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Prevalence and Factors Associated with Neonatal Mortality at Ndola Teaching Hospital, Ndola Zambia

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Abstract

Background: The impact of neonatal mortality continues to be a challenge worldwide. Some of the causes of neonatal deaths include: preterm birth, infections and asphyxia neonatorum. The aim of the study was to determine the prevalence and factors that were associated with neonatal mortality at Ndola Teaching Hospital in Zambia. **Methodology:** A case series retrospective quantitative analytical study design was used. Data were collected using a structured questionnaire from 169 case notes from January to December, 2021 that were randomly selected from Neonatal Intensive Care Unit at Ndola Teaching Hospital. Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Chi-square test was used to test associations between variables and the level of significance was set at 0.05 and at 95% confidence interval. **Results:** The prevalence of neonatal mortality was 8.9%. Concerning neonatal characteristics, 60.2% were male, the most common length of stay in the NICU was less than 7 days representing 75.7%. There was an association between being born preterm or very preterm and neonatal mortality (P-value = 0.001). Neonates who were resuscitated at birth and admitted with subnormal temperatures (35 degrees or below) were more likely to die (P-value = 0.0001). **Conclusion:** The study revealed that Neonatal mortality is high among hospitalized neonates at Ndola Teaching Hospital in Zambia. There is a need to scale up interventions such as strengthening antenatal care and staff to be familiar with resuscitation of neonates to mitigate risk factors to neonatal mortality.

Keywords

Neonate, Mortality, Prevalence, Factors Associated with Neonatal Mortality

1. Introduction

The first 28 days of life are the most vulnerable time for a child's survival [1]. The causes of death may be associated with lack of quality care at or immediately after birth [2]. Globally, 2.4 million children died in the first month of life in 2020, representing 6500 neonatal deaths every day. The World Health Organization (WHO) states that nearly half of the under 5 deaths occurred in the neonatal period, an increase from 40% in 1990 globally, though a decline in neonatal deaths was recorded from 5 million in 1990 to 2.4 million in 2020. However, the reduction has been very slow [3]. Although neonatal mortality is a global problem, it is more prevalent in developing, low and middle-income countries. According to the WHO [2], in sub-Saharan Africa, 27 deaths per 1000 live births were recorded with 43% of global newborn deaths followed by Central Africa and Asia representing 23 deaths per 1000 live births with 36 % of global new deaths.

The causes of neonatal mortality are numerous and vary in different places. According to a study conducted in South America [4], significant factors that contributed to neonatal mortality were absence of a partner, maternal age above 35 years, multiple gestation, very low birth weight, gestation age of less than 37 weeks and absence of prenatal care among others. Additionally, a similar study [5] found that primipara, prematurity, low birth weight, perinatal asphyxia, respiratory distress syndrome, neonatal sepsis and duration of hospital stay were associated with neonatal mortality.

In Zambia, neonatal mortality rate stands at 27 deaths per 1000 live births [6]. The Ministry of Health (MOH) has developed measures to reduce the neonatal mortality by developing the Essential Newborn Care Guidelines in 2014. Other solutions that have been put in place include: increasing the number of women attending antenatal care visits to 80%, skilled birth attendance to 80%, and children to be fully immunized by their first birthday to 80% among others [3].

Ideally, all newborns must survive and grow to be productive adults. However, the WHO [2] observed that newborns succumb to death due to lack of access to basic lifesaving interventions such as skilled birth attendants at birth, lack of quality postnatal care, lack of breastfeeding, no access or inability to vaccinate the child and inadequate treatment of common childhood diseases. The above factors reduce the chances of neonatal survival. Therefore, the WHO is working with ministries and partners in order to improve quality of maternal and neonatal care from pregnancy through to the entire postnatal period to reduce neonatal mortality and improve chances of neonatal survival.

Despite the development of the guidelines on provision of quality maternal and child health services by the Ministry of Health (MOH), the neonatal mortality continues to be high at 27 per 1000 live births [6]. Ndola Teaching Hospital has continued to record high numbers of neonatal mortality; hence this study endeavored to determine the prevalence and factors that are associated with neonatal mortality at Ndola Teaching Hospital.

Research Question: What is the prevalence and what factors are associated

with neonatal mortality at Ndola Teaching Hospital?

2. Objectives of the Study

2.1. General Objective

The general objective of this study is to determine the prevalence and factors that are associated with neonatal mortality at Ndola Teaching Hospital.

2.2. Specific Objectives

The specific objectives of the study were:

1) To establish the prevalence of neonatal mortality at Ndola Teaching Hospital.

2) To determine factors that were associated with neonatal mortality at Ndola Teaching Hospital (NTH).

2.3. Justification

The WHO had accelerated progress for the survival of neonates by promoting the health and wellbeing of neonates through strengthening quality of health care provision. Some of the strategies that had been put in place included the introduction of newborn care where every newborn must have received: thermal protection, hygiene, umbilical care, and exclusive breastfeeding among others [2]. These measures could help to reduce neonatal mortality.

In sub-Saharan Africa, neonatal morbidity and mortality were identified as significant contributors to under-five morbidity and mortality [5]. In this study factors that were associated with neonatal mortality were identified as perinatal asphyxia, congenital anomaly, sepsis (early and late) and gestational age among others. Neonatal deaths could have been prevented if antenatal care, follow up and emergency obstetric care services were improved. In this regard, research was conducted to determine the prevalence and factors that were associated with neonatal mortalities at Ndola Teaching Hospital.

Neonatal mortality is a major public health problem worldwide and it accounts for one third of the deaths of children under the age of five [4] [7]. In Zambia, the neonatal mortality continues to be high at 27 per 1000 live births [6]. This study was conducted in response to an urgent need to identify and document the prevalence and factors that were associated with neonatal mortality at Ndola Teaching Hospital that could help to generate evidence-based protocols for monitoring neonates. If this problem was not addressed, it could be a huge financial burden on the economy of the country as well as wiping out the younger generation that are likely to take up adult roles in future. The neonatal mortality rate will consistently remain high. The hospitals and other health care service providers may lose trust and credibility from the community that they serve.

The government of the Republic of Zambia, Ministry of Health (MOH) in collaboration with other partners such as UNICEF and WHO help to implement maternal child health programmes in order to reduce maternal and neonatal mortal-

ity. The COVID pandemic could have also contributed to the neonatal deaths [8]. The findings from the study would provide valuable reference to the scientific community and the body of knowledge as far as the prevalence and factors that are associated with neonatal mortality. In addition, recommendations would be made on how to intensify neonatal care to policy makers, maternal and Child Health (MCH) Coordinators, Nurse Managers, Nurses, midwives, other health care professionals as well as Non-Governmental Organizations and the community at large in order to design strategies that can help neonatal mortality to identify factors that are associated with neonatal mortalities. The findings from the study would also provide a critical appraisal of the current protocols for management of neonates and generate recommendation to improve these protocols. Therefore, the research was conducted in order to determine the prevalence and actual factors that are associated with neonatal mortality. Furthermore, studies have been conducted to explore the prevalence and factors associated with neonatal mortality, however, no such study had been conducted in Ndola. This study determined the prevalence and factors that were associated with neonatal mortality at Ndola Teaching Hospital.

3. Methodology

A quantitative analytical design was used. The researcher used this study design to determine the prevalence and factors that were associated with neonatal mortality. This study design allowed the researcher to study data in retrospective that gave a wide view of the problem of neonatal mortality at Ndola Teaching Hospital. The researcher conducted a retrospective study at Ndola Teaching Hospital in Neonatal Intensive Care Unit (NICU). Data was retrieved for the period 1st January to 31st December 2021 from the NICU's admission registers, discharge registers, neonatal mortality summary sheets and annual reports. The information that was retrieved included the following details: date of admission, date of death, year of admission, duration of stay in NICU, sex, age at presentation, age of death, mode of delivery, weight at birth, gestational age at birth and the final diagnosis. This information was entered in Statistical Package for Social Sciences (SPSS). Thereafter, meanings were drawn, and conclusions were made that showed links between the dependent variable; neonatal mortality and the independent variables such as prematurity, sepsis and asphyxia among others.

Simple random sampling method was used to select the case records that were available to ensure representativeness. This method relied on data that was selected by those who provided it, in this case the nurses and the medical records clerks that handle case notes for the patients. The researcher worked with the clerks and nurses to identify case notes of the neonatal mortalities. A lottery method was used where each neonatal case record was assigned a unique number, papers were folded and later picked. The papers were then picked until the desired sample size was achieved, ensuring that each newborn had an equal chance of being included in the case group. If the case note did not have complete information,

it was removed and another case note was picked.

Inclusion criteria: The researcher included all the case notes of neonatal admissions that were delivered after 28 weeks of gestation from January to December, 2021. According to World Health Organization (WHO), a fetus is viable by 28 weeks of gestation.

Exclusion criteria: The case notes that had inadequate or incomplete information such as missing diagnosis, those out of the study time and all unregistered mortalities were excluded from the study.

As shown in Figure 1, 8.9% (15) neonates died whereas 91.1% (154) survived.

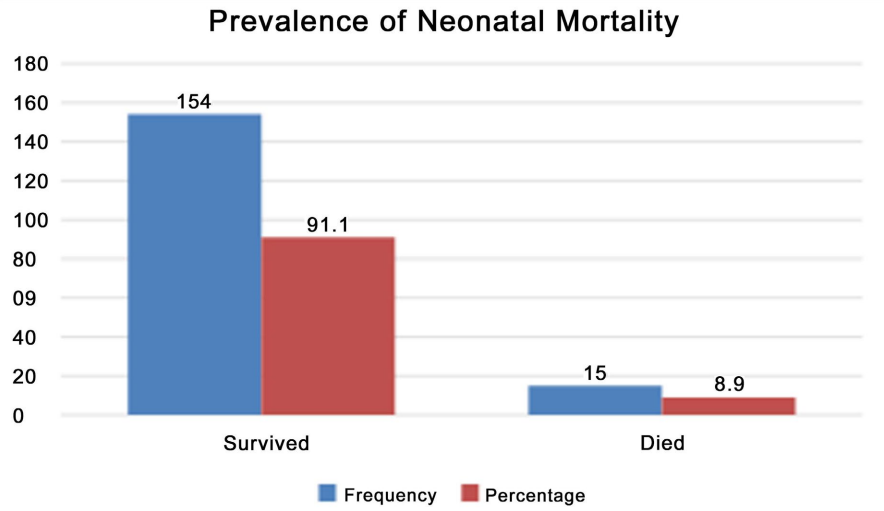

Figure 1. Prevalence of neonatal mortality (n = 169).

In this study, case notes of neonatal mortalities from January 2021 to December, 2021 made up the sample size.

The sample size was calculated using the Krejcie and Morgan (1970) formula for the final population as follows:

$$n = Z_2NP(1 - P)/d^2(N - 1) + Z_2P(1 - P)$$

P = the prevalence, in this study the prevalence 50% is expressed as 0.5 in decimals.

Z = 1.96 is the standard normal variate at 95% confidence level.

d = ±5% = ±0.05 is the degree of accuracy (5%), expressed as a proportion (0.05); It is the standard of error.

N = Population size.

$$n = Z_2NP(1 - P)/d^2(N - 1) + Z_2P(1 - P)$$

$$n = 1.96 \times 1.96 \times 251 \times 0.5(1 - 0.5)/0.05 \times 0.05(251 - 1) + 1.96 \times 1.96 \times 0.5(1 - 0.5)$$

$$= 3.8416 \times 251 \times 0.5 \times 0.5/1.5854$$

$$= 241.0604/1.5854$$

$$= 152$$

Adjusting for 10% case notes. This was done to carter for any dropouts and to

increase the power of the sample:

$$152/0.90 = 168.8$$

Therefore, the sample size of the case notes that was reviewed was 169.

Sample size calculation for prevalence

$$N = \frac{\left[\left(z_1 - a/2\right)^2 p\left(1-q\right)\right]}{d^2}$$

In Zambia, Neonatal mortality stands at 24.6% (World Bank, 2021).

p = prevalence of the event in the study group 24.6%.

d = expected absolute allowable error 10%.

$$z = 1.96$$

$$= \frac{\left(1.96\right)^2 0.246\left(0.754\right)}{0.10^2}$$

$$= 71$$

The single proportion to study prevalence was 71 neonatal deaths.

The sample size for the proportion of association that was reviewed was 169 as this was a bigger sample.

Validity of the tool was maintained by reviewing literature extensively on the variables of interest. The data collectors were supervised and data collected were checked for consistency and completeness on daily basis. The checklist was also pretested. The researcher consulted current sources of literature and experts on the topic. The research tool was tested before the main study was conducted using a pilot study in an environment with similar characteristics as the environment in which the main study was conducted to ensure stability of the data collection tool.

Data were collected from the Ndola Teaching Hospital-Neonatal Intensive Care Unit (NICU) after approval from the University of Zambia Biomedical Research Ethics Committee (UNZABREC), the National Health Research Authority and Ndola Teaching Hospital. All the data collectors were informed as soon as permission to handle the patients' case notes was granted. After collection of data, it was first corrected for completeness, uniformity and accuracy. The questions were then coded according to their variable categories and then graded against the set. Normality of data was checked using the Smirnov test. Data analysis was done using a computer software, Statistical Package for Social Sciences (SPSS) version 26 the level of statistical significance was set at 95% confidence level. Chi square testing was utilized to determine the relationship between categorical variables in circumstances where the cells had frequencies more than five and Fishers exact test was used when less than five. Multivariable logistic regression was used to assess the predictors of neonatal mortality such as prematurity, asphyxia neonatorum, neonatal sepsis and congenital birth defects.

4. Discussion

In this study, the main characteristics were maternal age group, maternal residence, age of neonate and sex of neonate. Table 1 shows that most of the mothers

who participated in this study were in the 20 - 24 age groups (31.8%, 51) and 25 - 39 age groups (23.7%, 40), and 85.8% (145) resided in urban areas. All the neonates were less than 7 days old, and 69.23% (117) were male. This is not a surprising finding as this age group is the child bearing age (46). This is similar to a study that was conducted in Ethiopia [5] titled Prevalence and Factors associated with Neonatal Mortality at Ayder Comphrehensive Specialized Hospital, Northern Ethiopia-A cross Sectional Study revealed that most of the neonates that died were born from primi para mothers, 89.8 (1603). This could be due to that first time mothers have inadequate knowledge and skills on how to care for the newborn babies [5]. This limitation in skills by health workers could be markers of the severity of neonatal outcomes. For instance, many of these mothers may not have enough knowledge on breast attachment and breast feeding among others. In addition primipara mothers might not have awareness about the importance of antenatal care follow up and postnatal period. Therefore, all mothers should have regular ANC follow-up and should get awareness about the importance of giving birth at the health facilities.

Table 1. Maternal and neonatal demographic characteristics (n = 169).

Variable	Category	Frequency (n)	Percent (%)
Maternal age group	15 - 19 years	22	13.0
	20 - 24 years	51	30.2
	25 - 29 years	40	23.7
	30 - 34 years	36	21.3
	Over 35 years	20	11.8
Maternal residence	Rural	24	14.2
	Urban	145	85.8
Age of neonate	Less than 7 days	169	100.0
Sex of neonate	Female	52	30.8
	Male	117	69.2

In a study titled Baby survival in Zambia: stillbirth and neonatal death in a local hospital setting reports that nurses and midwives need to assess patient risk and conduct timely referral [9]. Furthermore, nurses and midwives at hospitals need to accurately assess patient condition, contact the obstetrician in a timely manner, and manage problems before obstetrician arrival in order to prevent these deaths.

The current study shows that most of the mothers had singleton pregnancies and majority of the mothers attended antenatal care during their last pregnancy. Further, the data shows that all the mothers, delivered from the health facility. In the present study, neonates born to para 2 - 4 were 36% at less odds of dying when compared to neonates born from primipara mothers (**Table 2**). The fact that all the mothers delivered from a health facility could be attributed to the policies by

the Zambian Government as outlined in the 2018 maternal and neonatal guidelines [6] encourages that women should deliver from the health facility. The WHO [2] also recommends women to deliver from the health facility for close [2] monitoring by skilled health workers and subsequently curb maternal and neonatal mortality.

Table 2. Maternal clinical characteristics (n = 169).

Variable	Category	Frequency (n)	Percent (%)
Multiple pregnancies	Yes	03	1.8
	No	166	98.2
Number of pregnancies	1 - 2	96	56.8
	2 - 4	54	31.9
	5 - 6	19	11.2
Antenatal care attendance	Yes	167	98.8
	No	02	1.2
Mode of delivery	Spontaneous	44	26.0
	Assisted	16	9.5
	Caesarean	109	64.5
Place of delivery	Facility	169	100.0
Presence of chronic illness	Yes	40	23.7
	No	129	76.3

This study revealed that neonates who stayed less than seven days at NICU were 75.7% less likely to die compared to neonates who stayed for more than seven days (**Table 3**). This finding is in line with a study titled Predictors of Neonatal Mortality in a NICU referral Hospital in Southern Ethiopia: a retrospective cohort study that reported that neonates born with a temperature of 35.5 degrees celsius had 1.6 times higher risk of dying than those with temperature 35.5 to 37.5 degrees celsius [10]. In the same study, neonatal mortality was high in the first week of life. The reason could be that most neonatal deaths happen in the early neonatal periods (0 - 6 days of life) than in the late neonatal period of life of 7 - 28 days. Consequently, it was found that neonatal mortality was related to the length of stay in hospita. Thus, health workers should pay due attention to neonates in the early neonatal period to reduce neonatal mortality in the health facilities. In this case neonates who are in a hypothermic state may be more prone to different infections compared to neonates with normal body temperature.

In this study neonates who were delivered by cesarean section had a higher chance of survival than neonates born spontaneously by vaginal route. This finding is in contrast with a study conducted at Pakistan, where delivery using C-section had increased risk of neonatal mortality [2]. Therefore, neonates born through C-section had a high probability of survival than neonates delivered

Table 3. Neonatal clinical characteristics (n = 169).

Variable	Category	Frequency (n)	Percent (%)
HIV exposure	Exposed	39	23.1
	Unexposed	128	75.8
	No information	02	1.2
Weight at birth	Less than 2.5 kg	39	23.1
	Greater than 2.5 kg	130	76.9
Gestation at birth	Less than 37 weeks	74	43.8
	Greater than 37 weeks	95	56.2
Resuscitated at birth	Yes	61	36.1
	No	108	63.9
Length of hospital stay	Less than 7 days	128	75.7
	Greater than or equal to 7 days	41	24.3
Temperature on admission	35 and below	137	81.1
	35 - 36	11	6.5
	36 - 37.2	11	6.5
	37.2 - 38	10	5.9

through the natural birth canal as C-section if performed early could reduce complications during delivery. Further, this result is in agreement with a study conducted in southern Ethiopia referral hospital NICU, where neonates delivered using C-section had 66% less chance of risk of death compared to SVD [7]. This could be attributed to timely decision making rather than simply waiting for vaginal delivery, which may save the life of the neonate and the mother. Thus, delivering through C-section with clear indications can reduce the risk of death by early identification and intervention of birth related complications such as prolonged labor. In Zambia, Mukosha *et al.* [10] reported that neonates who were born by caesarean section had high chances of survival compared to those born by the vaginal delivery who had increased hazards for mortality.

4.1. Prevalence of Neonatal Mortality

In this study, the prevalence of neonatal mortality was 8.9% as calculated from a denominator of 169 sampled case notes (**Table 4**). However, the result of this study is higher than the prevalence of neonatal mortality reported in the Somali region, Ethiopia (5.7%) [11] , a study that was conducted in Jimma zone, Southwest Ethiopia (3.2%) [5], a study that was conducted in North Gondar, Northwest Ethiopia (4.4%) [5], and a study that was conducted in Ayder referral hospital, Mekelle (6.6%) [5]. The prevalence of neonatal mortality in this study is lower than the findings in similar studies conducted in Gondar university teaching hospital, Northwest Ethiopia (14.3%) and Felege Hiwot referral hospital, Bahir Dar

(13.3%) [5]. The differences could be explained by the existence of sociocultural and socio-economic differences across Ethiopian regions regarding health service utilization, differences in hospital set-ups (equipment available and skilled persons). Besides, there will be differences in awareness of the community upon utilization of available health services such as delivery at health facilities, and visiting health facilities for sick neonates and children.

Table 4. Prevalence of neonatal mortality (n = 169).

Variable	Category	Frequency (n)	Percentage (%)
Neonatal mortality	Survived	154	91.1
	Died	15	8.9
Documented Cause of mortality	Prematurity	3	1.8
	Very low birth weight	1	0.6
	Low birth weight	2	1.2
	Sepsis	4	2.4
	Birth asphyxia	3	1.8
	Respiratory distress syndrome	2	1.2
	Others	154	91.1

A study that was conducted in the Democratic Republic of Congo titled Predictors of Mortality in neonatal sepsis in a resource limited setting revealed that the neonatal mortality was at 21% [11]. This could be attributed to neonatal infections, intrapartum complications, premature delivery and asphyxia neonatorum among others. In Zambia the second most frequent maternal condition associated with acute intrapartum events was complication of the placenta, cord, or membrane at 38.1% [9]. Of these, 6 cases (75.0%) had prolapsed cords, and 2 cases (25.0%) had nuchal cords.

4.2. Factors Associated with Neonatal Mortality

In this study, the factors that were associated with neonatal mortality were maternal and neonatal respectively (**Table 5(a)**). The results further show that the mother's age (P = 0.033) was significantly associated with neonatal mortality. The current study has revealed that most (72%) of the neonates were sero-negative for HIV and AIDs (**Table 5(a)**). This suggests that a significant portion of the neonates were not at risk of vertical transmission of the virus from their mothers. This may imply that efforts to prevent mother-to-child HIV transmission are relatively effective in the study area, which is important for neonatal health. A study that was conducted in Nigeria titled Trends and predictors of in-hospital mortality among babies with hypoxic ischaemic encephalopathy at a Tertiary hospital in Nigeria: A retrospective cohort study revealed that place of birth, level of prenatal care, the cause of asphyxia, gestational age, maternal age, maternal illness, socio-

economic status, availability of resources for neonatal care among others contributed to neonatal mortality [12]. Therefore, maternal illnesses could be significant contributors to neonatal mortality. In a study that was conducted in Zambia [2] it was observed that improving maternal health would improve neonatal health and subsequently reduce mortality.

Table 5. Association between neonatal mortality and maternal and neonatal characteristics.

(a)				
Variable	**Category**	**Neonatal mortality**		**P-value**
		Survived, N = 154 n (%)	**Died, N = 15 n (%)**	
Maternal age	14 - 19	21 (95.5)	1 (4.5)	**0.033[FE]**
	20 - 24	49 (96.1)	2 (3.9)	
	25 - 29	32 (80.0)	8 (20.0)	
	30 - 34	25 (97.2)	1 (2.8)	
	35 and above	17 (85.0)	3(15.0)	
Age of neonate	Median (IQR)	1 (1, 1)	3 (2.3)	**<0.0001**
Sex of neonate	Female	48 (92.3)	4 (7.7)	0.486[FE]
	Male	106 (90.6)	11 (9.4)	
HIV exposure	Exposed	37 (94.9)	02 (5.1)	**0.007[FE]**
	Unexposed	117 (91.4)	11 (8.6)	
	No information	00 (0.0)	2 (100.0)	
Residence	Rural	22 (91.7)	2 (8.3)	0.639[FE]
	Urban	132 (91.0)	13 (9.0)	
Gestation at birth	<37 weeks	60 (81.1)	14 (18.9)	**<0.0001[CH]**
	≥37 weeks	94 (98.9)	1 (1.1)	
Maturity of the neonate at birth	Very preterm	17 (89.5)	2 (10.5)	**<0.0001[FE]**
	Late preterm	42 (77.8)	12 (22.2)	
	Term	95 (99.0)	1 (1.0)	
Temperature on admission	≥35	2 (13.3)	13 (86.7)	**<0.0001[FE]**
	35 - 36	9 (81.8)	2 (18.2)	
	36 - 37.2	133 (100.0)	0 (0.0)	
	37.2 - 38	10 (100.0)	0 (0.0)	
Number of pregnancies	1 - 2	86 (89.6)	10 (10.4)	0.616[FE]
	3 - 4	51 (94. 4)	3 (5.6)	
	5 - 6	17 (89.5)	2 (10.5)	

Continued

(b)

Variable	Category	Neonatal mortality		P-value
		Survived, N = 154 n (%)	Died, N = 15 n (%)	
Resuscitation at birth	Yes	50 (182.0)	11 (18.0)	**0.002[CH]**
	No	104 (96.3)	4 (3.7)	
Antenatal attendance	Yes	152 (91.0)	15 (9.0)	0.830[FE]
	No	2 (100.0)	0 (0.0)	
Multiple pregnancies	Yes	3 (100%)	0 (0.0)	0.755[FE]
	No	151 (91.0)	15 (9.0)	
Mode of delivery	Spontaneous	41 (93.2)	3 (6.8)	0.912[FE]
	Assisted	15 (93.8)	1 (6.3)	
	Caesarean	98 (89.9)	11 (10.1)	
Presence of Chronic Illness	Yes	35 (87.5)	5 (12.5)	0.263[FE]
	No	119 (92.3)	10 (7.8)	
Weight at birth	<2.5 kg	33 (84.6)	6 (15.4)	0.099[FE]
	≥2.5 kg	121 (93.1)	9 (6.9)	
Length of hospital stay	<7 days	115 (89.8)	13 (10.2)	0.244[FE]
	≥7 days	39 (95.1)	2 (4.9)	

FE = Fisher's Exact Test, **CH =** Chi-Squared Test.

Majority of mothers (84.6%) delivered preterm infants (**Table 5(b)**). Preterm birth is a significant risk factor for neonatal mortality, as premature infants often have underdeveloped organs and are more susceptible to various health complications. The findings are in agreement with the findings from a study that was conducted in Jordan where neonatal mortality was associated with low birth weight and prematurity [13]. This finding implies a need for further investigation into the causes of preterm births and measures to improve the care of preterm neonates. The finding of a significant association between the gestation age of the neonate and the cause of neonatal mortality suggests that the gestational age at which a baby is born is a critical factor influencing neonatal mortality. This indicates that preterm neonates (born before 37 weeks of gestation) may be at a higher risk of neonatal mortality, likely due to their underdeveloped organs and physiological systems. The study finding is similar to a study that was conducted in Ethiopia which revealed that neonatal mortality occurred due to prematurity among neonatal sepsis, hypothermia and asphyxia neonatorum [5]. The study concluded that prematurity and low birth weight contributed greatly to neonatal mortality. Another study reported similar findings that prematurity was a leading cause of neonatal mortality and that 47% of all deaths occurred in children under five years globally [14].

About 56% of neonates were categorized as preterm is consistent with the high prevalence of preterm deliveries among the mothers. Preterm neonates are at increased risk of neonatal mortality due to their developmental immaturity (Table 5(b)). Research should focus on the specific causes of preterm births and the strategies in place to manage and support preterm infants. In this study, 33 (84.6%) of neonates had a birth weight of less than 2.5 kilograms. Birth weight is a critical indicator of a neonate's health and potential for survival. Adequate birth weight is associated with a lower risk of neonatal mortality. The study has shown positive association between a neonate's birth weight and the cause of neonatal mortality. Low birth weight neonates were at higher risk for a range of health complications, which lead to mortality. This finding suggests that low birth weight is a crucial determinant of neonatal health and survival.

The finding that most (81.8%) of neonates had hypothermia on admission is of concern. Hypothermia can be a life-threatening condition for neonates. This implies that measures to maintain adequate temperature and warmth for neonates on admission may need improvement. There was an association between the neonate's temperature on admission and the cause of neonatal mortality which suggests that hypothermia or extremely low body temperature in neonates upon admission is a significant risk factor for neonatal mortality. It highlights the critical importance of maintaining a stable body temperature in neonates, as hypothermia can lead to serious health complications.

A significant finding in this study was that most of the neonates required resuscitation ($p = 0.002$) at birth. (Table 5(b)). Understanding the reasons for neonatal resuscitation and the effectiveness of the resuscitation efforts is crucial for improving neonatal outcomes. There was an association between resuscitation at birth and the cause of neonatal mortality which indicates that neonates who require resuscitation are at a significantly higher risk of mortality. This implies that effective and timely resuscitation is critical in preventing neonatal deaths, highlighting the importance of skilled healthcare providers and proper equipment for neonatal care during and immediately after birth. Neonates requiring resuscitation are inherently in more critical condition and are at risk of dying if interventions are not instituted early. Most (75.7%) neonates stayed less than 7 days before their demise suggests that a substantial proportion of neonates did not survive beyond the first week of life. Research should explore the specific causes of mortality during this critical period.

The finding that 56.8% of the mothers had a gravidity between 1 - 2 implies that a significant portion of the mothers in this study were relatively new to the experience of childbirth. This may suggest that first-time or second-time mothers could benefit from additional support, education, and guidance during pregnancy and childbirth. It is gratifying to note that a large percentage (98.8%) of the mothers attended antenatal clinics during their pregnancies. Regular antenatal care is crucial for ensuring the health and well-being of both mothers and their neonates. The WHO has put antenatal care attendance as one of the strategies to reduce neonatal

mortality [2]. In a study titled Neonatal survival in subsahara: A Review of Kenya and South Africa reported that antenatal attendance of pregnant women is crucial to the identification of maternal complications that can impact on neonatal health. In this study, the high antenatal clinic attendance rate implies that access to antenatal care services is relatively good in the study area. Further, majority of mothers (98.2%) had single-tone pregnancies and this implies that most pregnancies were not complicated by the presence of multiple fetuses (Table 2). Single-tone pregnancies are generally considered lower-risk than multiple pregnancies.

The finding show that all (100%) mothers delivered in an urban health facility. This finding is in contrast with the study that was conducted in Brazil where most neonatal deaths occurred in rural areas [15]. Delivering in a healthcare facility with skilled healthcare providers and proper medical equipment can significantly reduce the risk of neonatal mortality. The finding that 76.3% of mothers did not suffer from any chronic illness suggests that most mothers were in good health. Chronic illnesses can complicate pregnancy and childbirth, so this is a positive finding that implies a relatively low prevalence of chronic health conditions among the study population.

4.3. Univariable and Multivariable Logistic Regression Analysis

Results in Table 6 show that at both univariable and multivariable analysis, the age of babies in days, gestation, and resuscitation are significantly associated with neonatal mortality at Ndola Teaching Hospital. Adjusting for other variables, a day increase in the age of the neonate increased the odds of mortality by a factor of 12.3 (aOR = 12.3, 95% CI = 2.75, 55.19, P-value = 0.001), and neonates who did not require any resuscitation had reduced odds of mortality (aOR = 0.10, 95% CI = 0.02, 0.70, P-value = 0.020). Furthermore, having a gestation age of at least 37 weeks, reduced the odds of dying by a factor of 0.02 (aOR = 0.02, 95% CI, 0.00, 0.42, P-value = 0.013) compared to having a gestation less than 37 weeks, keeping other variables constant.

Table 6. Univariable and multivariable logistic regression analysis results on factors associated with neonatal mortality at Ndola Teaching Hospital.

Variables	Univariable analysis			Multivariable analysis		
	cOR	CI (95%)	P-value	aOR	CI (95%)	P-value
Age in days	4.58	2.25, 9.32	**<0.0001**	12.33	2.75, 55.19	0.001
Gestation age						
Less than 37 weeks	**Ref**			**Ref**		
Greater than 37 weeks	0.05	0.01, 0.36	0.003	0.02	0.00, 0.42	0.013
Resuscitation						
Yes	**Ref**			**Ref**		
No	0.17	0.01, 0.05	0.004	0.10	0.02, 0.70	0.020

Continued

Hospital of stay						
<7 days	**Ref**			**Ref**		
≥7 days	0.45	0.31, 0.98	0.312	0.00003	1.09, 0.08	0.010

cOR = Crude Odds Ratio, **aOR** = adjusted Odds Ratio, **CI** = Confidence Interval.

4.4. Causes of Neonatal Mortality

The finding revealed that 2.4% of neonates died due to sepsis (Table 4). This is a significant and concerning revelation in the context of neonatal mortality. These findings are similar to a study were it was reported that decreasing neonatal mortality in middle-income countries continued to be a challenge and that neonatal sepsis was a significant contributor to these deaths [16]. In another study titled Neonatal sepsis and mortality in low income and middle income countries from a facility based birth cohort—an International multiste prospective observational study reported that neonates who were born by caesarean section had an increased risk of neonatal sepsis due to long stay in hospital after birth [17]. The finding raises questions about the quality of delivery and obstetric care provided at the hospital. In Zambia, guidelines for maternal and neonatal care that health workers are expected to refer to when managing neonates are available [6]. Proper monitoring and timely interventions during childbirth are essential to prevent and manage neonatal sepsis. This finding suggest a need for improvements in obstetric and neonatal care practices.

In this study, Birth asphyxia (1.8%), prematurity (1.8%), neonatal sepsis (2.4%), low birth weight (1.2%) and respiratory distress syndrome (1.2%) were the major causes of neonatal mortality. This finding is similar to a study that was conducted in Mizan Tepi university teaching hospital that revealed prematurity (31%), neonatal sepsis (29.7%), low birth weight (15.3%) and birth asphyxia (7.7%) as the leading causes of death [10]. Majority of neonatal deaths in developing countries are due to conditions of labor, intrapartum and the immediate newborn care practices. From this finding, it can be deduced that neonatal survival interventions are not targeting the intrapartum as well as immediate and early neonatal periods, and as a direct result, neonatal mortality has not declined in the needed manner.

This study revealed that neonates who were admitted because of birth asphyxia had a higher chance of death compared to those who were not asphyxiated at all. This finding is consistent with a study that was conducted in southern Ethiopia referral hospitals [17], which found that neonates with birth asphyxia had 2 times higher risk of death than their counterparts. This may be due to the fact that besides commencement of adequate efforts after admission, neonates with respiratory problems like birth asphyxia had a greater risk for a poor prognosis and death compared to neonates admitted with other medical problems. Therefore, neonates with a respiratory distress have higher chance of death when compared to those who do not experience any respiratory distress.

Another study further reports that systemic infections of the newborn such as

septicaemia accounts for one-third of neonatal deaths worldwide [18]. These infections include septicaemia, meningitis, pneumonia, arthritis, osteomyelitis and urinary tract infections among others. In the same study, sepsis was attributed to cause approximately 400,000 neonatal deaths in 2015 globally, half of which occurred in sub-Saharan Africa where 34.6% to 66.0% of neonatal deaths reportedly occur within the first 24 hours of life [18].

In another study titled Analysis of neonatal risk factors in Brazil: a systematic review and meta analysis of observational studies revealed the significant factors that contributed to neonatal mortality as absence of partner, maternal age ≥35 years, male gender, multiple gestation, inadequate and absent prenatal care, presence of complications during pregnancy, congenital malformation in the assessed pregnancy, Apgar score < 7 at the fifth minute, low and very low birth weight, gestational age ≤ 37 weeks, and caesarean delivery [4]. These findings are in agreement with the study that was conducted in Zambia which revealed that most of the neonates died due to acute intrapartum events (n = 21; 84.0%) or malformations, deformations, or chromosomal abnormalities (n = 4; 16.0%). Neonatal deaths were related primarily to complications from intrapartum events (n = 19; 44.2%); low birth weight or prematurity (n = 16; 37.2%); or infection (n = 3; 7.0%) and fetal unspecified causes [9].

4.5. Association between Variables

The independent variables for this study included age of the neonate, gestation age, temperature on admission, prematurity, Birth Asphyxia, Low birth weight, Very low birth weight, sepsis, hypoxic ischaemic encephalopathy and congenital anomalies. Maternal variables included maternal age, maternal residence, parity, number of pregnancies, antenatal attendance, mode of delivery, place of delivery and presence of chronic illness whereas the dependent variable was neonatal mortality. As indicated in **Table 5(a)** the findings revealed a significant association between age of the neonate, gestation at birth and temperature of the neonate on admission with the cause of neonatal mortality. Neonates who were born preterm or very preterm were more likely associated with one of the causes of neonatal mortality. **Table 5(a)** shows that neonatal mortality was significantly associated with the age of the neonate ($p < 0.0001$), term of the baby, ($p < 0.0001$), gestation ($p < 0.0001$), the temperature of the baby ($p < 0.0001$) and HIV status ($P = 0.0007$). The table further shows that the mother's age ($P = 0.033$) was significantly associated with neonatal mortality.

4.6. Application of Conceptual Framework to Research Findings

This study was based on the premise that factors can influence one another. The conceptual framework that guided this study was Mosley and Chen 1984 who studied how factors influence one another. In tandem with this conceptual framework, neonatal mortality was affected by multiple factors such as: Maternal, Antenatal, Intra-partum, Household and socioeconomic. The infant's characteristics

that included sex, weight, age of the neonate at admission, resuscitation at birth, temperature and duration of stay in NICU influenced neonatal mortality at Ndola Teaching Hospital. In this study, neonatal mortality was influenced by multiple factors such as maternal, neonatal and socio-economic.

According to the WHO [2], it was recommended that Low birth weight and preterm babies required increased attention to keep warm, assistance with initiation of breastfeeding and extra attention to identify danger signs; Sick newborns: Identify danger signs as soon as possible and give appropriate health care service. If the baby was sick at home, the family needed help to transport the baby to the hospital or health facility for care; Newborns of Human Immune Deficiency Virus (HIV) infected mothers: preventive antiretroviral treatment (ART) for the mother and newborn, counseling and support to mothers for infant feeding among others.

4.7. Implications of Findings on the Health Care System

4.7.1. Nursing and Midwifery Education

The results of this study indicate that Neonatal mortality at Ndola Teaching Hospital (NTH) was 8.9%. There was a significant association between temperature of the neonate on admission and neonatal resuscitation at birth and neonatal mortality. Given the significant association between the need for neonatal resuscitation at birth and neonatal mortality, nursing and midwifery education programs should strengthen comprehensive neonatal resuscitation in the nursing and midwifery curricula. This includes not only the technical skills but also the ability to recognize signs of neonatal distress. The resuscitation that was done at birth could have been done wrongly or late for neonates to die.

4.7.2. Nursing and Midwifery Practice

This study has revealed that Neonatal mortality is high at Ndola Teaching Hospital. Therefore Nurses should be vigilant in assessing neonates' gestational age, birth weight, and vital signs to identify those at risk. Regular monitoring during and after birth is crucial to detect any early signs of distress. Appropriate documentation of the neonates' condition at birth should also be emphasized. In addition, Nurses on the front lines of care must be skilled in neonatal resuscitation techniques and should be prepared to provide immediate intervention when necessary. This is particularly important for preterm neonates. Further, ensuring warmth for the neonate at birth could predict neonate outcome. Ensuring proper thermoregulation, including skin-to-skin contact with the mother, is part of nursing practice that is critical to prevent hypothermia and maintain a stable body temperature in neonates.

4.7.3. Nursing and Midwifery Administration

The findings revealed that some neonates died after being resuscitated. This could be as a result of inadequate skills by the service providers as well as poor monitoring after resuscitation. Nursing administration should allocate resources for ongoing training, education, and staffing to ensure that healthcare facilities are well-

equipped to provide high-quality neonatal care. This includes having the necessary equipment for resuscitation and thermoregulation. In addition, infrastructure development is also key to improve neonatal service provision. This implies that neonatal units need to be spacious owing to the high number of neonatal admissions, Kangaroo mother care rooms need adequate linen, beds and privacy among others. Nursing administration can lead quality improvement initiatives to monitor and enhance the quality of care provided to neonates. Regular audits, feedback mechanisms, and adherence to standardized protocols are essential. Adequate staffing levels should be maintained to ensure that nurses have the time and resources needed to provide Ongoing mentoring of newly and already employed staff.

4.7.4. Nursing and Midwifery Research

Fewer studies have been conducted on the subject area. More research should be conducted in order to reduce neonatal morbidity and mortality and to enable evidence-based practice provision to neonates. Further research into neonatal resuscitation protocols, their effectiveness, and factors influencing successful resuscitation is necessary. This can lead to improvements in guidelines and training. In addition, research on best practices for thermoregulation, including the use of warmers, clothing, and skin-to-skin contact, can inform evidence-based care for neonates. In this study, it was established that neonatal management protocols are available. However, it is unclear whether health workers are utilizing them effectively owing to the high number of neonatal mortalities. Therefore, there is greater need to establish factors contributing to inability of health workers to effectively utilize these protocols.

5. Conclusions

The general objective of the study was to determine the prevalence and factors associated with neonatal mortality at Ndola Teaching Hospital. The literature that was reviewed showed that Neonatal Mortality remains a huge burden worldwide. Therefore, this study recommends that health workers are continuously trained and mentored in neonatal care that could subsequently reduce neonatal morbidity and mortality.

This study shows a high rate of neonatal mortality (8.9%) during the study period. Neonatal mortality was highly associated with neonatal and maternal factors. It is expected that all responsible stakeholders should work hard to improve care for all neonates with special attention to the care of high-risk neonates. For instance, the Neonatal Intensive Care Unit (NICU) should work on improving the facility by providing skilled manpower such as paediatric nurses, paediatricians and critical care nurses to provide specialized care and early referral of neonates. The neonatal intensive care unit should work on early diagnosis, proper documentation of the condition of the neonate at admission and there should be good continuous monitoring of the neonate's condition following admission to NICU.

6. Recommendations

6.1. Ministry of Health

The researcher recommends that the MoH should spearhead the implementation and review of protocols for neonatal and maternal care that will guide nurses, midwives and Doctors in the management of mothers and neonates.

6.2. Nursing and Midwifery Practice

Nurses, Midwives and Doctors need constant supervision in order to provide quality nursing care and subsequently improve survival of the neonates based on the finding that most of the neonates that died were resuscitated and some of them had low temperature on admission to NICU. More Nurses and Doctors need to be trained in neonatal care for them to provide specialized neonatal care. Ongoing mentorship for the new and already employed nurses working in NICU needs to be emphasized for them to grasp the principles of neonatal care.

6.3. Nursing and Midwifery Research

There is a need to conduct research in neonatal care as this will help determine the gaps and limitations in neonatal care. Once the protocols of neonatal care and other relevant documents are revised, supervisors must ensure that implementation is done as soon as possible for effective and quality neonatal care. In addition, strengthening antenatal care at primary level is also crucial to the survival of the neonates. The researcher also recommends strengthening of maternal, perinatal, death surveillance (MPDSR) committee that will be able to identify, discuss and offer recommendations whenever necessary.

6.4. Strength and Limitations of the Study

The study has provided evidence on the prevalence and factors associated with neonatal mortality at Ndola teaching hospital NICU. The study findings have also been documented for future reference. The study only involved review of case notes by the researcher, clerks and nurse in charge of NICU at Ndola Teaching Hospital. Therefore, generalization of the findings should be done with caution as these findings may not be a true reflection of what is prevailing at Ndola Teaching Hospital. In addition, this study did not collect information on the neonatal mortalities that occurred in the community rather in the hospital setting. Therefore, the neonatal mortality in this study may not reflect the mortality in the community for families that live far from the point of seeking health care and those that have financial constraints. Further research need to be conducted to establish the causes of neonatal mortalities in the community settings.

6.5. Utilization and Dissemination of Findings

Bound hard copies of the dissertation will be submitted to UNZA, School of Nursing Sciences. The findings and recommendations will be presented at Ndola and

Kitwe Teaching Hospitals respectively. The findings of the study will be presented at local, national and international conferences, symposiums and meetings. A manuscript will be submitted to a peer review journal for publication.

Conflicts of Interest

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

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