

## Original article

# Predictors of Neonatal mortality among Neonates who admitted in Neonatal intensive Care Unit at Arba Minch General Hospital

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## Abstract

**Introduction:** The neonatal period refers to the first 28 days of life. Newborns are particularly vulnerable to death. The predictors associated with neonatal mortality need to be addressed, as identifying the predictors will contribute to reducing the rates of neonatal morbidity and mortality.

**Method:** A facility-based retrospective cohort study was conducted of 332 records of neonates who were admitted to the neonatal intensive care unit at Arba Minch General Hospital. Data were collected from randomly selected neonate records using computer-generated random numbers. Data were entered into Epi-info version 3.5.1 and exported to SPSS v.23 for analysis. Crude hazard ratios, adjusted hazard ratios and 95% confidence intervals were used to assess the strength of association and statistical significance. The incidence density rate of death with respect to 'person time at risk' was calculated. Variables which had a p-value of  $\leq 0.25$  in bivariate analysis were considered as candidates for multivariate regression analysis; variables that had a p-value of  $\leq 0.05$  in the multivariate analysis were considered as independent predictors of neonatal mortality in the final Cox regression analysis.

**Result:** The incidence density rate of neonatal mortality was 31.6 per 1,000 neonate days. The neonatal mortality predictors were 5<sup>th</sup>-minute APGAR score  $\leq 5$  (AHR: 1.9; 95%CI: 1.02,3.54); 2<sup>nd</sup> to 4<sup>th</sup> birth order (AHR:13; 95%CI: 5.1,33.4); 5<sup>th</sup> birth order (AHR:24; 95%CI: 10.5,55.2); history of two to four live births(AHR: 0.16; 95%CI: 1.07,3.63); history of  $\geq 5$  live births (AHR: 0.18; 95%CI: 0.06,0.51); and not initiating exclusive breastfeeding within the first hour of delivery (AHR: 1.8; 95%CI: 1.03,3.18).

**Conclusion:** The incidence density rate of neonatal mortality was 31.6 per 1,000 neonate days, and maternal age, APGAR score, birth order, parity, and exclusive breastfeeding initiation were independent predictors of neonatal mortality. [*Ethiop.J. Health Dev.* 2019; 33(1):46-52]

**Key words:** Neonatal mortality; Predictors; Arba Minch General hospital

## Introduction

The neonatal period refers to the period in the first 28 days of life(1). Newborns are the future generations, and ensuring their healthy growth and development must be the major concern of societies. Newborns are particularly vulnerable to death. There has been a relatively rapid decline in the global mortality of children under the age of five(2). Globally in the year 2016, about 2.6 million children died in the first 28 days of life (neonatal period). At a global neonatal mortality rate (NMR) of 19 deaths per 1,000 live births, this means about 7,000 neonates died every day(3).

According to a 2013 WHO report, global neonatal mortality was reduced from 4.4 million in 1990 to 3 million in 2011, and there was a reduction in the NMR from 32 to 22 per 1,000 live births(4).The global NMR between 1990 and 2013 declined from 31.9 to 18.4 deaths per 1,000 live births(5). Forty percent of this rate of decline lags the progress made in decreasing the rate of mortality for children aged between one month and 59 months(1).Neonatal death, which was 2.8 million in 2013, contributes to the incidence of under-5 deaths, which increased from 37.4% in 1990 to 41.6% in 2013. These trends have been projected to continue, with anticipated further rapid declines in under-5 mortality(3).

In Sub Saharan Africa(SSA), which has an average NMR of 41 per 1000 live births, this burden still remains unresolved (6).The Neonatal Mortality rate

was reduced from 37 deaths per 1000 live births at 1990 to 19 deaths per 1000 live births at 2016(3).

Disparities in child survival exist across regions and countries. In SSA, for example, approximately one child in 13 dies before their 5<sup>th</sup> birthday, whereas in the world's high-income countries, the ratio is 1 in 189. Among newborns in SSA, about one child in 36 dies in the first month, while in the world's high-income countries, the ratio is 1 in 333(7).According to the Ethiopian Demographic and Health Survey Report (EDHS) 2016, the NMR in Ethiopia is 29 per 1,000 live births(8).

The predictors associated with neonatal mortality need to be addressed because identifying the predictors contributes to reductions in the morbidity and the mortality rates of neonates, and also contributes to the appropriate modifications in the prevention and treatment of health problems among neonates. Therefore, the objective of this study was to determine the incidence of neonatal mortality and identify predictors of mortality in a cohort of neonates admitted to the neonatal intensive care unit (NICU) at ArbaMinch General Hospital, South Ethiopia.

## Methods and Materials

**Study Design, setting and period:** A retrospective cohort study was conducted in Arba Minch General Hospital, the only hospital with an NICU in GamoGofa Zone. Arba Minch is located 468km to the south of

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Addis Ababa (the capital city of Ethiopia) and 280km from Hawassa (the capital of the regional state of Southern Nations, Nationalities, and Peoples' Region). The hospital has an average of 632 neonatal admissions per year. The study was conducted from 01 January 2015 to 31 December 2017.

**Source and study populations:** All neonates aged less than or equal to 28 days who were admitted to the NICU in Arba Minch General Hospital were the source populations. The study population was selected from this source population.

**Selection Criteria:** All neonates aged 28 days and less who were admitted to Arba Minch General Hospital NICU from 01 January 2015 to 31 December, 2017 were included.

**Sample size determination, Technique and Procedures:** A simple random sampling technique was used to recruit a predetermined 332 samples that has been determined through Epi info version 7 stat calc program. The client registration numbers were used as a sample frame. From a total of 2012 neonate records that were enrolled from 1<sup>st</sup> January, 2015 to December, 31<sup>st</sup>, 2017, the determined samples were selected and the data were extracted with its necessary information.

**Study Variables:** The dependent variable was neonatal death and the independent variables were categorized into two categories. The first category consisted of neonatal factors: age of the neonate at admission; sex of the neonate; APGAR score in the 5th minute; initiation of exclusive breastfeeding (EBF); time of EBF initiation; birth type; and gestational age. The second category consisted of maternal and neonatal factors: maternal age; number of antenatal care (ANC) visits; birth order; history of previous pregnancy; birth interval; number of births; complications at birth; onset of labor; duration of labor; time of rupture of membrane; and mode of delivery.

**Data collection method and instrument:** The source of data was individual patient records, including registers, monitoring cards and patient admission books. Data were collected using a structured checklist/questionnaire, which was prepared nationally as the 'Ethiopian NICU Network – Data collection form', with appropriate modifications made in relation to this study.

**Data collection procedure:** The data were collected by researchers [nurses] with diplomas in midwifery, who were supervised by researchers [nurses] with BSc degrees in midwifery, who were trained in basic emergency mother and neonatal care (BEMoNC). The data was collected by reviewing the patient's medical records.

**Data quality management:** Data quality was assured by carrying out careful designs of data extraction formats and carrying out modifications; by recruiting suitable data collectors, and by giving adequate training and follow-up to the data collectors and supervisors. To check the consistency of the data collection tool and to check the activity of the data collectors, a pre-test was conducted on a small sample (5%) of the population in Arba Minch General Hospital, using neonates' admission records from January 2018.

**Data processing and Analysis:** Data were entered, coded, edited and cleaned using Epi-info version 7 and exported to SPSS version 23 for Windows. Then, exploratory data analysis was carried out to check the levels of missing values and proportionality of hazards over time. Bivariate analysis was done to identify associations between dependent and independent variables. Crude hazard ratios and adjusted hazard ratios, 95% CIs and P-values were used to assess the strength of association and statistical significance. Incidence of death with respect to 'person time at risk' was calculated. Variables with a p-value of  $\leq 0.25$  in bivariate analysis were considered as candidates for multivariate analysis; variables with a p-value of  $\leq 0.05$  level in the multivariate analysis was considered as significant predictors of neonatal mortality in the final Cox-regression analysis. The backward stepwise regression method was applied. The data were presented in tables and graphs.

**Ethical consideration:** Ethical clearance was obtained from Arba Minch University, College of Medicine and Health Sciences' ethical review board, and a support letter was obtained accordingly, prior to data collection.

## Result

**Socio-demographic characteristics:** A total of 332 records were reviewed – a response rate of 100%. Two hundred and twelve neonates (63.9%) were male. The minimum and maximum ages of neonates was 1 day and 27 days, respectively, with a mean age of  $3.6 \pm 5.79$  days. The number of neonates who were 1 day old, 2 to 4 days old and  $\geq 5$  days old was 238(7.7%), 32(9.6%) and 62(18.7%), respectively.

**Neonatal factors:** From the total client charts reviewed, 281(84.6%) neonates' 5th-minute APGAR scores were measured; the scores ranged from 3 to 10, with a mean score of 6.8 (standard deviation of 1.3). Of those who had their APGAR score measured, 41(14.6%) had a score of below or equal to 5. From the total records reviewed, 240(72.3%) mothers initiated EBF. Among those mothers who initiated EBF, 208(86.7%) initiated breastfeeding within one hour of delivery.

Table 1: Characteristics of neonates admitted in NICU at Arba Minch General Hospital, Southern Ethiopia, 2015-2017G.C (n=332)

Variables	Category	Frequency(n)	Percent(%)
Age of Neonate at admission(days)	1	238	71.7
	2-4	32	9.6
	≥5	62	18.7
Sex of Neonate	Male	212	63.9
	Female	120	36.1
The 5 <sup>th</sup> minute APGAR score	≤5	77	24.9
	>5	232	75.1
Initiation of Exclusive breast feeding	Yes	240	72.3
	NO	92	27.7
Time of Exclusive breast feeding initiation	With in 1 hour	208	86.7
	After 1 hour	32	13.3
Birth type	Single tone	301	90.7
	Multiple	31	9.3
Gestational Age	Less than 37 weeks	194	58.4
	≥ 37 weeks	138	41.6

**Maternal and obstetric related factors:** From the total reviewed records, 308(92.8%) mothers of neonates attended Antenatal care visits. Of those who attended ANC visits, 44(13.3%) attended one visit and 76(22.9%) attended four visits. Among the reviewed records, 181(54.5%) had a previous history of pregnancy- (81(24.4%) had one previous instance of pregnancy, 47(14.2%) had two previous instances of pregnancy, 36(10.8%) had three previous instances of

pregnancy. From the total records reviewed, 284(85.5%) had spontaneous labor. Regarding the duration of Labor, 222 (66.9%) had a labor that lasted less than 12 hours. Regarding the mode of delivery, spontaneous vaginal delivery(SVD), Cesarean section and Instrumental delivery accounted 248(74.8%), 63(18.9%) and 21(6.3%) cases respectively. Regarding the birth order, 147(44.3%) were mothers' first birth and 53(16%) were mothers' fifth births or more.

Table 2: Maternal characteristics of Neonatal mortality among Neonates admitted in NICU at Arba Minch General hospital, Southern Ethiopia, 2015-2017G.C (n=332)

Variables	Category	Frequency(n)	Percent (%)
Maternal age(year)	< 18	11	33.4
	18-34	279	84
	≥35	42	12.6
Number of ANC visits	1	44	14.3
	2	53	17.2
	3	135	43.8
	≥4	76	24.7
Birth order	1 <sup>st</sup>	147	44.3
	2-4	132	39.7
	≥5	53	16
History of previous pregnancy	Yes	181	54.5
	No	151	45.5
Birth Interval(years)	< 2	128	70.7
	≥ 2	53	29.3
Number of Births	Primipara	180	54.2
	2-4	125	37.7
	≥ 5	27	8.1
Complication at birth	Yes	326	98.2
	No	6	1.8
Onset of Labour	Spontaneous	284	85.5
	Induced	48	14.5
Duration of Labour(hrs)	≤ 12	222	66.9
	> 12	110	33.1
Duration of rupture of membrane(hrs)	<12	104	31.3
	≥12	228	68.7
Mode of delivery	SVD	248	74.7
	Instrumental delivery	21	6.3
	Caesarean section	63	19

**Incidence rate of Neonatal Mortality:** During the study period, 332 Neonates were followed for a total of 2,121 neonate days. During this period, a total of 67 neonates died. Therefore, the overall incidence density rate of Neonatal mortality was 31.6 per 1000 neonate days of follow up. Two hundred and thirty two (69.88%) Neonates were alive or Discharged with

recovery, 67(20.18%) died and the remaining 33(9.94%) withdrew a treatment.

**Predictors of Neonatal mortality:** Of the Neonatal factors, APGAR score at 5<sup>th</sup> minute and initiation of EBF were the candidate predictors for multivariable analysis (p value  $\leq 0.25$ ).

Table 3: **Bivariable Cox-proportional hazard model of Neonatal factors for predictors of Neonatal Mortality at Arba Minch General Hospital, Southern Ethiopia, 2015-2017 G.C(n=332)**

Variables	Category	Died	Censored	CHR with 95% CI
Age of Neonate at admission(days)	1	57	181	2.77(1.26,6.09)*
	2-4	3	29	1.1(0.28,4.19)
	$\geq 5$	7	55	1
Sex of Neonate	Male	39	173	1
	Female	28	92	1.29(0.79,2.11)
APGAR score at 5 <sup>th</sup> minutes	$\leq 5$	40	37	4.8 (3.61,9.87) *
	$> 5$	25	207	1
Initiation of EBF	Yes	40	200	1
	NO	27	65	1.9(1.16,3.09)*
Duration to initiation of EBF	With in 1 hour	36	172	1
	After 1 hour	4	28	1.79(1.09,2.96)
Birth type	Single tone	59	242	1
	Multiple	8	23	1.3(0.63,2.75)
Gestational Age	Less than 37 weeks	37	157	0.84(0.52,.36)
	$\geq 37$ weeks	30	108	1

\* indicates predictors which have p-value  $\leq 0.25$

Among the Maternal and obstetric-related factors, maternal age, number of antenatal visits, birth order, history of previous pregnancy, birth interval, number of

births, onset of labor, time of rupture of membrane and the mode of delivery were the predictors chosen for multivariable analysis(p-value  $\leq 0.25$ ).

**Table 4: Bivariable Cox-proportional hazard model of maternal and obstetrics factors for predictors of neonatal mortality at Arba Minch General Hospital, Southern Ethiopia, 2015-2017(n=332)**

Variables	Category	Died	Censored	CHR with 95% CI
Maternal age (year)	< 18	8	3	29.2(6.19,138.25)*
	18-34	57	222	5.1(1.24,20.9)*
	≥35	2	40	1
Number of ANC visits	1	6	38	1.9(1.1,3.4)*
	2	7	46	0.83(0.42,1.64)
	3	29	106	0.7(0.39,1.39)
	≥4	15	61	1
Birth order	1 <sup>st</sup>	11	136	1
	2-4	25	107	2.4 (1.194,4.934) *
	≥5	31	22	9.4(4.71,18.68) *
History of previous pregnancy	Yes	33	148	1
	No	34	117	1.48(0.92,2.4)*
Birth Interval	< 2 years	27	101	2.6(1.09,6.23)*
	≥ 2 years	6	47	1
Number of Births	Primipara	43	137	1
	2-4	18	107	0.52(0.29,0.89)*
	≥ 5	6	21	0.78(0.33,1.83)
Complication at birth	Yes	66	260	1.65(0.23,11.94)
	No	1	5	1
Onset of Labour	Spontaneous	53	231	1
	Induced	14	34	1.92(1.06,3.48)*
Duration of Labour(hrs)	≤ 12	45	177	1
	> 12	22	88	0.97(0.58,1.62)
Duration of rupture of membrane(hrs)	<12	10	94	1
	≥12	57	171	2.5(1.29,4.98)*
Mode of delivery	SVD	45	203	1
	Assisted delivery	5	16	1.66(0.66,4.19)
	Caesarean section	17	46	1.9(1.08,3.34)*

\* indicates predictors which have p-value ≤0.25

**Multivariable analysis:** Neonates born from mothers 18 years old or younger have about 12 times higher risk of mortality compared to those born from mothers aged 35 years or older(AHR: 12.6; 95%CI: 2.45,64.9). Neonates who have a 5<sup>th</sup> minute APGAR score of 5 or less have a mortality risk of about twice that of those with a score more than 5(AHR: 1.9; 95%CI: 1.02,3.54). Neonates in the 2<sup>nd</sup> to 4<sup>th</sup> birth order have a 13 times higher hazard of mortality compared in the first birth order, and those in the 5<sup>th</sup> birth order and above have a 24 times higher hazard of mortality(AHR:24; 95%CI:

10.5,55.2). Neonates born from mothers with a history of live births(Parity) have 16% a protective effect from neonatal mortality as compared to those with that of primiparas(AHR: 0.16; 95%CI: 1.07,3.63) and those born from mothers who have five and above live births have 18% protective effect from neonatal mortality as compared to those of primiparas(AHR: 0.18; 95%CI: 0.06,0.51). Neonates who were not initially exclusively breast fed had 1.8 times higher hazard of mortality compared to the counterparts who were initially exclusively breast feed(AHR: 1.8; 95%CI: 1.03,3.18).

**Table 5: Multivariable Cox-proportional hazard model for predictors of neonatal mortality at Arba Minch General Hospital, Southern Ethiopia, 2015-2017(n=332)**

Variables	Category	Died	Censored	CHR with 95% CI	AHR with 95% CI
Maternal age(year)	≤ 18	8	3	29.2(6.19,138.25)*	12.6(2.45,64.9)**
	19-34	57	222	5.1(1.24,20.9)*	3.6(0.83,15.7)
	≥35	2	40	1	1
APGAR score at 5 <sup>th</sup> minutes	≤5	40	37	4.8 (3.61,9.87) *	1.9(1.02,3.54)**
	>5	25	207	1	1
Birth order	1 <sup>st</sup>	11	136	1	1
	2-4	25	107	2.4 (1.194,4.934) *	13(5.1,33.4)**
	≥5	31	22	9.4(4.71,18.68) *	24(10.5,55.2)**
Number of live Births	Primipara	43	137	1	1
	2-4	18	107	0.52(0.29,0.89)*	0.16(1.07,3.63)**
	≥ 5	6	21	0.78(0.33,1.83)	0.18(0.06,0.51)**
Initiation of EBF	Yes	40	200	1	1
	NO	27	65	1.9(1.16,3.09)*	1.8(1.03,3.18)**

\*indicates predictors which have p value ≤0.25; \*\* indicates predictors which have p-value ≤0.05

## Discussion

This study assessed the predictors of neonatal mortality among the neonates admitted to the NICU at Arba Minch General Hospital, and revealed that the independent predictors of neonatal mortality were maternal age younger than 18 years old, APGAR score at 5<sup>th</sup> minutes  $\leq 5$ , birth order, total number of births (parity) and not initiating EBF within one hour.

This study revealed that, Neonates born from mothers 18 years old or younger have about a 12 times higher risk of mortality compared to those born from mothers aged 35 or older. This finding is similar with the study conducted in Ethiopia which indicates that neonates born from mothers aged 18 years or younger have a 1.41 times higher risk of neonatal death compared to those born from mothers aged 35 years and older. This finding that neonates born from younger mothers have a much higher risk of death compared to those born from older mothers is similar to a study conducted in Fallujah District Hospital in Iraq, and to a further study in Ethiopia (9, 10). This finding might be due to low physiological adjustment or immaturity of reproductive organs of the mothers, which leads the mothers to face obstetric danger signs and neonatal mortality (11).

Neonates who have a 5<sup>th</sup> minute APGAR score less than 5 have a 1.9 times higher risk of neonatal death compared to those who have a score greater than 5. This finding is similar to studies conducted in Egypt and Cameroon, which reported risks of death 1.3 and 18.56 times higher in Egypt and Cameroon, respectively (2, 12). This might be due to the fact that neonates who have a 5<sup>th</sup> minute APGAR score less than 5 were severely asphyxiated, and also may be associated with labor and pregnancy complications.

In the current study, neonates born from mothers who have previously given birth between two and four times have a 13 times higher risk of death compared to those who give birth for the first time (AHR: 13; 95% CI: 5.1, 33.4). In contrast to this, a study conducted in rural northern Ethiopia revealed that mothers who had previously given birth between two and four times have an 85% lower risk of losing their newborn to neonatal death (13). Also, those neonates born from mothers who have history of five or more births had a 24 times higher risk of death (AHR: 24; 95% CI: 10.5, 55.2). This is similar to a study conducted in Tikur Anbessa Hospital in Addis Ababa, which revealed that those in the 5<sup>th</sup> or higher birth order were 1.61 times more likely to die than 1<sup>st</sup> order births (14). In contrast, in a study conducted in Jimma, compared to 2<sup>nd</sup> to 4<sup>th</sup> order births, 1<sup>st</sup> order births were 5.45 times more likely to die during the neonatal period, and 5<sup>th</sup> order births and above were 2.61 times more likely to die (15). This variation might be due to the fact that as the birth order increases, the maternal age increases. So, as a mother's age increases, the risk of obstetric complications increases. In addition, as the mother's birth order increases, there

may be a short birth interval, which may cause maternal depletion syndrome and resource competition between siblings.

The number of births also has a protective effect on neonatal mortality. It indicates that, compared to the first birth, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> order births have an 84% protective effect, and 5<sup>th</sup> order births and above have an 82% protective effect. This finding is similar to a study conducted in Burkina Faso, where having a nulliparous mother had a 4.3 times higher risk of neonatal death compared to multiparas (16). This may be due to increased awareness of pregnancy complications and their effect on neonatal mortality in previous pregnancies, and increased trends in the health care-seeking behavior of mothers because of past negative experiences. In addition, mothers who have a previous experience of pregnancy and delivery have more information on the timing of the initial and consecutive ANC visits, and are also knowledgeable about obstetric danger signs, birth preparedness and complication readiness, because all are critical factors for the reduction of neonatal mortality.

Neonates who were not initially exclusively breast fed had 1.8 times higher risk of mortality compared to the counterparts who were initially exclusively breast fed (AHR: 1.8; 95% CI: 1.03, 3.18). This finding is similar with the study conducted in Tigray which revealed that those neonates who were not initially exclusively breast fed had 7.5 times higher risk of neonatal death as compared to those who initially exclusively breast fed (17). This might be due to the fact that exclusive breast feeding especially the colostrums which is rich in protective factors and reduces occurrence of diarrhea, reduces risk of gastro intestinal infections and pneumonia.

## Conclusion

This study revealed that the incidence density rate of neonatal mortality was 31.6 per 1000 neonate days. The independent predictors of neonatal mortality were maternal age less than 18 years old, the fifth minute APGAR score five and below, increased birth order, being a first birth and not initiating exclusive breast feeding within one hour of giving birth.

Therefore, community involvement is required to reduce the high birth rate through the utilization of family planning methods, strengthening government involvement in the provision of contraceptive methods, and also health professionals should intensively follow neonates who have low APGAR score.

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