*ORIGINAL ARTICLE*

# PERINATAL MORTALITY AND ASSOCIATED RISK FACTORS: A CASE CONTROL STUDY

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**ABSTRACT**

***BACKGROUND:*** ***Perinatal mortality is reported to be five times higher in developing than in developed nations. Little is known about the commonly associated risk factors for perinatal mortality in Southern Nations National Regional State of Ethiopia.***

***METHODS:*** ***A case control study for perinatal mortality was conducted in University hospital between 2008 and 2010. Cases were stillbirths and early neonatal deaths. Controls were those live newborns till discharged from the hospital. Subgroup binary logistic regression analyses were done to identify associated risk factors for perinatal mortality, stillbirths and early neonatal deaths.***

***RESULTS:*** ***A total of 1356 newborns (452 cases and 904 controls) were included in this analysis. The adjusted perinatal mortality rate was 85/1000 total delivery. Stillbirths accounted for 87% of total perinatal mortality. The proportion of hospital perinatal deaths was 26%. Obstructed labor was responsible for more than one third of perinatal deaths. Adjusted odds ratios revealed that obstructed labor, malpresentation, preterm birth, antepartum hemmorrhage and hypertensive disorders of pregnancy were independent predictors for high perinatal mortality. In the subgroup analysis, among others, obstructed labor and antepartum hemorrhage found to have independent association with both stillbirths and early neonatal deaths.***

***CONCLUSION:*** ***The perinatal mortality rate was more than two fold higher than the estimated national perinatal mortality;and obstructed labor, malpresentation, preterm birth, antepartum hemmorrhage and hypertensive disorders of pregnancy were independent predictors. The reason for the poor progress of labor and developing obstructed labor is an area of further investigation.***

***KEY WORDS:***

***Case control, early neonatal death, Ethiopia, obstructed labor, perinatal mortality, stillbirth***

## INTRODUCTION

World health organization (WHO) defines perinatal mortality for developing countries as neonatal deaths of less than seven days of age and fetal deaths after 28 weeks of gestation, which is known as perinatal mortality-I (1). Perinatal mortality rate (PMR) is taken as one of the indicators of the health status of a given society. It is multifactorial in etiology and depends on the quality of health care provided to the pregnant women and their babies (1-3). The PMR is five times higher in developing than in developed nations (10 per 1000 and 50 per 1000 total births in developed and developing nations, respectively) (1). Out of about 6 million perinatal mortalities estimated worldwide, stillbirths account for about 3.3 million, and more than 97% of this occur in low and middle income countries (1, 4).

In urban population based cohort study in Pakistan in 2009 showed that the PMR-I (i.e. stillbirths plus all early neonatal deaths) and PMR-II (i.e. stillbirths plus all neonatal deaths) were 70.4 per 1000 and 82.5 per 1000 total births with a stillbirth to early neonatal mortality ratio of 1:1 (5). Specific to Africa, the PMR is reported to be as high as 75 per 1000 total births (1). One of the lowest PMRs was reported from rural South Africa (31 per 1000 total births) (2). To the contrary, a qualitative perinatal audit from Tanzania showed that the PMR was 92 per 1000 total births (6).

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According to the 2006 WHO estimate, in Ethiopia, there were a total of 168,000 perinatal deaths making the PMR 57/1000 total births. Of which, 58,000 were stillbirths and 110,000 were early neonatal deaths (ENNDs) (1). The finding in the 2011 Ethiopian Demographic and Health Survey (EDHS), however, showed that the PMR was 46 per 1000 total births (204 stillbirths and 347 ENNDs) (7).

The PMRs reported from some other health facilities were about two-three fold of the EDHS finding. A retrospective study done in Jimma Hospital (South West Ethiopia) showed that the overall PMR was about 139 per 1000 total births; obstructed labor was the single most important factor contributing to 37.4% of the total perinatal deaths (8). A cohort study conducted in babies born at health facilities in Addis Ababa showed that neonatal mortality rate was about 72 per 1000 live births (9). Another study from the central referral hospital in Addis, the gross perinatal and early neonatal mortality rates were about 92 and 26/1000 total births, respectively (10), which was almost comparable with another study reported from the same hospital about 35 years back (91/1000 total births) (11).

In developing countries, obstructed labour, abnormal fetal presentation, and hypertensive disorders of pregnancy are known to increase the risk of perinatal mortality by more than five-fold and all these may account for more than one-third of all perinatal deaths (12-14). All the four health facility based studies reported from Ethiopia had identified mechanical factors; specifically, malpresentation, uterine rupture and obstructed labour as the leading causes of perinatal mortality (8-11).

On the other hand, although about 99% of the neonatal deaths happen in low and middle income countries, yet most researches focus on the 1% perinatal deaths occurring in developed nations (13). Other authors also pointed out that information on perinatal deaths in most low and middle income countries is scanty (13-15). Specific to Ethiopia, despite having one of the world high infant mortalities (77/1000 live births), which is mainly due to early neonatal deaths (7), there are few hospital based studies in other regional states but to the present, there is no published study on perinatal mortality in the third largest regional state of Ethiopia where this study hospital located in. Given the paucity of reliable perinatal data as a country and absence in the region, the purpose of this study was to determine the commonly associated risk factors among babies delivered in the study hospital in three years period.

## METHODS

This is a three year case-control study done among all births in Hawassa University hospital; a referral hospital for the Southern Nations Nationalities Regional state of Ethiopia where the total population is estimated to be about 16 million, as extrapolated from the 2007 national census. During the study period, 5030 babies were delivered after 28 weeks of gestation. Cases were all stillbirths and neonatal deaths within seven days after delivery. Control groups were those newborns discharged from the hospital as healthy.
Based on the assumption that prematurity is the commonest cause of PMR: with about 20% survival, 95% CI and 80% power (1-B), and control to case ratio of 2:1, sample size was calculated using EPI-info 2002 version 6. The total sample size determined was 1356 (452 cases and 904 controls). That is, every perinatal death (stillbirth or ENND) as exposed (cases) was matched with two live discharged babies as unexposed (controls) using the date of delivery as matching criteria. During subgroup analysis, the matching of cases with controls was changed from 1:2 in the total cases (perinatal mortality) to 1:2.3 in stillbirth cases and to 1:15.6 in ENND cases.

Controls were selected systematically from the same period registration log books one before and one after each case. It was possible to get the sample size, specifically the cases, in three years period (September 2008 – August 2010). The data was collected from clinical records of mothers' and newborns' cards using a structured data collecting format. Selected mothers' cards were traced through the hospital's registry book.

Some of the data collected include maternal age, residence, pregnancy and delivery history (gravidity, antenatal care, gestational age, fetal presentation, mode of delivery, birth weight, APGAR score and condition of the new born at birth), obstetric and medical complications. The dependent variables were perinatal deaths, stillbirths and ENNDs.

Ethical approval and clearance was obtained from Hawassa University College of Medicine and Health Sciences Institutional Review Board (IRB). Since this analysis used entirely registered data, it didn't require informed consent. Furthermore, confidentiality and anonymity was assured by analyzing and disseminating the findings in aggregate.

In this study, PMR is to mean the number of stillbirths starting from 28 weeks of gestation plus neonatal deaths in the first week of life per 1000 total births (PMR-I). A newborn delivered with signs of life and died before the first week of life were counted as ENNDs. Gestational age was determined either from last normal menstrual period or from ultrasound report. Amenorrhea of 9 months was approximated to 40 weeks' gestation. Apgar score was classified as very low (0-3), low (4-6) and normal (7-10).

The data was entered, coded and analyzed using SPSS version 16.0 computer software program. Binary logistic regression analysis was done at two stages-first for total cases (perinatal mortality) and then sub-group analysis for stillbirths and ENNDs with fixed controls. P-value < 0.05 was taken as statistically significant.

## RESULTS

**Magnitude of Perinatal Mortality (Cases):** As shown in Table 1, during the study period, the overall gross and adjusted PMRs were found to be 90/1000 and 85/1000 total births, respectively. The adjusted PMR (excluding congenital anomalies incompatible with life) trend was almost stable in three years period: 80, 86 and 86 per 1000 total births. Out of 452 perinatal deaths, 394 (87.2%) were stillbirths and 58 (12.8%) were ENNDs that resulted in the stillbirth to ENND ratio to be about 7:1.

Table 1: Distribution of cases, controls, and perinatal mortality rate by year of study, Hawassa University hospital, Ethiopia, 2008-2010.

| Year | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|
| Total babies born | 914 | 1722 | 2394 | 5030 |
| Cases | 80 | 157 | 215 | 452 |
| Controls | 160 | 314 | 430 | 904 |
| Gross PMR* | 88 | 91 | 90 | 90 |
| Adjusted PMR*† | 80 | 86 | 86 | 85 |
| Stillbirths | 72 | 134 | 188 | 394 |
| ENNDs | 7 | 24 | 27 | 58 |
| SB to ENND ratio | 10:1 | 6:1 | 7:1 | 7:1 |

*Per 1000 total births; † Excluding congenital anomalies incompatible with life.
ENND = early neonatal death. PMR = perinatal mortality rate. SB = Still birth

Out of 394 stillbirths, 333(73.7%) were admitted to the hospital as stillbirth but 61 (13.5%) were admitted to the hospital with positive fetal heartbeats and later on were reported as hospital stillbirths. As a result, the proportion of hospital deaths was 119 (26.3%). Among the cases, the proportion of hospital perinatal death was highest in women with HDP (50%) with the majority being stillbirths. The contribution of obstructed labor for ENNDs was nearly 2-5 folds higher than other obstetric complications (Table 2).

Table 2. The proportion of perinatal deaths before and after arriving to the hospital by type of obstetric complications, Hawassa University hospital, Ethiopia, 2008-2010.

| Obstetric complication | Total cases (N) | Stillbirths before arrival (%) | Hospital deaths (%) | | |
|---|---|---|---|---|---|
| | | | Stillbirths | ENND | Total |
| Obstructed labor | 61 | 68.9 | 4.9 | 26.2 | 31.1 |
| APH | 49 | 77.5 | 8.2 | 14.3 | 22.5 |
| HDP | 42 | 50.0 | 38.0 | 12.0 | 50.0 |
| Malpresentation | 38 | 84.2 | 10.5 | 5.3 | 15.8 |
| PROM | 20 | 65.0 | 25 | 10.0 | 35.0 |
| Cord accident | 18 | 77.8 | 16.7 | 5.5 | 22.2 |
| Other* | 224 | 77.2 | 11.6 | 11.2 | 14.3 |
| Total | 452 | 73.7 | 13.5 | 12.8 | 100.0 |

* Including congenital anomalies incompatible with life and uterine ruptures. ENND= Early neonatal death; APH=antepartum hemorrhage; HDP=hypertensive disorders; PROM= premature rupture of membranes

**Demographic and Obstetric Characteristics of Mothers of Cases and Controls:** The mean age of mothers for cases and controls was 26.5 ± 6.17 and 25.9 ± 5.39 years, respectively. Mothers who were 35 years and above were higher in the cases than in the control group (13.7% versus 8.4%, respectively). Most of the mothers of controls, 728(80.5%), were from urban areas while 227(50.2%) of the cases were from rural areas. Primigravida mothers were higher in the control group than the cases. The proportion of cases and controls whose mothers had antenatal follow up were 208 (46%) and 651(72%), respectively. Among the cases, only 271(60%) had vertex presentation while it was 823 (91%) in the controls. The risk of death in breech and transverse presentations was 47.3% and 79.6%, respectively (Table 3).

Table 3: Demographic and obstetric characteristics of perinatal deaths (cases) and controls, Hawassa University hospital/Ethiopia, 2008- 2010.

| Variable | Category | Cases N = 452 | Controls N = 904 | Total N = 1356 |
|---|---|---|---|---|
| **Maternal age in years:** | < 20 | 36(8.0) | 62(6.8) | 97(7.2) |
| | 20 – 34 | 350(77.4) | 761(84.2) | 1121(81.9) |
| | 35+ | 62(13.7) | 76 (8.4) | 138(10.2) |
| | Unrecorded | 4(0.9) | 5(0.6) | 9(0.7) |
| **Maternal residence:** | Urban | 209(46.2) | 728(80.5) | 937(69.1) |
| | Rural | 227(50.2) | 155(17.2) | 382(28.2) |
| | Unrecorded | 16(3.6) | 21 (2.3) | 37(2.7) |
| **Gravidity:** | I | 141(31.2) | 409(45.2) | 550(40.6) |
| | II – IV | 161(35.6) | 391(43.3) | 552(40.7) |
| | V+ | 148(32.7) | 104 (11.5) | 252(18.6) |
| | Unrecorded | 2(0.5) | 0 | 2(0.1) |
| **Duration of labor in hours:** | <12 | 69 (15.3) | 288(31.9) | 357(26.3) |
| | 12-24 | 121(26.8) | 306(33.8) | 427(31.5) |
| | 25-48 | 71 (15.7) | 61(6.7) | 132(9.7) |
| | >48 | 35 (7.7) | 16(1.8) | 51(3.8) |
| | Unrecorded | 156(34.5) | 233(25.8) | 389 (28.7) |
| **Fetuses number** | Singleton | 425 (94.0) | 857(94.8) | 1282(94.5) |
| | Multiple | 27 (6.0) | 47 (5.2) | 74(5.5) |
| **Fetuses sex** | Male | 218 (48.2) | 470 (52.0) | 690(50.9) |
| | Female | 147 (32.5) | 409 (45.2) | 555(40.9) |
| | Unrecorded | 87 (19.3) | 25 (2.8) | 112(8.2) |
| **1st Minute APGAR score** | 0-3 | 440(97.4) | 20 (2.2) | 460(33.9) |
| | 4-6 | 11(2.4) | 238 (26.3) | 249 (18.4) |
| | 7-10 | 0 | 632 (69.9) | 632(46.6) |
| | Unrecorded | 1 (0.2) | 14 (1.6) | 15 (1.1) |
| **5th Minute APGAR score** | 0-3 | 437(96.7) | 2 (0.2) | 439(32.4) |
| | 4-6 | 10 (2.2) | 49(5.4) | 59 (4.3) |
| | 7-10 | 4 (0.9) | 839(92.8) | 843 (62.2) |
| | Unrecorded | 1 (0.2) | 14 (1.6) | 15 (1.1) |

One hundred seventy eight (39.4%) of the cases and 520 (57.5%) of the controls were delivered vaginally. With regard to the durations of labor, relatively long duration of labor was observed among cases. The median duration of labor in the cases and the controls group was 24 and 27 hours, respectively. From the total births, 460 (33.9%) had very low 1st minute Apgar score (0-3). Of

which, 97.3% were among the cases. Overall, nearly three-fourths of the cases were born at term and the birth weight for more than half of the cases was in the normal range. However, preterm births were higher in the cases than the control group. There was also higher proportion of very low and low birth weight newborns (9.5% and 17.7%) in the cases than in the controls (0.7% and 7.1%).

Three hundred seventy one (82.1%) of the cases were born from mothers having at least one type of obstetric complication while it was only 238 (26.3 %) in the control group. Specifically, antepartum hemorrhage, hypertensive disorders of pregnancy (all severe preeclampsia or eclampsia), uterine rupture, obstructed labor, and malpresentations were the commonest obstetric complications in the cases than in the controls. Premature rupture of fetal membranes and meconium stained amniotic fluid were more common among the controls than the cases. Newborns with very low and low birth weight were responsible for 27.2% of the total perinatal deaths with case fatality rate of 87.8% and 55.6%, respectively. Obstructed labor without uterine rupture had a case fatality rate of 73.5%.

Table 4: Binary logistic regression for factors associated with perinatal mortality, Hawassa University hospital/Ethiopia, 2008- 2010.

| Variable | Cases N = 452 | Controls N = 904 | Crude OR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|---|
| **Fetal presentation** | | | | |
| Vertex | 271(60.0) | 823(91.1) | 1 | 1 |
| Breech | 44(9.7) | 49(5.4) | 2.7 (1.78-4.19)* | 1.8 (0.93-3.66)*** |
| Transverse | 43(9.5) | 11(1.2) | 11.9 (6.04-23.35)* | 11.6 (4.62-29.27)* |
| Other | 12(2.7) | 11(1.2) | 3.3 (1.44-7.60)** | 3.9 (1.27-12.50)*** |
| Unrecorded | 82(18.1) | 10(1.1) | 24.9 (12.73-48.7)* | 3.7 (1.26-11.18)*** |
| **Gestational age** | | | | 2.3 (1.42-3.66)** |
| Preterm | 109(24.1) | 67(7.4) | 3.8 (2.73-5.28)* | 1 |
| Term | 337(74.6) | 787(87.1) | 1 | 0.5 (0.19-1.48) |
| Post term | 6(1.3) | 50(5.5) | 0.3 (0.12-0.66)** | |
| **Mode of delivery** | | | | |
| Spontaneous vaginal | 178(39.4) | 520(57.5) | 1 | 1 |
| Caesarean section | 130(28.8) | 313(34.6) | 1.2 (0.93-1.58) | 0.4 (0.25-0.59)* |
| Instrumental | 10(2.2) | 64(7.1) | 0.5 (0.23-0.91) | 0.6 (0.28-1.42) |
| Not documented | 2(0.4) | 7(0.8) | 0.8 (0.17-4.05) | 0.4 (0.05-3.26) |
| Laparotomy | 102(22.6) | NA | | |
| Destructive | 30 (6.6) | NA | | |
| **Birth weight (kg)** | | | | |
| <1.50 | 43(9.5) | 6(0.7) | 23.6 (9.90-56.02)* | 16.2 (6.06-43.02)* |
| 1.5-2.49 | 80(17.7) | 64(7.1) | 4.1 (2.87-5.89)* | 1.7 (0.95-2.97)* |
| 2.5-4.00 | 231(51.1) | 759(83.9) | 1 | 1 |
| >4.00 | 98(21.7) | 75(8.3) | 4.3 (3.07-6.00)* | 0.9 (0.62-1.49) |
| **Obstetric complications** | | | | |
| None | 81(17.9) | 666(73.7) | 1 | 1 |
| Antepartum hemorrhage | 49(10.8) | 20(2.2) | 7.7 (3.56-16.48)* | 12.2 (4.70-31.71)* |
| Hypertensive disorder | 42(9.3) | 58(6.4) | 2.3 (1.14-4.51)*** | 3.2 (1.33-7.53)* |
| PROM | 20(4.4) | 64(7.1) | 0.9 (0.46-2.08)* | 1.5 (0.61-3.84) |
| Obstructed labor | 61(13.5) | 22(2.4) | 8.7 (4.12-18.24)* | 19.8 (7.58-51.90)* |
| Cord accidents | 18(4.0) | 6(0.7) | 9.4 (3.18-27.7) | 15.9 (4.28-59.1)* |
| Meconium stained | 2(0.5) | 15(1.6) | 0.8 (0.18-3.61) | 1.1 (0.19-6.27) |
| Malpresentation | 38(8.4) | 53(5.9) | 2.24(1.11-4.51)* | 1.83(0.68-4.91)* |
| Cong malformation | 25(5.5) | 0 | | |
| Uterine rupture | 98(21.7) | 0 | | |
| Other | 18(4.0) | 0 | | |

* P < 0.0001; ** P < = 0.001; *** P < 0.05, PROM= premature rupture of membranes; NA = Not applicable

Binary logistic analysis was done to show the association between obstetric conditions and still births as cases. Both the crude and adjusted analysis showed that the stillbirth rate was highest among mothers who had no ANC follow up. In the crude analysis, it has been shown that being primiparas has about 50% protective effect for stillbirth (COR, 0.5; 95%CI, 0.34-0.70). But this association was not shown when primiparity was adjusted for other variables in the Table. In the crude analysis, grand multipara mothers had 1.89 times increased risk of having stillbirth than multiparas (COR, 1.9; 95% CI, 1.30-2.77). Very low and low birth weight newborns had 8.9 and 2.8 times increased risk of still birth than normal weight newborns. It has been also showed that APH, HDP and obstructed labor were independently associated with stillbirths (Table 5).

Table 5: Binary logistic regression for factors associated with stillbirths (cases), Hawassa University hospital/Ethiopia, 2008- 2010**.**

| Variable | Cases N = 394 | Controls N = 904 | Crude OR (95%CI) | Adjusted OR (95%CI) |
|---|---|---|---|---|
| **ANC follow up** | | | | |
| Yes | 177(44.9) | 651(72.0) | 1 | 1 |
| No | 131(33.3) | 80(8.9) | 0.6 (0.41-0.76)* | 0.39(0.23-0.66)* |
| Unknown | 86(21.8) | 173(19.1) | 2.9 (2.05-4.29)* | 0.45-(0.29-0.690* |
| **Gestational age** | | | | |
| Term | 288(73.1) | 787(87.1) | 1 | 1 |
| Preterm | 100(25.4) | 67(7.4) | 3.8 (2.75-5.30)* | 3.03(1.92-4.78)* |
| Post term | 6(1.5) | 50(5.5) | 0.4 (0.15-0.82)*** | 0.79(0.31-2.02) |
| **Parity** | | | | |
| I | 66(16.8) | 409(45.2) | 0.5 (0.34-0.70)* | 1.1(0.66-1.79) |
| II - IV | 118(29.9) | 391(43.3) | 1 | 1 |
| **V**+ | 94(23.9) | 104(11.5) | 1.9 (1.30-2.77)** | 1.3 (0.73-2.20) |
| Unknown | 116(29.4) | 0 | | |
| **Birth weight in kg** | | | | |
| 2.5-4.00 | 197(50.0) | 759(84.0) | 1 | 1 |
| <1.50 | 38(9.6) | 6(0.7) | 13.9 (6.98-27.7)* | 8.9 (3.91-20.5)* |
| 1.50-2.49 | 68(17.3) | 64(7.1) | 3.6 (2.51-5.18)* | 2.8 (1.78-4.46)* |
| **Obstetric complication** | | | | |
| None | 62(15.7) | 666(68.1) | 1 | 1 |
| Antepartum hemorrhage | 42(10.7) | 20(2.2) | 12.3 (7.22-20.95)* | 6.2 (3.33-11.38)* |
| Hypertensive disorder | 37(9.4) | 58(6.4) | 4.6 (2.92-7.38)* | 3.3 (1.94-5.68)* |
| PROM | 18(4.6) | 64(7.1) | 2.2 (1.22-3.80)*** | 2.2 (1.18-4.16) |
| Obstructed labor | 45(11.4) | 22(2.4) | 9.4 (5.76-15.23)* | 7.7 (4.44-13.30)* |
| Uterine rupture | 98(24.9) | 0 | | |
| Cord accident | 17(4.3) | 6(0.7) | 19.2(7.75-47.6)* | 18.6 (6.92-49.90)* |
| Meconium stained | 1(0.3) | 15(1.7) | 0.5 (0.65-3.77) | 0.8 (0.106.12) |
| Malpresentation | 36(9.1) | 53(5.9) | 5.2 (3.22-8.33)* | 4.2 (2.44-7.15)* |
| Cong malformation | 25(6.3) | 0 | | |
| Other | 13(3.3) | 0 | | |

* P < 0.0001; ** P < = 0.001; *** P < 0.05, PROM= premature rupture of fetal membranes

Binary logistic regression was performed to see the association between ENNDs as cases and obstetric factors and birth outcome. In this analysis, both the crude and adjusted analysis showed that preterm birth and parity had no association with early neonatal death. But very low and low birth weight had 3.95 and 2.52 times increased risk of ENND than those who had normal birth weight, respectively. Additionally, both the crude and adjusted analysis showed that

APH and obstructed labor were associated with increased risk of ENND (Table 6).

Table 6: Binary logistic regression for factors associated with early neonatal deaths (cases), Hawassa University hospital/Ethiopia, 2008- 2010.

| Variable | Category | Cases N = 58 | Controls N = 904 | Crude OR (95%CI) | Adjusted OR (95%CI) |
|---|---|---|---|---|---|
| **Gestational age** | Term | 49(84.5) | 787(87.1) | 1 | 1 |
| | Preterm | 9(15.5) | 67(7.4) | 1.18(0.57-2.45) | 0.61(0.24-1.51) |
| | Post term | - | 50(5.5) | | |
| **Parity** | II-IV | 9(15.5) | 391(43.3) | 1 | 1 |
| | I | 4(6.9) | 409(45.2) | 0.48(0.15-1.57) | 0.58(0.17-1.96)** |
| | V+ | 9(15.5) | 104(11.5) | 1.81(0.71-4.65) | 1.61(0.60-4.28) |
| | Unknown | 36(62.1) | 0 | | |
| **Birth weight in kg** | 2.50-4.00 | 34(58.6) | 759(84.0) | 1 | 1 |
| | <1.50 | 5(8.6) | 6(0.7) | 3.19(1.19-8.57)** | 3.95(1.20-12.9) |
| | 1.50-2.49 | 12(20.7) | 64(7. | 2.56(1.29-5.06)** | 2.52(1.18-5.41)** |
| | >4.00 | 7(12,1) | 75(8.3) | 1.19(0.52-2.72) | 1.02(0.41-2.52) |
| **Obstetric complication** | None | 19(32.8) | 666(68.1) | 1 | 1 |
| | APH | 7(12.1) | 20(2.2) | 3.86(1.59-9.400)** | 3.94(1.48-10.5)** |
| | HDP | 5(8.6) | 58(6.4) | 1.80(0.67-4.87) | 1.24(0.44-3.49) |
| | PROM | 2(3.4) | 64(7.1) | 0.84(0.19-3.61) | 0.85(0.19-3.72) |
| | OL | 16(27.6) | 22(2.4) | 8.17(4.09-16.3)* | 8.19(3.94-17.1)* |
| | Cord A | 1(1.7) | 6(0.7) | 1.49(0.19-11.5) | 1.08(0.13-8.85) |
| | MSAF | 1(1.7) | 15(1.7) | 2.14(0.27-16.9) | 1.49(0.18-12.3) |
| | Malpresent | 2(3.4) | 53(5.9) | 0.77(0.18-3.33) | 0.69(0.16-3.08) |
| | conganomal | 3(0.8) | 0 | | |
| | Other | 2(3.4) | 0 | | |

* P < 0.0001; ** P < 0.05,

APH=antepartum hemorrhage; HDP=hypertensive disorders of pregnancy; PROM= premature rupture of membranes; OL=obstructed labor; MSAF=meconium stained amniotic fluid. Cord A = Cord accident; Malpresent= malpresentation; Cong malf = congenital malformation.

## DISCUSSION

This study demonstrated that the PMR was nearly two-fold of the national PMR estimated for 2011 (7). This is probably because most of the mothers of the cases in this study and other hospital based studies (8-10) came very late and with serious obstetric complications. As a result, such hospital based perinatal death studies may not reflect rather may overestimate the actual perinatal mortalities at the community level, which was also noted by previous investigators as a potential for selective referral bias (5, 16). With that limitation, the PMR in this study was almost comparable with two other hospital based studies in the capital (9, 10) but lower than the report from Jima hospital, which showed a 1.6 times increased rate of perinatal mortality as compared to this study finding (8).

On the other hand, probably because of better care provided for the neonates in the hospital, the stillbirth to ENND ratio (7:1) in this study was the reverse of the community based reports by EDHS 2011, in which the ratio was close to 1:2 (7). However, this finding has to be interpreted very cautiously. Firstly, some of the newborns discharged from the study hospital as healthy probably died at home or somewhere else during the first week of their life. Secondly, in this study, more than 85% of the perinatal deaths occur due

to stillbirths and more than eighty percent of these stillbirths presented to the hospital with negative fetal heart beat. Thirdly, being the study retrospective (case-control) by design is a limitation to capture all early neonatal deaths that usually occur in the neonatal unit. WHO also estimated that for every early neonatal death, there is at least one stillbirth (1). Otherwise, stillbirths in this study were almost comparable with the finding in Jima (where stillbirths were responsible for nearly 90% of perinatal deaths (8) but higher than the report from Addis (10).

Several literature have noted that low and middle income countries account for the vast majority of perinatal mortalities across the world (1, 4, 14), but little was done to identify associated risk factors and vulnerable groups. As this and few previous studies (8, 10, 17) done in this country have shown, the majority of perinatal deaths were primarily due to mechanical factors (like obstructed labor, uterine rupture, malpresentations) unlike the developed nations where prematurity and low birth weight were major contributors for few occurring perinatal deaths (18, 19). It was because mechanical factors were dominant, nearly three-fourths of the cases were at term and the birth weight for more than half of the cases was in the normal range. Similarly, a study done in Bangladesh showed that obstructed labor, abnormal fetal presentations and HDP increased the risk of perinatal mortality (12). This doesn't necessarily mean that prematurity and low birth weight has not been a problem in the study hospital. Nearly one-fourth of the total perinatal deaths were preterm, and the association of preterm delivery with higher rate of perinatal mortality is well noted in several studies (6, 18, 19, 20). Studies done in Ethiopia similarly showed that preterm and low birth weight were important risk factors associated with perinatal mortality (21, 22). In this study, the common obstetric complications associated with preterm births were APH, HDP and PROM which altogether contributed for about one third of all preterm births. As a result, PMR was found to have highly statistically significant association with APH and HDP, which is consistent with previous reports (9, 17).

But in this study and other previous hospital based studies, mechanical factors were major contributors for high perinatal mortality. It has been proved in the developed nations that perinatal mortality due to mechanical causes is preventable. The implication is, if those women who experienced perinatal fetal deaths due to mechanical factors like malpresentation and obstructed labor were provided optimal intrapartal care, almost all babies could have been salvaged, and no mother should have developed rupture in unscarred uterus.

On the other hand, having as many perinatal deaths as it has been before in other parts of the country (8, 10), mainly from rural areas, definitely reflect the underutilization of obstetric care probably because of inaccessibility of health facilities for the majority of pregnant women or probably due to their big delay in health care seeking behavior. This is because significant number of mothers of cases arrived with long duration of labor; had no antenatal care follow up; experienced obstructed labor and uterine rupture; and diagnosed to have severe form of HDP, which all these probably happen because of big delay due to geographical, financial or behavioral barrier.

To be more specific, unlike the controls, nearly one-fourth of the cases had been in labor for more than 24 hours prior to arrival. In short, the high PMR and the associated factors being mainly preventable mechanical factors indicate the very infantile nature of obstetric service in the region in terms of availing or utilizing the service. Other authors also discussed that PMR indicates the degree of pregnancy loss and the quality and quantity of health care provided to mothers and their newborns (2, 23). In other words, many of the risk factors for perinatal deaths could be prevented by availing comprehensive intrapartal essential obstetric care to the mothers and their newborns, which is regarded as critical for perinatal health (21, 24-26).

In this study, nearly two thirds of the ENNDs occurred within the first 2 hours of delivery. This happened probably because majority of the neonates were severely asphyxiated while in utero. This is because majority of the ENNDs occurred among women with obstructed labor, which is well known obstetric risk factor for intrapartal fetal asphyxia and death (27). This study has also shown that male newborns had 1.2 times higher risk of dying in the perinatal period than female newborns. Other reports also showed that female

newborns had a better survival than male newborns (1, 21).

In this country, as one of indicators of poor obstetric care, more than 26,000 untreated obstetric fistula cases estimated (28) despite five only fistula treating hospitals have been established. Additionally, the high prevalence of obstructed labor and its complications is in our daily clinical observation. Is it only because of delay in getting skilled health personnel attended delivery what is contributing for high intrapartum complications including high PMR? Could there be as well significant developmental problem in majority of Ethiopian women probably due to the high prevalence of malnutrition and rickets (29), which is likely to risk the women for different types of labor abnormality and high proportion of intrapartum complications including perinatal death? A recent comparative study on intrapartum outcome among immigrant women from Ethiopia and the general obstetric population in Israel showed that the incidence of operative delivery and major perinatal morbidity were higher among Ethiopians (30). The authors hope that these findings will invite researchers to do large scale study within the country and comparative studies among low setting countries.

One of the strength of this study is reviewing the perinatal deaths at three stages (stillbirths before arrival, stillbirths and ENNDs in the hospital) and doing a subgroup analysis. As a limitation, since more than one third of all stillbirths and nearly one-third of all perinatal deaths were due to obstructed labor with or without uterine rupture, it may mask the real association of other potential factors for perinatal deaths. Although it is known from practice that majority of babies die during labor in obstructed labor and uterine rupture, it was not possible to ascertain whether some of the babies died even before the onset of labor.

In conclusion, the PMR was more than two fold higher than the national estimate. Stillbirths accounted for about 87% of PMR. Hospital perinatal deaths accounted for 26% of the total perinatal deaths. Obstructed labor with or without uterine rupture accounted for about one third of perinatal deaths. Obstructed labor, APH and HDP attributed for more than half of all perinatal deaths. The reason for the poor progress of labor and developing obstructed labor has to be further investigated at the community level.

**ACKNOWLEDGEMENTS**

We are grateful to UNFPA Ethiopia for modest financial support.

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