

Neonatal Mortality and Morbidity in the Neonatology Unit of the Pediatrics Department of the Reference Health Center of Commune III of the District of Bamako

Djita Ba^{1*}, Bourama Kané², Isabelle Marie Angèle Traoré¹, Alima Tarata¹, Fatou Sadio Mangara¹, Mohamed Koita¹, Mady Niakaté³, Alassane Mono³, Dieneba Sacko⁴, Ouazoun Coulibaly⁵, Kadiatou Ba⁶, Mamadou Diakité⁷, Maimouna Kanté⁴, Mariam Kané⁸, Yaya Traoré⁹, Nouhoum Traoré¹⁰, Ibrahima Keita¹¹, Moussa Thienta¹¹, Fatoumata Mohamed Sako¹²

¹Pediatrics Department of the Referral Health Center of Commune III, Bamako, Mali

²Pediatrics Department of the Mali Hospital, Bamako, Mali

³Pediatrics Department, CHU Hôpital Mère Enfant Le Luxembourg, Bamako, Mali

⁴Pediatrics Department of the Referral Health Center of Commune V, Bamako, Mali

⁵Pediatrics Department of the Referral Health Center of Commune I, Bamako, Mali

⁶Pediatrics Department of the Referral Health Center of Commune II, Bamako, Mali

⁷Pediatrics Department, Clinique Alliance Médicale, Bamako, Mali

⁸Pediatrics Department of the Mohamed VI Perinatal Clinic, Bamako, Mali

⁹Regional Health Directorate of the District of Bamako, Bamako, Mali

¹⁰Pediatrics Department of the Referral Health Center of Commune IV, Bamako, Mali

¹¹Research and Training Center on Parasites and Microbes, Bamako, Mali

¹²Computer Science Department, Mali Hospital, Bamako, Mali

Email: *djitaba2008@gmail.com

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Abstract

Introduction: In 2022, nearly half (47%) of deaths in children under 5 years of age occurred during the first 28 days of life, which corresponds to the neonatal period. Sub-Saharan Africa had the highest neonatal mortality rate in the world at 27%. In Mali in 2024, according to the Demographic Health Survey, the neonatal mortality rate is estimated at 29‰. Our neonatology unit did not have data on newborns. The objective is to study neonatal morbidity and mortality in the said unit. **Materials and Methods:** This was a prospective descriptive study from September 2022 to June 2023 including newborns aged 0-28 days admitted to the Neonatology Unit of the Reference Health Center of Commune III of the Bamako district. **Results:** From September 2022 to June 2023, we consulted 518 newborns, 245 of whom were hospitalized, representing a frequency of 47.2%. The average age was 0.93 days. The sex ratio was 1.2

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in favor of boys. The average age of mothers was 26.6 years. They were mostly in school (74.3%) and pauciparous (38.4%). Pregnancies were well monitored in 73.1% of them. The mode of delivery was vaginal at 67.3%. The most common pathologies were perinatal anoxia (62.8%), prematurity (35.4%) and neonatal infection (23.2%). We recorded a cure rate of 83.7% and a mortality rate of 13.9%. The only factors significantly associated with neonatal deaths in our study were the age of newborns (OR: 0.19, [95% CI OR: 0.04; 0.83], $p = 0.024$) and the number of parities of the mothers (OR = 2.465, $p = 0.038$). **Conclusion:** Neonatal mortality remains a public health problem in Mali despite government efforts. Newborns continue to die in our healthcare facilities from often preventable causes. The main factors significantly associated with neonatal deaths in our study were the age of the newborns and the number of parities of the mothers. Generally, good pregnancy monitoring and good surveillance of deliveries reduce the rate, even if our study did not prove it.

Keywords

Neonatal, Morbidity, Mortality, CSREF III of the Bamako District

1. Introduction

Neonatal mortality is defined as the death of children between 0 and 28 days of life. It is composed of early neonatal mortality where death occurs within the first 7 days of life and late neonatal mortality which means the occurrence of death between the eighth and twenty-eighth day of life [1]. The birth of a baby is a natural process and an important social event for the newborn's parents and for the wider community. However, the moment of birth and the first month constitute a very risky period for the child [1]. In 2022, the number of newborn deaths was 2.3 million. Neonatal deaths have decreased by 44% since 2000. Yet, in 2022, nearly half (47%) of deaths in children under five years of age occurred during the first 28 days of life, which corresponds to the neonatal period [2].

In 2022, sub-Saharan Africa accounted for 57% (between 2.5 and 3.3 million, or 2.8 million) of all under-five deaths and only 30% of live births worldwide. Its neonatal mortality rate was also the highest in the world at 27 deaths per 1000 live births, followed by Central and South Asia at 21 deaths per 1000 live births [2].

In 2022, of the 238 newborns admitted to the neonatology unit of the Felix Houphouët Boigny General Hospital, 75 died, representing an overall mortality rate of 31.5% [3].

In 2019, a study carried out in the pediatrics department of the Sylvanus-Olympio University Hospital in Lomé, Togo, showed a mortality rate of 17.8% among newborns [4]. Preterm births, birth complications (neonatal asphyxia and birth trauma), neonatal infections and congenital anomalies remain the leading causes of death in newborns [2].

Death within the first 28 days of life may be caused by a condition or illness

related to inadequate care during childbirth, or to the lack of care or treatment provided by qualified personnel immediately after birth and during the first days of life [2].

In Mali in 2023, according to the Demographic Health Survey (EDS VII), the neonatal mortality rate is estimated at 29 per 1000 live births [5].

In Mali in 2024, according to the Annual Report on the Surveillance of Maternal, Perinatal and Pediatric Deaths, 2056 newborns died, including 1978 newborns aged 0 to 7 days, *i.e.*, 96.2%, and 78 newborns aged 8 to 28 days, *i.e.*, 3.8% [6]. The main causes of death in newborns aged 0 to 7 days were asphyxia (45.7%) followed by prematurity (39.1%) and neonatal bacterial infection (8.4%). As for newborns aged 8 to 28 days, the causes of death in order of frequency were bacterial infection (36%), asphyxia (33%) and prematurity (17%) [6].

In Mali, in 2017, a study carried out in the pediatric department of the Nianakoro Fomba regional hospital in Ségou revealed a neonatal mortality rate of 25.1%. [7].

In Mali, in 2023 another study conducted on newborns aged 0 to 28 days at the neonatology unit of the Commune I Reference Health Center showed a mortality rate of 26.9% [8].

The Neonatology Unit of the Pediatrics Department of the Reference Health Center of Commune III of the Bamako district did not have data on newborns, which is why we initiated this work to study neonatal morbidity and mortality in the said unit.

2. Goals

2.1. General Objective

To study neonatal morbidity and mortality in the Neonatology Unit of the Pediatrics Department of the Reference Health Center of Commune III of the Bamako District.

2.2. Specific Objectives

- To determine the epidemiological characteristics of newborns hospitalized in the neonatology unit;
- Identify the main pathologies observed in these newborns;
- Describe the immediate outcome of sick newborns.

3. Methodology

3.1. Location of the Study

Presentation of the pediatric unit

Mali's health services are organized into 3 levels of care:

- The 1st level (community level): is the first contact for patients, it is made up of community health centers [9].
- The 2nd level (circle level): is the 1st reference. It is made up of referral health centers where appropriate care is provided for the condition that could not be

managed at level 1. There are 6 referral health centers for the 6 districts of Bamako [9].

- The 3rd level (regional level): is the 2nd reference. It is made up of public hospital establishments which have a higher technical platform than the reference health centers where conditions which cannot be treated at the reference health center have been evacuated [9].

Our study took place in the Neonatology Unit of the Pediatrics Department of the Reference Health Center of Commune III of the Bamako district.

3.2. Type and Period of Study

This was a prospective, descriptive, cross-sectional study and analytical from September 1, 2022 to June 30, 2023, a period of 10 months.

3.3. Study Population

Our study population was newborns aged 0 - 28 days who were hospitalized in the Neonatology Unit of the Pediatrics Department of the Reference Health Center of Commune III of the district of Bamako. It was classified into 2 age categories: [≤ 7 days] and [>7 days].

3.4. Sampling

Our study sample was exhaustive (all sick newborns aged 0 - 28 days hospitalized in the department during the study period).

3.5. Inclusion Criteria

The following were included during the study period:

- all sick newborns aged 0 - 28 days who were born in the maternity ward of our health center and who stayed in the Neonatology Unit during the study period;
- all sick newborns aged 0 - 28 days who have been referred to by other health facilities or by their families for care.

3.6. Non-Inclusion Criteria

Not included in the study:

- Patients over 28 days old;
- Sick newborns aged 0 - 28 days whose parents did not give their consent by participating in the study;
- Sick newborns aged 0 - 28 days hospitalized outside our study period;
- healthy newborns aged 0 - 28 days admitted for a routine check-up during the study period;
- Sick newborn files aged 0 - 28 days cannot be used (missing data).

3.7. Data Collection Process

It consisted of reviewing the medical records of newborns in order to include those that could be used in the study. Data collection was done using a question-

naire developed for this purpose. This questionnaire included the sociodemographic characteristics of the parents and newborns, the clinical and paraclinical characteristics, and their intra-hospital developments.

3.8. Variables Studied

The variables studied were of 3 orders:

- **Sociodemographic data**
Like the sex, age, origin of the newborns, age, the level of education and the occupation of mothers.
- **Clinical data**
Such as the mothers' medical and obstetrical history, weight, temperature and diagnosis.
- **Scalable data**
Such as the length of hospitalization and the outcome of patients.
- The dependent variable was the outcome of the newborns
- The independent variables were:
 - The age group, education level of the mothers, medical-surgical and gynecological history, parity group, mode of delivery of the mothers;
 - The age group, sex, birth weight and term of the newborns.

3.9. Operational Definition

- Newborn: is a child less than 28 days old [10].
- Neonatal mortality: is defined as any death of a live-born child occurring between 0 and 28 days [10].
- **Early neonatal mortality:** is the set of children born alive but who died before the 8th day of life [10].
- **Late neonatal mortality:** is the set of children born alive but who died between birth and the 8th and 28th day of life [10].
- Primiparous: is a woman who has given birth once [10].
- Pauciparous: is a woman who has had 2 or 3 births [10].
- Multiparous: is a woman who has had 4 to 5 births [10].
- **Large multiparous:** is a woman who has given birth more than 5 times [10].
- Full-term newborn: defined as a child born between 37 and 42 weeks of amenorrhea [10].
- Post-maturity or post-term: is a birth after 42 weeks of amenorrhea [11].
- Premature newborn: is a child born before the 37th week of amenorrhea [10].
- Intrauterine growth retardation is defined by a birth weight below the 10th percentile for gestational age [10].
- Macrosomia: is defined by a birth weight greater than 4 kilograms [12].
- Twins: sharing the same uterus during the same gestation [13].

3.10. Data Entry and Analysis

Data was collected from the hospitalization medical records of newborns hospi-

talized during the study period. Missing data were supplemented by the maternity and neonatal unit registers and by imputation by the mean. They were entered and analyzed using SPSS software version 25 and the software “R”. We conducted a univariate analysis by calculating frequencies, percentages, means, minimum values and maximum values. Bivariate analysis was used to determine the risk factors associated with mortality. Comparisons of proportions were performed using the Fisher test and Chi-square. The significance threshold was set at $p < 0.05$ and the confidence interval at 0.5%. Word and Excel version 2019 software were used for writing and processing the tables.

3.11. Ethical Considerations

In our study, data collection procedures were carried out with the permission of the local health authorities of the center and that of the patients’ parents. The information collected was only accessible to those involved in the study. Coding helped secure the collected data. There were no conflicts of interest. The results obtained will not be used for any other purposes; they will be used to improve medical practice.

4. Results

4.1. Univariate Analysis

Epidemiological Characteristics

1) Frequency

From September 2022 to June 2023, we consulted 518 newborns, 245 of whom were hospitalized in the neonatology unit, a proportion of 47.2%.

2) Sociodemographic characteristics

- Sociodemographic characteristics of mothers

Table 1. Distribution of newborns according to the sociodemographic characteristics of the mothers.

Age in years	Frequency N = 245	%
[15 - 25]	126	51.4
[26 - 35]	95	38.8
>35	24	9.8
Mothers’ educational level	Frequency N = 245	%
Koranic	7	2.9
not educated	56	22.9
Primary	77	31.4
Secondary	68	27.8
Superior	37	15.1

Continued

Mothers' profession	Frequency N = 245	%
Housekeeper	5	2.0
Hairdresser	5	2.0
Shopkeeper	14	5.7
Seamstress	2	0.8
Student	34	13.9
Housewife	131	53.5
Restaurateur	1	0.4
Employee	27	11.0
Dyer	2	0.8
Saleswoman	24	9.8

More than half of the mothers of our newborns were in the age group [15 - 25 years] or 51.4%. The average age was 26.6 years with extremes of 16 and 45 years. They were mostly educated at primary level (31.4%), secondary level (27.8%) and higher level (15.1%). They were also mostly housewives (53.5%) (**Table 1**).

- **Sociodemographic characteristics of newborns**

Most newborns were in the age range [0 - 7 days] of life at admission, *i.e.* 96.7%. The mean age was 0.93 days with extremes of 0 and 28 days. The male sex was predominant with a sex ratio of 1.2 in favor of boys. Most of our newborns come from 2nd level health centers (**Table 2**).

Table 2. Distribution of newborns according to their sociodemographic characteristics.

Age in days	Frequency N = 245	%
[0 - 7]	237	96.7%
>7	8	3.3
Sex	Frequency	%
Male	138	56.3
Female	107	43.7
Total	245	100.0
Origin	Frequency	%
Residence	29	11.8
1st level health center	35	14.3
2nd level health center	180	73.5
Private clinic	1	0.4

3) Clinical features

• Clinical characteristics of mothers

A small proportion of our newborns' mothers had a medical or surgical history (7.3%). The most common medical histories were high blood pressure (4.5%), followed by diabetes (2.6%) and sickle cell disease (1.2%) (Table 3).

Table 3. Distribution of newborns according to the mothers' medical and surgical history.

Medical and surgical history	Frequency N = 245	%
Asthma	1	0.4
Diabetes	3	1.2
Sickle cell disease	3	1.2
High blood pressure	7	2.9
High blood pressure and diabetes	4	1.6
No background	227	92.7

Table 4. Distribution of newborns according to the mothers' gynecological-obstetric history.

Pregnancy number range	Frequency N = 245	%
1	69	28.2
[2 - 3]	80	32.7
≥4	96	39.2
Parity	Frequency N = 245	%
Primiparous	69	28.2
Pauciparous	94	38.4
Multiparous	55	22.4
Large multiparous woman	27	11.0
Abortion number range	Frequency N = 245	%
0	226	92.2
[1 - 2]	15	6.1
≥3	4	1.6
Total	245	100.0
Obstetric history	Frequency N = 245	%
Boundary basin	1	0.4
Caesarean section	10	4.1
No obstetric history	234	95.5

More than half of the mothers of our newborns had one to three pregnancies, *i.e.* 60.7%. Ninety-four mothers out of the 245 were pauciparous, *i.e.* 38.4%, and 28.2% were primiparous. Most of the mothers of our newborns did not have an abortion, *i.e.* 92.2%. A small proportion of the mothers of our newborns had a history of obstetrics (4.5%). This was a cesarean section in 4.1% and borderline pelvic section in 0.4% (**Table 4**).

The vast majority of our newborns' mothers had three or more prenatal visits, or 73.1% of them. A small proportion of our newborns' mothers were fully immunized against tetanus, or 4.1%.

HbsAg serology was performed on 156 of our 245 newborn mothers, a proportion of 63.6%. It came back positive in 3.3% (**Table 5**).

Table 5. Distribution of newborns according to the progress of the mothers' pregnancy.

Prenatal consultation period	Frequency N = 245	%
0	38	15.5
[1 - 2]	28	11.4
≥3	179	73.1
Tetanus vaccine dose range	Frequency N = 245	%
0 dose	175	71.4
[1 - 2 doses]	60	24.5
≥3 doses	10	4.1
Serologies		
Hbs antigen	Frequency N = 156	%
Negative	151	96.7
Positive	5	3.3
BW	Frequency N = 164	%
Negative	162	98.7
Positive	2	1.3
Toxoplasmosis	Frequency N = 115	%
Negative	107	93.0
Positive	8	7.0
HIV	Frequency N = 194	%
Negative	189	97.4
Positive	5	2.6

BW serology was performed on 164 of the 245 mothers of our newborns, a proportion of 66.9%. It came back positive in 1.3%.

Toxoplasmosis serology was performed on 115 of our 245 newborn mothers, a proportion of 46.9%. It came back positive in 7%.

HIV serology was performed on 194 of our 245 newborn mothers, a proportion of 79.1%. It came back positive in 2.6%.

Obstetric ultrasound was performed in 66.9% of the mothers of our newborns. It revealed, in order of frequency, multiple pregnancies in 11% of patients, followed by hydrocephalus in 1.2% and malformations in multiple pregnancies in 0.8% (**Table 6**).

Table 6. Distribution of newborns according to the number and results of obstetric ultrasound performed by the mothers.

Number of obstetric ultrasounds performed	Frequency N = 245	%
0	42	17.1
1	88	35.9
2	76	31.0
≥3	39	15.9
Obstetric ultrasound results	Frequency N = 245	%
Anamnios	1	0.4
Circular cord	1	0.4
Triple circular cord	1	0.4
Double circular cord	1	0.4
Multiple pregnancy	25	10.2
Hydrocephalus	3	1.2
Functional ovarian cyst	1	0.4
Malformations in multiple pregnancies	2	0.8
Moderate oligoamnion	1	0.4
Low fetal weight and circular cord	1	0.4
Placenta previa type 2	1	0.4
Seat presentation	1	0.4
No anomaly	166	67.8
Total	245	100.0

Pathologies were observed in 124 of the 245 mothers, a proportion of 50.6%. The most frequently found pathologies were malaria (45.1%), followed by non-malarial infection (20.1%) and pre-eclampsia and eclampsia (16.1%) (**Table 7**).

Table 7. Distribution of newborns according to pregnancy pathologies.

Pregnancy pathologies	Frequency	%
Anemia	14	5.7
Anemia and non-malarial infection	2	0.8
Anemia and preeclampsia	1	0.4
Chorioamnionitis and malaria	1	0.4
Eclampsia	2	0.8
Retroplacental hematoma	4	1.6
Retroplacental hematoma and malaria	2	0.8
High blood pressure	4	1.6
Non-malarial infection	20	8.2
Non-malarial infection and high blood pressure	3	1.2
Malaria	48	19.6
High blood pressure and malaria	2	0.8
Placenta previa	3	1.2
Preeclampsia	14	5.7
Preeclampsia and malaria	3	1.2
Providence of the cord	1	0.4
Without associated pathology	121	49.4
Total	245	100.0

Delivery was spontaneous in 74.2% of mothers. The rupture of the water bag was observed in 8.2 of them. The vaginal route was the most frequent mode of delivery (67.3%). The presentation was cephalic in many of our newborns (96.3%). Instrumental maneuvers were performed in 10.6% of mothers (**Table 8**).

- **Clinical characteristics of newborns**

- Twenty-one of the 245 newborns were twins, a proportion of 8.6% (**Table 9**).
- The mean gestational age was 35.7 weeks of amenorrhea with extremes of 28 and 47 weeks of amenorrhea. 63.7% of cases were full-term newborns, 35.9% were premature, and one was a post-mature newborn.
- A large number of newborns (48.6%) have a weight in the range [25,001 - 3999 grams]. The average weight was 2449.3 grams with extremes of 990 and 5300 grams. More than half of the newborns (56.7%) are in the size range [46 - 54 centimeters]. The average size is 46.7 centimeters with extremes of 38 to 55 centimeters. One hundred and eighteen newborns out of the 245 have a head circumference in the range [32 - 36 centimeters] or a proportion of 48.6%. The average head circumference is 32.2 centimeters with variances of 25 and 42 centimeters.

Table 8. Distribution of newborns according to the course of delivery.

Childbirth	Frequency N = 245	%
Spontaneous	182	74.3
Triggered	63	25.7
Premature rupture of the water bag	Frequency N = 245	%
No	225	91.8
Yes	20	8.2
Mode of delivery	Frequency N = 245	%
low track	165	67.3
Caesarean section	80	32.7
Presentation	Frequency N = 245	%
Cephalic	236	96.3
Seat	8	3.3
Transversal	1	0.4
Instrumental maneuver	Frequency N = 245	%
Forceps	2	0.8
Suction cup	24	9.8
Without instrumental maneuver	219	89.4

Table 9. Distribution of newborns according to their gestational ages and birth parameters.

Twin	Frequency N = 245	%
No	224	91.4
Yes	21	8.6
Gestational age range	Frequency N = 245	%
Premature newborn	88	35.9
Full-term newborn	156	63.7
Post-mature newborn	1	0.4
Weight range in grams	Frequency N = 245	%
<1500	32	13.1
[1500 - 2499]	91	37.1
[2500 - 3999]	119	48.6
[4000 - 6000]	3	1.2
Size range in centimeters	Frequency N = 245	%
<46	105	42.9
[46 - 54]	139	56.7
>54	1	0.4
Head circumference slice in centimeters	Frequency N = 245	%
<32	118	48.2
[32 - 36]	115	46.9
>36	12	4.9

Perinatal anoxia was the most frequent pathology (62.8%) followed by prematurity (35.4%) and neonatal infection (23.2%) associated or not with other pathologies (Table 10).

Table 10. Distribution of newborns according to morbidity.

Morbidity	Frequency	%
Perinatal anoxia	81	33.1
Perinatal anoxia and anemia	3	1.2
Perinatal anoxia and imperforation of the right choana	1	0.4
Perinatal anoxia and neonatal infection	22	9.0
Perinatal anoxia, neonatal infection, prematurity and twinning	1	0.4
Perinatal anoxia, neonatal infection and heart disease	1	0.4
Perinatal anoxia and macrosomia	2	0.8
Perinatal anoxia and malformation	1	0.4
Perinatal anoxia and prematurity	25	10.2
Perinatal anoxia, prematurity, twinning and malformation	1	0.4
Perinatal anoxia, prematurity and twinning	2	0.8
Perinatal anoxia, prematurity and microphthalmia	1	0.4
Perinatal anoxia and intrauterine growth retardation	12	4.9
Perinatal anoxia, twinning and intrauterine growth retardation	1	0.4
Hydrocephalus and intrauterine growth retardation	1	0.4
Congenital hydrocephalus	1	0.4
Jaundice and intrauterine growth retardation	1	0.4
Neonatal infection	20	8.2
Neonatal infection and hypoglycemia	1	0.4
Neonatal infection and prematurity	6	2.4
Neonatal infection, twins and prematurity	2	0.8
Neonatal infection and intrauterine growth retardation	2	0.8
Neonatal infection, intrauterine growth retardation due to trisomy	1	0.4
Neonatal infection and twinning	1	0.4
Prematurity	24	9.8
Prematurity and intrauterine growth retardation	4	1.6
Prematurity and twinning	21	8.6

Continued

Intrauterine growth retardation	4	1.6
Delayed resorption of pulmonary fluid	1	0.4
Hemorrhagic syndrome	1	0.4
Total	245	100.0

We recorded a cure rate of 83.7%, a dropout rate of 0.8%, and a mortality rate of 13.9%. This included early mortality in 73.5% of cases and late mortality in 26.4%. Four of the 245 newborns were referred to third-level hospitals for specific care (Table 11).

Table 11. Distribution of newborns according to their intra-hospital outcome.

Intra-hospital care of newborns	Frequency	%
Cured	205	83.7
Early death	25	10.2
Late death	9	3.7
Referred	4	1.6
Abandon	2	0.8
Total	245	100.0

4.2. Bivariate Analysis

4.2.1. Sociodemographic Characteristics and Future

- Sociodemographic characteristics of mothers and the outcome of newborns (Table 12).
- Sociodemographic characteristics of newborns and their outcome (Table 13).

Table 12. Distribution of newborns according to outcome and level of education, and the age group of their mothers.

Age group of mothers in years	Outcome		Total	p-value ¹
	Death	Healing		
[16-25]	20 (50.0%)	106 (51.7%)	126 (51.4%)	0.8
[26-35]	15 (37.5%)	80 (39.0%)	95 (38.8%)	
[≥36]	5 (12.5%)	19 (9.3%)	24 (9.8%)	
Mothers' educational level	Death	Healing	Total	p-value ¹
Schooled	28 (70.0%)	161 (78.5%)	189 (77.1%)	0.33
No scolored	12 (30.0%)	44 (21.5%)	56 (22.9%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

Table 13. Distribution of newborns by age group, sex and their outcome.

Age group in days	Outcome		Total	p-value ¹
	Death	Healing		
≤7	36 (90.0%)	201 (98.0%)	237 (96.7%)	0.032
>7	4 (10.0%)	4 (2.0%)	8 (3.3%)	
Sex	Death	Healing	Total	p-value ²
Male	19 (47.5%)	119 (58.0%)	138 (56.3%)	0.2
Female	21 (52.5%)	86 (42.0%)	107 (43.7%)	
Origin	Death	Healing	Total	p-value ²
Residence	9 (31%)	20 (69%)	29 (100%)	0.06
1st level health center	5 (15%)	28 (85%)	33 (100%)	
2nd level health center	26 (15%)	152 (85%)	178 (100%)	
Private structures	0 (0%)	1 (100%)	1 (100%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

4.2.2. Clinical Characteristics and Outcome

- Clinical characteristics of mothers and the outcome of newborns (Tables 14-16).
- Clinical characteristics of newborns and their outcome (Table 17, Table 18).

Table 14. Distribution of newborns according to their outcome and the medical and surgical history of their mothers.

Medical and surgical history	Outcome		Total	p-value ¹
	Death	Healing		
Asthma	0 (0.0%)	1 (0.5%)	1 (0.4%)	0.8
Diabetes	0 (0.0%)	3 (1.5%)	3 (1.2%)	
Sickle cell disease	1 (2.5%)	2 (1.0%)	3 (1.2%)	
High blood pressure	1 (2.5%)	6 (2.9%)	7 (2.9%)	
High blood pressure and diabetes	0 (0.0%)	4 (2.0%)	4 (1.6%)	
No medical or surgical history	38 (95.0%)	189 (92.2%)	227 (92.7%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

Table 15. Distribution of newborns according to their outcome and the gynecological-obstetric history of their mothers.

Parity	Outcome		Total	p-value ¹
	Death	Healing		
Primiparous	13 (32.5%)	56 (27.3%)	69 (28.2%)	0.6
Pauciparous	17 (42.5%)	77 (37.6%)	94 (38.4%)	
Multiparous	6 (15.0%)	49 (23.9%)	55 (22.4%)	
Large multiparous woman	4 (10.0%)	23 (11.2%)	27 (11.0%)	
Obstetric history	Death	Healing	Total	p-value ¹
Boundary basin	0 (0.0%)	1 (0.5%)	1 (0.4%)	0.7
History of cesarean section	1 (2.5%)	9 (4.4%)	10 (4.1%)	
No Obstetric History	39 (97.5%)	195 (95.1%)	234 (95.5%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

Table 16. Distribution of newborns according to their outcome and monitoring of the pregnancy, method of delivery.

Prenatal consultation	Outcome		Total	p-value ¹
	Death	Healing		
Poorly monitored pregnancy	13 (32.5%)	53 (25.9%)	66 (26.9%)	0.5
Pregnancy well monitored	27 (67.5%)	152 (74.1%)	179 (73.1%)	
Mode of delivery	Death	Healing	Total	p-value ¹
Caesarean section	11 (27.5%)	69 (33.7%)	80 (32.7%)	0.5
low track	29 (72.5%)	136 (66.3%)	165 (67.3%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

Table 17. Distribution of newborns according to gestational age, birth weight and their outcome.

Gestational age range in weeks of amenorrhea	Outcome		Total	p-value ¹
	Death	Healing		
<37	13 (32.5%)	75 (36.6%)	88 (35.9%)	0.7
[37 - 42]	27 (67.5%)	129 (62.9%)	156 (63.7%)	
>42	0 (0.0%)	1 (0.5%)	1 (0.4%)	
Weight range in grams	Death	Healing	Total	p-value ¹
<1500	3 (7.5%)	25 (12.2%)	28 (11.4%)	0.7
[1500 - 4000]	37 (92.5%)	177 (86.3%)	214 (87.3%)	
>4000	0 (0.0%)	3 (1.5%)	3 (1.2%)	
Total	40 (100.0%)	205 (100.0%)	245 (100.0%)	

Table 18. Association of deaths with newborn age and maternal parity.

Variable	Estimate (β)	Std. Error	z-value	p-value	OR (exp(β))	95% CI OR (approximate)
(Intercept)	2.4677	0.9853	2505	0.0123*	—	—
Tetanus vaccination for mothers	0.7613	0.4411	1726	0.0844	2.14	[0.90; 5.07]
Age range of newborns	-1.6606	0.7388	-2.248	0.0246*	0.19	[0.04; 0.83]
Mothers' education level	-0.6358	0.415	-1.53	0.125	0.529	
Parity number	0.9024	0.434	2.08	0.038	0.9024	
Number of pregnancies	-0.7144	0.483	-1.48	0.139	0.489	

5. Comments and Discussion

5.1. Descriptive Study

Epidemiological Characteristics

1) Frequency

From September 2022 to June 2023, we consulted 518 newborns, 245 of whom were hospitalized in the neonatology unit, a proportion of 47.2%. Our frequency is higher than that of Sangaré *et al.* [14] and Zagré *et al.* [15] which respectively recorded frequencies of 13.7% and 8.6%. It is lower than that of Omoigberale *et al.* [16] who found a frequency of 84.6% in their study.

2) Sociodemographic characteristics

• Sociodemographic characteristics of mothers

○ Age of mothers

More than half of the mothers of our newborns (51.4%) were in the age group (15 - 25 years) with a mean age of 26.6 years and extremes of 16 and 45 years. The mean age of the mothers in our series is close to that of Kedy *et al.* [17]. (26.8 years old) and that of Mr. Diarra [18] (27 years). It is lower than that reported by C. Sylla [19] (29.5 years old).

○ Mothers' educational level

The mothers of our newborns were mostly educated (74.3%): primary level (31.4%), secondary level (27.8%), higher level (15.1%). Our data are higher than those of S. NKounou [20] who found a frequency of 57.6% of educated mothers in his study. However, Mr. Diarra [18] reported a high frequency (66.5%) of non-school-going mothers in their study.

○ Mothers' profession

In our study, the mothers of our newborns were mostly housewives (53.5%) as in most studies, notably that of Mr. Diarra [18] (82%), that of S. Nkounou [20] (61.9%) and Sangaré *et al.* [14] (60%).

• Sociodemographic characteristics of newborns

○ Age

Most newborns were less than one week old at admission, *i.e.*, 96.7%. The mean age of our newborns was 0.93 days, with extremes of 0 and 28 days. This is lower

than that of Nagalo *et al.* [21] and Kedy *et al.* [17] who respectively recorded average ages of 2 and 4 days. It is higher than that of and Zagré *et al.* [15] which recorded an average age of 0.18 days.

- Sex

In our series, the male sex was predominant with a sex ratio of 1.2 in favor of boys. Our result is consistent with data from the literature. [12] [22] and those reported by most authors, notably that of Yenan *et al.* [23], Okechukwu *et al.* [24], Zagré *et al.* [15], Mukhtar-Yola *et al.* [25]. On the other hand, Boiro *et al.* [26] had a female predominance (58.2%) in their series.

5.2. Clinical Features

5.2.1. Clinical Characteristics of Mothers

- **Mothers' medical history**

A small proportion of our newborns' mothers had a medical or surgical history (7.3%). The most common medical histories were high blood pressure (4.5%) followed by diabetes (2.6%) and sickle cell disease (1.2%). Our data are similar to those of Boiro *et al.* [26] who mainly observed high blood pressure as an antecedent in 18.1% of mothers followed by obesity (13.4%) and sickle cell disease (5.5%). They are different from those of S. NKounou [20] who reported in order of frequency sickle cell disease (50%) and asthma (20%).

- **Gynecological-obstetric history**

- Ninety-four mothers out of 245 were pauciparous (38.4%) and 28.2% were primiparous. Our data are comparable to those of Boiro *et al.* [26] who found mostly pauciparous (42.5%) and primiparous (40.9%) mothers in their series while Nagalo *et al.* [21] had a high frequency of multiparous (56.1%) in their study.
- We noted a history of abortion in 19 mothers out of 245, a proportion of 7.7%, whereas Boiro *et al.* [26] noted almost double in their sample (15.7%).
- A small proportion of the mothers of our newborns had a history of obstetrical complications (4.5%). This included a history of cesarean section in 4.1% and borderline pelvic delivery in 0.4%.

- **Course of pregnancy**

- Pregnancy was well monitored in most mothers of our newborns (73.1%) because they had more than 3 prenatal consultations. Our data are higher than those of S. NKounou [20] (41%), of C. Sylla [19] (35.3%) and Boiro *et al.* [26] (34.6%).
- Malaria was the most frequently associated pathology with pregnancy in the mothers of our newborns (45.1%) followed by non-malaria infection (20.1%) and preeclampsia/eclampsia (16.1%). However, in the study by Boiro *et al.* [26], preeclampsia was the most frequently observed in mothers with a frequency of 15.3%.

- **Progress of childbirth**

- Rupture of water membranes lasting more than 18 hours was observed in

8.2% of mothers. Our result is close to that of Boiro *et al.* [27] who observed rupture of water membranes in 10.2% of mothers. However, it is significantly lower than that of Yasmina *et al.* [28] who observed rupture of the water membranes in 66.6% of mothers in their study.

- Labor was induced in 25.7% of our parturients while Ben Guigui *et al.* [29] induced labor in 54.5% of the parturients in their study.
- Vaginal delivery was performed in 67.3% of mothers. Our result is slightly lower than that of Sangaré *et al.* [14] who found a frequency of 78%. It is significantly higher than that of Boiro *et al.* [26] who only had a frequency of 2.4% of vaginal delivery.
- The presentation was the seat in 3.3% of our parturients almost as in the study of Mukuku *et al.* which had a frequency of 2.5%.

5.2.2. Clinical Characteristics of Newborns

• Gestational age

The mean gestational age was 35.8 weeks of amenorrhea with extremes of 28 and 67 weeks of amenorrhea. 63.7% of the cases were full-term newborns, 35.9% were premature and 0.4% were post-maturity. Our data were comparable to those of Nagalo *et al.* [21] who reported a high frequency of full-term newborns (64.1%) followed by premature (33.6%) and post-maturity (2.3%) while Boiro *et al.* [26] observed 66.3% of premature and 33.7% of full-term newborns in their series.

• Birth weight

In our sample, a large number of newborns had a weight in the (2001 - 300 grams) range. The average weight was 2449.3 grams with extremes of 990 and 5300 grams. The average weight of the newborns in our sample is close to that of Nagalo *et al.* [21] (2632 grams). It is higher than that of Boiro *et al.* [26] (1879 grams) and lower than those of Kedy *et al.* [17] and Mukuku *et al.* who respectively found average birth weights of 3000 and 3168 grams in their studies.

• Morbidity

Perinatal anoxia was the most frequent pathology (62.8%) followed by prematurity (35.4%) and neonatal infection (23.2%) associated or not with other pathologies. Our data are comparable to those of most authors, notably those of Omoigberale *et al.* [16], Hedstrom *et al.* [30], by Mukhtar-Yola *et al.*, by Okechukwu *et al.* [24] and Ekwochi *et al.* [31]. On the other hand, Nagado *et al.* [21] found in order of frequency neonatal infection (23.5%), anomalies related to the duration of gestation and fetal growth (17.9%) and congenital malaria (15.1%). As for Kedy *et al.* [17], they observed in their series a high frequency of neonatal infection (76.8%) followed by neonatal jaundice (16.6%) and asphyxia (15.9%).

• Mortality

We recorded a cure rate of 83.7%, a dropout rate of 0.8%, and a mortality rate of 13.9%. Our mortality rate is identical to those of Miles *et al.* [32] (13.9%) from Thomson *et al.* [33] (13.5%) and Okechukwu *et al.* [24] (13.3%). It is slightly

higher than those of Diallo *et al.* [10] (12.7%) and Katamea *et al.* [34] (12.9%). However, rates higher than ours have been recorded by several authors, notably by Ekwochi *et al.* [31] (14.2%), by Ntambue *et al.* [35] (27%) by Ouattara *et al.* [36] (29.8%) and by Zagré *et al.* [15] (92.7%).

It was mainly early mortality (73.5%) as in Arsène's studies *et al.* [37] of Ouattara *et al.* [36], and of Hadgu *et al.* [38] which respectively reported high early neonatal mortality rates of 85.6%, 89% and 98.3% in their series.

5.2.3. Analytical Study

The only factors significantly associated with neonatal deaths in our study were the age of newborns and the number of parities of the mothers. Newborns less than a few days old were significantly more at risk of death than those a little older (OR: 0.19, [95% CI OR: 0.04; 0.83], ($p = 0.024$) and newborns of multiparous and grand multiparous women were also significantly more at risk of death than those of primiparous women (OR = 2.465, $p = 0.038$). These risk factors for death are different from those of most authors. Ouattara *et al.* [36] showed in their study that the number of prenatal consultations, the occurrence of a pathology during pregnancy, the use of sulfadoxine pyrimethamine, the term of pregnancy at delivery, the place of delivery, the mode of delivery, the sex of the newborn, his age, his weight, the health structure that referred him and the main diagnosis were significantly associated with neonatal mortality at the threshold of 20%. As for Arsene *et al.* [37], they found as risk factors associated with death in their study asphyxia ($p = 0.007$) and neonatal infection (0.042). In the study of Akolly *et al.* [4], neonatal factors significantly associated with death were admission during the first 24 hours of life ($p = 0.001$), place of birth outside the university hospital ($p = 0.002$) and duration of initial resuscitation greater than ten minutes ($p = 0.000^*$).

In that of Djivoheoussoun A *et al.* [3], the determining factors of early neonatal mortality found were the insufficient number of prenatal consultations ($p = 0.001$), poor Apgar ($p = 0.001$), prematurity ($p = 0.001$) and very low birth weight ($p = 0.001$).

6. Conclusions

Neonatal mortality remains a major public health problem in Mali, despite efforts by the government and its partners. Newborns continue to die in our health facilities from often preventable causes. Generally, high-quality prenatal consultations and the monitoring of deliveries by qualified personnel in well-equipped health facilities contribute to a reduction in this rate.

Our study revealed that the main pathologies suffered by our newborns were, in order of frequency, perinatal anoxia, prematurity and neonatal infection. It also found that the only factors significantly associated with neonatal deaths were the age of the newborns and the number of parities of the mothers. These conditions can be prevented by proper pregnancy monitoring and delivery surveillance. However, it also emerged that the pregnancies of a large majority of the mothers

of our newborns had been monitored and most of them had given birth in a health facility.

Conflicts of Interest

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

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