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## RESEARCH ARTICLE

# Causes and Timing of Maternal Death in Mizan – Tepi University Teaching and Bonga General Hospital from 2011 – 2015: A Case Control Study and Using Propensity Score Matching Analysis

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### Abstract:

#### Background:

Death of women during pregnancy, delivery and within 6 weeks of postpartum can threaten the survival of the entire family. Even though our country reduces the maternal death, still the number of death that occurs is high as WHO maternal death classification. So the need of further study is unquestionable to identify cause and timing of maternal death.

#### Methods:

A case control study on 595 charts, 119 cases and 476 controls was conducted in MTU teaching & Bonga general hospital. Data was analyzed by STATA 13.1. Propensity score matching analysis was used to see causes. Confidence interval of 95% was used to see the precision and the level of significance of p value  $\leq 0.05$ .

#### Result:

Most death (74.8%) occurred during post-partum period. Only 17.6% of women died in Intrapartum period. The major causes of maternal death in the study area were hemorrhage 47.9% ( $\beta = 0.58$  (95% CI (0.28, 0.87))) in hospital but when projected to population based on our sample ( $\beta = 0.26$  (95% CI (0.22, 0.31))). Infection 36 (25.21%) ( $\beta = 0.50$  (95% CI (0.08, 0.92))).

#### Conclusion:

Most of the women died in post-partum period particularly within three days. Hemorrhage was the leading cause of death.

**Key words:** : Cause of death, Maternal death, Timing of death.

## INTRODUCTION

Death of women during pregnancy, delivery and within 6 weeks of postpartum can threaten the survival of the entire family. Particularly new born baby and young children in the family are endangered by the death of the mother. Many women shoulder a double burden of helping to support the family by working outside the home and taking full responsibility for household duties and child care. Yet, despite this vital role played by women in society, the health needs of a women is neglected which is evidenced by high level of maternal mortality in many poor countries [1, 2].

Women in developing countries lose more disability-adjusted life years (28 million) to maternal causes than to any other. Different literatures show that children less than 9 year are more likely to be chronically malnourished and to die than children who lost their father. Studies in developing countries indicate that the risk of death for children less than

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five years doubles or triples if their mother dies. Other studies estimate that children whose mothers have died are 3-10 times more likely to die within two years than those whose parents are both alive. The other consequence is economic burden on family, total lost economic productivity and out of pocket expenditure of households with maternal death is 10 times higher than that in without maternal death [3 - 6].

The maternal mortality rate (MMR) in developing regions in 2013, which is 230/100,000, was 14 times higher than in developed regions, which is 16/100,000. This figure indicates that death of woman is most commonly burden of developing countries. Africa has the highest MMR in the world which is 460/ 100,000. Sub-Saharan Africa (SSA) covers the highest range maternal death including our country Ethiopia. Sera Leone and 15 countries (all in SSA) in the world have extremely high MMR and very high MMR respectively. Ethiopia is grouped under high MMR with 420/100,000 in 2013 [7].

Understanding the underlying factors that led to the deaths for successful reduction of MMR is important. 70–80% of maternal death is due to direct obstetric causes, and these maternal deaths could be prevented through actions that are proven to be effective and affordable, even in the poorer countries of the world [8]. In Ethiopia Abortion was the major cause in 1980s; however in 2000 sepsis become the major causes. Currently pregnancy induced hypertension is an increasing cause of maternal death as observed in Tigray region [9, 10].

Study conducted in south west Ethiopia showed that there were 49 maternal deaths, resulting in a MMR of 425 per 100,000 live births (95% CI: 318–556). Among the 49 maternal deaths, 6 (12%) occurred during pregnancy, 18 (37%) during labour, and 25 (51%) after birth within six weeks [11].

Even though our country reduces the maternal death from previous times as the report of international organizations, still the number of death that occurs currently is high as World Health Organization (WHO) maternal death classification. So the need of further study is unquestionable to identify causes and timing of maternal death. The aim of the study is to identify causes and timing of maternal death in Mizan Tepi university (MTU) teaching & Bonga general hospital from 2011 – 2015.

## **METHODS**

### **Study Area**

Institution based case control study was conducted among women who visited maternal health services from 2011 – 2015 at MTU teaching & Bonga general hospital, Southwestern Ethiopia. Both hospitals are found in southern nations and nationalities region of Ethiopia in Southwestern direction. MTU teaching hospital is 570 km far from the capital Addis Abeba whereas Bonga hospital is 465 km far. They provide maternal health services including essential obstetric care services. In both hospitals not more than 40 physicians (18 in MTU teaching hospital and 12 Bonga hospital) are found. They don't have blood bank facilities. But they provide care for about 5 million people in inpatient and outpatient services.

### **Source Population**

The source Population of this study was all charts of mothers who visited MTU teaching & Bonga general hospital for maternal health service utilization. Whereas the Study Population was all charts of mothers who died during pregnancy, delivery and 42 days after delivery in MTU teaching & Bonga general hospital from 2011 – 2015 were cases. All charts of mothers who visited both hospitals for maternal health service utilization (MHSU) from 2011 – 2015 were considered as Controls

### **Sampling Procedures**

Cases that fulfill the standard definitions of maternal mortality given by international classification of disease - 10 (ICD – 10) and controls which came for MHSU were included in the study. Whereas cases that are registered on the log book but whose charts' were missed and didn't include the assessment of admission and status of mother (dead or alive) during discharge were excluded from the study.

Records of both cases and controls were selected from delivery ward, operation theatre, post-natal care (PNC) ward; gynecologic ward which full fills the inclusion and exclusion criteria of the study. First cases were identified from log book or registration book, which were found in the study period, from respective wards.

After identifying the cases included in the sample the time of admission was identified for each selected cases. For

each case four controls who were survived mothers were selected, which were admitted immediately preceding or following a case. A total of 595 selected charts, 119 maternal death (cases) and 476 controls charts were reviewed.

### **Data Collection**

Data collection instrument was adapted from Maternal Death Surveillance and Response Technical Guideline of Ethiopia [12]. The checklist consists of socio-demographic data, obstetric and delivery history, presence of comorbidities, cause of death, antenatal and intranatal risks and presence of complications. Three midwives were recruited and trained for three days. The training was cover about the contents of the tool, ethical considerations and way of extraction of necessary information from chart. Two supervisors monitor and follow data collection while the principal investigator supervises the overall data collection process.

To assure the quality of data, data collectors were trained until they became well conversant with the instrument. Every day filled checklist was reviewed and checked for completeness and relevance by supervisors and principal investigator.

### **Definitions of Terms**

Maternal death: death of a mother during pregnancy or within 42 weeks of termination of pregnancy irrespective of the duration and site of pregnancy due to pregnancy related or aggravated by pregnancy or mismanagement or omission of management not by accidental or incidental causes [2]. Abortion: it is termination of pregnancy before 28 weeks of gestation. Any kinds of abortion cases was included in this study. Anemia: hemoglobin level less than 7mg/dl. Pregnancy induced hypertension: the presence of preeclampsia or eclampsia during pregnancy.

### **Data Processing and Analysis**

After data collection, each filled checklist was given a unique code by the principal investigator. Data was entered using Epi Data version 3.1 then exported to STATA version 13.1 for analysis. Frequencies was used to check for entry errors, missed values and outliers. Any errors identified at this time was corrected after revision of the original data using the code numbers. The collected data was entered into Epi Data version 3.1 and then exported for analysis to STATA version 13.1. The data was cleaned for inconsistencies and missing values. Simple frequencies was run to see the overall distribution of the study subject with the variables and to see any missing data. Graphical presentation such as tables and bar charts was used to present the result findings.

Cause of death of women was identified by the WHO applications of ICD-10 to maternal death. The distribution of cause of death was observed using frequency distribution. Propensity score matching analysis was used to determine the cause of death. It controls confounders by matching in exposed and non-exposed group by calculating propensity score of variables. Patients with the same propensity score, cause is unrelated to confounders. Therefore, the cases and controls tend to have similar distribution of measured confounders other than cause, something that we would also achieve using randomization. In the model there is outcome variable (in our case maternal death), treatment dependent variable or causes of death (like PIH (pregnancy induced hypertension), hemorrhage, infection, anemia and abortion) and treatment independent variable (observed confounders or independent variables). Causal inference is determined at the level of significance of p value  $\leq 0.05$ . The coefficient ( $\beta$ ) is reported and interpreted in 95% CI level of precision from the model.

### **Ethical Clearance**

Prior to data collection, ethical clearance was obtained from Research and Ethics committee of Mizan-Tepi University. Written permission letter was also received from both hospitals. In order to establish anonymous linkage only the codes, not the names of the participant from the chart, was registered on the questionnaire. During the training of data collectors and supervisor, ethical issues was addressed as important component of the research.

## **RESULT**

A total of 119 cases (dead women) and 476 controls (survived women) were included in the study. Majority of the women age was with 20-34 years which were 397(66.7%). The least age group was age greater or equal to 35 years old. More than 22% of women died from the age group of 20 – 34. From age group of less than 20 years 15% of women were died. From women who were above 35 years 15.8% of them were died.

**Obstetric Complications**

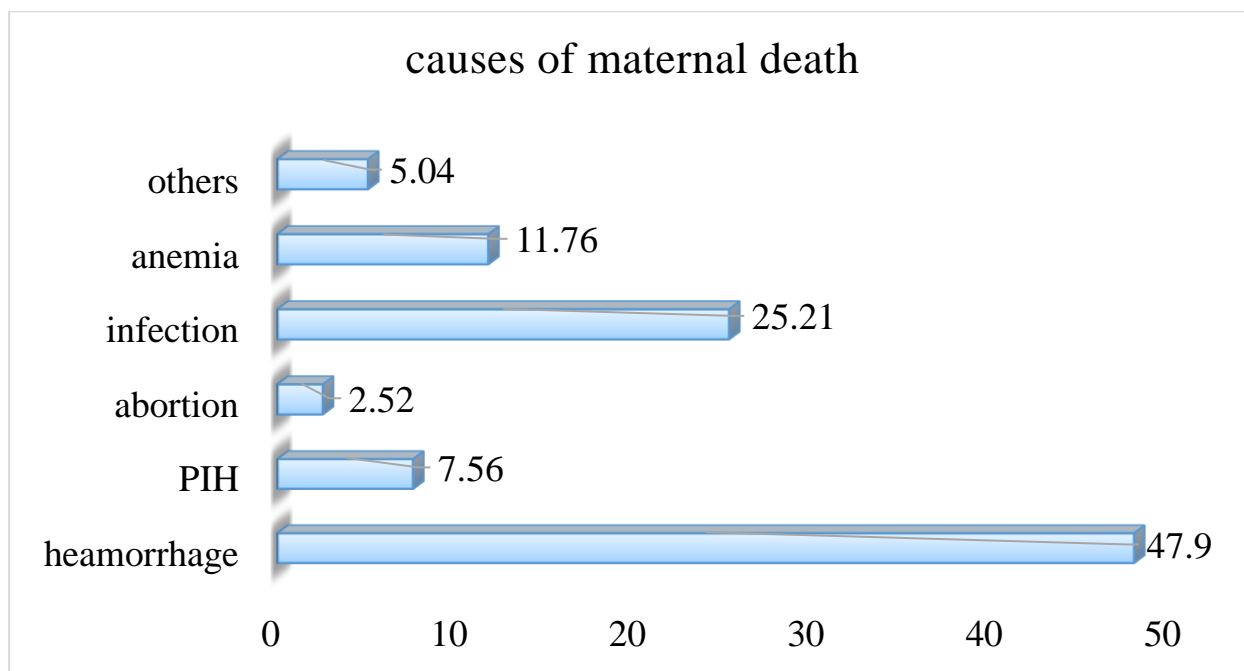
From the total women 177(29.7%) were developed different types of obstetric complications. The leading obstetric complications were obstructed labor (OL), and uterine rupture which accounts 67 (37.9%), and 64 (36.2%) respectively. From women who developed infections majority were died. The second killer was uterine rupture and hemorrhage (Table 1).

**Table 1. Obstetric complications among women delivered from 2011 -2015 at MTU teaching and Bonga hospitals, 2016.**

	Status of women	
	Alive	Dead
<b>General Presence of obstetric complications</b>		
Yes	79(44.6%)	98(55.4%)
No	397(95%)	21(5%)
Hemorrhage	5(17.2%)	24(82.8%)
PIH	14(70%)	6(30%)
Abortion	3(20%)	12(80%)
Infection	1(10%)	9(90%)
OL	34(50.7%)	33(49.3%)
Uterine rupture	11(17.2%)	53(82.8%)
APH	15(45.5%)	18(54.5%)
Postdate pregnancy	7(70%)	3(30%)

**Causes of Maternal Death**

The major causes of maternal death in the study area were hemorrhage, which were 57(47.9%) and followed by infection which were 36 (25.21%). From the indirect causes of maternal death anemia accounts 14 (11.76%) (Fig. 1).



**Fig. (1).** Causes of maternal death among women delivered from 2011 -2015 at MTU teaching and Bonga hospitals, 2016.

The propensity score matching analysis shows Hemorrhage, infection and abortion were significant causes of maternal death. As the result shows if 100 females came with Hemorrhage in hospital 58 of females would die exclusively because of hemorrhage, if 100 women came with infections 50 of women would die exclusively because of infections and if 100 women came with abortions 56 of women would die exclusively because of abortion (Table 2).

**Table 2. Causes of maternal death among study participants (samples) using propensity score matching analysis among women delivered from 2011 -2015 at MTU teaching and Bonga hospitals, 2016.**

Causes	$\beta$	P – value	[95% CI]
hemorrhage	<b>0.58</b>	<b>&lt;0.001</b>	<b>(0.28, 0.87)</b>
PIH	0.07	0.45	(-0.12, 0.25)
Infection	<b>0.50</b>	<b>0.02</b>	<b>(0.08, 0.92)</b>
Abortion	<b>0.56</b>	<b>&lt;0.001</b>	<b>(0.34, 0.78)</b>
Anemia	-0.13	0.46	(0.45, 0.20)

If projected to population or community based on our data only hemorrhage and pregnancy induced hypertension are significant causes of maternal death. As the result shows in the following table if 100 females caught with Hemorrhage in the community 26 of women would die exclusively because of hemorrhage and if 100 women caught with pregnancy induced hypertension in the community 16 of women would die exclusively because of pregnancy induced hypertension (Table 3).

**Table 3. Causes of maternal death among population by extrapolation using propensity score matching analysis among catchment area of MTU teaching and Bonga hospitals, 2016.**

Causes	$\beta$	P – value	[95% CI]
hemorrhage	<b>0.26</b>	<b>&lt;0.001</b>	<b>(0.22, 0.31)</b>
PIH	<b>0.16</b>	<b>&lt;0.001</b>	<b>(0.13, 0.19)</b>
Infection	-0.07	0.35	(-0.21, 0.07)
Abortion	0.03	0.20	(-0.01, 0.07)
Anemia	0.06	0.79	(0.42, 0.55)

### Timing of Maternal Death

Most death 89(74.8%) occurred during post-partum period. From post-partum period the first three days is crucial. From 89 deaths in post-partum period 69(77.5%) of deaths occurred within 72 hours of delivery. Only 17.6% of women died in Intrapartum period. The rest (7.6%) occurred following post abortal complications.

### DISCUSSION

Most of death (74.8%) occurred during post-partum period. It is consistent with study done in India, which revealed that deaths in postpartum period account 70% [13]. But it is higher than finding from Bonke wereda which is 51%. This difference might be because of sample size difference, that is only 49 deaths was included in study performed from Bonke wereda but in this research 119 maternal death were included. The other reason for their difference might be introduction of recall bias in study from Bonke wereda since respondents are asked to respond with a five year recall of events prior to the data collection. However study from maternity hospital of Nigeria shows 61.9% of maternal deaths occurred in post-partum period which is lower than finding from this research (74.8%). This difference might be because of sample size difference, which is only 84 maternal deaths in two year study period were included but this research includes 120 deaths in 5 year period [11, 14]. Higher number of maternal death in post-partum period implies that the management following delivery and during delivery might be poor. Prolonged period of labour due to OL (obstructed labour) or due to not having timely intervention might contribute a lot for death occurring in post-partum period.

In the current study 21(17.6%) of maternal death occurred intra-partum period. However, lower than 37% of maternal death occurred in intra-partum period from study done in Bonke wereda. This difference might be because of difference in site of delivery, which is 92% and less than 10% of delivery occurred in home from study in Bonke wereda and in this research respectively [11]. In home delivery, complications are not managed well and there is no skilled birth attendant. Thus, high number of death may occur in intra-partum period when home delivery is high. But when we compare the intrapartum death with maternity hospital of Nigeria, which is 13.1%, this research finding is a bit higher. One of the reason for this difference might be because of relatively high number of women, which is 25% (10.7% of antepartum death and 14.3% of death following post-abortal complications) of women died before reaching to intra-partum period in maternity hospital of Nigeria. Maternity hospital of Nigeria doesn't have blood bank during the study period. So this might contribute to poor quality of abortion care. The other reason might be dramatic reduction

of maternal death related with abortion due to the introduction of misoprostol or safe mother hood services or emergency contraception in Ethiopia [14, 15]

None of the death in this study were not occurred in ante-partum, but study done in Ethiopia Bonke wereda and Nigeria showed that 12% and 10.7% death occurred at ante-partum respectively. This might be due to high coverage of ANC in this study, which helps to prevent death during ante-partum period. The other difference might be difference in awareness level, this might create poor follow up of women during ante partum in south west Ethiopia study [11, 14]. These imply that proper care during antenatal period reduce home delivery, improved intra-partum care and care after abortion.

In general the major reason of inflated postpartum death and relative small number of death in intra-partum and ante-partum in these hospitals as compared to Bonke wereda study is that set up difference i.e. death in health institution represents only 14% of females who utilize institutional delivery but the study of Bonke wereda represents 86% of females who did not utilize institutional delivery.

Hemorrhage was the commonest (47.90%) cause of maternal death which is much higher than study done in Ghana (22.8%) and in Senegal Dakar hospital which is 21% [16, 17]. In Ghana and Senegal infectious disease as a cause of maternal death is predominant rather than hemorrhage. In these countries one third of pregnant females die due to malaria and viral hepatitis before reaching to intrapartum period. In addition there is classification error of underlying causes of maternal death in both study performed in previous countries. They put uterine rupture as single classification which is the major source of hemorrhage. This under estimated the figure of hemorrhage in the previous studies. Comparing with studies performed in Ambo and Tigray hospital. Our finding is still higher than Tigray study which is 39% [9]. This might be because of 56% of dead mothers in our finding are referred cases from different health institutions. Referral may result delay in reaching to the hospital. So they may die by long lasting hemorrhage. The other reason might be geographical differences. There are many ups and downs in the catchment area where the study set ups are located, which is headache for ease transportations. So relatively high number of maternal death is expected due to the delays for treatment contributed by the aforementioned reasons. This study finding is lower than study done at Ambo hospital which is 54.8% [18]. This might be because of difference of time, the study of ambo was done before 10 years back, where Ethiopia having annualized maternal mortality decline of 3.8%, but this research is done in recent five years [15]. Thus the difference might be due to improved health seeking behavior of females and effect of different safe motherhood activities.

Fatality of hemorrhage is also observed in propensity score matching analysis as previously written on the result section ( $\beta = 0.58$  (95% CI (0.28, 0.87))). Based on this study data if extrapolated to population 26 females ( $\beta = 0.26$  (95% CI (0.22, 0.31))) die exclusively because of hemorrhage out of 100 females caught with Hemorrhage in the community.

Infection was the second common cause of maternal death, which accounts 30(25.21%). This finding is in line with study finding in Ambo hospital, which is 30.2% and study done at Nigeria (23.8%). But our finding is much higher than findings at Tigray, which was 8%. This might be because of around 56% of dead mothers in our finding are referred cases from different health institutions and 47% of females have prolonged labour before they die. But findings from Tigray region in Ethiopia shows only 22% mothers who died had prolonged labour before they die [9]. Prolonged labour and delay in seeking care during intrapartum period exposes the women for sepsis and infections.

Fatality of infection is observed in propensity score matching analysis. If 100 females came with infection in hospital 50 of females would die exclusively because of infection ( $\beta = 0.50$  (95% CI (0.08, 0.92))). If projected to population based on our data it is not significant.

PIH was the causes of death in this study for 7.6% of females, which was lower than study conducted in Tigray which were 19% [9]. The reason for this discrepancy might be, as this study area is in tropical rainforest areas, it is reach in spices, fruits and vegetables. Thus they have different feeding habits from peoples living in Tigray region. This might have positive impact on reducing PIH. Study from India shows pregnancy- induced hypertension accounts 8 (10%), which is in line with our finding [13]. The Indian study has classification error. It includes late referral as one cause of death. So the presence of this classification may underestimate the figure.

By propensity score matching analysis, based on this study data, if extrapolated to population 16 females ( $\beta = 0.16$  (95% CI (0.13, 0.19))) die exclusively because of pregnancy induced hypertension out of 100 females caught with pregnancy induced hypertension in the community.

## CONCLUSION

Most of the women died in post-partum period particularly within three days. Most maternal death occurred because of direct obstetric causes. Hemorrhage is the leading cause of death. Infection and anemia were the other major causes of maternal death. In causal inference estimation: hemorrhage, Infection and anemia were the significant cause of maternal death.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The data was collected from patients' records or charts. Prior to data collection, ethical clearance was obtained from Research and Ethics committee of Mizan-Tepi University. Written permission letter was also received from both hospitals.

## HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

## CONSENT FOR PUBLICATION

Not applicable.

## AVAILABILITY OF DATA AND MATERIALS

The data sets (STATA format) and the checklist is available however we do not share until the manuscript is published.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

## FUNDING

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## AUTHORS' CONTRIBUTIONS

Tegene Legese, Keadnew M. and Tensay K. conceived the study, involved in the study design, data analysis, drafting the manuscript and critically reviewing the manuscript. All authors read and approved the final manuscript.

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## AUTHORS' INFORMATION

All authors are academicians. TL has MPH in reproductive health, KM has MPH in Epidemiology and Biostatistics and TK has MSc in Reproductive and Maternal health Nursing.

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