

# Neonatal Mortality at Felege Hiwot Comprehensive Specialized Hospital in Ethiopia Over 5 years: Trends and Associated Factors

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## ABSTRACT

**BACKGROUND:** Globally, neonatal mortality remains a serious catastrophic problem for newborns, particularly in a low-resource setting. There were no neonatal mortality trend studies in the study area.

**OBJECTIVE:** This study aimed to determine the trends and risk factors of neonatal mortality at the neonatal intensive care unit of Felege Hiwot Comprehensive Specialized Hospital, Northwest Ethiopia.

**METHODS:** An institution-based retrospective cross-sectional study was conducted among 870 admitted neonates from January 1, 2016 to December 31, 2020 in the neonatal intensive care unit by a stratified simple random sampling technique. Data were entered into EpiData and then exported to STATA 14.0 for analysis. A linear regression statistical model was used for trend analysis and binary logistic regression was carried out to identify explanatory variables of neonatal mortality.

**RESULTS:** Overall, neonatal mortality averagely increased by 2.1% per year throughout the 5 consecutive years. In this study, rural residency [adjusted odds ratio (AOR): 1.96, 95% confidence interval (CI): (1.26, 3.06)], birth asphyxia (AOR: 7.73, 95% CI: 4.31, 13.84), congenital deformity (AOR: 3.61, 95% CI: 1.17, 11.18), low birth weight (AOR: 2.13, 95% CI: 1.23, 3.67), respiratory distress syndrome (AOR: 3.32, 95% CI: 1.97, 5.59), Ambu-bag resuscitation (AOR: 0.16, 95% CI: 0.07, 0.38), taking antibiotics (AOR: 0.50, 95% CI: 0.27, 0.90), glucose (AOR: 0.47, 95% CI: 0.30, 0.72), and oxygen (AOR: 0.26, 95% CI: 0.16, 0.41) were associated with neonatal mortality.

**CONCLUSIONS:** This 5-year trend analysis revealed an increased trend of NMR, indicating more work is still needed to make progress toward meeting the SDG goal by 2030. Rural residency, birth asphyxia, congenital deformity, low birth weight, respiratory distress syndrome, Ambu-bag resuscitation, taking antibiotics, glucose, and oxygen were associated with neonatal mortality. Therefore, all stakeholders shall give due attention to reducing this timely-increasing trend of neonatal mortality.

**KEYWORDS:** Neonatal mortality, trends, associated factors

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## Background

Neonatal mortality (NM) is the term used to describe fatalities that occur within the first 4 weeks of life after birth.<sup>1</sup> Early neonatal mortality (ENM) and late neonatal mortality (LNM) are the 2 categories of neonatal mortality that refer to deaths that occur within the first 7 days of life and between 8 and 28 days following birth, respectively.<sup>2,3</sup>

Neonatal mortality was a substantial contributor to morbidity and mortality in children under the age of 5 years, particularly high in low-income countries including Ethiopia. Numerous factors might have contributed to NM. Poor power of women to seek healthcare, women's low habit of postnatal visits, giving birth at home, delayed breastfeeding after birth, and giving multiple births were all linked to a higher likelihood of NM.<sup>4</sup> In addition to these, neonatal sepsis, birth asphyxia, low birth weight, prematurity, mode of delivery, meconium

staining, neonatal medical, and congenital-related causes are also having a large contribution to NM.<sup>5,6</sup>

Global and national strategies were designed to reduce NM. For instance, the Sustainable Development Goals (SDGs) have been applied internationally since 2016. The country, Ethiopia, adapted a national preventive strategy of NM in line with a United Nations health agenda. Ethiopia designed a National Strategy for Newborn and Child Survival in June 2015 with an ambitious vision of reducing the NMR from 28 to 11/1000 by 2019/2020. To soundly achieve the above vision and goals of the country, the provision of high-quality health-care is essential for mothers, infants, and children, and it will be successfully practiced to reduce the impact of NM.<sup>7</sup>

Although attempts to reduce NM have been made gradually since 1990, more efforts were still required, to achieve a national and global neonatal health agenda.<sup>8</sup> Given that, NM



must be adequately addressed to achieve the SDGs aim since it continues to be a major national and global health concern.<sup>9</sup> Globally, NM currently contributes to two-thirds of under-5, and childhood mortality.<sup>10</sup> It is estimated that 2.5 million newborns died within their first month of life, equating to almost 7000 deaths every day.<sup>11</sup>

Though global trends in neonate mortality have shown progress Sub-Saharan Africa has made the weakest progress in lowering neonatal death rates.<sup>12</sup> For instance, Sub-Saharan Africa (SSA) together with South Asia accounted for 79 percent of all neonatal deaths at the country level, with SSA having the highest NMR<sup>13</sup> and of the 20 countries with the greatest risk of neonatal death worldwide, 75% are in Africa.<sup>14</sup> Additionally, a recent study found that the yearly NMR in developing countries was 9 times greater than that of developed countries.<sup>8</sup>

In Ethiopia, NM accounted for 42% of all deaths in children under the age of 5 years.<sup>15</sup> Despite making great strides, Ethiopia continues to have one of the highest NMRs in the world, ranking among the 10 countries that account for two-thirds of all newborn deaths globally and among the 6 that account for half of all deaths among children under the age of 5 years.<sup>15-17</sup>

Readers bear in mind that NM reported in the neonatal intensive care unit (NICU) was a subcomponent of NM reports in the general population. In a study done in Amhara Regional State in 2018, NMR in the NICU was 186 per 1000 admitted neonates which was very high as compared with a study conducted in different regions of the country, Ethiopia.<sup>18</sup> An occasional report in 2019/20 from the NICU of Felege Hiwot Comprehensive Specialized Hospital (FHCSH), implied that NM was raised gradually.<sup>19</sup> This makes it impossible to accomplish the 2030 health agenda unless this real problem was timely identified and genuine evidence-based scientific solutions were made. Though NM reports from all over the world and SSA showed a considerable decline, EDHS 2019 and occasional annual reporting in FHCSH revealed a rise.<sup>17,20</sup> This calls for attention to be given to meet SDG 3.2's goal of reducing NMR to 12 deaths per 1000 live births by 2030.<sup>9</sup>

Not only these but also there were no clear progressive NM trend studies in the NICU across the country including our study area, and no one could not deny that the issue needs validation. As a result, designing a title that addresses these specific objectives like; trends and associated factors of neonatal mortality rate at the neonatal intensive care unit of Felege Hiwot Comprehensive Specialized Hospital from January 1, 2016 to December 31, 2020, in Bahir Dar, Northwest Ethiopia, 2021 was compulsory. Additionally, results obtained from this study will help programmers to evaluate their efforts toward the goal of SDG. Furthermore, this study will serve as baseline information for further studies.

## Methods and Materials

### *Study design, setting, and population*

An institution-based retrospective cross-sectional study was conducted at the NICU of FHCSH from January 1, 2016, to December 31, 2020, in Bahir Dar city, Northwest Ethiopia. Bahir Dar is the capital city of Amhara Regional State which is located 565 km away from Addis Ababa, the capital city of Ethiopia.<sup>21</sup> In this hospital, the pediatrics NICU had 4 sub-departmental units (ie, preterm unit, KMC unit, mother side unit, and septic unit), containing 20, 20, 30, and 10 beds respectively. In these sub departmental units there were a total of 1300, 1380, 1040, 2660, and 2020 admitted neonates in the year 2016, 2017, 2018, 2019, and 2022 respectively. All medical records of admitted neonates in the NICU of FHCSH were considered as source population where as those who were eligible and randomly selected medical records of neonates were included in the study. However, medical records of neonates with incomplete and lack of pertinent information were excluded from the study.

### *Sample size determination*

The sample size was calculated by using the smallest AOR of the previous study at NICU<sup>22</sup> by using the following formula:

$$N = E/P (E)^{23}$$

$$E = \frac{4(Z_{\alpha/2} + Z_{\beta})^2}{(\ln OR)^2}$$

Where:  $N$ =total sample size;  $E$ =required number of events (death);  $P(E)$ =the probability of an event (death) obtained from the previous study is 0.17;  $Z_{\beta}$ =the power of the study, the area under the normal curve for the value of  $\beta$  (power=80%),  $Z_{\beta}$ =0.84; OR=Odd Ratio. After the substitution of each value in the following formula:

$$E = 4(1.96 + 0.84)^2 = 7.8 \times 4/0.21 = 31.2/0.21 = 148$$

$$(\ln 1.58)^2$$

Then,  $N = 148/0.17 = 870$ . Therefore, the total sample size was 870 neonatal medical records.

### *Sampling technique*

Initially, eligible neonates' medical registration numbers (MRN) from January 1, 2016 to December 31, 2020 were taken from registration book. Then, we list out every month's MRN and their corresponding index serial numbers in Excel and SPSS. Finally, eligible MRNs were generated through a random computer generation system. A stratified simple random sampling technique was employed step by step in the subsequent months using MRN as a sampling frame. After this, when the records of neonates had no pertinent information inside were randomly replaced by withdrawal of cards. Again, if it has no any information inside for

the second time, withdrawal of the second card without replacement of the first card by simple random was carried out. Based on simple random sampling without replacement (SRSWOR) sampling technique, 15 neonatal medical records were replaced. According to the data obtained from FHCSH, the total number of admissions from 2016 to 2020 was 8400. A random computer generation system with a stratified simple random sampling technique was employed after proportionally allocated. The reason for performing proportional allocation and random sampling for every month separately was, for the sake of handling trend data, to make chronologically arranged and uniform distributions of the study units in each month.

### *Variables*

Neonatal mortality is the outcome variable and variables listed under neonatal-related factors were; calculated gestational age at birth, sex of the neonate, birth weight, and maternal-related factors including maternal place of residence, mode of delivery, place of delivery, maternal Human immunodeficiency virus (HIV) status, maternal positive laboratory results like hepatitis B virus (HBV) and hepatitis C virus (HCV) infection as well as venereal disease research laboratory (VDRL) tests. In addition to these, variables that were listed under neonatal medical condition-related factors were; respiratory distress syndrome, birth asphyxia, sepsis, and congenital malformation. Finally, variables that were grouped under the type of treatment given were; Ambu-bag resuscitation, antibiotics, anticonvulsants, glucose, oxygen, blood transfusion, and thermal care were independent predictor factors of neonatal death.

### *Operational definitions*

*Maternal laboratory results:* VDRL, HBV, and HCV test results.

*Gestational age:* intrauterine fetal age was measured from the beginning of the woman's last menstrual period until the time of birth or based on ultrasound estimation.

*Mode of delivery:* were classified as cesarean section and vaginal delivery (including both spontaneous and assisted delivery).

*Birth weight:* classified as normal birth weight if a weight of a newborn is greater than 2500 g, low birth weight if below 2500 g, and macrosomic if above 4000 g based on WHO classification. Other causes of neonatal admission include meningitis, meconium aspiration syndrome, anemia, small bowel obstruction, large bowel obstruction, jaundice, and thermal burns.

### *Data collection tools and procedures*

The data extraction checklist was adapted from the NICU registration books and reviewed from different kinds of

literature which were conducted previously.<sup>24</sup> The data was extracted from NICU medical registration books and neonatal medical charts by 2 trained BSc nurses.

### *Data processing and analysis*

First, the data was coded and edited after that checked for its completeness and consistency, and then entered into EpiData version 3.1 and exported to STATA 14.0. Finally, binary logistic regression was carried out to identify the associated factors of NM. Trends in the overall neonatal mortality were numerically calculated as the average increment minus average reduction of the consecutive years divided by 5 years. Descriptive statistics were used to measure the characteristics of the study variables. In addition, trend analysis with linear regression statistical model was used to show the 5 years neonatal mortality trends in the NICU. All variables with  $P < .2$  in the bivariable analysis were included in the final model of multivariable analysis to control all possible confounders. Finally, the AOR with 95% CI was computed and variables with a  $P$ -value less than .05 in the multivariable simple logistic regression model were taken as significant risk factors of NM.

### *Data quality assurance*

To assure data quality, a 1-day training was given for the 2 data collectors and a supervisor. The data was checked daily to reduce incompleteness and inconsistency by the principal investigator. Feedback and corrective actions were taken upon review of the daily submitted data.

### *Ethical consideration*

Ethical clearance was obtained from the Institutional Review Board of Bahir Dar University with an approval number med287/2021. After discussing the purpose and method of the study, verbal informed consent was obtained from Felege Hiwot Comprehensive Specialized Hospital official bodies before collecting data. Since the study used secondary data from the registration logbook informed consent for the participants was waived by the Ethical Review Committee of school of Public Health, College of Medicine and Health Science, Bahir Dar University. No identifying information were indicated on the checklists, and confidentiality was assured throughout the study.

## **Results**

### *Study population characteristics*

A total of 870 admitted neonates were included in the study. Among these admitted neonates, more than 57% were male, and about 37% were low birth weights. Again, about 38%, 60%, and 2% were preterm, term, and post-term in gestational age at delivery.

**Table 1.** Maternal-related factors of neonatal mortality whose neonates were admitted from January 1, 2016, to December 31, 2020, at NICU of FHCSH, Northwest Ethiopia, 2021 (n=870).

VARIABLE	CATEGORIES	FREQUENCY	PERCENTAGE (%)
Residence	Urban	372	42.76
	Rural	498	57.24
Mode of delivery	SVD	688	79.08
	C/S	182	20.92
Place of delivery	At FHCSH	473	54.37
	Home delivery	35	4.02
	Other health institutions	362	41.61
Maternal HIV status	Negative	798	91.72
	Positive	64	7.36
	Unknown	8	0.92
Maternal Hepatitis B status	Negative	824	94.71
	Positive	38	4.36
	Unknown	8	0.92
Maternal Hepatitis C status	Negative	838	96.32
	Positive	16	1.84
	Unknown	16	1.84

### Maternal characteristics

Among 870 women, 57.24% were from rural areas and 7.36% among all women were HIV positive (Table 1).

### Causes of neonatal admission and death

Among NICU-admitted neonates, the leading cause of neonatal admission was sepsis (77.82%), whereas the least cause of admission was congenital malformation (3.10%; Table 2). Sepsis was the leading cause of neonatal death (29%), and the least (1%) cause was congenital malformation (Figure 1).

### Neonatal treatment-related characteristics

Among 870 neonates, the highest number of neonates were treated with antibiotics and the least number of neonates were treated by blood transfusion (Table 3).

### Proportion of neonatal mortality

Among 870 neonates, 190 (21.80%) of them died during the study period at the NICU of FHCSH. Therefore, the cumulative incidence rate was 218 per 1000 admitted neonates.

**Table 2.** Causes of neonatal admission among neonates admitted at NICU of FHCSH, Northwest Ethiopia, 2021 (n=870).

VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE (%)
Respiratory distress	No	712	81.84
	Yes	158	18.16
Birth asphyxia	No	728	83.68
	Yes	142	16.32
Sepsis	No	193	22.18
	Yes	677	77.82
Congenital malformation	No	843	96.90
	Yes	27	3.10
With other problems <sup>a</sup>	No	852	97.93
	Yes	18	2.07

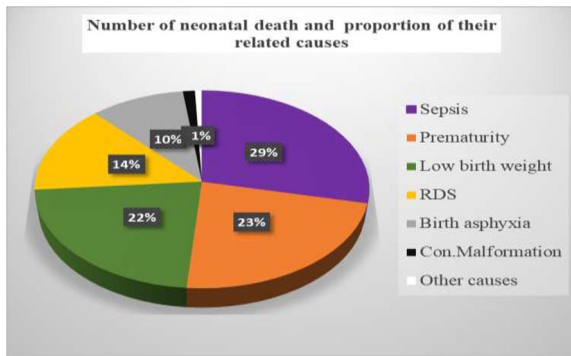
<sup>a</sup>Other causes of neonatal admission includes; meningitis, meconium aspiration syndrome, anemia, small bowel obstruction, large bowel obstruction, jaundice, and thermal burn.

### Trends of neonatal mortality from 2016 to 2020

In this 5 years trend graph in the 12 months moving average trend graph, the average reduction of NM from 2016 to 2017 was 16% and from 2017 to 2018 was 17%, while the average increment of NM from 2018 to 2019 was 19% and from 2019 to 2020 was 35%. As a result, to clearly understand, the overall NMR at the NICU was numerically calculated as the average increment minus average reduction divided by 5 years [(ie,  $0.35 + 0.19/2) - (0.17 + 0.16/2)]/5$  years which is equal to 2.1%. Therefore, the average increment of NMR from 2016 to 2020 was 2.1% per year. As shown in the graph in (Figure 2), the 12 months moving average trend graph from 2016 to 2020, clearly showed the increasing trends of NM after making 12 months per moving average. As a result, the thin red moving average trend graph was nearly overlapped with the red thicker linear line trend graph after taking 12 months of the central moving average.

### Risk factors of neonatal mortality

Logistic regression analysis was employed to select the statistically significant variables. The following 22 variables; residence, sex, mode of delivery, place of delivery, maternal HIV status, maternal hepatitis B virus, maternal hepatitis C virus, maternal VDRL, gestational age of neonate at birth, presence of prematurity, presence of sepsis, presence of birth asphyxia, presence of congenital deformity, presence of low birth weight, presence of RDS, giving of Ambu-bag resuscitation, antibiotics, anticonvulsant, glucose, oxygen therapy, blood transfusion, and thermal care were entered into bi-variable analysis. In the final



**Figure 1.** Neonatal death and their causes among neonates admitted at the NICU of FHCSH, in Bahir Dar, Northwest Ethiopia, 2021 (n=870).

model, only 9 variables such as; place of residence, presence of birth, asphyxia, presence of congenital deformity, presence of low birth weight, presence of RDS, Ambu-bag resuscitation, antibiotics given, glucose, and oxygen therapy were statistically significant risk factors of neonatal mortality with a *P*-value of less than .05 at 95% CI.

The odds of death of neonates who came from rural areas were 1.96 times (AOR: 1.96, 95% CI: 1.26, 3.06) compared to urban areas by keeping other factors constant. Moreover, neonates admitted with birth asphyxia was 7.73 times the odds of death (AOR: 7.73, 95% CI: 4.31, 13.84) as compared with health institution delivery. Furthermore, the odds of death of neonates admitted due to congenital deformity were 3.61 times (AOR: 3.61, 95% CI: 1.17, 11.18) than those without congenital deformity. Not only these but also the odds of death of neonates admitted due to low birth weight 2.13 times (AOR: 2.13, 95% CI: 1.23, 3.67) compared to normal birth weight. In addition to these, the odds of death due to RDS was 3.32 times (AOR: 3.32, 95% CI: 1.97, 5.59) compared to those admitted without RDS. Finally, the odds of death of neonates who got Ambu-bag resuscitation, antibiotics, glucose, and oxygen therapy were 84% (AOR: 0.16, 95% CI: 0.07, 0.38), 50% (AOR: 0.50, 95% CI: 0.27, 0.90), 53% (AOR: 0.47, 95% CI: 0.30, 0.72), and 74% (AOR: 0.26, 95% CI: 0.16, 0.41) risk reduction compared to neonates who did not get the corresponding treatments respectively by keeping other factors constant for all interpretations (Table 4).

**Discussion**

In this study, NM was 218 per 1000 NICU-admitted neonates. This finding was higher as compared with a study in Amhara Referral Hospitals 186,<sup>18</sup> southern Ethiopia study 165,<sup>22</sup> Gondar University Hospital 173,<sup>25</sup> and Jimma University hospital 133 per 1000 live births.<sup>26</sup> These variations between studies could be due to differences in sample size, and follow-up periods.<sup>18,25</sup> In this study, the average annual NMR trend was 2.1% per year in the NICU from 2016 to 2020. This finding was supported by Ethiopian mini EDHS 2019 and annual 2019/2020 reports from the NICU of FHCSH even though

**Table 3.** Type of treatments given among neonates admitted at the NICU of FHCSH, in Bahir Dar, Northwest Ethiopia, 2021 (n=870).

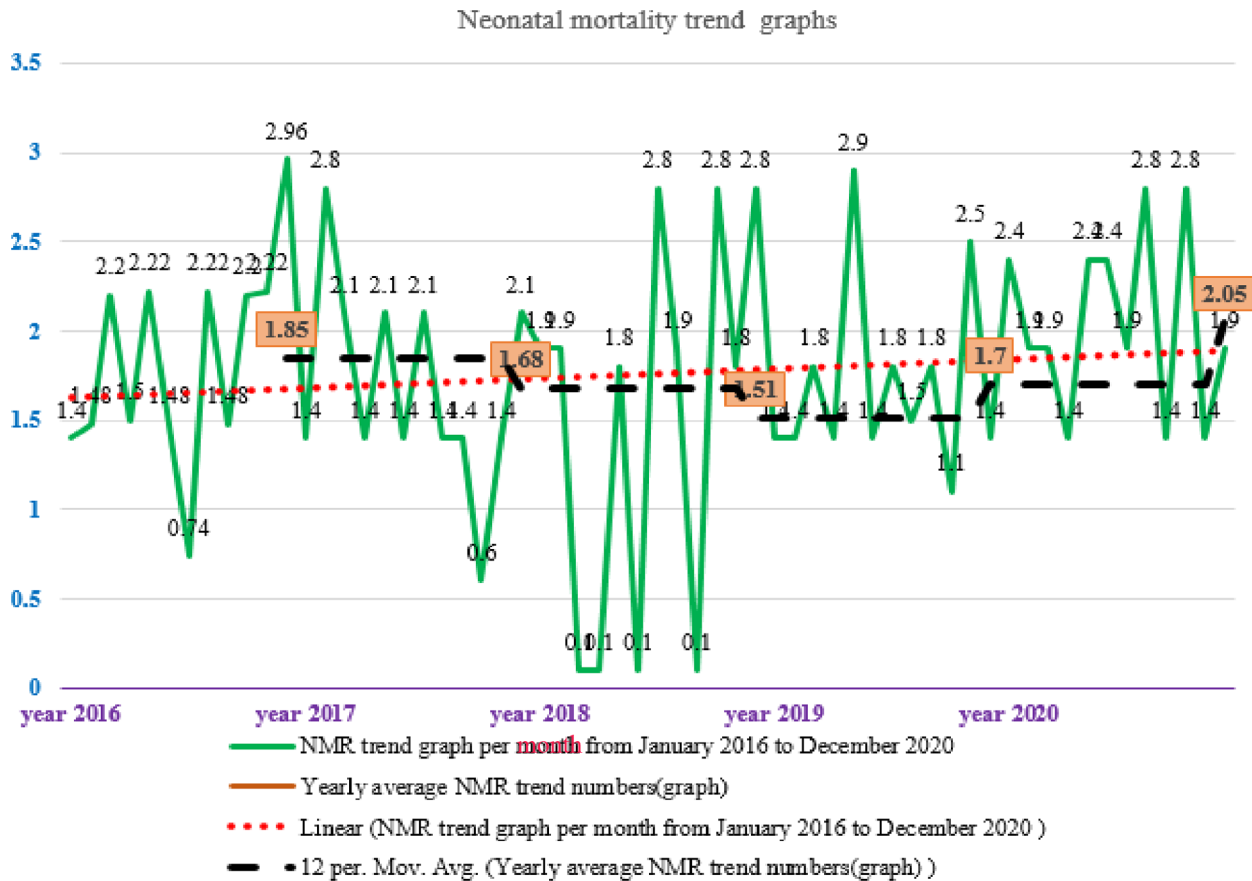
VARIABLE	CATEGORY	FREQUENCY	PERCENTAGE
Ambu-bag resuscitation	No	728	83.68
	Yes	142	16.32
Antibiotics	No	128	14.71
	Yes	742	85.29
Anticonvulsant	No	839	96.44
	Yes	31	3.56
Glucose	No	421	48.39
	Yes	449	51.61
Oxygen	No	474	54.48
	Yes	396	45.52
Blood transfusion	No	855	98.28
	Yes	15	1.72
Thermal care	No	844	97.01
	Yes	26	2.99

the rate was double in my study.<sup>17,20</sup> This might be due to the weak monitoring system.<sup>27</sup>

In this study, the odds of death of neonates from rural areas were 1.96 times (AOR: 1.96, 95% CI: 1.26, 3.06) higher than in urban. This finding was supported by studies at Nekemte Referral Hospital.<sup>24</sup> This might be due to the differences in healthcare-seeking behavior between urban and rural residents and the difference in average distance from the health setup. Place of delivery was a significant factor of NM. As a result, home deliveries were 3.73 times more likely to die than health institutions. This finding was supported by a study conducted by the University of Gondar.<sup>28</sup> This could be due to the absence of safe delivery practices and post-natal care at home.<sup>29</sup>

In addition to this, the odds of congenital deformity-related death were 3.61 times (AOR: 3.61, 95% CI: 1.17, 11.18) higher compared to those without congenital deformity. This was supported by a study conducted in a global network study.<sup>13</sup> Again, the odds of death due to low birth weight were 2.13 times (AOR: 2.13, 95% CI: 1.23, 3.67) more than normal birth weight. This is supported by a study in eastern Ethiopia,<sup>30</sup> and a Global Network study in low-income countries.<sup>13</sup>

Furthermore, the presence of respiratory distress syndrome and birth asphyxia were also important risk factors for NM. The odds of death of neonates who were admitted with the presence of respiratory distress and birth asphyxia were 3.32 and 7.73 times higher than neonates without respiratory distress syndrome and birth asphyxia respectively. These findings were supported by a study conducted in Eastern Ethiopia,<sup>30</sup> in the referral hospital of Debre Markos,<sup>31</sup> a Hospital of St.Luke



**Figure 2.** Trends of NMR based on 12months per MA among neonates admitted at the NICU of FHCSH from 2016 to 2020, Bahir Dar, Northwest Ethiopia, 2021 (n=870).  
Abbreviation: MA/Mov, Avg is a short form of moving average.

**Table 4.** The bivariable and multi-variable logistic regression analysis of neonatal mortality among neonates admitted at the NICU of FHCSH, in Bahir Dar, Northwest Ethiopia, 2021 (n=870).

VARIABLES	CATEGORY	OUTCOMES		COR [95% CI]	AOR [95% CI]	PVALUE
		DIED	ALIVE			
Residence	Urban	49	323	1	1	
	Rural	141	357	2.60 [1.81, 3.72]*	1.96 [1.26, 3.06]	<.003**
Sex	Male	110	391	1	1	
	Female	80	289	0.98 [0.71, 1.36]	1.04 [0.69, 1.58]	.832
Mode of delivery	SVD	163	525	1	1	
	C/S	27	155	0.56 [0.35, 0.87]*	0.63 [0.35, 1.11]	.111
Delivery place	Health setup	171	664	1	1	
	Home	19	16	1.01 [0.76, 1.34]	0.94 [0.65, 1.35]	.741
Maternal HIV status	Negative	155	652	1	1	
	Positive	35	28	0.35 [0.21, 0.59]*	0.66 [0.36, 1.21]	.183
Weight (in g)	2500-4000	40	372	1	1	
	<2500	150	308	0.90 [0.69, 1.17]*	0.96 [0.64, 1.43]	.866

(Continued)

Table 4. (Continued)

VARIABLES	CATEGORY	OUTCOMES		COR [95% CI]	AOR [95% CI]	PVALUE
		DIED	ALIVE			
Gestational age	Term	58	461	1	1	
	Preterm	132	219	0.22 [.15, 0.31]*	0.58 [0.23, 1.14]	.233
Prematurity	No	63	476	1	1	
	Yes	127	204	4.70 [3.33, 6.63]*	1.62 [0.62, 4.24]	.317
Sepsis	No	32	161	1	1	
	Yes	158	519	1.53 [1.00, 2.32]*	1.93 [1.12, 3.31]	.017
Birth asphyxia	No	135	593	1	1	
	Yes	55	87	2.77 [1.88, 4.08]*	7.73 [4.31, 13.84]	<.001**
Congenital deformity	No	183	660	1	1	
	Yes	7	20	1.26 [0.52, 3.03]	3.61 [1.17, 11.18]	.025
Low birth weight	No	66	478	1	1	
	Yes	124	202	4.44 [3.16, 6.25]*	2.13 [1.23, 3.67]	.006**
Presence of RDS	No	110	602	1	1	
	Yes	80	78	5.61 [3.86, 8.14]*	3.32 [1.97, 5.59]	.001**
Ambu-bag resuscitation	NO	180	548	1	1	
	Yes	10	132	0.23 [0.11, 0.44]*	0.16 [0.07, 0.38]	<.001**
Antibiotics given	No	37	91	1	1	
	Yes	153	589	0.63 [.41, 0.97]*	0.50 [0.27, 0.90]	.022**
Anticonvulsant given	No	180	659	1	1	
	Yes	10	21	1.74 [0.80, 3.76]	1.43 [0.53, 3.84]	.469
Glucose given	No	112	309	1	1	
	Yes	78	371	0.58 [.41, 0.80]*	0.47 [0.30, 0.72]	<.001**
Oxygen given	No	149	325	1	1	
	Yes	41	355	0.25 [0.17, 0.36]*	0.26 [0.16, 0.41]	<.001**
Blood given	No	189	666	1	1	
	Yes	1	14	0.25 [.032, 1.92]	0.55 [0.06, 4.99]	.602
Thermal care	No	182	662	1	1	
	Yes	8	18	1.61 [0.69, 3.77]	0.86 [0.30, 2.49]	.793

1-Reference category.

\*Associated variables based on bivariable selection criteria.

\*\*Statistically significant variables at multivariable analysis with a 5% level of significance.

at Wolisso,<sup>32</sup> a referral hospital at Dilchora Dire Dawa,<sup>33</sup> and a study in SSA.<sup>34</sup> Likewise, birth asphyxia was supported by a study conducted in Southern Ethiopia,<sup>22</sup> Eastern part of Ethiopia, and Northern parts of Ethiopia, in Tigray.<sup>30,35</sup> In addition, this finding was also supported by a study in Bangladesh<sup>36</sup> and a study in developing countries.<sup>1</sup> This was strongly due to the difficulty of breathing.

Finally, the odds of death of neonates who got Ambu-bag resuscitation, taking antibiotics, glucose, and oxygen given were 84% (AOR: 0.16, 95% CI: 0.07, 0.38), 50% (AOR: 0.50, 95% CI: 0.27, 0.90), 53% (AOR: 0.47, 95% CI: 0.30, 0.72), and 74% (AOR: 0.26, 95% CI: 0.16, 0.41) risk reduction compared to neonates who did not get the above corresponding treatment modalities respectively by keeping other factors constant for all

interpretations. The reason could be birth asphyxia is the leading cause of neonatal mortality. However, this medical state and other causes of neonatal mortality might be resolved with bag and mask resuscitation together with oxygen therapy, antibiotics, and glucose. This finding is supported by studies carried out by Shikuku, Hadgu, and WHO.<sup>37-39</sup>

### *Limitations and strengths of the study*

The main strength of this study was to show the 5-year trends of NM by using the historical data from the period 2016 to 2020. Despite these strengths, this study did not address the impact of training on the reduction of neonatal mortality.

### **Conclusion and Recommendation**

According to this 5-year trend analysis study, the average trend of NMR has risen from January 1, 2016, to December 31, 2020, indicating that more work is still needed to make progress toward meeting the SDG goal by 2030. Place of residence, having birth asphyxia, congenital deformity, low birth weight, RDS, Ambu-bag resuscitation, taking antibiotics, glucose, and oxygen therapy were found to be statistically significant factors of neonatal mortality. Therefore, all stakeholders shall give due attention to reducing this timely rising trend of neonatal mortality.

### **Abbreviations**

ANC: Antenatal Care; AOR: Adjusted Odds Ratio; CI: Confidence Interval; EDHS: Ethiopian Demographic Health Survey; ENM: Early Neonatal Mortality; FHCSH: Felege Hiwot Comprehensive Specialized Hospital; HBV: Hepatitis B Virus; HCV: Hepatitis C Virus; HIV: Human Immune Virus; KMC: Kangaroo Mother Care; LNM: Late Neonatal Mortality; MRN: Medical Registration Number; NICU: Neonatal Intensive Care Unit; NM: Neonatal Mortality; NMR: Neonatal Mortality Rate; RDS: Respiratory Distress Syndrome; SRSWOR: Simple Randomly Sampling Without Replacement; SDG: Sustainable Development Goals; SSA: Sub-Saharan Africa; VDRL: Venereal Diseases Research Laboratory; WHO: World Health Organization.

### **Declarations**

#### *Ethical Approval and Consent to Participate*

Ethical clearance was obtained from the Institutional Review Board of Bahir Dar University with an approval number med287/2021. After discussing the purpose and method of the study, verbal informed consent was obtained from Felege Hiwot Comprehensive Specialized Hospital official bodies before collecting data. Since the study used secondary data from the registration logbook informed consent for the participants was waived by the Ethical Review Committee of school of Public Health, College of Medicine and Health Science, Bahir Dar University. No identifying information were

indicated on the checklists, and confidentiality was assured throughout the study.

#### *Consent for publication*

Not applicable.

#### *Author Contributions*

Zewdu Bishaw Aynalem: Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Software; Validation; Writing – original draft; Writing – review & editing. Ayalew Kassie: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Software; Supervision; Validation; Writing – original draft; Writing – review & editing. Mulugeta Kassie: Data curation; Formal analysis; Methodology; Validation; Writing – original draft; Writing – review & editing. Berihun Bantie: Data curation; Formal analysis; Investigation; Methodology; Validation; Writing – original draft; Writing – review & editing. Tewodros Worku Bogale: Data curation; Formal analysis; Validation; Writing – original draft; Writing – review & editing.

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#### *Competing Interests*

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#### *Availability of Data and Materials*

The datasets used for analysis are available from the corresponding author upon reasonable request.

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