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Predictors of time to death among preterm neonates admitted to neonatal intensive care units at public hospitals in southern Ethiopia: A cohort study

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Abstract

Background

Although the survival of preterm neonates has improved, thanks to advanced and specialized neonatal intensive care, it remains the main reason for neonatal admission, death, and risk of lifelong complication. In this study, we assessed time to death and its predictors among preterm neonates admitted to neonatal intensive care units (NICU) at public hospitals in southern Ethiopia.

Methods

A hospital based retrospective cohort was conducted among preterm neonates admitted to NICU at public hospitals in west Guji and Borena zones, Oromia National Regional State, southern Ethiopia. Simple random sampling technique was used to select records of preterm neonates admitted to both major hospitals in the study area. Data on neonatal condition, obstetric information, and status at discharge were collected from admission to discharge by trained research assistant through review of their medical records. Kaplan Meir curve and Log rank test were used to estimate the survival time and compare survival curves between variables. Cox-Proportional Hazards model was used to identify significant predictors of time to death at $p<0.05$.

Result

Of 510 neonates enrolled, 130(25.5%; 95% CI: 22–29) neonates died at discharge or 28days. The median survival time was 18 days with an interquartile range of (IQR = 6, 24). The overall incidence of neonatal mortality was 47.7 (95% CI: 40.2–56.7) per 1000 neonatal days. In the multivariable cox-proportional hazard analysis, lack of antenatal care (AHR: 7.1; 95%CI: 4–12.65), primipara (AHR: 2.3; 95% CI: 1.16–4.43), pregnancy complications

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Abbreviations: AHR, Adjusted Hazard Ratio; ANC, Antenatal Care; APGAR, Appearance pulse grimace activity respiration; CI, Confidence Interval; CS, Caesarean section; DM, Diabetic Mellitus; FMoH, Federal Minster of Health; HIV, Human Immunodeficiency Virus; HR, Hazard Ratio; HSTP, Health Sector Transformation Plan; KMC, Kangaroo Mother Care; nCPAP, Nasal continuous positive air pressure; NICU, Neonatal Intensive Care Unit; PNA, Perinatal Asphyxia; PROM, Pre-labour rupture of membrane; RDS, Respiratory Distress Syndrome; SDGs, Sustainable Development Goals; SVD, Spontaneous vaginal delivery; UNICEF, United Nations international emergency children fund; WHO, World Health Organization.

(AHR: 3.4; 95% CI: 1.94–6.0), resuscitation at birth (AHR: 2.1, 95% CI: 0.28–0.77) and not receiving Kangaroo mother care (AHR: 9.3, 95% CI: 4.36–19.9) were predictors of preterm neonatal death.

Conclusion

Despite admission to NICU for advanced care and follow up, mortality of preterm neonates was found to be high in the study settings. Addressing major intrapartum complications is required to improve survival of neonates admitted to NICU.

Introduction

Preterm birth is defined as a live birth before 37 completed weeks of pregnancy [1] and remains one of the common causes of hospitalization, death and long-term complications of the neonatal period. Although survival of preterm neonates has improved significantly, partly thanks to the advanced and specialized care in the neonatal intensive care unit (NICU), it still remains the main reason for neonatal admission, death, and risk of lifelong complication [2]. Globally, the sub-Saharan Africa has the highest newborn mortality rate 27 deaths per 1,000 live births, followed by Central and Southern Asia 25 deaths per 1,000 live births [3]. Similarly, Ethiopia is one of the top five countries where almost 50% of all the global neonatal mortality occurred [3].

The current level of neonatal death reflects that Ethiopia is far behind the goal set by the national Health Sector Transformation Plan (HSTP-I) which was 10 deaths per 1,000 live births by 2020 [4] and the sustainable development goals (SDGs), target of reducing neonatal mortality to 12 deaths per 1,000 live births by 2030 [4, 5]. Neonatal mortality in Ethiopia is still high despite the country's goal of reducing it from 28 to 11 per 1000 by 2020 as part of the national newborn and child survival strategy (2015–2020) [6]. Study on increasing trends of under-five mortality in the aftermath of Millennium Development Goal in Eastern Ethiopia revealed that overall under five mortality rate was 46.3 per 1000 live births with significant increase from 27.9 in 2015 to 54.7 in 2020 [7].

Despite all strategies and interventions that have been implemented to reduce neonatal mortality, especially preterm neonatal death, Ethiopia's neonatal mortality rate is unacceptably high. Although admission to the NICU will definitely improve the survival of preterm neonate, there is paucity of data on survival of preterm neonates and its determinants in many parts of Ethiopia in general, and in this pastoral community in particular.

The aim of this study was to determine time to death and its predictors among preterm neonates admitted to NICU at public hospitals in pastoral community in southern Ethiopia.

Materials and methods

Study design and setting

A hospital based retrospective cohort study was conducted among preterm neonates admitted to the NICU of two major public hospitals (Bule Hora and Yabelo) in West Guji and Borana Zones of Oromia, a predominantly pastoral setting. All neonates admitted from September 11, 2018 to September 10, 2021 in both hospitals were included. Bule Hora hospital, located in the capital of Guji Zone, is a zonal hospital with annual delivery of 3,250.

The hospital is a comprehensive general bedded hospital with 22 beds in the NICU. In this hospital neonatology ward accommodate 16 beds in including 8 total beds from NICU ward.

According to 2019/21 health department health management information system report, while Yabelo general hospital has 6,948 total number of birth attended by skilled health personnel from 2018 to 2021. In this hospital obstetrics and gynecological ward accommodate 24 total number of beds. Annual number of neonatal admissions including preterm neonates estimated to be 560. Nurse to patient ratio and physician to patient ratio is 1:2 and 1:12 respectively.

Population and sampling

All preterm neonates admitted to NICU at public hospitals of West Guji and Borena zones constitute the source population while all preterm neonates admitted in Bule Hora and Yabelo Hospitals NICU from September 11, 2018 to September 10, 2021 were the study population. Neonates with incomplete records: date of admission, date of discharge, vital status at discharge were excluded.

The sample size was calculated by using STATA 14.1 by considering the following assumptions: hazard ratio (HR) (1.62) of the selected covariate (presence of jaundice) and probability of failure (event) 0.288 were taken from a previous study [8]. Assuming probability of type I error or alpha 0.05, power of the study 80% and withdrawal probability of 0.1. Presence of jaundice was selected out of 5 covariates since it provides a maximum sample. Accordingly, the calculated sample size was 522. Simple random sampling technique was used to select a predetermined sample size by using their unique medical registration number (obtained from the admission register) as a sampling frame.

Data collection

The checklist for this study was adapted from neonates' medical card and logbook with modification based on literature review. The data were extracted from each individual neonate's medical card and logbook using a structured checklist. The checklist consisted of the information on maternal and neonatal socio demographic factors, neonatal related factors, maternal medical and obstetric-related factors.

Since the data were collected from neonates' medical card, the data collectors were trained on how to extract appropriate data and there was close daily monitoring and supervision at the data collection site.

Data processing and analysis

Data was entered to Epi Data 3.1 and cleaned and analyzed using STATA 15. Kaplan–Meier curve was used to estimate median survival time, cumulative probability of survival, and compare survival difference between the different covariates. Log rank test was used to compare statistical survival difference between categories of different explanatory variables. Life table was used to estimate the cumulative probability of survival at the different time intervals.

Multi-collinearity was checked using variance inflation factor (VIF<10) indicating non-existence of multicollinearity. In bivariable analysis crude hazard ratio test was carried out to identify candidate variables for the multivariable Cox regression model at p-value < 0.25. Variables with p-value <0.25 was entered into the multivariable Cox regression model to determine the predictors of preterm neonatal death. Proportional hazard assumption was assessed both graphically and Schoenfeld residual global test and PH assumption was met (chi2 = 2.14 Prob>chi2 = 0.0965). Hazard Ratios (HR) with 95% Confidence Intervals (CI) was used to assess the relationship between predictors associated with the occurrence of preterm neonatal death. Statistical significance was declared at p-value < 0.05.

Ethical considerations

The study protocol was reviewed and approved by the Institutional Health Research Ethics Review Committee (Ref no: IHRERC/193/2021/YYY) of College of Health and Medical Sciences, Haramaya University, Ethiopia. As the study was retrospective, the need for individual informed consent was waived. However, informed consent was obtained from the medical director and head of NICU of both hospitals. Confidentiality of the patient was ensured using anonymous data collection and authors had no access to individual identifier throughout the research process.

Results

Socio-demographic factors

Of the 522 neonatal records reviewed, 510 (97.7%) which met the enrollment requirements were included. However, 12 charts were excluded (5 unrecorded dates of admission, 4 unrecorded dates of discharge, 3 of the charts were not available at the time of data collection). Out of 510 neonates 261(51.2%) were from Yabelo general hospital while 249(48.8%) of them were from Bule hora general hospital. Almost a half of neonates 270(52.9%) were male and near to two-thirds of their mothers, 349(68.4%), came from rural area. Majority of the mothers, 353 (69.2%), were between 20–34 years with median age of the 26 years (IQR = 22, 30) (Table 1).

Obstetrics characteristics and medical conditions

Two third (65.9%) of the women had at least antenatal care. Nearly half (46.9%) of the women were multiparous. More than half (57.1%) gave birth at hospital and (76.9%) was spontaneous vaginal delivery (Table 2).

Neonates related factors

Six in ten (60.2%) of the neonate had a low birth weight (1500–2499 gm), with a mean weight of 1770 (±615 SD) gm. Four hundred and five neonates (79%) cried immediately after birth and resuscitation was performed for 41.8% of preterm neonates studied. About 136 (26.7%) had a body. More than a half 299(58.6%) of the neonates were diagnosed with neonatal sepsis

Table 1. Socio-demographic characteristics of mothers of preterm neonates admitted to NICU at Bule Hora and Yabelo general hospitals from September 11, 2018 to September 10, 2021(n = 510).

Characteristics	Frequency	Percentage
Hospital		
Yabelo	261	51.2
Bule hora	249	48.8
Age of mother		
<20	103	20.2
20–34	353	69.2
≥35	54	10.6
Maternal residence		
Urban	161	31.6
Rural	349	68.4
Sex of neonates		
Male	270	52.9
Female	240	47.1

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Table 2. Obstetric characteristics of mothers of preterm neonates admitted to NICU at Bule Hora and Yabelo general hospitals from September 11, 2018 to September 10, 2021(n = 510).

Characteristics	Frequency	Percentage
Antenatal care follow up		
Yes	336	65.9
No	174	34.1
Level of ANC follow up(n = 336)		
1–3 visits	272	81
≥4 visits	64	19
Parity		
Primipara	119	23.3
Multipara	239	46.9
Grand multipara	152	29.8
Complication during last pregnancy		
Yes	132	25.9
No	378	74.1
Previous bad obstetrics history		
Yes	87	17.1
No	423	82.9
Type of pregnancy		
Singleton	412	80.8
Multiple	98	19.2
Onset of labor		
Elective caesarean section	80	15.7
Spontaneous	375	73.5
Induced	55	10.8
Place of birth		
Home	92	18
Health center	127	24.9
Hospital	291	57.1
Mode of deliver		
Spontaneous vaginal delivery	392	76.9
Caesarean section	115	22.5
Instrument assisted delivery	13	0.6
Duration of labor in hours		
< 4hrs	47	11.1
4-18hrs	322	76.3
>18hrs	53	12.6
Preeclampsia		
Yes	107	21
No	403	79
Diabetic Mellitus		
Yes	17	3.3
No	493	96.7
Anemia		
Yes	12	2.4
No	498	97.6

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at the admission. From the total 510 neonates 237(46.5%) had received kangaroo mother care during the hospital stay (Table 3).

Survival status of preterm neonates

Neonates were followed for a minimum of 1 day and maximum of 28 days with a median follow-up period of 4 days. At the end of follow-up period, 130(25.5%) (95% CI: 22, 29) of the neonates died. The total time at risk for neonates was 2723 neonatal days. The overall incidence of neonatal mortality rate was 47.7 (95% CI: 40.2, 56.7) per 1000 neonatal days. From all deaths, about 58 (45%) of the neonates died within first 24 hours and about 48(37.2%) of the neonatal deaths occurred in the first 1 week of life.

The cumulative probability of survival at the first, seventh and 28th days was 80.1% (95% CI: 76–84), 62% (95%CI: 56–68) and 45.6% (95%CI: 34–56) respectively. The overall median survival time was 18 days with an interquartile range of (IQR = 6.24). Overall median Length of hospital stay for preterm neonates under the study was 4 days, with an interquartile range of (3, 7) neonates' days (Table 4).

The Kaplan Meier failure and log-rank test was used to compare hazard of death between preterm neonates with the different conditions The Kaplan Meier failure curve shows the probabilities of failure at 10, 20, and 28 days of follow up time which indicates increasing trend over time (Fig 1).

The log rank test revealed that the survival trend or period to neonatal mortality differed significantly between the categories of neonatal mortality: kangaroo mother care (Log rank test, $x^2 = 102.98$), neonatal sepsis (Log rank test, $x^2 = 8.54$), ANC (Log rank test, $x^2 = 167.2$) and complication during last pregnancy (Log rank test, $x^2 = 106.23$) (Fig 2).

Predictors of time to death

In the bi-variable cox regression analysis, maternal residence, antenatal care follow up, complication during last pregnancy, previous bad obstetrics history, place of birth, mode of delivery, preeclampsia, diabetic mellitus, gestational age, weight for gestational age, neonate cried immediately at birth, bag and mask resuscitation at birth, perinatal asphyxia at birth, neonate diagnosed with respiratory distress, hypoglycemia, neonatal sepsis, phototherapy, nasal continuous positive airway pressure, not receiving kangaroo mother care and radiant warmer were predictors of mortality at $p<0.05$. However, the multivariable cox-proportional hazard results revealed that the hazard of death among neonates born to mothers who had no antenatal care was 7 times higher compared to those neonates born to mothers who had at least one antenatal care during index pregnancy (AHR: 7.1, 95%CI: 4–12.65). There was a 2-fold increase in the hazard of mortality among preterm infants born to primipara compared to those born to multipara mothers (AHR: 2.3, 95%CI: 1.16–4.43).

This study revealed that babies from mother with pregnancy complication were more likely to die compared to those born to a mother with no pregnancy complication (AHR: 3.4, 95% CI: 1.94–6). The hazard of death among neonates who were resuscitated at birth was twice more likely than those who were not resuscitated (AHR: 2.1, 95%CI: 0.28–0.77). Finally, there was a 9-fold increase in the hazard of mortality among neonates who did not receive kangaroo mother care compared to their counterparts (AHR: 9.3, 95%CI: 4.36–19.9) (Table 5).

Discussion

This study was conducted to determine time to death and its predictors among preterm neonates admitted to the neonatal intensive care unit in two general hospitals in a predominantly pastoral community in southern Ethiopia. We found that the overall incidence of neonatal

Table 3. Characteristics of preterm neonates admitted to NICU at Bule Hora and Yabelo general hospitals from September 11, 2018 to September 10, 2021(n = 510).

Characteristics	Frequency	Percentage
Gestational age		
Extremely preterm	39	7.6
very preterm	79	15.5
moderate preterm	138	27.1
late preterm	254	49.8
Weight for gestational age at birth		
Small	252	49.4
Appropriate	258	50.6
Weight of neonate (gm)		
<1000	26	5.1
1000–1499	133	26.1
1500–2499	307	60.2
≥2500	44	8.6
Fifth minute APGAR score		
<7	346	74.1
≥7	121	25.9
Newborn cry immediately at birth		
Yes	405	79.4
No	105	20.6
Bag and mask resuscitation at birth		
Yes	213	41.8
No	297	58.2
Newborns temperature within 1 h of admission		
≤32	46	9
32.1–34	113	22.2
34.1–35	117	23
35.1–36	136	26.7
≥36	97	19.1
Peri-natal asphyxia diagnosed at birth		
Yes	83	16.3
No	427	83.7
Newborn diagnosed with respiratory distress		
Yes	116	22.7
No	394	77.3
Hypothermia diagnosed at admission		
Yes	258	50.6
No	252	49.4
Hypoglycemia diagnosed at admission		
Yes	97	19
No	413	81
Jaundice		
Yes	21	4.1
No	489	95.9
Newborn diagnosed with sepsis		
Yes	299	58.6
No	211	41.4

(*Continued*)

Table 3. (Continued)

Characteristics	Frequency	Percentage
Neonate received photo therapy		
Yes	44	8.6
No	466	91.4
Neonate received continuous positive airway pressure (nCPAP)		
Yes	143	28
No	367	72
Newborn received kangaroo mother care		
Yes	237	46.5
No	273	53.5
Newborn heated with radiant warmer		
Yes	308	60.4
No	202	39.6

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mortality rate was 47.7 (95% CI: 40.2, 56.7) per 1000 neonatal days with median survival time of 18 days. Predictors of death were no antenatal care, birth to primipara mother, obstetric complications, resuscitation at birth, and no kangaroo mother care.

Our finding is consistent with finding from Pakistan (47.3 per 1000 neonatal days) [9]. But higher than Tanzania (6.5 per 1,000) [10], and other parts of Ethiopia :- Wolaita Sodo (27 per 1000 person- days) [11], in Jimma (28.9 per 1, 000 neonate-days) [12], Debre Markos (29.2 per1000 person-day) [13], and Tikur Anbessa (39.1 per 1000-person day) [14] and it is lower than study conducted in Mizan Tepi (62deaths per 1000 person-days) [15]. This might be related with level of care differences. For example, settings with specialized and well-equipped neonatal care facilities could provide better care to the preterm neonates compared to the resource limited health care settings [16] and Similarly, socio demographic variation across the study areas might explain some of the difference. Given our study is in a predominantly pastoral community, women will seek care only in case of severe conditions.

The proportion of preterm neonatal death at the end of follow up period was (25.5% (95% CI: 22, 29). This is consistent with the findings from the studies conducted in Gondar (25.2%) [17], teaching hospitals in Addis Ababa (25.3%) [18], and in Jimma University Medical Center (25.1%) [12].

It is however, higher than findings from Uganda (8%) [19], in Woliata (16.5%) [11], and systematic review and meta-analysis in Ethiopia (19.2%) [20]. proportion of preterm neonatal death is lower than the studies reported from Mizan Tepi (35%) [15], Jimma University specialized hospital (34.9%) [21], tertiary hospital of Uganda (31.6%) [22], Addis Ababa

Table 4. Failure probability of preterm neonates admitted to NICU at Bule Hora and Yabelo general hospitals from September 11, 2018 to September 10, 2021 (n = 510).

Time in days	Total at the beginning	Death	censored	Failure probability%	95%CI
0–5	510	82	196	20	(16.4,24.1)
5–10	232	38	125	37.9	(32.3,44)
10–15	69	6	37	45.2	(38,53.1)
15–20	26	3	16	54.4	(43.5,65.9)
20–25	7	0	6	54.4	(43.5,65.9)
25–28	1	1	0	1	

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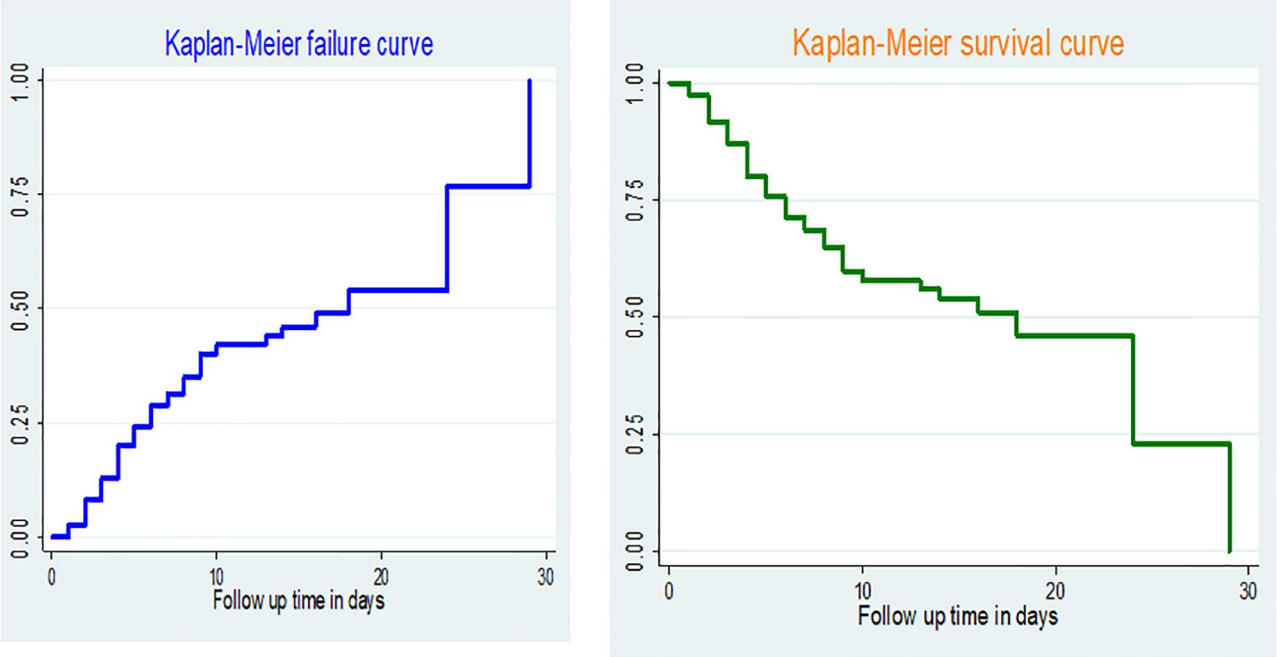

Fig 1. Kaplan-Meier failure and survival curve for overall time to death among preterm neonates admitted to NICU at Yabelo and Bule Hora hospitals from September 10, 2018 to September 11, 2021 (n = 510).

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University specialized hospital (29.7%) [14], Gondar (28.8%) [8], Debre Markos referral hospital (27.11%) [13], and France (27%) [23]. The variation between these studies could be attributable to differences in the quality of service provided.

We found that the hazard of death among neonates born to mothers who had no antenatal care was 7 times higher compared to those who had at least one antenatal care in index pregnancy. This is supported by the studies conducted in South Western Uganda [16], University of Gondar [17], Bombe primary hospital southern Ethiopia [24], and Mizan Tepi University Teaching hospital [15]. Possible reason could be lack of ANC visits may result in sufficient pregnancy monitoring, which may lead to neonatal problems during and after birth, which may be related with an increased risk of neonatal death.

There was a 2-fold increase in the hazard of mortality among infants born to primipara mothers compared to those born to multipara mothers. this is line with Tigrai [25] and Jimma [26]. This could be linked to the higher risk of unfavorable neonatal outcomes and intrapartum complications among of primipara mothers.

This study revealed that babies from mother with pregnancy complication were more likely to die than those from mother with no pregnancy complication. This is in line with the study from Sudan [27], Jimma Ethiopia [12] and Indonesia [28]. This could be explained by the fact that pregnancy complications impair the fetus's health and can contribute to preterm delivery, which can lead to life-threatening preterm complications, potentially increasing the risk of newborn death. Association of obstetric complications and adverse perinatal outcomes has been reported previously in [29].

Hazard of death among neonates who were resuscitated at birth were twice more likely than those who were not resuscitated at birth. This is in line with the study in Uganda [22] and southern Ethiopia [11]. The possible explanation could be resuscitation is given to the neonates with low 5th Minute APGAR score or failed to cry at birth.

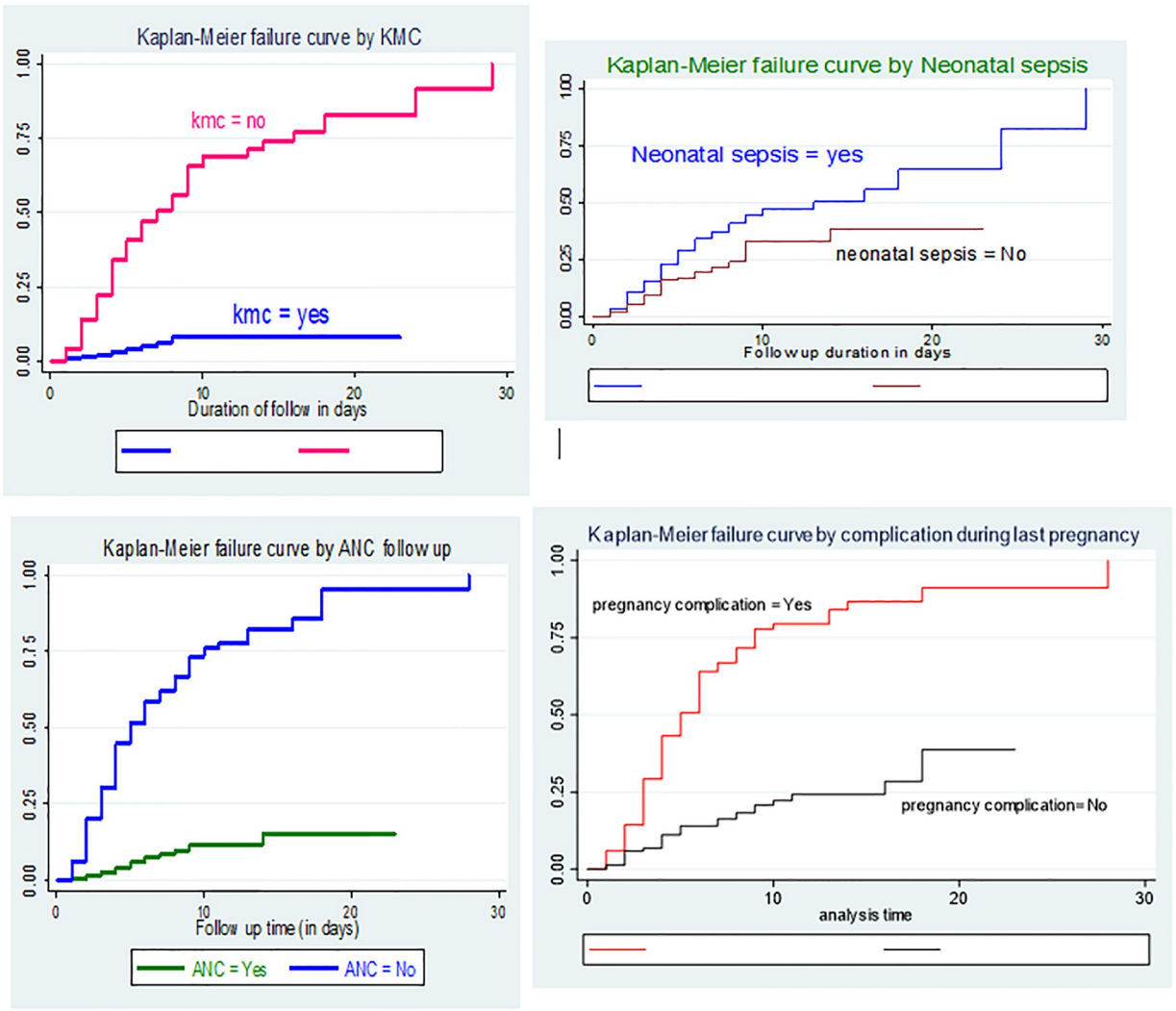

Fig 2. Kaplan-Meier failure curves of time to death among exposed and unexposed preterm neonates admitted to NICU at Yabelo and Bule Hora hospitals from September 10, 2018 to September 11, 2021 (n = 510).

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This study revealed 9-fold increase in hazard to mortality among preterm neonates who had not received KMC compared to those who were received KMC during hospital stay. This is consistent with the findings from the study in Uganda [16], Mizan Tepi [15], in Jimma [12] and Gondar Ethiopia [8]. There are various mechanisms through which immediate kangaroo mother care could be beneficial. The baby is more likely to be colonized by the mother's protective microbiome and to obtain early breastfeeding because the mother and baby are in close contact from birth. In addition, there is less handling of the newborn by other individuals, lowering the risk of infection.

Strength and limitation of the study

This study's strength is in its attempt to determine the factors that predict the time to death in preterm neonates admitted to the NICU, highlighting for the professional in the field when to be particularly concerned, especially in a resource-constrained settings. Additionally,

Table 5. Multivariable cox-proportional hazard regression for predictors of time to death among preterm neonates admitted to NICU at Bule Hora and Yabelo general hospitals from September 11, 2018, to September 10, 2021(n = 510).

		Survival status			
Variable	**Category**	**Died (N, %)**	**Censored (N %)**	**CHR 95% CI**	**AHR 95% CI**
Age of mother	<20	16(3.1)	87(17.1)	0.6(0.35,1.01)	0.6(0.28,1.29)
	20–34	97(19)	256(50.2)	1	1
	≥35	17(3.3)	37(7.25)	1.28(0.76,2.15)	0.77(0.38,1.56)
Maternal residence	Urban	48(9.4)	113(22.2)	1	1
	Rural	82(16.1)	267(52.3)	0.69(0.48,0.99) *	0.77(0.47,1.27)
ANC	Yes	20(3.9)	316(62)	1	1
	No	110(21.6)	64(12.6)	11.34(7.03,18.27)***	7.1(4,12.65) ***
Parity	Primipara	24(4.7)	95(18.6)	0.73(0.46,1.17)	2.3(1.16,4.43) *
	Multipara	66(12.9)	173(3.9)	1	1
	Grand multipara	40(7.8)	112(22)	0.97(0.65, 1.44)	1.5(0.88,2.42)
Complication during last pregnancy	Yes	78(15.3)	54(10.6)	5.1(3.57,7.22) ***	3.4(1.94,6) ***
	No	52(10.2)	326(63.9)	1	1
Previous bad obstetrics history	Yes	58(11.4)	29(5.7)	4(2.85,5.73)***	0.6(0.33,1.11)
	No	72(14.2)	351(68.8)	1	1
Type of pregnancy	Singleton	113(22.2)	299(58.6)	1.5(0.90,2.51)	0.83(0.44,1.58)
	Multiple	17(3.3)	81(15.9)	1	1
Onset of labor	Elective C/S	21(4.1)	59(11.6)	1.34(0.83,2.16)	2.3(0.95,5.39)
	Spontaneous	91(17.8)	284(55.7)	1	1
	Induced	18(3.5)	37(7.2)	1.56(0.94,2.59)	1.8(0.91,3.47)
Place of birth	Home	57(11.2)	35(6.9)	4.1(2.77,5.99)***	1.2(0.68,2.00)
	Health center	25(4.9)	102(20)	1.1(0.66, 1.75)	1.1(0.61,2.01)
	Hospital	48(9.4)	243(47.6)	1	1
Mode of delivery	SVD	93(18.2)	299(58.6)	1	1
	CS	37(7.2)	81(15.9)	1.66(1.13,2.45)*	0.6(0.27,1.30)
Preeclampsia	Yes	46(9)	61(12)	2.4(1.66,3.43)***	0.6(0.35,1.18)
	No	84(16.5)	319(62.5)	1	1
Diabetic mellitus	Yes	10(2)	7(1.4)	2.28(1.19,4.35)*	1.1(0.43,2.75)
	No	120(23.5)	373(73.1)	1	1
Gestational age	Extremely preterm	14(2.7)	25(4.9)	1.73(0.94,3.18)	1.5(0.71,3.32)
	very preterm	35(6.9)	44(8.6)	2.32(1.48,3.64) ***	1.4(0.76,2.44)
	moderate preterm	39(7.6)	99(19.4)	1.5(0.97,2.33)	1.2(0.76,2.06)
	late preterm	42(8.2)	212(41.6)	1	1
Weight for gestational age at birth	Small	84(16.5)	168(32.9)	1.8(1.24,2.56) **	0.8(0.50,1.38)
	Appropriate	46(9)	212(41.6)	1	1
neonate weight(gm)	<1000	13(2.5)	13(2.5)	2(0.83, 4.87)	0.9(0.29,2.67)
	1000–1499	48(9.4)	85(16.7)	1.8(0.85,3.79)	1.7(0.70,4.13)
	1500–2499	61(12)	246(48.2)	1.16(0.56,2.44)	1.7(0.76,3.92)
	≥2500	8(1.6)	36(7.1)	1	1
Neonate cry immediately at birth	Yes	79(15.5)	326(63.9)	1	1
	No	51(10)	54(10.6)	2.36(1.65,3.36) ***	0.6(0.35,1.16)
Bag and mask resuscitation at birth	Yes	75(14.7)	138(27.1)	2.3(1.62,3.28) ***	2.1(0.28,0.77) **
	No	55(10.8)	242(47.4)	1	1
Peri-natal asphyxia diagnosed at birth	Yes	46(9)	37(7.2)	2.74(1.91,3.93) ***	1.1(0.57,2.15)
	No	84(16.5)	343(67.2)	1	1

(*Continued*)

Table 5. (Continued)

		Survival status			
Variable	**Category**	**Died (N, %)**	**Censored (N %)**	**CHR 95% CI**	**AHR 95% CI**
Neonate diagnosed with RDS	Yes	59(11.2)	57(11.2)	2.37(1.68,3.36) ***	1.2(0.72,2.16)
	No	71(13.9)	323(63.3)	1	1
Hypoglycemia diagnosed at admission	Yes	33(6.5)	64(12.5)	1.63(1.09,2.42) *	1.5(0.88,2.42)
	No	97(19)	316(62)	1	1
Neonate diagnosed with sepsis	Yes	96(18.8)	203(39.8)	1.75(1.19,2.60) **	0.9(0.55,1.44)
	No	34(6.7)	177(34.7)	1	1
(CPAP)	Yes	52(10.2)	91(17.8)	1	1
	No	78(15.3)	289(56.7)	1.51(0.46, 0.94) *	0.6(0.37,1.00)
KMC	Yes	10(2)	227(44.5)	1	1
	No	120(23.5)	150(30)	12.64(6.62,24.13) ***	9.3(4.36,19.9) ***

(**Note**: AHR: adjusted hazard ratio; CHR: crude hazard ratio; CI: confidence interval

*p-value <0.05

**p-value <0.01

***p-value <0.001

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characteristics including not receiving kangaroo mother care, lack of ante natal care follow-up, and intrapartum complications were identified to be predictors of time to death. As a result, high-risk newborns may receive priority care and appropriate attention.

Some limitations should also be considered. First, follow-up was limited to until discharge. Some post discharge events may have occurred after discharge. Second, due to the nature of the study design and incomplete records, certain major predictors of preterm mortality, such as mother demographics, nutritional condition, and institutional factors, were not addressed. Selection bias is possibly introduced during secondary data collection because patients with incomplete records were excluded so that the incidence of death may be underestimated.

The fact that data was collected retrospectively from secondary sources might also have an effect on the quality of the study.

Conclusions

Despite admission to NICU for advanced care and follow up, mortality of preterm neonates was found to be high in the study settings. Addressing major intrapartum complications is required to improve survival of neonates admitted to NICU. Study on the appropriateness of care and delays in care is essential to fully understand the reasons behind high mortality.

Supporting information

S1 Dataset.
(XLS)

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