Magnitude of preterm hospital neonatal mortality and associated factors in northern Ethiopia: a cross-sectional study

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ABSTRACT

Objective This study aimed to assess the magnitude of preterm neonatal mortality in hospitals and associated factors in northern Ethiopia.

Design Institutional-based cross-sectional study.

Setting Comprehensive specialised hospitals in the Tigray region, northern Ethiopia.

Participants Preterm neonates admitted in Ayder and Aksum comprehensive specialised hospitals.

Primary outcome Magnitude of preterm neonatal mortality.

Secondary outcome Factors associated with preterm neonatal mortality.

Result This study was conducted from 1 April 2019 to 15 May 2019 among 336 participants with a response rate of 96.8%. The magnitude of preterm neonatal mortality was 28.6% (95% CI: 24.0 to 33.7). In multivariable logistic regression, respiratory distress syndrome (adjusted odds ratio [AOR]=2.85; 95% CI: 1.35 to 6.00), apnoea of prematurity (AOR=5.45; 95% CI: 1.32 to 22.5), nulli parity (AOR=3.63; 95% CI: 1.32 to 9.94) and grand parity (AOR=3.21; 95% CI: 1.04 to 9.94) were significant factors associated with preterm neonatal mortality. However, receiving Kangaroo mother care (AOR=0.08; 95% CI: 0.03 to 0.20) and feeding initiated during hospitalisation (AOR=0.07; 95% CI: 0.03 to 0.15) were protective against preterm neonatal mortality.

Conclusions The magnitude of preterm neonatal mortality in hospitals was still high. Interventions geared towards curbing preterm in-hospital neonatal mortality should strengthen early diagnosis and treatment of preterm newborns with respiratory distress syndrome and apnoea of prematurity; while concomitantly reinforcing the implementation of kangaroo care and early feeding initiation is important.

INTRODUCTION

In the world, preterm-related complications are the leading causes of neonatal mortality1; especially in low-income and middle-income countries (LMICs).1-5 The global rate of neonatal mortality is 18 deaths per 1000 live births; 35% due to prematurity.2 According to the WHO report, 81.1% of preterm births occur in LMICs, this is due to low quality of care for pregnant mothers.4,5 Moreover, the neonatal mortality ranges from 19.9% to 69%.6,7 In sub-Saharan Africa and South Asia, prematurity is responsible for 0.75 million deaths of under 5 years of age; but the reduction rate of neonatal mortality is very low.8 Preterm newborns (born before 37 completed weeks of gestation)8 had high risk of mortality9,10 and morbidity11 as compared with full-term newborns. Studies showed that preterm newborns are more vulnerable to organ failure, neurodevelopmental and learning impairment, visual disorders that are responsible for 0.75 million deaths of under 5 years of age; but the rate of neonatal mortality is very low.1

To achieve the global sustainable development goal (SDG) of decreasing the neonatal mortality rate and mortality of under 5 to at least 12 and 25 deaths per 1000 live births, respectively by 2030,18 better preventive and treatments of the leading causes of mortality are necessary. Furthermore, the WHO designed different strategies including essential newborn care, neonatal resuscitation, Kangaroo mother care (KMC), treatments of premature babies with complications and comprehensive neonatal intensive care.13,19,20 Even though, previous studies...
identified respiratory distress syndrome (RDS), asphyxia, maternal residency, gestational age, birth weight, jaundice, hypothermia, neonatal sepsis and maternal chronic disease as factors of mortality, preterm neonatal death remains a global burden. In Ethiopia, approximately 42% of mortality among under 5 is attributed to neonatal deaths. Although the federal health ministry designed and implemented different strategies such as antenatal care (ANC) service and family planning service to prevent preterm birth and also in 2015 developed another strategy to reduce neonatal mortality, preterm mortality is still high in our country. According to the Ethiopian Mini Demographic Health Survey (EDHS) 2019 report, the neonatal mortality rate is 30%, which is increased from EDHS 2016 report (29%).

To facilitate the reduction rate of this mortality, extensive and ongoing studies are needed to identify factors. However, in Ethiopia little is known about the magnitude of preterm in hospital neonatal mortality and its associated factors. Therefore, to support the achievement of the SDG plan, we aimed to assess the magnitude of preterm neonatal mortality in the hospitals and its associated factors in northern Ethiopia.

METHODS AND MATERIALS

Study setting and design
An institutional-based cross-sectional study was conducted from 1 April 2019 to 15 May 2019 in the comprehensive specialised hospitals of Ayder and Aksum, Tigray, Ethiopia. The Tigray region is one of the nine federal administrative regions in Ethiopia and has two comprehensive specialised hospitals. The Tigray region has an estimated total population of 5,377,144: 2,651,167 males and 2,725,977 females. Among the total population, 159,164 are under 1 year of age. There are 2 comprehensive specialised hospitals, 15 general hospitals, 23 primary hospitals, 245 health centres and 750 health posts.

Ayder comprehensive specialised hospital provides its service to more than 9 million people in its catchment areas of the Tigray, Afar and northern parts of the Amhara regional state. It has a total capacity of about 500 inpatient beds in all departments and other specialty units, including 45 neonatal beds in the neonatal intensive care unit (NICU) and more than 1,700 patient flows per year. The hospital has more than 2165 staffs. Aksum comprehensive specialised hospital provides its service to a population of over 3.6 million from the central, northwest and western zones of the Tigray regional state. It has a total capacity of 173 beds, including 13 neonatal beds.

Source and study population
All preterm neonates admitted in Ayder and Aksum comprehensive specialised hospitals were source population. The study population was preterm neonates admitted in these hospitals from 1 February 2017 to 30 January 2019.

Eligibility criteria
Neonates born before their 37 weeks of gestation were included in this study. Preterm newborns with an incomplete record for the outcome variable were excluded.

Sample size determination and sampling technique
The sample size was estimated using a single population proportion formula with a CI of 95%, \( \alpha=0.05 \), and \( p=28.8\% \) taken from a study conducted in Gonder, Ethiopia. By considering a 10% non-response rate, the total sample was 347. A total of 1242 preterm neonates were admitted to these hospitals from 1 February 2017 to 30 January 2019. Participants were proportionally selected using a simple random sampling technique from both hospitals.

Operational definitions
RDS: which is characterised by grunting while breathing, rapid or shallow breathing, and flaring of the nostrils.

Apnoea of prematurity: respiratory pauses >20s or pauses <20s that are related to bradycardia (<80 beats/min), central cyanosis and/or oxygen saturation <85% in neonates born at <37 weeks gestation and without causal disorders that induce apnea.

Perinatal asphyxia: an Apgar score that remained less than 7 (at 5 min after birth) and evidence of acute hypoxic compromise with acidaemia.

Data collection procedure and tool
The lists of participants were obtained from NICU health management system registration book. To collect the data from the charts, we used a pretested adapted English version data extraction checklist. Lastly, the data were scouted by two data collectors from randomly selected charts.

Data quality control
We conducted a pretest on 5% (15) of the sample in Mekelle General Hospital. A single imputation was used to manage missing values. After 2 days of training, two data collectors (BSc nurses) and one supervisor (MSc in paediatrics and child health nursing) participated in the data collection. The twofold data entry was done and the consistency of the entered data was verified by comparing the two distinctly entered data. The content validity and inter-rater reliability tests were conducted to check the validity and reliability of the tool, respectively.

Data processing and analysis
Data were coded and entered by Epi-data manager V.4.4.2.1 and exported to Stata statistical software V.14 for clearance and analysis. Descriptive statistics frequency and percentage were conducted. Bivariate and multivariable analysis was performed to see the statistical association between the outcome and independent variables. Factors with a \( p \) value <0.2 in the bivariate analysis were entered into multivariable logistic regression. Variables with a \( p \) value <0.05 in multivariable analysis were considered.
statistically significant factors. Lastly, we used an adjusted OR with 95% CI to determine the association.

**Patient and public involvement**

The patient and/or the public were not involved in the design, development, analysis and publication of this study.

**RESULT**

Of 347 preterm newborns, 336 were eligible and included in this study with a response rate of 96.8%.

**Neonatal, maternal and obstetric-related characteristics**

Two hundred and eighty-one (83.63%) mothers delivered in the hospital. Two hundred and sixty-nine (80.06%) mothers were found in the age range of 20–35 years; a median age of 27 years (IQR: 22–30). One hundred and eighty-five (55.06%) mothers were primipara and 330 (98.21%) mothers had follow-up of ANC. Only 34 (10.12%) mothers had obstetric complications during their index pregnancy (table 1).

Among 336 preterm newborns, 191 (56.85%) were males and 260 (77.38%) were within gestational age between 28 and 32 weeks; but not including 32. Feeding was initiated for 218 (64.88%) of preterm newborns during their hospital stay and only 118 (35.12%) of the neonates received KMC. Three hundred and nine (91.96%) neonates had low birth weight (<2500 gram) and approximately 147 (43.75%) and 242 (72.02%) preterm neonates had RDS and sepsis, respectively (table 2).

**Magnitude of preterm hospital neonatal mortality**

In this study, the magnitude of preterm in-hospital neonatal mortality was 28.6 with 95% CI (24.0 to 33.7). Among the neonates who died, 88 (91.7%) of them were within the first 7 days of life.

**Factors associated with preterm neonatal mortality**

In the bivariate analysis gestational age, KMC, feeding status, birth weight, maternal residency, hypoglycaemic at admission, sepsis, RDS, parity and apnoea of prematurity were significantly associated with preterm neonatal mortality. However, in the multivariable analysis RDS, parity, KMC, feeding status and apnoea of prematurity were still statistically significant factors.

The odds of mortality for preterm newborns who received feeding during their hospital stay were reduced by 93% (adjusted odd ratio (AOR)=0.07; 95% CI: 0.03 to 0.15) compared with their counterparts. Similarly, providing KMC reduces the risk of death by 92% (AOR=0.08; 95% CI: 0.03 to 0.20) compared with their comparison group. Preterm newborns diagnosed with RDS and apnoea of prematurity had 2.8 (AOR=2.85; 95% CI: 1.35 to 6.00) and 5.4 times (AOR=5.45; 95% CI: 1.32 to 22.5) higher mortality risk compared with their opposite groups, respectively. Furthermore, neonates born to nulliparous mothers had 3.6 times higher risk of death compared with neonates born to multipara mothers (AOR=3.63; 95% CI: 1.59 to 8.24) and neonates born to grand para mothers had 3.2 times (AOR=3.21; 95% CI: 1.04 to 9.94) higher risk of mortality compared with those born to multipara mothers (table 3).

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**Table 1** Sociodemographic and obstetric characteristics related to mothers of preterm newborns admitted to the NICU of the Ayder and Aksum comprehensive specialised hospitals, northern Ethiopia, 2019 (n=336)

| Characteristics                      | Frequency | Per cent |
|--------------------------------------|-----------|----------|
| Maternal age in years                |           |          |
| Less than 20                         | 27        | 8.04     |
| Between 20 and 35                    | 269       | 80.06    |
| 35 and above                         | 40        | 11.90    |
| Place of delivery                    |           |          |
| Home                                 | 16        | 4.76     |
| Health centre                        | 39        | 11.61    |
| Hospital                             | 281       | 83.63    |
| Maternal residency                   |           |          |
| Urban                                | 191       | 56.85    |
| Rural                                | 145       | 43.15    |
| Parity                               |           |          |
| Nulli parity                         | 185       | 55.06    |
| Multiparty                           | 111       | 33.04    |
| Grand parity                         | 40        | 11.90    |
| ANC visit                            |           |          |
| One                                  | 5         | 1.5      |
| Two                                  | 39        | 11.6     |
| Three                                | 161       | 47.9     |
| Four and above                       | 122       | 36.3     |
| Type of pregnancy                    |           |          |
| Singleton                            | 196       | 58.33    |
| Multiple                             | 140       | 41.67    |
| Mode of delivery                     |           |          |
| Spontaneous vaginal delivery         | 268       | 79.76    |
| Caesarean section                    | 68        | 20.24    |
| Obstetric-related complication during index pregnancy | |          |
| Yes                                  | 34        | 10.12    |
| No                                   | 302       | 89.88    |
| Mother received corticosteroid before delivery | |          |
| Yes                                  | 291       | 86.61    |
| No                                   | 45        | 13.39    |
| Maternal serostatus (HIV)            |           |          |
| Positive                             | 15        | 4.46     |
| Negative                             | 321       | 95.54    |

ANC, antenatal care; NICU, neonatal intensive care unit.
DISCUSSION

In the present study, the magnitude of preterm hospital neonatal mortality was 28.6; 95% CI (24.0 to 33.7). This finding is similar to studies done in Iran (28.7%43 and 27.4%)48 Nigeria (27.7%),44 Ethiopia (25.2%),45 and 29.7%,21 and WHO and UNICEF multicounty report 29.3%.45 It was high compared with studies done in Iran (9.1%),30 Cameroon (15.7%),7 Ethiopia (18.2%46 and 16.7%)47 and save the children multicounty report 15%.48 This could be due to variation in the study population, quality of care provided and difference in the availability of basic interventions, especially surfactant.

However, it was low compared with studies done in Ethiopia (34.9%24 and 36.1%),49 South Africa (64%),50 population-based study done in LMIC (37.5%)50 and Jordan (40%).51 This might be due to the improvement in care in recent years due to access to healthcare service, the accessibility of trained healthcare professionals and the behaviour of the community toward the search and utilisation of health in Ethiopia.52

Preterm newborns diagnosed with RDS had a higher risk of death. This finding was in line with studies done in Ethiopia (Gonder40 and Jimma 24). Another study conducted in selected Ethiopian hospitals support this finding.53 This might be due to the inaccessibility of surfactant treatment in our country, the similarity in the study setting (specialised hospitals), and RDS also leads to acute complications such as pulmonary haemorrhage and intraventricular haemorrhage that increase the risk of mortality.54

In this study, KMC had a protective effect on preterm neonatal mortality. This finding was in line with the study done in Gonder, Ethiopia.40 This finding was also supported by a systematic review and meta-analysis study that showed that KMC reduces neonatal mortality.55 This might be due to the fact that KMC has the benefit of protecting the newborn from infection, effectively treating hypothermia, improving gastrointestinal function and cardiorespiratory stability and encouraging breast feeding.56

Preterm neonates born to nulliparous and grand-parity mothers had high mortality compared with neonates born to multiparty mothers. This finding was supported by studies done in northern Ethiopia,49 Uganda57 and Australia.58 This might be related to nulli and grandparous mothers who are at increased risk of unfavourable newborn outcomes and intrapartum complications.59 60

In the present study, preterm neonates who received feeding during their hospital stay had a low risk of mortality. The current finding was supported by studies conducted in Ethiopia,49 50 Uganda57 and Australia.58 This might be related to null and grandparous mothers who are at increased risk of unfavourable newborn outcomes and intrapartum complications.59 60

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Apnoea of prematurity was also identified as a significant predictor of preterm death. It might be due to the potential it has to decrease systematic blood pressure that

Table 2 Characteristics of preterm neonates admitted in NICU of Ayder and Aksum comprehensive specialised hospitals, northern Ethiopia, 2019 (n=336)

| Characteristics                                      | Frequency | Per cent |
|------------------------------------------------------|-----------|----------|
| Place of admission                                   |           |          |
| Ayder                                                | 279       | 83.03    |
| Aksum                                                | 57        | 16.97    |
| Sex of the neonate                                    |           |          |
| Male                                                 | 191       | 56.85    |
| Female                                               | 145       | 43.15    |
| Gestational age at birth in weeks                     |           |          |
| Very preterm (28 to <32 weeks)                       | 260       | 77.38    |
| Moderate or late preterm (32 to <37 weeks)           | 76        | 22.62    |
| Birth weight at birth (in grams)                      |           |          |
| Less than 2500                                       | 309       | 91.96    |
| 2500 and above                                       | 27        | 8.04     |
| Feeding initiated during hospitalisation              |           |          |
| Yes                                                  | 218       | 64.88    |
| No                                                   | 118       | 35.12    |
| Newborn received Kangaroo mother care                 |           |          |
| Yes                                                  | 118       | 35.12    |
| No                                                   | 218       | 64.88    |
| Weight for gestational age at birth                   |           |          |
| Small                                                | 31        | 9.23     |
| Appropriate                                          | 305       | 90.77    |
| Hypoglycaemic diagnosed at admission                  |           |          |
| Yes                                                  | 24        | 7.14     |
| No                                                   | 312       | 92.86    |
| Hypothermia diagnosed at admission                    |           |          |
| Yes                                                  | 154       | 45.83    |
| No                                                   | 182       | 54.17    |
| Newborn with clinical diagnosed sepsis               |           |          |
| Yes                                                  | 242       | 72.02    |
| No                                                   | 94        | 27.98    |
| Newborn diagnosed with apnoea of prematurity          |           |          |
| Yes                                                  | 14        | 4.17     |
| No                                                   | 322       | 95.83    |
| Perinatal asphyxia diagnosed at birth                 |           |          |
| Yes                                                  | 14        | 4.17     |
| No                                                   | 322       | 95.83    |
| Newborn diagnosed with jaundice                       |           |          |
| Yes                                                  | 37        | 11.01    |
| No                                                   | 299       | 88.99    |
| Newborn diagnosed with respiratory distress syndrome  |           |          |
| Yes                                                  | 147       | 43.75    |
| No                                                   | 189       | 56.25    |

NICU, neonatal intensive care unit.
leads to hypoperfusion of the brain and hypoxic ischaemic injury, and occurred mainly with desaturation and bradycardic episodes.64

Each study has its own limitations. This study had some limitations. First, it was a cross-sectional study that does not show a cause and effect relationship. Second, due to the retrospective nature of the study, some variables were squandered, such as institutional-related factors. Lastly, although our study was a region-wide study, its generalizability to other settings could be another limitation.

**CONCLUSION**

In the current study, the magnitude of neonatal mortality was still high. RDS, apnoea of prematurity, KMC, feeding status and mother parity were significantly associated with preterm in-hospital neonatal mortality. Therefore, to reduce the burden of this problem, it is better to encourage the implementation of KMC and early initiation of feeding. Also, it is better to strengthen early diagnosis and treatment of preterm neonates with RDS and apnoea of prematurity. Furthermore, we recommend

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**Table 3** Factors associated with preterm in-hospital neonatal mortality in Ayder and Aksum comprehensive specialised hospitals, northern Ethiopia, 2019 (n=336)

| Characteristics                                      | Mortality |  |  |  |  |  |  |
|------------------------------------------------------|-----------|---|---|---|---|---|---|
| Feeding initiated during hospital stay               |           |  |  |  |  |  |  |
| Yes                                                  | 22        | 196 | 0.07 (0.04 to 0.12) | 0.07 (0.03 to 0.15)* |  |  |
| No                                                   | 74        | 44  | 1                          |  |  |  |
| Maternal residency                                   |           |  |  |  |  |  |  |
| Urban                                                | 46        | 145 | 1                          |  |  |  |
| Rural                                                | 50        | 95  | 1.66 (1.03 to 2.67) | 1.68 (0.85 to 3.34) |  |  |
| Hypoglycaemic at admission                           |           |  |  |  |  |  |  |
| Yes                                                  | 3         | 21  | 2.97 (0.86 to 10.20) | 1.00 (0.12 to 8.07) |  |  |
| No                                                   | 93        | 219 | 1                          |  |  |  |
| Newborn with clinical diagnosed sepsis               |           |  |  |  |  |  |  |
| Yes                                                  | 76        | 166 | 1.69 (0.96 to 2.97) | 1.31 (0.56 to 3.08) |  |  |
| No                                                   | 20        | 74  | 1                          |  |  |  |
| Newborn diagnosed with RDS                           |           |  |  |  |  |  |  |
| Yes                                                  | 67        | 80  | 4.62 (2.77 to 7.71) | 2.85 (1.35 to 6.00)* |  |  |
| No                                                   | 29        | 160 | 1                          |  |  |  |
| Newborn with apnoea of prematurity                   |           |  |  |  |  |  |  |
| Yes                                                  | 8         | 6   | 3.54 (1.19 to 10.51) | 5.45 (1.32 to 22.5)* |  |  |
| No                                                   | 88        | 234 | 1                          |  |  |  |
| Newborn received KMC                                 |           |  |  |  |  |  |  |
| Yes                                                  | 7         | 111 | 0.09 (0.04 to 0.20) | 0.08 (0.03 to 0.20)* |  |  |
| No                                                   | 89        | 129 | 1                          |  |  |  |
| Birth weight at birth in grams                       |           |  |  |  |  |  |  |
| Less than 2500                                       | 93        | 216 | 3.44 (1.01 to 11.72) | 3.03 (0.62 to 14.83) |  |  |
| 2500 and above                                       | 3         | 24  | 1                          |  |  |  |
| Gestational age                                       |           |  |  |  |  |  |  |
| Very preterm (28 to <32 weeks)                       | 41        | 35  | 4.36 (2.54 to 7.49) | 1.70 (0.77 to 3.74) |  |  |
| Moderate or late preterm (32 to <37 weeks)           | 55        | 205 | 1                          |  |  |  |
| Parity                                               |           |  |  |  |  |  |  |
| Nulliparity                                          | 48        | 137 | 1.48 (0.890 to 2.48) | 3.63 (1.59 to 8.24)* |  |  |
| Multiparity                                          | 38        | 73  | 1                          |  |  |  |
| Grand parity                                         | 10        | 30  | 1.56 (0.69 to 3.53) | 3.21 (1.04 to 9.94)* |  |  |

*Significantly associated factors.
AOR, adjusted odd ratio; COR, crude odd ratio; KMC, Kangaroo mother care; RDS, respiratory distress syndrome.
prospective multicentre studies to identify institutional factors.

Collaborators  No.

Contributors  BG was the principal investigator and guarantor who started the research, subscribed the research proposal, piloted the fieldwork, managed data entry, analysed the data and wrote the manuscript. JN critically reviewed, provided essential comments and contributed to the intellectual content of this article and made extensive aids to the conception and manuscript preparation. All authors read and agreed on the final manuscript.

Funding  The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests  None declared.

Patient and public involvement  Patients and/or the public were not involved in the design, conduct, or reporting or dissemination plans of this research.

Patient consent for publication  Not applicable.

Ethics approval  Ethical clearance was obtained from the institutional review board (ERC 1272/2019) the College of Health Sciences of Mekelle University. A permission letter was obtained from the medical director offices of Ayder and Aksum comprehensive specialised hospitals. The study was carried out according to the Declaration of Helsinki. The confidentiality of patient data was safeguarded. Patient letter was obtained from the medical director offices of Ayder and Aksum (ERC 1272/2019) the College of Health Sciences of Mekelle University. A permission letter was obtained from the medical director offices of Ayder and Aksum comprehensive specialised hospitals. The study was carried out according to the Declaration of Helsinki. The confidentiality of patient data was safeguarded.

Provenance and peer review  Not commissioned; externally peer reviewed.

Data availability statement  Data are available upon reasonable request. The data included in this study are available and can be accessed by contacting the corresponding author through this email address bekahenggi@gmail.com or Bekahenggi@edu.et.

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