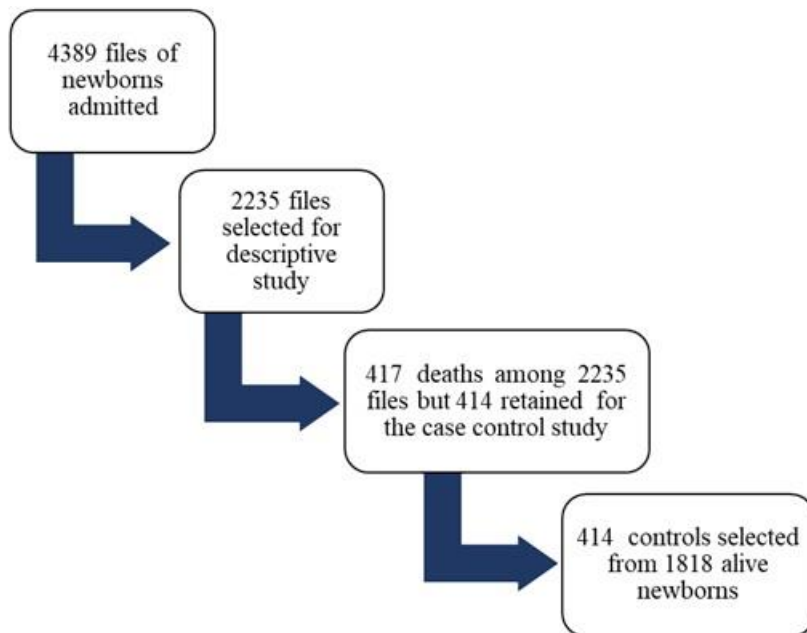


Figure 1: Flow chart of participant selection