

BMJ Open Morbidity and mortality patterns of preterm low birthweight neonates admitted to referral hospitals in the Amhara region of Ethiopia: retrospective follow-up study

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ABSTRACT

Objective This study aimed to assess the morbidity and mortality patterns of preterm neonates with low birth weight admitted in the Amhara region referral hospitals in Ethiopia.

Design Hospital-based retrospective follow-up study.

Setting Amhara region referral hospitals, Ethiopia.

Participants A total of 291 preterm neonates low birth weight that were admitted to referral hospitals in the Amhara region between 1 January 2017 and 30 December 2018 were reviewed. Data were entered into Epi-data V.4.4.2.1 and exported to STATA V.14 for analysis, and variables with a p value of <0.05 at 95% confidence level in multivariable logistic regression model analysis were declared as statistically significant associated factors of mortality.

Primary outcome Morbidity and mortality patterns in preterm low birthweight neonates.

Results This study revealed that 37.8% (95% CI 32.4% to 43.5%) of preterm low birthweight neonates died. The most common morbidities found were 219 (75.26%) hypothermia, followed by 201 (69.07%), 145 (49.83%), 39 (13.4%) and 24 (8.25%) with sepsis, respiratory distress, jaundice and congenital anomalies, respectively. Sepsis (AOR: 2.0; 95% CI 1.03 to 3.89), respiratory distress (AOR: 4.6; 95% CI 2.51 to 8.40), hypoglycaemia (AOR 3.91; 95% CI 1.09 to 10.52), APGAR score at fifth minute <7 (AOR 0.39; 95% CI (0.18 to 0.82) and duration of hospital stay below mean (<9.82 days) (AOR 0.17; 95% CI 0.09 to 0.33) were associated with mortality.

Conclusion The mortality rate of preterm low birthweight neonates was high, indicating that this is a public health issue. Hypothermia, sepsis, respiratory distress, jaundice and congenital anomalies were the common morbidities. Sepsis, respiratory distress, hypoglycaemia, Apgar score at fifth minute <7 and duration of hospital stay below the mean were independent factors of mortality. However, these need to be further investigated in future research and appropriately addressed using prospective follow-up.

INTRODUCTION

Globally, in 2017, there were about 5.4 million cases of mortality under the age of 5 years, out

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The study was conducted at multiple referral hospitals, which increased the generalisability of the findings to the entire population.
- ⇒ This study used a multivariate logistic regression analysis to regulate all likely confounders.
- ⇒ Data were collected from secondary sources, and some factors were not available in the patients' medical charts, thereby creating the potential for missing factors that might have a significant association with death.

of which 2.5 million died in the first 28 days, with approximately two-thirds and 80% of the neonates being delivered with preterm and low birth weight (LBW), respectively.¹ The increasing number of preterm LBW neonates was one of the leading contributors to the levelling off of infants and neonatal mortality rates in 2013 in the USA.² In many Asian and African countries, being born preterm LBW is the main risk factor for the development of various morbidities and neonatal mortality.^{3,4} In Sri Lanka, approximately 28% of neonates die because of LBW and prematurity.⁴

Preterm LBW-related morbidities were the main causes of admission to the neonatal intensive care unit (NICU). In Bangladesh, 12.4% of admissions were due to preterm LBW and which was the cause of 6.5% of deaths.⁵ Furthermore, preterm LBW leads to prolonged hospital stay in neonates and can lead to adverse neurodevelopmental outcomes, with massive implications for the family and society in the future.⁶ In different regions of Ethiopia, preterm LBW is the major contributor to neonatal death, and neonates born both LBW and preterm show higher mortality rates during the neonatal

period than those with normal birth weight and term neonates.^{7–10} Of all the neonatal deaths in the south-western region of Ethiopia (22.8%), more than two-thirds of these (76%) were caused by LBW and prematurity.¹⁰

Despite the introduction of modern techniques in NICU facilities, preterm LBW neonates are still at a high risk of developing numerous morbidities.¹¹ The overall mortality of preterm neonates with LBW varies depending on the pattern of morbidities.¹² Preterm neonates with LBW are predisposed to infectious diseases because of their immature immune system and develop severe morbidities such as hypoglycaemia, respiratory distress syndrome (RDS),¹³ sepsis, jaundice, apnea and birth asphyxia.^{14–15} The mortality rate of preterm LBW neonates differs depending on the type of morbidity.^{16–17} The risk of developing morbidities varied among different categories of preterm LBW neonates. Extremely low birth weight (ELBW) and extremely preterm neonates have higher rates of morbidity and mortality.¹⁸

Currently, some trials aim to implement novel techniques for the prevention of preterm LBW births and to reduce neonatal morbidity and mortality related to preterm LBW. The United Nations sustainable development goal 3 emphasises reducing neonatal deaths with the goal of reaching 12 or fewer neonatal deaths per 1000 live births per country by 2030. They aim to achieve this through different interventions including kangaroo mother care and extra support for feeding LBW and preterm babies with breast milk as well as other interventions during the postnatal period.¹⁹

Despite these trials, many previous studies in Ethiopia have identified a high prevalence of preterm LBW neonates and a higher risk of neonatal morbidity and mortality in preterm LBW neonates. Although the prevalence of preterm LBW births is high, there is an information gap regarding the pattern of morbidity and mortality in preterm LBW neonates and the factors associated with mortality in this study area. Therefore, this study aimed to assess the morbidity and mortality pattern of preterm LBW neonates admitted to referral hospitals in the Amhara region of Ethiopia to fill this information gap. The findings of this study will help to identify major morbidities and understand the causes of mortality in preterm LBW neonates and facilitate healthcare providers in the application of prevention strategies for any modifiable causes of morbidity and mortality. Furthermore, referral hospitals in the Amhara region will provide an advanced insight into the factors associated with preterm LBW neonatal mortality. Finally, this study will provide insights for future research that is needed along this line.

METHODS AND MATERIALS

Study design, area and period

An institution-based retrospective follow-up study was conducted among preterm LBW neonates admitted to the NICU ward in selected referral hospitals of Amhara region between 1 January 2017 and 30 December 2018.

There are four referral hospitals in the region, (Bahirdar, Debremarkos, Dessie and Debrebirhan Referral Hospitals), out of which, two of them were selected by lottery method (Dessie Referral Hospital and Bahirdar/Felege Hiwot Referral Hospital). This study was conducted between 1 January 2019 and 1 February 2019 (data collection period).

Population and eligibility criteria

All neonates with a gestational age of less than 37 weeks weighing 500–2499 g admitted to the NICU wards of the Amhara region referral hospitals were the source population. All selected preterm LBW neonates admitted to the referral hospitals of the NICU ward from 1 January 2017 to 30 December 2018 were included in the study. Live birth neonates with a gestational age of less than 37 weeks weighing 500–2499 g admitted to the NICU wards of the Amhara region referral hospitals were eligible for the study.

Sampling techniques and procedure

The samples were allocated proportionally to each hospital. All preterm LBW neonates admitted to the NICU ward between 1 January 2017 and 30 December 2018 were recruited using the admission registration book by recording their medical record numbers sequentially. A simple random sampling was used to select the required number of participants.

Sample size determination

The sample size was determined by using a single population proportion formula considering the following assumptions; 95% confidence level, margin of error (0.05) and the rate of preterm mortality 25.2% from previous study conducted in Gondar, Ethiopia.²⁰

$$n = (Z_{\alpha/2})^2 \times p(1-p) / (d)^2$$

$$n = (1.96)^2 \times 0.252 \times 0.748 / (0.05)^2 = 289.65 \sim 290.$$

The sample size after adding a 10% non-response rate was 319.

Variables of the study

The dependent variable was the outcome of preterm LBW neonates dichotomised as deceased or alive.

The independent variables of this study were as follows:

- ▶ Sociodemographic variables: sex, age, age of mother and duration of hospital stay.
- ▶ Maternal and obstetric variables: maternal chronic diseases (HIV and Diabetes Mellitus), pregnancy status and pregnancy-related complications (pregnancy-induced hypertension).
- ▶ Neonatal complication/morbidity variables: sepsis, necrotising enterocolitis, asphyxia, RDS, jaundice, pulmonary haemorrhage, congenital anomalies, hypothermia and hypoglycaemia and neonatal related variables (place of delivery and mode of delivery).

Table 1 Sociodemographic characteristics of preterm low birthweight neonates and their mothers admitted to NICU in Amhara region referral hospitals, Ethiopia, 2019 (n=291)

Characteristics	Category	Total, n (%) n=291	Alive, n (%) n=181	Death, n (%) n=110	P value
Sex of the neonate	Female	106 (36.43)	70 (66.04)	36 (33.96)	0.307
	Male	185 (63.57)	111 (60)	74 (40)	
Maternal age (years)	<20	46 (15.81)	29 (63.04)	17 (36.96)	0.778
	20–34	205 (70.45)	128 (62.44)	77 (37.56)	
	≥35	40 (13.75)	24 (62.2)	16 (37.8)	
Neonatal age at admission	<24 hours	186 (63.9)	116 (62.4)	70 (37.6)	
	1–7 day	99 (34)	60 (60.6)	39 (39.4)	
	>7 day	6 (2.1)	5 (83.3)	1 (16.7)	
Mean length of stay in NICU (days)	<9.82	116 (39.9)	95 (81.9)	21 (18.1)	0.00
	≥9.82	175 (60.1)	86 (49.1)	89 (50.9)	

NICU, neonatal intensive care unit; NICU, neonatal intensive care unit.

Operational definitions

Pattern: frequent/repeated ways in which morbidity and mortality occur or widespread incidence of morbidity and mortality.

Morbidity: was defined as the diagnosis identified by health professionals using clinical, laboratory or other investigation methods (RDS, sepsis, congenital anomalies, asphyxia, jaundice, pulmonary haemorrhage, necrotising enterocolitis, hypoglycaemia and hypothermia) that were recorded in the neonate's medical chart.

Mortality: was defined as death in the NICU before discharge as certified by the death certificate (death summary note) in the chart.

Preterm LBW: neonates with a gestational age of less than 37 weeks and weighing less than 2500 g.

Data collection tools and procedures

After reviewing the literature, an existing checklist was adapted to address the objectives of the study. The checklist consists of information on maternal and neonatal sociodemographic data, neonatal-related factors, complication/morbidity factors and maternal and obstetric-related factors. Data were extracted from each neonatal medical chart by using the resulting structured checklist.

Table 2 Maternal medical and obstetrics characteristics of preterm low birthweight neonates and neonatal outcome admitted to NICU in Amhara region referral hospitals, Ethiopia, 2019 (n=291)

Characteristics	Category	Total, n (%) n=291	Alive, n (%) n=181	Death, n (%) n=110	P value	
Maternal chronic medical disease	No	281 (96.56)	178 (63.35)	103 (36.65)		
	Yes	10 (3.44)	3 (30)	7 (70)		
Maternal chronic medical disease	HIV	No	285 (97.94)	179 (62.81)	106 (37.19)	
		Yes	6 (2.06)	2 (33.33)	4 (66.67)	
	DM	No	289 (99.31)	181 (62.63)	108 (37.37)	
		Yes	2 (0.69)	–	2 (100)	
	Others	No	289 (99.31)	180 (62.28)	109 (37.72)	
		Yes	2 (0.69)	1 (50)	1 (50)	
Obstetric complications	No	228 (78.35)	149 (65.35)	79 (34.65)	0.036	
	Yes	63 (21.65)	32 (50.79)	31 (49.21)		
Obstetric complication	PIH	No	246 (84.54)	158 (64.23)	88 (35.77)	0.095
		Yes	45 (15.46)	23 (51.11)	22 (48.89)	
	Placenta – abruption	No	279 (95.88)	175 (62.72)	104 (37.28)	0.37
		Yes	12 (4.12)	6 (50)	6 (50)	
	Placenta – previa	No	285 (97.94)	178 (62.46)	107 (37.54)	0.533
		Yes	12 (2.06)	6 (50)	6 (50)	

NICU, neonatal intensive care unit; NICU, neonatal intensive care unit ; PIH, pregnancy induced hypertension ; PIH, pregnancy-induced hypertension.

Data quality assurance

Different measures were taken to ensure the data quality. One day of training was provided to the data collectors and supervisors on the objective of the study and how to gather information using the prepared data extraction checklist. The data collectors included were six nurses working in the NICU who had NICU training. An MSc nurse supervisor was assigned to support and facilitate data collection at each selected data collection site. The supervisor supervised the data collectors throughout the data collection process. The supervisor conducted daily evaluations of the checklists' completeness.

Data processing, analysis and presentation

After checking for completeness and consistency, the collected data were coded and entered into the Epi-data statistical software package V.4.4.2.1. The data were then exported to STATA V.14 for cleaning and analysis. Descriptive statistics performed and were presented in the tables. Bivariate and multivariate analyses were conducted using logistic regression to determine the association between factors and dependent variables. Based on the bivariate analysis, those variables with a *p* value <0.25 in the binary logistic regression were transferred to the multivariate analysis, and those variables with a *p* value <0.05 at 95% confidence level were considered independent factors for the mortality of preterm LBW neonates. The final measure of the association between independent and dependent variables was expressed as the adjusted OR.

Patient and public involvement

The study participants were not involved in the development of the research question or design, conduct, reporting, implementation or dissemination plans and evaluation.

RESULTS

Out of 319 preterm LBW neonates medical chart reviewed, 28 (8.8%) medical charts were excluded since 20 charts were not available at the time of data collection and 8

of them were incomplete medical charts. The remaining 291 preterm LBW neonates were included in the analysis making response rate of 91.2%.

Neonatal and maternal sociodemographic characteristics

Of the 291 total sampled neonates, the majority (*n*=185; 63.57%) were male. The mothers of 205 (70.45%) of the neonates belonged to the age category of 20–34 years. Most of the participants (60.1%) had length of stay more than 9 days in NICU (table 1).

Maternal and obstetrics related characteristics

The majority (*n*=45; 15.46%) of preterm LBW neonates were born to mothers who had a diagnosis with pregnancy-induced hypertension (table 2).

Neonatal characteristics

The vast majority (*n*=273; 93.81%) of preterm LBW neonates were born in healthcare institutions. The majority (79.73%) of these were born via vaginal delivery. Two hundred and nineteen (80.22%) preterm LBW neonates had a 1 min Apgar score of <7. One hundred and fifty-two (55.68%) preterm LBW neonates had a 5 min Apgar score of >7 (table 3).

Morbidity and mortality pattern of preterm LBW neonates

Morbidity distribution

In this study 219 (75.26%), 201 (69.07%), 145 (49.83%), 39 (13.4%), 24 (8.25%), 21 (7.22%) 10 (3.44%), 23 (7.9%) and 7 (2.41%) neonates were diagnosed with hypothermia, sepsis, RDS, jaundice, congenital anomaly, hypoglycaemia, necrotising enterocolitis, meningitis and perinatal asphyxia, respectively. Most participants who had a diagnosis with sepsis (44.28%), RDS (54.48%), hypothermia (40.18%) and hypoglycaemia (57.14%) died (table 4).

Morbidity distribution with maternal and neonatal characteristics

In this study, sepsis was observed in 75.7%, 76.1%, 60.0%, 71.7%, 71.2% and 74.6% of the male neonates, neonates

Table 3 Neonatal characteristics of preterm low birthweight neonates and neonatal outcome admitted to NICU in Amhara region referral hospitals, Ethiopia, 2019 (*n*=291)

Characteristics	Category	Total, n (%) n=291	Alive, n (%) n=181	Death, n (%) n=110	P value
Place of delivery	Health institution	273 (93.81)	171 (62.64)	102 (37.36)	0.55
	Home	18 (6.19)	10 (55.56)	8 (44.44)	
Mode of delivery	Caesarean	59 (20.27)	43 (72.88)	16 (27.12)	0.6
	Vaginal	232 (79.73)	138 (59.48)	94 (40.52)	
Type of pregnancy	Single	185 (63.57)	118 (63.78)	67 (36.22)	
	Multiple	106 (36.43)	63 (59.43)	43 (40.57)	
Apgar score first minute	<7	135 (53.6)	90 (66.67)	45 (33.33)	0.144
	≥7	156 (46.4)	91 (58.33)	65 (41.67)	
Apgar score fifth minute	<7	220 (75.6)	149 (67.73)	71 (32.27)	0.001
	≥7	71 (24.4)	32 (45.07)	39 (54.93)	

NICU, Neonatal intensive care unit; NICU, neonatal intensive care unit.

Table 4 Overall morbidity characteristics of preterm low birthweight neonates admitted to NICU in Amhara region referral hospitals, Ethiopia, 2019 (n=291)

Morbidity characteristics	Category	Total, n (%) n=291	Alive, n (%) n=181	Death, n (%) n=110	P value
Sepsis	No	90 (30.93)	69 (76.67)	21 (23.33)	0.001
	Yes	201 (69.07)	112 (55.72)	89 (44.28)	
RDS	No	146 (50.17)	115 (78.77)	31 (21.23)	0.000
	Yes	145 (49.83)	66 (45.52)	79 (54.48)	
Jaundice	No	251 (86.6)	159 (63.10)	93 (36.90)	0.424
	Yes	39 (13.4)	22 (56.41)	17 (43.59)	
Congenital anomaly	No	267 (91.75)	170 (63.67)	97 (36.33)	0.09
	Yes	24 (8.25)	11 (45.83)	13 (54.17)	
Hypoglycaemia	No	270 (92.78)	172 (63.7)	98 (36.30)	0.064
	Yes	21 (7.22)	9 (42.86)	12 (57.14)	
Hypothermia	No	72 (24.74)	50 (69.44)	22 (30.56)	0.145
	Yes	219 (75.26)	131 (59.82)	88 (40.18)	
Perinatal asphyxia	No	284 (97.59)	181 (63.73)	103 (36.27)	
	Yes	7 (2.41)	–	7 (100)	
Meningitis	No	268 (92.1)	167 (62.31)	101 (37.69)	0.891
	Yes	23 (7.90)	14 (60.87)	9 (39.13)	
Others*	No	281 (96.56)	179 (63.7)	102 (36.3)	
	Yes	10 (3.44)	2 (20)	8 (80)	

*'Others' including neonatal enterocolitis, meconium aspiration syndrome, anaemia and pulmonary haemorrhage. NICU, neonatal intensive care unit; NICU, neonatal intensive care unit.

born from mothers aged <20 years, neonates born from mothers with chronic medical disease, neonates born from mothers with obstetric complications, neonates born with Apgar score of first min <7 and Apgar score of fifth minute <7 in NICU, respectively. RDS was found on approximately 74.2% of the ELBW neonates in NICU. Similarly, RDS observed approximately in 50.3%, 55.0% and 80.0% of the male neonates, neonates born from mothers aged ≥35 years and neonates born from mothers with chronic medical disease respectively among preterm LBW neonates (table 5).

Factors associated with mortality of preterm LBW neonates

Preterm LBW neonates with sepsis had two times higher odds of mortality compared with those without sepsis (AOR: 2.0; 95% CI 1.03 to 3.89). Preterm LBW neonates diagnosed with RDS had 4.6 times higher odds of mortality than those without RDS (AOR: 4.6; 95% CI 2.51 to 8.40). Preterm LBW neonates with a diagnosis of hypoglycaemia had 3.91 times higher odds of mortality than their counterparts (AOR 3.91; 95% CI 1.09 to 10.52).

Preterm LBW neonates with fifth minute Apgar score of greater than seven had 61% times less likely to die than their counterparts (AOR 0.39; 95% CI 0.18 to 0.82). Preterm LBW neonates with duration of hospital stay above mean duration (≥9.82 days) had 83% lower odds of mortality than their counterparts (AOR 0.17; 95% CI 0.09 to 0.33) (table 6).

DISCUSSION

Background

This retrospective follow-up study was conducted to determine the morbidity and mortality patterns in preterm LBW neonates and identify factors associated with mortality.

General finding

In this study, the overall rate of preterm LBW neonatal mortality was 37.8% (95% CI 32.4 to 43.5). The present study also revealed that neonatal hypothermia (75.26%), sepsis (69.07%), RDS (49.83%), jaundice (13.4%) and the presence of congenital anomalies (8.25%) were the most common morbidities and the reasons for admission to NICU. Moreover, sepsis, respiratory distress, hypoglycaemia, Apgar score at fifth minute <7 and duration of hospital stay below the mean were independently associated with mortality.

Comparison with similar studies

In the current study, approximately 37.8% (95% CI 32.4 to 43.5) preterm LBW neonates died. This result was higher than that found by studies conducted in India at 6.5%¹⁸ and Iran at 28.7%.²¹ A key difference between the present study and the previous study conducted in Iran was that the previous study excluded neonates with severe fetal malformations, whereas the present study did not exclude those neonates, which may have increased the

Table 5 Morbidity distribution of preterm low birthweight neonates admitted in NICU of Amhara region referral hospitals, Ethiopia, 2019 (n=291)

Characteristics	Category	Morbidity					
		Sepsis (%)	RDS (%)	Jaundice (%)	Hypoglycaemia (%)	Hypothermia (%)	Meningitis (%)
Sex of neonate	Female	57.5	49.1	14.2	5.7	78.3	6.6
	Male	75.7	50.3	13.0	8.1	73.5	8.6
Maternal age (year)	<20	76.1	54.3	6.5	4.3	76.1	15.2
	20–34	67.3	47.8	15.1	8.3	73.7	5.4
	≥35	70.0	55.0	12.5	5.0	82.5	12.5
Maternal chronic disease	No	69.4	48.8	13.9	7.1	75.1	8.2
	Yes	60.0	80.0	–	10.0	80.0	–
Mode of delivery	Caesarean	62.7	45.8	13.6	3.4	72.9	10.2
	Vaginal	70.7	50.9	13.4	8.2	75.9	7.3
Obstetric complications	No	66.7	46.9	14.0	7.5	74.6	8.3
	Yes	77.8	60.3	11.1	6.3	77.8	6.3
PIH	No	67.9	48.4	14.2	6.9	73.6	8.9
	Yes	75.6	57.8	8.9	8.9	84.4	2.2
Place of delivery	Health institution	68.5	50.5	14.3%	7.3	75.1	8.1
	Home	77.8	38.9	–	5.6	77.8	5.6
Type of pregnancy	Single	67.6	47.0	11.9	6.5	71.9	11.4
	Multiple	71.7	54.7	16.0	8.5	81.1	1.9
Apgar first minute	<7	71.2	57.7	12.8	7.1	75.0	5.8
	≥7	66.7	40.7	14.1	7.4	75.6	10.4
Apgar fifth minute	<7	74.6	60.6	14.1	8.5	73.2	5.6
	≥7	67.3	46.4	13.2	6.8	75.9	8.6
Weight category (g)	<1000	67.7	74.2	12.9	9.7	80.6	0.0
	1000–1499	68.1	57.4	12.8	9.6	75.5	8.5
	1500–2499	69.9	41.0	13.9	5.4	74.1	9.0

NICU, neonatal intensive care unit; NICU, Neonatal intensive care unit; PIH, pregnancy induced hypertension .

mortality risk of neonates in the sample. This discrepancy with the study conducted in India may be because this study focused only on short-term outcomes, whereas the present study covered a longer neonatal period.

The present finding of the overall mortality rate is lower than that of studies conducted in Isfahan city, Iran, with 64.4%²² and Telangana, India, with 88.8%.²³ This difference may be related to differences in the inclusion criteria between the studies, where the study in Iran included neonates with birth weights of less than 1500g and those with a gestational age of less than 30 weeks. The risk of mortality is considerably higher in neonates with lower birth weights and gestational age.

The current study also revealed that neonatal hypothermia (75.26%), sepsis (69.07%), RDS, (49.83%), jaundice, (13.4%) and congenital anomalies (8.25%) were the most common morbidities and reasons for admission to the NICU. This result is supported by studies conducted in Sharda hospital, India,¹⁶ Western Nepal,¹⁷ Telangana, India,¹⁸ Isfahan city, Iran,²² teaching hospital, Telangana, India,²³ New South Wales and the Australian Capital Territory.²⁴

In the present study, preterm LBW neonates with sepsis had two times higher odds of mortality compared with neonates without sepsis (AOR: 2.0; 95% CI 1.03 to 3.89). This result is in agreement with those of a study conducted in Telangana, India,¹⁸ New South Wales and Australian Capital Territory,²⁴ and Mahatma Gandhi Memorial Government Hospital, India.²⁵ A possible reason for this is that preterm LBW neonates typically have immature host defence mechanisms making them susceptible to devastating infections that can often lead to neonatal death.

In addition, preterm LBW neonates diagnosed with RDS had 4.6 times higher odds of mortality than preterm LBW neonates without RDS (AOR: 4.6; 95% CI 2.51 to 8.40). This result is supported by studies conducted at Aga Khan University Hospital, Karachi, Pakistan,⁶ Telangana, India,¹⁸ New South Wales and Australian Capital Territory,²⁴ and Mahatma Gandhi Memorial Government Hospital, India.²⁵ A possible reason for this is that neonates with RDS often have the complication of lung collapse, which may facilitate death more readily in preterm LBW neonates.

Table 6 Multivariate logistic regression analysis of factors associated with mortality of preterm low birthweight neonates admitted to NICU in Amhara region referral hospitals, Ethiopia, 2019 (n=291)

Characteristics	Category	Alive	Death	COR (95% CI)	AOR (95% CI)	P> z
Sepsis	No	69	21	1	1	
	Yes	112	89	2.61 (1.49 to 4.58)	2.0 (1.03 to 3.89)	0.040*
RDS	No	115	31	1	1	
	Yes	66	79	4.44 (2.66 to 7.42)	4.6 (2.51 to 8.40)	0.000*
Congenital anomaly	No	170	97	1	1	
	Yes	11	13	2.07 (0.89 to 4.81)	2.41 (0.87 to 6.67)	0.090
Hypoglycaemia	No	172	98	1	1	
	Yes	9	12	2.34 (0.95 to 5.75)	3.91 (1.09 to 10.52)	0.035*
Hypothermia	No	50	22	1	1	
	Yes	131	88	1.53 (0.86 to 2.7)	1.58 (0.79 to 3.14)	0.192
Maternal History of PIH	No	158	88	1	1	
	Yes	23	22	1.72 (0.91 to 3.26)	1.76 (0.81 to 3.83)	0.155
Apgar first minute	<7	45	90	0.7 (0.43 to 1.13)	1.12 (0.57 to 2.20)	0.737
	≥7	65	91			
Apgar fifth minute	<7	65	56	0.39 (0.25 to 0.68)	0.39 (0.18 to 0.82)	0.013*
	≥7	106	46	1	1	
Duration of hospital stay(days)	<9.82	95	21	0.214 (0.12 to 0.37)	0.17 (0.09 to 0.33)	0.000*
	≥9.82*	86	89	1	1	

9.8179=mean duration of hospital stay from admission to discharge(alive) or to death (days).

*Significant at p value <0.05 in multivariable analysis, 1=considered as reference category.

NICU, neonatal intensive care unit; NICU, Neonatal intensive care unit; PIH, pregnancy-induced hypertension; RDS, respiratory distress syndrome.

Preterm LBW neonates with a diagnosis of hypoglycaemia had 3.91 higher of odds of mortality than who had no diagnosis of hypoglycaemia (AOR 3.91; 95% CI 1.09 to 10.52). This finding supports those studies conducted in Telangana, India,¹⁸ and Mahatma Gandhi Memorial Government Hospital.²⁵ This may be related to preterm neonates having immature organs, often leading to failure in glycogen storage and ultimately causing death.

In addition, this study found that preterm LBW neonates with a fifth minute Apgar score of >7 had 61% lower likely to die than their counterparts (AOR 0.39; 95% CI 0.18 to 0.82). This result is supported by the study conducted in China.²⁶ A possible reason for this study may be that an Apgar score of <7 indicates neonates in an asphyxiated state, which implies indirect death of the neonate.

Preterm LBW neonates with a length of hospital stay above the mean duration (≥9.82 days) had 83% lower odds of mortality than their counterparts (AOR 0.17; 95% CI 0.09 to 0.33). This may be the reason why the short length of hospital stay indicates the lower neonatal age, is predisposed to the risk of being unable to adapt to the environment and can develop different complications that can lead to mortality.

This study was conducted at two referral hospitals in the region, thus increasing the generalisability of the findings to the entire population. This study had some limitations. As this was a retrospective study, it did not address some of the participant-related associations of mortality in preterm LBW neonates.

Policy implication and future research

Currently, some trials running aim to implement novel techniques for the prevention of preterm LBW births and to reduce neonatal morbidity and mortality related to preterm LBW in Ethiopia. In 2012, the World Health Assembly put a plan for the year 2025 third target of 30% reduction, 3% relative reduction per year in LBW between 2012 and 2025 by applying multiple interventions at the country and community level, prepregnancy interventions and antenatal care interventions for all women.²⁷ However, the current study's findings indicated that preterm LBW-related morbidity and mortality were high owing to different associated factors. This highlights that neonates born prematurely and with LBW are at a higher risk of developing comorbidities and related mortalities. Thus, the government of Ethiopia needs to strengthen existing trials and strategies to decrease the proportion of different morbidities and preterm and LBW related mortality in neonates by preventing predictive factors. In addition to governmental organisations, other non-governmental organisations should focus on morbidity and mortality reduction intervention programmes to control the prevalence of different morbidities and mortalities in preterm LBW neonates. Additional attention should be given to preterm LBW neonates with sepsis, respiratory distress, hypoglycaemia, Apgar score at fifth minute <7 and duration of hospital stay below the mean. Preterm LBW neonates diagnosed with sepsis have a significant impact on their mortality. Similar findings in a previous study confirmed that sepsis can affect the survival status of neonates.^{18,24} Immature host

defence mechanisms make preterm neonates susceptible to devastating infections that can lead to death. In this study, preterm neonates diagnosed with RDS also had higher mortality. Other similar findings indicated that if neonate with RDS diagnosis had high risk of mortality.⁶¹⁸²⁴ RDS creates respiratory insufficiency in neonates that may lead to death. Preterm LBW a neonate with hypoglycaemia morbidity is also had high risk of mortality. Other similar findings showed that neonates with diagnosis of hypoglycaemia had high mortality.¹⁸²⁵ preterm neonates have immature organs, often leading to failures in glycogen storage and ultimately causing death. Health education and motivation should be given for those mothers who had preterm LBW neonates with sepsis, respiratory distress, hypoglycaemia, Apgar score at fifth minute <7 and duration of hospital stay below mean. Different concerned bodies at different health institutions including clinicians should be encouraged to minimise the risk of different morbidities and mortalities.

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Patient consent for publication Not applicable.

Ethics approval To conduct this study, ethical clearance letter was obtained from the institutional review board of Mekelle University, College of Health Sciences with reference number 1270/2019. Permission letters were written for FHRH and Dessie referral hospital. Data were collected after consent of cooperation was obtained from Felege Hiwot referral hospital and Dessie referral hospital administrator. Participants gave informed consent to participate in the study before taking part.

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