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Research Article

Mortality and its Predictors among Neonates Admitted to a Neonatal Intensive Care Unit in Hadiya Zone, Southern Ethiopia: A Retrospective Cohort Study

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Abstart

Background: A large number of children die soon after birth. Improving the survival chances of newborns remains an urgent challenge that needs intensified commitment to achieve the Sustainable Development Goals (SDGs) target of neonatal mortality reduction. This study aimed to estimate neonatal mortality rate and identify predictors of neonatal death among neonates admitted into the neonatal intensive care unit (NICU) of a general hospital in Hadiya Zone, Southern Ethiopia.

Method: A Facility-based retrospective cohort study was conducted in Wachemo University Nigist Elleni Mohammed Memorial Hospital (WUNEMMH) from January 1 to December 31, 2020. All 1104 neonates admitted to NICU during the study period were taken as a sample. Data were extracted from both patient cards and NICU logbooks using an open data kit (ODK). SPSS version 20 and Stata version 14.2 were used for data analysis. Follow-up time was calculated from the date of admission to the date of death or censoring. Cox proportional hazards regression model was used to identify the predictors of death.

Result: Data from a total of 1104 neonates, which contributes to 8,285 person-days, were reviewed over two years. There were 207 (18.8%) deaths of neonates with an overall incidence of 25 deaths per 1000 neonate-days. Low birth weight of ≤1500 grams [AHR= 3.5,95% CI; 2.25, 5.49], Gestational age (GA) of ≤32 weeks [AHR= 1.9, 95% CI: 1.18, 3.18], both 1st minute APGAR score of ≤ 3 [AHR=2, 95% CI; 1.27, 3.22] and 5th minute APGAR score of ≤ 3 [AHR= 3.6; 95% CI; 1.58, 8.25], asphyxia [AHR= 3.1,95% CI; 2.167, 4.32], prematurity(AHR= 1.48; 95%CI:1.01,2.19), hypothermia[AHR:2.95;95%CI:1.41,6.15], respiratory distress syndrome (RDS) [AHR= 2.1, 95% CI;1.50,2.99], resuscitation [AHR= 1.70,95% CI; 1.17, 2.64], oxygen therapy [AHR= 1.98,95% CI;1.42,2.75] as well as no antenatal care (ANC) [AHR=1.59,95% CI;1.02,2.46], and maternal complication [AHR= 1.6, 95% CI;1.10, 2.18] were predictors of neonatal mortality.

Conclusion: High neonatal death at NICU was demonstrated and most of the predictors were neonate-related factors that could be influenced by maternal and obstetric health; so, promotion of maternal and child wellbeing; strengthening and ensuring the quality of healthcare service needs to be intensified.

Keywords: Survival; Neonatal mortality; NICU; Southren Ethiopia

Abbreviations

ANC: Antenatal Care; BPM: Breath Per Minute; C/S: Cesarean Section; CPAP: Continuous Positive Airway Pressure; EDHS: Ethiopian Demographic and Health Survey; HR: Heart Rate; IQR: Inter Quartile Range; KMC: Kangaroo Mother Care; LBW: Low Birth Weight; NICU: Neonatal Intensive Care Unit; NMR: Neonatal Mortality Rate; ODK: Open Data Kit; RDS: Respiratory Distress Syndrome; RR: Respiratory Rate; SDG: Sustainable Development Goal; SSA: Sub Saharan Africa; WCUNEMM: Wachemo University Nigist Eleni Mohammed Memorial Hospital

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Introduction

The neonatal period is one of the crucial and vulnerable times in an infant's life. The neonatal period is globally accepted as beginning at birth and ending at 28 completed days of life [1,2]. Neonatal deaths (deaths among live births during the first 28 completed days of life) may be subdivided into early neonatal deaths, occurring during the first 7 days of life, and late neonatal deaths, occurring after the 7th day but before the 28th completed days of life [2,3]. Although being newborn is not a disease, large numbers of children die soon after birth; many of them in the first four weeks of life (neonatal deaths), and most of those during the first week of life (early neonatal deaths) [4].

Globally, approximately 7000 newborns die daily and the majority of all neonatal deaths (75%) occur during the first week of life, and about 1 million newborns die within the first 24 hours [5,6]. Worldwide, deaths among children aged 1 month to 5 years old have fallen dramatically in recent decades. But progress in reducing the deaths of newborn babies age less than 1 month has been less impressive [3,7]. The burden of neonatal deaths is also unevenly distributed across regions and countries [3,5]. Sub-Saharan Africa had the highest neonatal mortality rate in 2018, 28 deaths per 1,000 live births followed by Central and Southern Asia with 25 deaths per

1,000 live births. A child born in sub-Saharan Africa or Southern Asia is 10 times more likely to die in the first month than a child born in a high-income country. Ethiopia is a country with neonatal mortality of 28.1 deaths per 1000 live births in 2018 [5]. One in every 34 children dies within the first month. Even though neonatal mortality declined from 39 deaths per 1,000 live births in 2005 to 29 deaths per 1,000 births in 2016, it has remained stable for the last couple of years since EDHS 2016 [8,9]. This indicates there is still a long way to achieve the SDG target for neonatal mortality rate, which is 12/1000 live birth [9,10]. According to WHO estimates, the leading causes of neonatal deaths in Ethiopia (2017) are preterm birth complications (26%) intrapartum related events (30%), sepsis and tetanus (18%), congenital abnormalities (11%), diarrhoea1%, pneumonia (8%), other conditions (7%) [11]. The neonatal mortality rate is considered a standard indicator for the evaluation of the health status of a country. Also reducing neonatal mortality is an essential part of the third Sustainable Development Goal (SDG) [10,12]. However, some institutions do not have an appropriate human and material resource so that it affects the survival of infants [13]. Health interventions needed to address the major causes of neonatal deaths generally differ from those needed to address other under-five deaths [9,10]. Improving the survival chances of newborns, children and young adolescents remains an urgent challenge [10,14]. Neonates admitted to the NICU are usually critically ill which need intensive care; consequently, the neonatal mortality rate among admitted neonates is higher than the mortality in the general population [9,15]. However, a higher neonatal mortality rate is reported among neonates admitted to NICU [16-18], which needs greater emphasis. To curb neonatal mortality in Ethiopia, knowing the predictors of neonatal mortality and morbidity is essential. However, reliable information is not available [8,9].Therefore, the aim of this study is to estimate neonatal mortality and identify predictors of neonatal death among neonates admitted to the NICU of WUNEMMH, Southern Ethiopia. This study can contribute to the evidence-base required to design interventions to minimize neonatal mortality and its complications.

Methods

This was a facility-based retrospective cohort conducted in WUNEMMH in Hadiya Zone, Southern Ethiopia, from January 30 to March 30, 2020. The Hospital is found in Hosanna Town. Hosanna town is located 230 km southwest of the capital city of Ethiopia, Addis Ababa. The hospital renders comprehensives maternal and child health-related services like delivery services, antenatal care, postnatal care, family planning, and other related services. Besides, the hospital provides inpatient pediatric care and treatment service, which incorporates a Neonatal Intensive Care Unit (NICU) which can admit and provide care and treatment services for an average of 16 neonates per week. The sample size was estimated using a double population proportion formula. The sample size was calculated both for mortality estimation (neonatal death rate at NICU of 27 per 1000 neonate-days [16]) and predictors of death. Cox proportional hazards model method was employed using Stata version 14.2 considering the presence of censoring adjusting for other covariates. A study from low and middle-income countries that showed the age of neonate at admission (<7days) as exposed and ≥7 days as unexposed [16] at a 95% confidence level, a margin of error of 1.5 %, and a confidence level of 95% and 80% power of the test. A sample size of 721 was obtained. However, to increase the power and precision of the study, all neonates who were admitted from January 1, 2018 to December 31, 2019 (1104 neonates) were included in the study. Medical Record Numbers (MRN) of the neonates was obtained from the NICU logbook. Then, the medical cards of the neonates were retrieved from the card room by card room workers. Data were retrieved using extraction format through an electronic data capture method using an ODK. Data extraction checklists were adapted from a national NICU logbook format as well as from several previous studies and took into account the local context [16,17,19-23]. Socio-demographic characteristics, maternal and obstetric history, and neonatal factors were collected. The ODK data extraction checklist was prepared in English. Data collectors were trained for two days on the purpose of the study, the ODK data collection tool, and the ethical aspects of the study. ODK data collection form was created using important commands to minimize the occurrence of an error during data collection. A pre-test was carried out before the actual study to check the validity of the checklist and appropriate corrective measure was taken. Data was collected by 4 nurse-midwives with experience in obstetric care. The data collection process was strictly supervised and data checked for consistency and completeness. Chart records with incomplete data were excluded from the sample. The electronic data collection software (ODK) was synchronized with Google Drive (server) and, then uploaded directly to Google Sheets at the time of data collection. After the data collection was accomplished, the data was downloaded from Google Drive in excel format and exported to SPSS version 20 and STATA version 14.2 for further analysis. Descriptive statistics such as median, Interquartile Range (IQR), or mean and Standard Deviation (SD) were used to summarize the characteristics of the cohort. Kaplan-Meier (KM) method was used to determine the survival probability after admission to NICU. The log-rank test was used to compare survival curves among the variables with categories. The Cox-proportional hazards model was employed to assess the relationship between predictors and mortality. Adjusted Hazard Ratio (AHR) with 95% Confidence Interval (CI) was used to measure the presence and strength of association between mortality and potential predictors. Variables with $p<0.25$ in bivariate analysis and known confounders were entered into a multivariable cox-proportional regression model. The proportional hazards assumption of the Cox model was assessed using the Schoenfeld residual test (phtest) after fitting a model with stcox (post estimation).

Results

Background characteristics of the neonates

A total of 1104 neonates were included in the study from a 2-year observation at the NICU of WCUNMMH. The median length of stay in NICU was six (IQR = 6.0) days. More than half (54.3%) of the neonates were males. Six hundred eighteen (56.7%) were from rural areas. Nine hundred thirty-four (84.6%) of the neonates were admitted within 24 hours after birth. Most (87.1.3%) of the mothers of neonates were 21-35 years old with a median age of 25 years (IQR=5.0) (Table 1).

Perinatal characteristics

Ninety-seven (8.8 %) of the neonates had very low birth weight and 273 (27.1%) had low birth weight. Nearly half (48.6%) of the neonates were born after 37 completed weeks of gestation. One thousand twenty-eight (93.5%) were singletons and 71(6.5) were multiple births. Four hundred seventeen (41.6%) and 740 (73.9%) of the neonates, respectively, had 1st minute and the 5th minute APGAR scores of 7-10. The mean (±SD) of the heart rate of the neonates at birth was 143.55 (±22.6) beats per minute and the mean (±SD) of the respiratory rate was 57.88 (±24.49) breaths per minute. Related

Table 1: Background characteristics of neonates and mothers of neonate admitted to NICU of WUNMMH, Southern Ethiopia, 2018-2019.

Variables (n=1104)	Number	Percentage (%)
Sex of the neonates		
Female	504	45.7
Male	600	54.3
Residency		
Urban	486	44.0
Rural	618	56.0
Age of neonates at admission		
< 1 days	934	84.6
≥ 1 days	170	15.4
Maternal age (years) (n=1098)	Median=25(IQR=5.0)	
≤20	110	10.0
21-35	967	87.1
>35	21	1.9

to breastfeeding initiation, the majority (72.8%) initiated within one hour of birth. More than two-third (672) had no new additional diagnosis and 432 (39.1) had a new additional diagnosis after admissions (Table 2).

Reasons for neonatal admission (admission diagnosis)

Hypothermia and neonatal sepsis contributed to half of the causes for admission that accounted for 801 (28%) and 582 (20 %), respectively. Furthermore, 389 (13%) of the neonates were admitted due to low birth weight, 304 (11%) due to Respiratory Distress Syndrome (RDS), 278 (10%) due to prematurity, and 262 (9%) due to asphyxia (Figure 1).

Treatments and care given to neonates at NICU

Among the neonates admitted to the NICU, 1002 (90.7%) were given antibiotics followed by glucose 658 (59.6%) and oxygen supplementation 376 (34%). Only 62 (5.4 %) of the neonates had received Kangaroo Mother Care (KMC) (Table 3).

Table 2: Perinatal characteristics of neonates admitted to NICU of WUNMMH, Southern Ethiopia, 2018-2019.

Variables(n=1104)	**Number**	**Percentage (%)**
Birth weight (n=1011)		
≤1500 grams	97	9.5
1501-2499 grams	273	27.1
≥2500 grams	641	63.4
Gestational age		
<32 weeks	95	8.6
32-36 weeks	472	42.8
≥ 37 weeks	537	48.6
APGAR score 1st minute(n=1003)		
≤ 3	186	18.5
4-6	400	39.9
7-10	417	41.6
APGAR score 5thminute(n=1001)		
≤ 3	14	1.4
4-6	247	24.7
7-10	740	73.9
Breastfeeding initiation (n=1100)		
Within 1 hour.	801	72.8
After 1 hour.	252	22.9
Not initiated	47	4.3
Respiratory rate (mean ±SD) (n=1099)	57.88 ±24.49	
30-60 Breath/minute	599	54.5
<30 or >60 Breath/minute	500	45.5
Heart rate (mean ±SD) (n=1078)	143.55 ±22.6	
100-205 Beat/minute	1061	98.4
<100 or >205 Beat/minute	17	1.6

Note: SD: Standard Deviation

Maternal obstetric characteristics

One thousand thirteen (92.7%) of the neonate's mothers had at least one ANC follow up, and more than half (52.7%) were multipara. Related to delivery, 706 (88%) of the mother had a spontaneous vaginal birth and 966 (87.5%) of the mothers gave birth to the neonate in health institutions. The mothers of 319 (29.5%) of the neonates had an intrapartum complication and 907 (82.9%) had normal labor duration (Table 4).

Neonatal mortality and survival estimates

The 1104 neonates observed contributed 8,285 neonate-days of observations. Two hundred seven (18.8%) died [95%CI; 16.4, 21.0]. The overall incidence of neonatal death was 25 deaths per 1000 neonate-days of NICU stay [95% CI; 21.8, 28.6]. Of the 207 neonatal deaths, 123 (59.4%) were early neonatal deaths (0-7 days). The Kaplan-Meir survival curve estimate shows the survival probabilities of the neonates during their stay in NICU. The mean survival time in NICU was 19.89 days [95% CI; 18.8, 20.91], and the cumulative proportion of surviving at the end of the 1st, 7th, and 28th days of NICU stay was 98%, 85%, and 49% respectively (Figure 2).

Bi-variable and multivariable Cox proportional hazard regression model for predictors of neonatal mortality

Neonates with a birth weight of ≤ 1500 grams and between 1500 and 2500 grams had 3.5 [AHR= 3.5; 95% CI; 2.25, 5.49] and 2 [AHR= 2.0, 95% CI; 1.27, 2.98] times higher hazard of death, respectively, as compared to neonates with birth weight ≥ 2500 gram. Neonates born

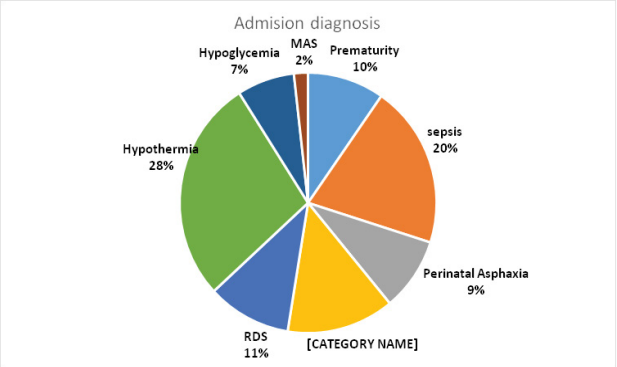

Figure 1: Admission diagnosis of neonates admitted to NICU of WUNMMH, Southern Ethiopia, 2018-2019.
Note: MAS: Meconium Aspiration Syndrom; RDS: Respiratory Distress Syndrome

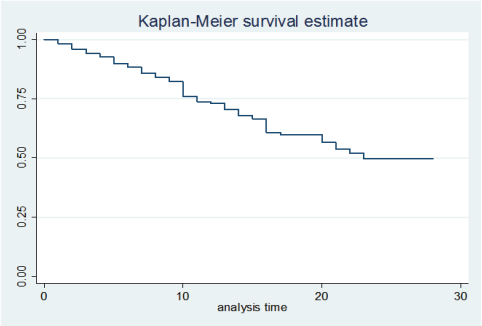

Figure 2: Kaplan-Meier survival curve estimate of the proportion of neonates who survived during the follow-up time (days) of neonates admitted to NICU of WUNMMH, southern Ethiopia, 2018-2019.

Table 3: Treatment given to neonates admitted to NICU of WUNMMH, Southern Ethiopia, 2018-2019.

Treatment given	Number	Percentage (%)
Antibiotics	1002	90.7
Glucose	658	59.6
Oxygen	376	34.0
Resuscitation	241	21.8
Incubator	126	11.4
Constant Positive Airway Pressure(CPAP)	115	10.4
Kangaroo mother care(KMC)	62	5.6
Anticonvulsant	60	5.4

Table 4: Maternal obstetric characteristics of neonates admitted to NICU of WUNMMH, Southern Ethiopia, 2018-2019.

Variables (n=1104)	Number	Percentage
ANC (n=1092)		
No	79	7.3
Yes	1013	92.7
Parity (n=1097)		
Prim Para	519	47.3
Multipara	578	52.7
Mode of delivery		
Caesarean section	52	4.7
Spontaneous vaginal	966	87.5
Instrumental assisted	86	7.8
Place of delivery		
Home	93	8.7
Health institution	1008	91.3
Intrapartum maternal complication		
No	764	70.5
Yes	319	29.5
Duration of Labour (n= 1094)		
≤14hr for prim/≤20hr multipara	907	82.9
>14hr for prim/>20hr for multipara	187	17.1

early (<32 weeks of gestation) have a 2-fold greater hazard of death as compared to those born at term [AHR= 2, 95% CI;1.18, 3.18]. And neonates born at GA 32-36 have not a significant difference in hazard of death as compared to neonates born at a GA of greater than or equal to 37 weeks. A neonate with the 1st minute APGAR scores of <3 had a doubled risk of death as compared to neonates with an APGAR score of 7-10 [AHR=2, 95% CI; 1.27, 3.22]. Neonate with the 5th minute APGAR scores ≤ 3 had 3.6 times the risk of death as compared to their counterparts [AHR= 3.6, 95% CI; 1.58, 8.25]. Premature neonates had a 48% higher hazard of death [AHR= 1.48, 95% CI; 1.01, 2.19] and those neonates with perinatal asphyxia have three times higher hazard of death than neonates without asphyxia (AHR: 3.06; 95% CI: 2.167, 4.32). The hazard of death among neonates admitted with the problem of Respiratory Distress Syndrome (RDS) was more than twice than that of neonates without RDS [AHR= 2.1; 95% CI; (1.50, 2.99]. Those neonates with hypothermia had 3 times the risk of death [AHR=3, 95% CI; 1.41, 6.15]. Neonates who had resuscitation had a 70 % higher hazard of death than those who were not resuscitated [AHR=1.7, 95% CI; 1.17, 2.64]. The hazard of death was 2 times higher among neonates treated with artificial oxygen than those who were not treated with oxygen [AHR= 2, 95% CI; 1.42, 2.75]. Neonates born to mothers who did not attend ANC visits during their pregnancy had a 59% higher hazard of death as compared to neonates born to mothers who had at least one ANC visit [AHR= 1.59, 95% CI; 1.02, 2.46]. Neonates born to mothers with intrapartum complications had a 55% higher hazard of death than those born to mothers without any intrapartum complication [AHR= 1.55, 95% CI; 1.10, 2.18] (Table 5).

Discussion

This study aimed to assess neonatal mortality and its predictors

Table 5: Bivariate and Multivariate Cox-proportional hazard regression for predictors of neonatal mortality among neonates admitted to NICU of WUNMMH, South Ethiopia, 2018-2019.

Variable	**Survival status**		**CHR 95% CI**	**AHR 95% CI**
	Censored	**Died**		
Residency				
Urban	393	93	1	1
Rural	504	114	0.815 (0.619,1.07)	0.85 (0.62, 1.18)
Age of neonate at admission				
<1 days	752	182	1	1
≥ 1 days	145	25	0.69 (0.45,1.04)	1.22 (0.74, 2.02)
Birth weight				
≤1500 grams.	25	72	10.32 (7.01,14.72)**	3.51 (2.25, 5.49)**
1501-2499 grams.	206	67	3.10 (2.16, 4.44)**	1.94 (1.27, 2.98)**
≥2500grams	588	53	1	1
Gestational age				
<32 week	37	58	8.96 (6.08, 13.20)**	1.94 (1.18, 3.18)**
32-36 week	370	102	2.87 (2.03, 4.06)**	1.38 (0.92, 2.07)
≥37 week	490	47	1	1
APGAR score 1st minute				
0-3	105	81	4.24 (2.97, 6.07)**	2.02 (1.27, 3.22)**
4-6	337	63	1.36 (0.90, 1.91)	1.23 (0.78, 1.92)
7-10	369	48	1	1
APGAR score 5th minute				
0-3	5	13	6.13 (3.44, 10.91)**	3.61 (1.58, 8.25)**
4-6	177	66	1.81 (1.33,2.46)**	0.80 (0.55, 1.17)
7-10	630	110	1	1
Gestation				
Single birth	605	130	1	1
Multiple birth	41	13	1.49 (0.90, 2.45)	1.57 (0.82, 3.00)
Meconium Aspiration Syndrome				
No	858	195	1	1
Yes	39	12	1.60 (0.89, 2.88)	0.73 (.33, 1.60)
Prematurity				
No	756	70	1	
Yes	141	137	6.03 (4.51, 8.04)**	1.48 (1.01, 2.19)*
Sepsis				
No	431	91	1	1
Yes	466	116	1.25 (0.95, 1.65)	1.19 (0.85, 1.67)
Asphyxia				
No	773	69	1	1
Yes	124	138	6.80 (5.09, 9.10)**	3.06 (2.16, 4.32)**
Respiratory Distress Syndrome				
No	705	95	1	1
Yes	192	112	3.39 (2.57, 4.45)**	2.11 (1.50, 2.99)**
Hypothermia				
No	279	10	1	1
Yes	606	195	7.58 (4.01, 14.32)**	2.95 (1.41, 6.15)**
Resuscitation				
No	771	92	1	1
Yes	126	115	5.12 (3.89, 6.74)**	1.70 (1.20, 2.42)**
Antibiotics				
No	72	30	1	1
Yes	825	177	0.55 (0.35, 0.76)*	1.66 (0.98, 2.80)
Anticonvulsant				
No	856	188	1	1
Yes	41	19	2.06 (1.28, 3.31)**	1.10 (0.60, 2.00)
Oxygen				
No	639	89	1	1
Yes	258	118	2.87 (2.18, 3.78)**	1.98 (1.42, 2.75)**
Additional diagnosis after admission				
No	579	93	1	1
Yes	318	114	1.96 (1.49, 2.57)**	1.13 (0.79, 1.62)
Antenatal Care				
No	38	41	3.15 (2.23 4.44)**	1.59 (1.02, 2.46)*
Yes	849	164	1	1

Maternal intrapartum complication				
No	662	102	1	1
Yes	216	103	2.74 (2.08, 3.61)**	1.55 (1.106, 2.18)*

*Note: **p < 0.001, *p < 0.05, CHR-Crude hazard ratio, AHR-Adjusted hazard ratio and CI-confidence interval, Proportionality Schoenfeld residual test (phtest) of (17) =16.73, P = 0.473, Sample size(n) for multivariable cox proportional hazard regression = 987.*

among neonates admitted to the NICU of WUNEMMH. In this study, the incidence of neonatal death was 25/1000 neonate-days of NICU stay. And, low birth weight, preterm birth, both 1st& 5th minute APGAR scores, perinatal asphyxia, prematurity, hypothermia, RDS, Oxygen therapy, resuscitation, ANC follow up and maternal intrapartum complication were predictors of neonatal mortality. Comparable to the results of the present study, an overall neonatal mortality rate of 25.8/1000 neonate-days and 27/1000 neonates-days observation was reported from studies done in northwest Ethiopia and WolayitaSodo Referral Hospital [24] respectively, while several previous studies did not report the neonate-days incidence of death [18,20,22,25]. Regarding the death rate among admitted neonates over 2 years, the death rate in our study (18.8%) which is comparable with a study done in Arba-Minch hospital which was 20.8% [18]. And lower than the death rate reported from a study done at Addis Ababa, Ethiopia in which 23.3% [26]. However, the finding of the current study is significantly higher than those of several previous studies conducted in Ethiopia and other countries. The death rate reported from studies of Iran 10.6%, 14.2% of Nigeria, 9.2% of Kenya, and 5.7% of Wollega, 13.3% of Felege Hiwot referral hospital, and 14.3% of Gondar Hospital [27] respectively. The variation could be due to differences in the setting; those health institutions with adequate skilled health providers could have better neonatal survival. Because, according to the UNICEF report of 2018, low levels of access to maternal and newborn health services provided by skilled health providers correlate strongly with high newborn mortality rates. Also, differences in quality care, infrastructure, and equipment among institutions and countries could result in different neonatal survival. In this study, nearly two-thirds (59.4%) of death occurred within the first week of the neonatal period, which is supported by several studies in Ethiopia [17,21,24,28], though another study indicated that the burden of neonatal death is during the early neonatal period particularly within 24 hours of life [22,29]. The possible reason might be complications occurring during pregnancy and birth, poor quality of antenatal care, delay in identification, and poor management of complications during pregnancy and birth by health workers. This implies that newborn transition from fetal to extrauterine life is critically important, and events during birth and the newborn transition are linked to the range of both immediate and life-threatening health condition immediately after birth [29,30]. In the present study, the three major causes of neonatal admissions were hypothermia, neonatal sepsis, and low birth weight, though another study showed neonatal sepsis and low birth weight were in the top three causes of admission in studies done in Ethiopia and Cameron [30-39]. However, the proportions of causes of admission vary across different studies conducted in Ethiopia [27,40]. This implies, in most of the case, neonatal infection and other neonatal problems were the commonest problems during the neonatal period and would be avoidable if proper infection prevention protocol, antenatal care implementation and on-time linkage of high-risk pregnant women to health institutions were in place [7]. Neonates with a birth weight <= 1500 grams had a higher hazard of death in our study, which is consistent with studies done in Ethiopia, Ghana, and Egypt, LBW is mainly caused by poor maternal nutrition and maternal health, and it would be prevented by providing appropriate care and support to mothers as well as temperature maintenance, hygienic cord, and skincare, and early detection and treatment of infections and complications. Moreover, establishing linkage with other sector offices (education, water, sanitation, and agriculture) on activities relevant to child survival & nutrition would improve the nutritional status of the women, thus, in turn, reduces neonatal mortality related to LBW and prematurity. The observed association between neonates born early (<32 weeks of gestation) and neonatal death is consistent with another study in Ethiopia, Cameron, and India [19,21,33,39, 40], The reason could be the fact that neonates who born early are usually are premature and have low weight at birth. As a result, they suffer from a problem related to LBW and physiological immaturity, which could result in neonatal mortality [9,41,42]. Also, low KMC service (5.4%) during the total admission time at NICU in this study might contribute to the death of neonates. However, some studies done in Ethiopia did not report GA as a predictor of neonatal mortality. The reason for such discrepancy could be due to differences in sample size and study design used. Another predictor of neonatal death was being1st minute APGAR score of ≤ 3 and 5th minute APGAR scores 0-3, which is supported by several studies done in Mexico and Ethiopia. Low APGAR score neonates are usually asphyxiated and it could be associated with a complication of labor and delivery, thus conditions were significantly associated with neonatal mortality in this study and other studies. This implies that early warning and appropriate neonatal resuscitation are very important to save the life of neonates during and right after delivery. Also, the APGAR score measures the overall breathing process and environmental adaptation of the neonate immediately after birth. So, a neonate with a low APGAR score has a poor response to the transition from fetal life to extrauterine life and they are at risk of death. Our study revealed that the risk of neonatal death was three times the higher hazard of death among neonates with perinatal asphyxia. The finding was in line with a study done in Ethiopia and Ghana. Even though death related to infection was declining through time, perinatal asphyxia did not show any change and may be due to delays in accessing appropriate care. The reason could be due to inadequate care for women during labor, maternal intrapartum complication, and basic neonatal resuscitation. Therefore, intrapartum monitoring of high-risk pregnancy and care at the time. The risk of neonatal death among those neonates with prematurity was 48% higher as compared to neonates without prematurity, which is supported by studies in Ethiopia and Egypt. This could be because neonates with low birth weight, those preterm and premature newborns had immaturity of immune systems and other body defense mechanisms that control newborn disease susceptibility. Moreover, delay in receiving quality care in a health facility due to lack of attention and infrastructure in low-income countries like Ethiopia would contribute to neonatal death. Neonates' diagnosed with Respiratory Distress Syndrome (RDS) had two times greater risk of death. Studies in Ethiopia, Mexico, and other African countries. Since problems related to the respiratory system needs urgent intervention, lack of on-time intervention and skill could contribute to neonatal mortality; and, this could be due to lack of infrastructure, accessibility, and availability of quality care near to the community and adequate human resources. Neonates who are resuscitated and treated with oxygen have a 70% and 98% higher risk of death as compared to not resuscitated and not treated with oxygen respectively. The finding is

consistent with a study done in Addis Ababa and Nekemte Referral Hospital, Ethiopia. This could be because those newborns that required resuscitation and oxygen therapy had a serious illness, they are at higher risk of death and usually they have respiratory distress and asphyxia. Neonatal mortality was significantly associated with maternal conditions such as no antenatal care visits and maternal intrapartum complications. Neonates born to mothers who had no ANC follow up history during the pregnancy of the index neonate had a greater risk of death as compared to their counterparts. This finding aligns with previous studies conducted in Ethiopia and SSA countries. The reason might be because during ANC follow up, dangers related to pregnancy are assessed and appropriate interventions would be provided. Also, the maternal intrapartum complication was another predictor of neonatal mortality. The previous study was done in Ethiopia, Cameron and Ghana supported the current finding. This could be because a woman's health is very closely linked with that of her fetus and the birth-related problem also has a high impact on the health and survival of the neonate.

Conclusion

The present study revealed a high neonatal mortality rate in the NICU and the majority of death occurred during the early neonatal period. Hypothermia, neonatal sepsis, and low birth weight were the three top neonatal problems that contributed to neonatal admission to the NICU. Low birth weight, preterm birth, both 1st& 5th minute APGAR scores, perinatal asphyxia, prematurity, hypothermia, RDS, treatment by oxygen, resuscitation, ANC follow up and maternal intrapartum complication were independent predictors of neonatal mortality. The government should focus on more intensified programmatic strategies targeting child survival at health facilities specifically for premature and preterm neonates, and neonate with very low birth weight. Health care professionals must provide comprehensive immediate newborn care and immediate postnatal care, targeted follow-up of pregnant women, and early identification and management of intrapartum complications are recommended to reduce neonatal mortality.

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