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Received: 16 Oct 2019 - Accepted: 07 Feb 2021 - Published: 22 Feb 2021

Keywords: Magnitude, neonatal death, risk factors, neonatal intensive care unit, Gedeo Zone-Ethiopia

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Cite this article: Akine Eshete et al. Magnitude and risk of neonatal death in neonatal intensive care unit at referral hospital in Godeo Zone: a prospective cohort study. Pan African Medical Journal. 2021;38(201). 10.11604/pamj.2021.38.201.20650

Available online at: https://www.panafrican-med-journal.com//content/article/38/201/full

Magnitude and risk of neonatal death in neonatal intensive care unit at referral hospital in Godeo Zone: a prospective cohort study

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Abstract

Introduction: even though newborn health is a priority agenda in Ethiopia, neonates’ risk of dying is unacceptable and one of the ten countries which accounts to two-third of global neonatal death. The magnitude and risk of death in the referral care facility was not well studied in the study area. This study was aimed to estimate neonatal death and its determinant. Methods: a prospective cohort study was conducted from November 2016 to January 2018 among neonates admitted to Dilla University Referral Hospital Neonatal Intensive Care Unit. We generated descriptive statistics and Cox-proportional hazard model to identify independent risk factors of neonatal death. Results: we identified 913 neonates with 6836 person-days of follow-up. Overall, 11.6% (n = 106) deaths of neonates were recorded. The estimated hazard ratios of neonatal death were higher among neonates whose mothers did not attend ANC follow up (HR=3.23), delivery assisted by TBA (HR=2.19), and maternal age ≥ 30 years at birth (HR=2.04). Urban residence [HR=0.54], family size of ≤ 3 (HR=0.47) and family size of 4 - 6 (HR=0.49), absence of abortion (HR=0.55), absence of illness during pregnancy (HR=0.47), iron folate intake (HR=0.29), birth weight ≥ 2500 grams (HR=0.43) were found to be protective factors. Conclusion: neonatal death at referral neonatal intensive care unit was relatively high. Early management of complications, improving quality of services at neonatal intensive care unit and ensuring maternal continuum of care are recommended to increase survival of neonates. Besides, maternal and neonatal health-related factors were among the independent risk factors that need to design context-based policy and interventions.

Introduction

Newborn health has been improved significantly in the era of Millennium Development Goal even though the target of reducing neonatal mortality by two-thirds was not achieved [1], with an estimated 2.6 million deaths of newborns within 28 days of life in the world in 2016 [2]. Moreover, neonatal mortality reduction has been slower (47%) compared to the progress of under-five mortality reduction (58%) and it constitutes 45% (44.9%-45.2%) of the total under-five deaths [3-5]. By 2030, the death and share of neonatal death are expected to rise to 69 million deaths and 52 percent respectively [3, 6]. Hence, neonatal health becomes the agenda of Sustainable Development Goals (SDGs) with an entitled target of reducing neonatal mortality below 12 per 1,000 live births by 2030 [3, 6-8]. Thus, ensuring newborn survival has become the most critical intervention to the overall childhood survival.

Ethiopia had one of the world’s highest neonatal mortality rate (NMR) (28.1 per 1000 live births) in 2016 [9, 10]. The NMR was higher than that of the Africa continent (27 deaths per 1,000 live births) and nine times higher than the developed countries (3 deaths per 1,000 live births), yet similar to the sub-Saharan African countries (29 deaths per 1000 live births) [3]. The NMR also varies among different socioeconomic strata and geographic regions of the country [11-14]. As a result, the federal ministry of Ethiopia designed neonatal survival strategies including establishments of the basic newborn care units (newborn corners) at primary health care centers and neonatal intensive care units (NICUs) at hospitals [15, 16]. These strategies are part of the global and national targets set in SDGs. However, the maternal and neonatal health of the country bears various health system bottlenecks [15-17] as so do other low and middle-income countries in the world [18].

To achieve SDGs, it needs to understand the multifactorial and inter-related determinants of neonatal death. Understanding the risk factors of neonatal mortality gives an important public health insight [3]. Several studies indicated maternal, neonatal, health system, and socioeconomic risk factors were related to neonatal survival. These factors could easily preventable through the provision of the continuum of care from pregnancy to delivery and to the immediate postnatal period [11-14, 19-22]. However, empirical evidence...
assessing the risk factors of neonatal death is lacking from the prospective cohort of neonates in Ethiopia. Available evidence generated so far were either from hospital-based secondary records or retrospective surveys with methodological limitations. Therefore, the present study aimed to estimate neonatal death (time to death) and assess the independent risk factors of neonatal death.

**Methods**

**Study design, setting, and populations:** a prospective cohort study was conducted among neonates admitted to Dilla University Referral Hospital Neonatal Intensive Care Unit (NICU) from November 2016 to January 2018. Dilla University referral hospital serves as a referral hospital for all districts in Gedo zone and Abay district of Oromia region and Dara District in Sidama zone. In Gedo zone, only Dilla University Referral Hospital Neonatal Intensive Care Unit is established. All neonates admitted to the neonatal care unit from Dillazuria, Wonago, Bule, Gedeb, Kocere, Yirgachefee, Dilla town, Abay and Dara districts were followed from cohort entry up to the occurrence of an event (death) or end of follow-up.

**Recruitment and interviewing of study participants:** structured and interview-administered questionnaire adopted from previous research and WHO standard questionnaires [23] was used to prospectively collect the data. The mothers of index neonates were the respondent for the interview in addition to the data collected from the clinical charts. Ten trained data collectors interviewed with mothers of index children and gathered clinical information by reviewing their clinical charts. Admitted neonates were daily visited by the data collectors. They followed the neonates from admission to death or discharge and the alive neonate was censored at the end of the study period.

**Measurements of variables:** the data that were collected prospectively consisted of time to death of neonates (dependent variable), and the socio-demographic, economic, neonatal, and maternal and health service-related characteristics (independent variables). The outcome variable was dichotomized to dead and censored for survival analysis. Neonatal death is defined as any death occurring during the first 28 completed days of life, with early neonatal deaths being those occurring in the first 7 days and late neonatal deaths those 8 to 28 days after birth. A final assessment of admission diagnosis and causes of death were set by physicians after conducting the necessary clinical and laboratory investigation.

**Data management and analysis:** we checked the data integrity using Epi Info version 7 and analyzed using statistical package for social sciences version 20. We generated descriptive statistics using the frequency distribution for categorical variables and using mean for continues variables. We assessed factors associated with neonatal death using a univariable and multivariable Cox-proportional hazard model. All variables having p-value, < 0.05 were considered as candidates for the final model.

**Ethics approval:** the study was approved by the health research and ethics review committee of the College of Health Sciences and medicine, Dilla University. Moreover, the respondent gave voluntary written consent before the interview. The information obtained was kept anonymous and thereby assured of confidentiality.

**Results**

**Characteristics of mothers and neonates:** overall, 987 neonates admitted to the NICU of Dilla University Referral Hospital. We included 913 neonates into the analysis and excluding those newborns with age greater than 28 days (n=74) at the time of admission. The majority of mothers (n=341, 37.3%) were between in the age group of 24-29 years in the last birth with a mean (±SD) age of 26.6 (±4.7) years. Three-fourths of mothers (75%) completed primary and high school education and about 58.6% of them were housewives (Table 1).
Even though most of the mothers (n=776, 85%) reported to have at least one antenatal care (ANC) visit during their last pregnancy, more than half of them (n=518, 56.7%) had less than four ANC visits (focused ANC). About (n=496, 54.3%) women gave their last birth at government hospitals while 327 (35.8%) women’s last delivery was at primary health care centers. Two hundred forty-eight mothers (27.2%) had experienced a complication during delivery while 241 (26.4%) of mothers had experienced a complication during pregnancy period. Bleeding (n=87, 23.8%), visual problem (n=74, 20.2%), and hypertension (n=61, 16.7%) were the most commonly reported complications during the prenatal period (Table 2). There was a male predominance of admission in the NICU (n=510, 56.7%). Most of the admissions (n=788, 86.3%) occurred during the first week of life. Above two-thirds of neonates were term babies (67.5%). The mean weight of neonates at admission and discharge was 2737.7 (SD=±839.8) and 2878.8 (SD=±1031) grams, respectively (Table 3).

**Magnitude and timing of death among admitted neonates:** overall, 11.6% (n=106); (95% CL (9.6-13.7)) of neonates died during the follow-up. The overall incidence of neonatal mortality was 15.5 per 1000 person-days. We found that 36(34.0%); 95% CL (25.5-43.4) and 65(61.3%); 95% CL (51.9-69.8) of deaths occurred during the first and second weeks of neonatal life, respectively. Late neonatal death (n=70, 66.0%); 95% CL (56.6-74.5) was higher compared to early neonatal deaths (n=36, 34.0%); 95% CL (25.5-43.4).

**Neonatal illness and cause-specific neonatal death during the follow-up:** the most common cause of admission was neonatal sepsis (56.5%) followed by low birth weights (19.5%) while the least common was congenital malformation (3.2%). Sepsis, (n=98, 42.1%), low birth weight (LBW), (n=67, 28.8%) were the main leading cause of deaths. Birth asphyxia was not the major cause of admission, but it accounted for a higher proportion (21.9%) of neonatal death (Figure 1).

**Risk factors for neonatal death:** both binary Cox-regression and multivariable Cox-regression analysis were carried out to identify risk factors of neonatal mortality (Table 4). In the multivariable Cox-regression model; maternal age greater than 30 years (HR=2.04, 95% CI: 1.13-3.66), delivery assisted with TBA and/or family (HR=2.19, 95% CI: 1.18-4.10) and neonates whose mothers did not have ANC follow up visit (HR=3.23, 95% CI: 1.06 - 9.84) carried a high risk of neonatal death. However, mothers who lived in urban area (HR=0.54, 95% CI: 0.27-0.93), household family size less than three (HR=0.47, 95% CI:0.22-0.98) and 4 up to 6 family (HR=0.49, 95% CI: 0.26-0.94), no history of abortion (HR=0.55, 95% CI: 0.30-0.92), mothers who did not have maternal illness during prenatal period (HR=0.47, 95% CI: 0.30-0.74), mothers who took iron folate tablets (HR=0.29, 95% CI: 0.09-0.89) and birth weight >2500 grams (HR=0.43, 95% CI: 0.24-0.77) remained as a lower risk for neonatal death among admitted neonates (Table 4).

**Discussion**

In this current study, we found that nearly one in every ten (11.6%) (95% CI: 9.6 - 13.7) infants were dying before celebrating their first month of life (neonatal period). This findings was higher compared to a study done in Tigray region-Ethiopia, (6.25%) [24], but lower compared to the overall estimated national neonatal mortality rate (29 per 1000 live births) for Ethiopia [10]. The higher death in this study might be neonates transferred to Neonatal ICU for admission might have risk of death.

In this study, shorter survival time (most of the neonatal death) found in the earlier age of neonatal life, which was in line with the previous studies [12, 24, 25]. This might be because preterm or severely sick newborn die early. In the study, we found that LBW contributing to being most of the neonatal deaths, (28.8%), this could be an alarm to health professionals to improve quality care at the time of birth and special care for sick and small newborns. Previous evidence also reported that...
poor or low availability quality of child health care facilities could further worsen the risk of death [26, 27].

Neonatal sepsis and low birth weights were the leading causes of neonatal death and hospital admission, which was consistent where the studies did Ethiopia and abroad [1, 10, 28, 29]. In the study, nearly one-third of deaths (33.1%) were recorded with the cause of sepsis and also 44.7% of deaths were attributed to by LBW. Therefore, this study alert for the establishment of advanced NICU and strengthens the referral systems. Besides, antenatal and intrapartum monitoring of high-risk pregnancy, care during labor and delivery as well as immediate neonatal care practices including adequate basic neonatal resuscitation care at the time of birth should be the highest priority intervention in the study area.

An infant born in an urban area has a lower risk of death than an infant born in a rural area. The reason may be those mothers who lived in the urban area have an awareness of the advantage of maternal health care service utilization to mothers and their babies during pregnancy, labor, immediate and early neonatal periods and that has an effect on child survival in the postnatal period. Maternal and neonatal health conditions have different impacts on neonatal survival status. The study showed that neonates whose mothers did not have the history of abortion; did not experience maternal illness during the prenatal period, and neonates whose mother took Iron foliate and neonates whose birth weight >2500 grams have a lower risk for neonatal death. Similar to previous studies done in Ethiopia [24, 30], neonates whose mothers completed high school and above had a lower risk of death compared to uneducated mothers. However, after adjusting for other variables, the risk of death didn’t vary significantly by educational status. In the study, neonates born to a mother who was greater than 30 years of age have a higher risk of death, like other studies conducted in Ethiopia [12].

On the other hand, variables such as infrequent or lack of ANC visit and delivery assisted with TBA and family members have a higher risk of neonatal death. Several previous studies [30, 31, 32] have also reported that lack of adequate and quality ANC visit that results in the inadequate monitoring of pregnancy, maternal and neonatal complication during and after delivery, which was associated with increased the risk of neonatal death. Moreover, maternal healthcare service is an important predictor of neonatal survival. Therefore, neonatal outcome depends on maternal health during the pregnancy period. Therefore, this finding suggests that special consideration needs to be given for maternal obstetric care during pregnancy.

**Conclusion**

The present study reported that the magnitude of neonatal death was (11.6%); (95% CI: 9.6 - 13.7), which is one of the highest and nearly threefold of the national estimated neonatal mortality rate, which seek more attention in order to meet the goal of child survival in Ethiopia to 11 per 1000 live births by 2020. Most of the neonatal death found in the earlier age of neonatal life. The risk of dying among admitted neonates is determined by both maternal socio-demographic and obstetric characteristics, and neonatal birth conditions. The leading causes of deaths, admission, and predictors of death were related to maternal socio-demographic and obstetric characteristics that could be improved a continuum of care to women during pregnancy, labor, immediate and early neonatal periods. The neonatal intensive care unit should work on early diagnosis, appropriate management and continuous care. Therefore, a responsive health care system that is equipped with lifesaving commodities and well-trained staff is the priority intervention in our setup.

**What is known about this topic**

- We found that nearly one in every ten infants was dying before celebrating their first month of life (neonatal period);
Most of the neonatal death found in the earlier age of neonatal life.

What this study adds
- The risk of dying among admitted neonates is determined by both maternal socio-demographic and obstetric characteristics, and neonatal birth conditions;
- A responsive health care system that is equipped with lifesaving commodities and well-trained staff is the priority intervention in our setup.

Competing interests
The authors declare no competing interests.

Authors' contributions
AE and HT involved in study conception, data analysis, interpretation of the data and manuscript writing. SA and TT involved in the data interpretation and critical review of the manuscript. All authors read and approved the final version of the manuscript.

Acknowledgments
We would like to acknowledge Dilla University for funding the study, and study participants.

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References
1. Liu L, Oza S, Hogan D, Chu Y, Perin J, Zhu J et al. Global, regional, and national causes of under-5 mortality in 2000 - 15: an updated systematic analysis with implications for the Sustainable Development Goals. Lancet. 2016 Dec 17;388(10063):3027-3035. PubMed | Google Scholar
2. WHO. Global Health Observatory (GHO) data; Neonatal mortality. Accessed 16th October 2019.
3. Inter-agency Group for Child Mortality Estimation (UN IGME). Levels and Trends in Child Mortality Report 2015. 2015;8-9.
4. Black RE, Levin C, Walker N, Chou D, Liu L, Temmerman M et al. Reproductive, maternal, newborn, and child health: key messages from Disease Control Priorities 3rd Edition. Lancet. 2016;(16):1-15. PubMed | Google Scholar
5. Lawn JE, Kerber K, Sankoh O, Claeson M. Uganda Newborn Study (UNEST): learning from a decade of research in Uganda to accelerate change for newborns especially in Africa. Glob Health Action. 2015 Mar 31;8:27363. PubMed | Google Scholar
6. WHO, UNICEF. Every Newborn Progress Report 2015. Geneva: World Health Organization.
7. UNICEF. Committing to Child Survival: A Promise Renewed; United Nations Child Fund. 2015.
8. WHO U. Every Newborn: an action plan to end preventable deaths: Executive summary. WHO, Geneva. 2014. Google Scholar
9. Knoema. Ethiopia - Neonatal mortality rate. Accessed 16th October 2019.
10. Central Statistical Agency (CSA) [Ethiopia] and ICF. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiop Rockville, Maryland, USA CSA ICF. 2016.
11. Weldearegawi B, Melaku YA, Abera SF, Ashebir Y, Haile F, Mulugeta A et al. Infant mortality and causes of infant deaths in rural Ethiopia: a population-based cohort of 3684 births. BMC Public Health. 2015 Aug 11;15:770. PubMed | Google Scholar
12. Wakgari N, Wencheko E. Risk factors of neonatal mortality in Ethiopia. Ethiop J Heal Dev. 2013;27(3):192-9. Google Scholar
13. Kokeb M, Desta T. Institution Based Prospective Cross-Sectional Study on Patterns of Neonatal Morbidity at Gonder University Hospital Neonatal Unit. Ethiop J Heal Sci. 2016;26(1):73-79. PubMed | Google Scholar
14. Yaya Y, Eide KT, Norheim OF, Lindtjorn B. Maternal and Neonatal Mortality in South-West Ethiopia: Estimates and Socio-Economic Inequality. PLoS One. 2014 Apr 30;9(4):e96294. PubMed | Google Scholar
15. FMoH. Health Sector Transformation Plan 2015/16 - 2019/20 (2008-2012 EFY). Federal Democratic Republic of Ethiopia Ministry of Health, Addis Ababa. 20.
16. FMoH. Health Sector Development Programme IV. Fed Democr Repub Ethiop Minist Heal. 2010;(October 2010).
17. FMoH. Country Implementation Plan for Prioritized Life-Saving Commodities for Women and Children. Fed Democr Repub Ethiop Minist Heal. 2013.
18. Victora CG, Barros AJD, Franca GVA, da Silva ICM, Carvajal-Velez L, Amouzou A. The contribution of poor and rural populations to national trends in reproductive, maternal, newborn, and child health coverage: analyses of cross-sectional surveys from 64 countries. Lancet Glob Health. 2017 Apr;5(4):e402-e407. PubMed | Google Scholar
19. Yirgu R, Molla M, Sibley L. Determinants of neonatal mortality in rural Northern Ethiopia: a population-based nested case-control study. PLoS One. 2017 Apr 18;12(4):e0172875. PubMed | Google Scholar
20. Akinyemi JO, Afolabi RF, Awolude OA. Patterns and determinants of dropout from maternity care continuum in Nigeria. BMC Pregnancy Childbirth. 2016 Sep 27;16(1):282. PubMed | Google Scholar
21. Ntambue AM, Malonga FK, Dramaix-wilmet M, Ngatu RN, Donnen P. Better than nothing maternal, newborn, and child health services and perinatal mortality, Lubumbashi, Democratic Republic of the Congo: a cohort study. BMC Pregnancy Childbirth. 2016 Apr 26;16:89. PubMed | Google Scholar
22. Shifa GT, Ahmed AA, Yalew AW. Early days of life are crucial for child survival in Gamo Gofa Zone, Southern Ethiopia?: a community-based study. BMC Pediatr. 2016 Mar 5;16:30. PubMed | Google Scholar
23. Anker M, Black R, Coldham C, Kalter H. A standard verbal autopsy method for investigating causes of death in infants and children. World Health organization. 1999;83. Google Scholar
24. Mengesha HG, Wuneh AD, Lerebo WT, Tekle TH. Survival of neonates and predictors of their mortality in Tigray region, Northern Ethiopia: prospective cohort study. BMC Pregnancy Childbirth. 2016 Aug 2;16(1):202. PubMed | Google Scholar
25. Hedstrom A, Ryman T, Otai CM, Nyonyintono J, McAdams RM, Lester D et al. Demographics, clinical characteristics and neonatal outcomes in a rural Ugandan NICU. BMC Pregnancy Childbirth. 2014 Sep 19;14:327. PubMed | Google Scholar
27. Debelew GT, Afework MF, Yalew AW. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: A multilevel analysis of prospective follow up study. PLoS One. 2014 Sep 18;9(9):e107184. PubMed | Google Scholar

28. FMOH/MCH. National Newborn and Child Survival Strategy Document Brief Summary 2015/16-2019/20. FMOH/MCH. 2015.

29. Kolola T, Gezahegn T, Addisie M. Health care seeking behavior for common childhood illnesses in jeldu district, Oromia regional state, Ethiopia. PLoS One. 2016;11(10):1-11. PubMed | Google Scholar

30. Getachew A, Ricca J, Cantor D, Rawlins B, Rosen H, Tekleberhan A et al. Quality of care for prevention and management of common maternal and newborn complications? a study of Ethiopia´s hospitals. Baltimore; 2011. Google Scholar

31. Gelaw YA, Biks GA, Alene KA. Effect of residence on mothers´ health care seeking behavior for common childhood illness in Northwest Ethiopia?: a community based comparative cross-sectional study. BMC Res Notes. 2014;7(705):1-8. PubMed | Google Scholar

32. Berhan Y, Berhan A. Reasons for persistently high maternal and perinatal mortalities in Ethiopia: Part II-Socio-economic and cultural factors. Ethiop J Health Sci. 2014 Sep;24 Suppl(0 Suppl):119-36. PubMed | Google Scholar
Table 1: socio-demographic characteristics of mothers among admitted neonates to Dilla University Referral Hospital Neonatal Intensive Care Unit, from November 2016 to January 2018

| Variables                     | Number (%)           | Mean (SD)   |
|-------------------------------|----------------------|-------------|
| **Age of mothers at the current pregnancy** |                       | 26.6 (± 4.7) |
| <24 Years                     | 287 (31.4)           |             |
| 25-29 Years                   | 341 (37.3)           |             |
| > 30                          | 285 (31.2)           |             |
| **Marital status**            |                      |             |
| Married                       | 891 (97.6)           |             |
| Other*                        | 22 (2.4)             |             |
| **Districts of the respondents** |                      |             |
| Dillazuria                    | 119 (13.0)           |             |
| Wonago                        | 108 (11.8)           |             |
| Bule                          | 81 (8.9)             |             |
| Gedeb                         | 79 (8.7)             |             |
| Kochere                       | 84 (9.2)             |             |
| Yiregacheffe town and district| 131 (14.3)           |             |
| Dilla town                    | 154 (16.9)           |             |
| Abay District, oromay region  | 82 (9.0)             |             |
| Dara District, Sidama zone    | 75 (8.2)             |             |
| **Place of residence**        |                      |             |
| Urban                         | 316 (34.6)           |             |
| Rural                         | 597 (65.4)           |             |
| **Mother’s educational status** |                      |             |
| Uneducated                    | 168 (18.4)           |             |
| Primary school (Grade 1-8)    | 324 (35.5)           |             |
| High school (Grade 9-12)      | 362 (39.5)           |             |
| Diploma and above             | 59 (6.5)             |             |
| **Husband /or partner educational status** |                |             |
| Uneducated                    | 75 (8.2)             |             |
| Primary school (Grade 1-8)    | 232 (25.4)           |             |
| High school (Grade 9-12)      | 325 (35.6)           |             |
| Diploma and above             | 281 (30.8)           |             |
| **Mothers’ occupational Status** |                      |             |
| Government or private employee| 52 (5.7)             |             |
| Self-employed including merchant| 326 (35.7)         |             |
| Housewife                     | 535 (58.6)           |             |
| **Husband /or partner occupation** |                      |             |
| Government or private employee| 378 (41.4)           |             |
| Self-employed including merchant| 303 (33.2)         |             |
| Unemployed including daily laborer| 59 (6.5)         |             |
| Farmer                        | 173 (18.9)           |             |
| **Family size**               |                      |             |
| Mean (SD)                     | 4.01 (± 2.3)         |             |
| Less than three family        | 495 (54.5)           |             |
| 4-6 family                    | 272 (29.8)           |             |
| Greater than seven family     | 146 (16.0)           |             |

SD: Standard Deviation, other* includes: Single, widowed and divorced,
| Variables | Number (%) |
|-----------|------------|
| ANC visit in the last pregnancy | |
| < 4 ANC visit | 518 (56.7) |
| > 4 ANC visit | 258 (28.3) |
| No ANC visit | 137 (15) |
| HEW visit during pregnancy | |
| 1-2 visit | 132 (14.5) |
| >3 Visit | 31 (3.4) |
| Not visited by HEW | 750 (82.1) |
| Iron folate taken during pregnancy | Mean (SD) 57 (±16.15) |
| Less than 60 days | 445 (48.7) |
| 60 days and above | 304 (33.3) |
| Not taking at all | 164 (18.0) |
| Place of delivery | Hospital 496 (54.3) |
| Health center | 327 (35.8) |
| Private clinic | 30 (3.3) |
| Home | 60 (6.6) |
| Mode of delivery | Vaginal delivery 691 (75.7) |
| Assisted delivery | 70 (7.7) |
| Cesarean section | 152 (16.6) |
| Delivery assistant | Skilled personnel 848 (92.9) |
| Family/or relatives and TBA | 65 (7.1) |
| Complication of labor | Yes 248 (27.2) |
| No | 665 (72.8) |
| Complication of pregnancy | Yes 241 (26.4) |
| No | 672 (73.6) |
| Type of disease diagnosed in last pregnancy | Hypertension 61 (16.7) |
| DM | 16 (4.4) |
| Asthma | 6 (1.6) |
| Anemia | 35 (9.6) |
| Malaria | 5 (1.4) |
| Headache | 57 (15.6) |
| Visual problem | 74 (20.2) |
| Pregnancy-related hypertension | 25 (6.8) |
| Bleeding | 87 (23.8) |
| Number of alive children | Mean (SD) 3.02 (±2.05) |
| Less than two children | 294 (32.2) |
| Three to four children | 154 (16.9) |
| Greater than five children | 142 (15.6) |
| No children | 323 (35.4) |
| History of abortion | Yes 74 (8.1) |
| No | 839 (91.9) |
| History of still birth | Yes 98 (10.7) |
| No | 815 (89.3) |

TBA: Traditional Birth Attendant, SD: Standard Deviation, ANC: Antenatal care, HEW: Health Extension Worker
**Table 3:** Neonates characteristics among admitted neonates to Dilla University Referral Hospital Neonatal Intensive Care Unit, from November 2016 to January 2018

| Variables                              | Number (%)          |
|----------------------------------------|---------------------|
| Age of the neonates at admission (days)|                     |
| Mean (SD)                              | 4.4 (± 4.03)        |
| 1-7 days                               | 788 (86.3)          |
| 7-14 days                              | 79 (8.7)            |
| 14-21 days                             | 40 (4.4)            |
| 21-28 days                             | 6 (0.7)             |
| Sex of neonate                         |                     |
| Male                                   | 510 (55.9)          |
| Female                                 | 403 (44.1)          |
| Weight of the neonates at birth        |                     |
| Mean (SD)                              | 2639.1 (± 818.4)    |
| < 2500 grams                           | 289 (31.7)          |
| > 2500 grams                           | 426 (46.7)          |
| I don’t know                           | 198 (21.7)          |
| Weight of the neonates at admission    |                     |
| Mean (SD)                              | 2737.7 (± 839.8)    |
| < 2500 grams                           | 342 (37.5)          |
| > 2500 grams                           | 571 (62.5)          |
| Weight of the neonates at discharge    |                     |
| Mean (SD)                              | 2878.8 (±1031)      |
| < 2500 grams                           | 320 (35.0)          |
| > 2500 grams                           | 593 (65)            |
| Gestation age at birth                 |                     |
| Mean (SD)                              | 37.2 (± 2.4)        |
| Preterm (< 37 weeks)                   | 297 (32.5)          |
| Term (>37 weeks)                       | 616 (67.5)          |
| Duration of stay in the NICU           |                     |
| Mean (SD)                              | 7.5 (± 4.07)        |
| Seven and less than seven days         | 619 (67.8)          |
| Greater than seven days                | 294 (32.2)          |

SD: Standard Deviation, NICU: Neonatal Intensive Care Unit
Table 4: adjusted hazard ratios of newborn related risk factors associated with neonatal death among admitted neonates to Dilla University Referral Hospital Neonatal Intensive Care Unit, from November 2016 to January 2018

| Variables                        | Neonatal death | Unadjusted HR (95% CI) | Adjusted HR (95% CI) |
|----------------------------------|----------------|-------------------------|----------------------|
| Place of residence               |                |                         |                      |
| Urban                            | 297 (36.8)     | 0.42                    | 0.25-0.68            |
| Rural                            | 510 (63.2)     | 1                       | 1                    |
| Mothers educational status       |                |                         |                      |
| Uneducated                       | 137 (17.0)     | 1                       | 1                    |
| Primary school (1-8 grade)       | 280 (34.7)     | 0.68                    | 0.43-1.08            |
| High school and above            | 391 (48.5)     | 0.35                    | 0.22-0.58            |
| Husband educational status       |                |                         |                      |
| Uneducated                       | 62 (7.7)       | 1                       | 1                    |
| Primary school (Grade 1-8)       | 188 (23.3)     | 1.05                    | 0.57-1.96            |
| High school (Grade 9-12)         | 297 (36.8)     | 0.45                    | 0.23-0.86            |
| House hold family number         |                |                         |                      |
| Less than three family           | 454 (56.3)     | 0.38                    | 0.24-0.62            |
| 4-6 family                       | 236 (29.2)     | 0.57                    | 0.35-0.93            |
| Greater than seven family        | 117 (14.5)     | 1                       | 1                    |
| Age of mothers at last birth     |                |                         |                      |
| <24 Years                        | 271 (33.6)     | 2.33                    | 1.33-4.14            |
| 25-29 Years                      | 293 (36.3)     | 2.56                    | 1.44-4.56            |
| >30 years                        | 243 (30.1)     | 1.81                    | 1.24-2.67            |
| Gestation age at birth           |                |                         |                      |
| Preterm (< 37 weeks)             | 251 (31.1)     | 0.82                    | 0.38-1.76            |
| Term (>37 weeks)                 | 556 (68.9)     | 1.11                    | 0.67-1.85            |
| History of abortion              |                |                         |                      |
| Yes                              | 82 (10.2)      | 1.19                    | 1.18-4.10            |
| No                               | 725 (89.8)     | 0.41                    | 0.24-0.68            |
| Who Assist during Delivery       |                |                         |                      |
| TBA and family/or relatives      | 51 (6.3)       | 2.16                    | 1.23-3.78            |
| Skilled personnel                | 756 (93.7)     | 2.19                    | 1.18-4.10            |
| Maternal illness during pregnancy|                |                         |                      |
| Yes                              | 192 (23.8)     | 0.35                    | 0.24-0.52            |
| No                               | 615 (76.2)     | 0.47                    | 0.30-0.74            |
| ANC follow up                    |                |                         |                      |
| Yes                              | 695 (86.1)     | 1.89                    | 1.20-2.96            |
| No                               | 112 (13.9)     | 3.23                    | 1.06-9.84            |
| Iron folate taken                |                |                         |                      |
| Yes                              | 667 (82.7)     | 0.43                    | 0.24-0.76            |
| Not taking                       | 140 (17.3)     | 0.29                    | 0.09-0.89            |
| Weight of neonates at birth      |                |                         |                      |
| < 2500 grams                     | 245 (30.4)     | 0.41                    | 0.26-0.66            |
| >2500 grams                      | 397 (49.2)     | 0.43                    | 0.24-0.77            |
| I don’t know                     | 165 (20.4)     | 0.83                    | 0.53-1.30            |

ANC: Antenatal care, HEW: Health Extension Worker,
Figure 1: clinical diagnosis and contribution to deaths in Neonatal intensive care unit at referral Hospital in Godeo Zone, from November 2016 to January 2018; a neonate having more than one diagnosis is counted more than once.