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CENTER FORPOPULATION STUDIES

PREDICTORS OF MATERNAL MORTALITY AMONG MOTHERS WHO DELIVERED IN SELECTED PUBLIC HOSPITALS IN ADDIS ABABA, ETHIOPIA: UNMATCHED CASE CONTROL STUDY

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APPROVAL SHEET

As thesis research advisor and co-adviser, we hereby certify that we have read and evaluated this thesis prepared under our guidance by Miheret Abebayehu entitled ‘predictors of maternal mortality among mothers who delivered in selected public hospitals of Addis Ababa, Ethiopia’. We recommend that it be submitted as fulfilling the thesis requirement.

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As members of the Board of Examiners of the Masters Degree thesis open defense examination, we certify that we have read and evaluated the thesis prepared by Miheret Abebayehu and examined the candidate. We recommend that the thesis be accepted as fulfilling the thesis requirements for the Masters degree in population studies.

Chairperson	Signature	Date
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Declaration

I, the undersigned, declare that this thesis work is my original work, has not been presented, in this or any other university and that all sources of materials used for the thesis proposal have been fully acknowledged.

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STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my own original work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis. This thesis is submitted in partial fulfillment of the requirement for Masters Degree in population studies to Addis Ababa University, College of Development Studies. I would like to declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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PROGRAM: MASTER DEGREE IN POPULATION STUDIES, COLLEGE OF DEVELOPMENT STUDIES, ADDIS ABABA UNIVERSITY.

Abstract

Background: Maternal mortality ratio in Ethiopia is one of the highest in the world. Despite measures to alleviate it and showing a promising declining trend, it still remains one of the highest at 401 nationally maternal deaths per 100,000 live births in 2017. The maternal death risks have been known to be associated with different socio-demographic and obstetric factors. This study aimed at assessing the predictors of maternal mortality among mothers delivered in selected public health hospitals in Addis Ababa, Ethiopia using unmatched case control design.

Objectives: To determine predictors of maternal mortality among mothers who had given birth the last three years in the selected public hospitals of Addis Ababa Ethiopia.

Methods: A case control study was conducted on pregnant mothers admitted to Addis Ababa selected public hospitals (St. Paul Hospital Millennium Medical College, Ghandi Memorial Hospital, and Zewditu Hospitals) for delivery from the past three years 2019 to 2021, data was collected from May 1-May 30/2022. Cases were pregnant mothers admitted to delivery and died, while controls were those who survived. A total sample size for this study was 245, of which 49 cases and 196 controls were proportionately allocated to each hospital. Data were collected from delivery registration logbook, death reports and referral papers. Data were analyzed by descriptive analysis and also logistic regression analysis used to see association between different characteristics and maternal mortality, controlling for confounders. The association was measured using crude and adjusted odds ratios (ORs), with 95% CI and p-value<0.05 as used to determine the presence of a statistically significant association.

Result: From the total of 245 study participants 49 were cases and 196 controls, all included in the analysis (100%). The mean age of cases were 32.6(±SD3.5). The mode of delivery (C/S) (AOR=4.86, 95% CI (1.18-14.94), mothers age being above 35(AOR=2. 11, 95% CI (1.15-7.10), being referred from other health facility (AOR=3.16, 95% CI (1.87-7.76), having history of no ANC (AOR=3.65, 95% CI (1.53-13.34) and having any chronic illness (AOR=9.54, 95% CI(6.54-17.38) were found to be factors that showed a statistically significant association with maternal mortality. The most common causes of death were postpartum hemorrhage, sepsis, retained placenta, post-operative complications and anemia.

Conclusion and recommendation: Caesarean delivery, older maternal age, being referred from another facility, having no ANC in previous delivery and having any chronic illness were Predictors for maternal mortality. As some of these factors were modifiable factors, identifying risky groups and designing targeted interventions must be given emphasis by stake holder.

Keywords: Mode of delivery, Maternal Mortality, Caesarean Section

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

AIDS:	Acquired Immune Deficiency Syndrome
APH:	Antepartum Hemorrhages
AMDD:	Averting Maternal Death and Disability
AOR	Adjusted Odds Ratio
CI	Confidence Interval
COR	Crude Odds ratio
CS:	Caesarean Section
EMA:	Ethiopian Midwives Association
EmOC:	Emergency Obstetric Care
EmONC:	Emergency Obstetric and Newborn Care
EPHI:	Ethiopian Public Health Institute
FMOH:	Federal Ministry of Health
HIV:	Human Immunodeficiency Virus
MMR:	Maternal Mortality Ratio
PPH:	Postpartum Hemorrhage
SD	Standard Deviations
SDGs:	Sustainable Development Goals
SVD:	Spontaneous Vaginal Delivery
WHO:	World Health Organization

1. Introduction

1.1 Background

Maternal mortality and morbidity is the most important indicator of maternal health status, and hence shows a country's development [World bank;2012]. Approximately, 585,000 women die every year from pregnancy and childbirth complications. Every minute, 110 women in the world experience a complication in their pregnancy, and one of them will die. For each woman that dies, more than 25 others suffer a debilitating injury, often with life-long consequences. More than 90% of these deaths and morbidities occur in developing countries [WHO; 2016]. Maternal mortality is the leading cause of premature death and disability among women of reproductive age in developing countries [Jill Gay et al;2003].

Maternal mortality in Ethiopia is high relative to developed countries and some developing countries [World bank;2015]. The recent Ethiopian DHS indicated that the maternal mortality ratio (MMR) for the period 2009-2016 was as high as 412 deaths per 100,000 live births, and it accounted for 25% of all deaths of women age 15-49 years [CSA;2016].

Reducing maternal mortality and improving maternal health have been key concerns of several international summits and conferences since the late 1990s, including the Millennium Summit in 2000 [UN;2000]. However, maternal mortality has decreased at an average of less than 1% per year globally and approximately 0.1% annually in sub-Saharan Africa between 1990 and 2005. Reducing maternal mortality requires increased attention to improved health care for women [World bank;2015].

In Ethiopia, health services are still beyond the reach of most women. According to EDHS 2016, 62% of mothers received antenatal care from skilled health professionals at least once for their last pregnancy; however, only 26% of births took place in health facilities and 28% of these births were attended by a skilled provider [CSA;2016].

Well aware of these facts, the government of the Federal Democratic Republic of Ethiopia (FDRE) attempts to reduce maternal mortality using different strategies at national and regional levels. Training human resource for health, construction of health institutions, procuring vehicles for transporting mothers to health institutions, and making reproductive health services free or

minimal charge are some of the interventions the government is doing in collaboration with development partners [WHO, UNICEF and UNFPA;2012].

In Ethiopia, prior evidences suggest the different direct causes of maternal deaths such as pregnancy induced hypertension (PIH), maternal hemorrhage, sepsis and abortion [Legesse T et al, 2017; Gidey G., 2013], however, there are also other underlying factors and the identification of these potential risk factors might provide insights for the country's intervention efforts in reducing maternal mortality. A recent analysis of national maternal health data set of 293 hospitals confirms that maternal mortality rates in Ethiopia varies according to mode of deliveries, and that higher rate of maternal mortality after Caesarean Section (CS) as compared to Normal Delivery (ND) has been more associated with postoperative infections, hemorrhage and anesthesia complications [Geleto A.; 2020].

Caesarean section (CS) is a surgical procedure used when women experience complications during pregnancy and childbirth in order to save the lives of mothers and babies [Jill Gay et al;2003]. The CS may be a helpful strategy in meeting Sustainable Development Goal 3 (SGD 3) of reducing the maternal mortality; however, its use has to be medically justified so that the operative procedure by itself might not have negative health repercussions and might also unnecessarily contribute for the postpartum maternal death [Jill Gay et al;2003].

1.2 Problem Statement

Because most maternal deaths occur at labor and delivery or within the first week following birth, Emergency obstetric care (EmOC) is the most important action that can be taken to reduce maternal mortality. Emergency obstetric care (EmOC) is the term used to describe the elements of obstetric care needed for the management of normal and complicated pregnancy, delivery and the postpartum period. Basic EmOC includes administration of antibiotics, oxytocin, anti-convulsant, manual removal of the placenta, removal of retained products, and assisted vaginal delivery with forceps or vacuum extractor. Comprehensive EOC includes all basic EOC functions plus Caesarean section and blood transfusion [Jill Gay et al;2003].

The delivery of the baby can generally be in two modes of delivery: Vaginal Delivery and Cesarean Delivery (Caesarean Sections/CS). Caesarean Section (CS), the delivery of the baby by surgical incision of the abdomen (Laparotomy) and uterus (hysterotomy),can be of elective

(consideration based on choice) or emergency [Jill Gay et al;2003]. In most cases, the emergency CS is medically justified and is recommended based on management of complications during birth [Walid F et al;2018].

Several factors, including the increased perception of safety and previous CS, have contributed to a recent worldwide increase in rates of caesarean section, particularly in urban areas [Al Mufti R et al;2007]. In many countries, these rates have reached epidemic proportions, motivating a debate about whether the high rates are appropriate or not, and thus contributing to a high burden of maternal mortality due to the unnecessary CS [Belizan JM et al;2013]. In Ethiopia the rate of CS varies by area of residence where only 1% CS rate was reported in rural areas as compared to 11% in urban areas, and the majority of the CS took place in Addis Ababa (CSA;2016).

Apart from the mode of delivery, other obstetric and socio-demographic related risk factors of maternal mortality have been explored in few studies conducted in Ethiopia. These studies however have been mostly conducted in rural settings [Yaya Y.,2012; Deneke YS,2014] and, in some case, among special population groups of pastoralist communities (Determinants of Maternal Death in a Pastoralist Area of Borena Zone, Oromia Region, Ethiopia: Unmatched Case-Control Study). The need for further investigation on the determinants of maternal mortality in urban Ethiopia is paramount as there are limited evidence in such setting in the country. Therefore, this study was aimed to determine the predictors of maternal mortality among mothers who delivered in selected public hospitals of Addis Ababa, Ethiopia.

1.3 Research questions:

- What are the predictors of maternal mortality among mothers who delivered in the public hospitals of Addis Ababa in the past three years?
- What are the direct and indirect causes of maternal mortality among mothers who delivered in the public hospitals of Addis Ababa in the past three years?

1.4 Research objectives:

1.4.1 General objective

• To determine the predictors of maternal mortality among mothers who gave birth in the past three years from January 1 2019 to December 31, 2021 at selected public health hospitals in Addis Ababa, Ethiopia.

1.4.2 Specific objective

• To determine the predictors of maternal mortality among mothers who delivered at selected hospitals in the last three years period from January 1, 2019 to December 31, 2021, Addis Ababa, Ethiopia.

• To examine the observed causes of death among mothers who delivered at selected hospitals in the last three years period from January 1, 2019 to December 31, 2021, Addis Ababa, Ethiopia.

1.5 Significance of the study:

This study will guide the health institutions to provide essential obstetric care in the interventions of reducing maternal deaths which need to address the identified determinants of and observed causes of maternal mortality in the study area..

The study being a case-control by design will also enable in obtaining epidemiologically reliable information that can predict any association between the possible determinant factors and maternal mortality and generally guides for better management strategy to reduce maternal mortality.

1.6 Scope and limitations of the research:

Despite to number of limitations such as time and finance the scope of the study is delimited to determining the predictors of maternal mortality t mothers who delivered in the public hospitals of Addis Ababa, in the last three years. The scope of the study focuses on four major areas (conceptual, geographical, methodology, time frame scopes).

The study intends to investigate the predictors of maternal mortality and its direct and indirect causes among pregnant mothers who had come to deliver in the public hospitals of Addis Ababa, in the last three years. This study was conducted in randomly selected public hospitals of Addis

Ababa, that are providing delivery and related comprehensive obstetric care for mothers. For the purpose of getting relevant information about the study participants (the cases and controls), relevant documents of mothers who had given birth in the hospitals in the past three years have been reviewed. The study has covered only the obstetric history and causes of death for the mothers. Public hospitals that provide a comprehensive obstetric care are many and dispersed in Addis Ababa. Addressing all these hospitals is not feasible economically and it is time consuming. Thus, the scope of this study has been limited to be conducted at the selected hospitals. The study has been concluded within the allotted time period i.e. up to July, 2022. Methodologically the study used the appropriate research design, sampling techniques, data collection tools and the like as the nature of the study required. It uses descriptive, case control research design and using quantitative approach.

2. Literature review

2.1 Conceptual literature: The Maternal mortality rate (MMR) is the annual number of female deaths per 100,000 live births from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) [WHO; 2016]**.** Although there are a number of causes of maternal mortality related to pregnancy and childbirth, most of these maternal mortalities are linked to the process of childbirth. There are three modes of delivery Spontaneous vaginal delivery (SVD), instrumental vaginal delivery (IVD) and Cesarean section (CS) delivery [WHO; 2016].

Reports showed that, even with a lot of supposed barriers against the utilization of Reproductive Health services by adolescents, efforts in recent years needs to focused on not only ensuring health service availability but also making its provision adolescent friendly that is, accessible, acceptable, equitable, appropriate, and effective (UNFPA, 2011; WHO, 2009).

In this study, reports from globally, regionally, and nationally reviewed regarding to the level of Adolescents' reproductive health service utilization. The scope of this study is limited to the following components of sexual and reproductive health services. They are sexual and reproductive health Information and education, modern contraceptive, HIV counseling and testing, diagnosis, and treatment of STI and. Factors associated with the utilization of Reproductive Health services will be discussed.

2.1.1 Utilization of Maternal health services

The utilization of reproductive health services by Adolescents' is not only varying from one part of the word to the other, but also it varies within a single country. It is also noted that utilization of Reproductive Health in many countries is low and lags what is expected to be even after long times of extensive investments in the area (Malarcher, 2010). For example, a finding done by young women in the USA between 2002 and 2008, reported that reproductive health service usage was 59%, including contraceptive (48%), and counseling services (37%). According to the report, the lifetime family planning service usage was declined by 15% from 2002 to 2008 and recent reproductive health service use by 8%, including gynecological exam (8%) and contraceptive (6%) services. Between 2006 and 2008, USA women were less likely to use reproductive health and contraceptive services than in 2002. The report added trends across

the year among sexually experienced women which were found similar but smaller in magnitude, 5% decline in both reproductive health and contraceptive service use (Hall et al., 2008). Another finding in USA showed that family planning and reproductive health service utilization was increased by 9% from 1995 to 2002, including rising use of services for contraceptive provision and counseling and STI testing, especially among the youngest women (Potter et al., 2009; Mosher and Jones, 2010).

The utilization of information, Education regarding to maternal health issues among mothers is a critical component to be seen in the Reproductive Health services. Research conducted in USA to examine associations between receipt of communication about Reproductive Health issues and use of services among adolescent population with 2,326 adolescents aged 15–19 in 2002 and 2006–2008 showed that the majority of adolescents had received parental (75%) and formal (92%) sexual and reproductive health communication; among those 43% reported recent service use (Hall et al., 2012).

In Ethiopia, findings from Jima town 28.8% of adolescents were users of Information Education and Communication about Reproductive Health issues (Ayalew et al., 2004). Another report showed that, 38.3% adolescents had ever heard about Reproductive Health services and reported health professionals 80.4% as the main sources of information followed by radio 15.5%, television 3.1% and print media like posters or leaflets) 1% (Abajobir and Seme, 2012).

2.1.2 Modern contraceptive

Reports from different countries in the world including Ethiopia, showed that the use of modern contraceptive for reproductive health services by adolescent women aged 15–19, variation was observed specially married women. According to Woog and his associates (2014) the overall, proportions ranged from 0% in Armenia to 52% in Mongolia. Modern contraceptive use was low among adolescents in all regions of Africa. In more than two-thirds of the countries in Africa, contraceptive use was lower than 20%. The proportions were highest by far in Swaziland (43%), Namibia (39%) and Zimbabwe (35%). In Ethiopia Gebre and Edossa reported in 2020 the modern contraceptive utilization among reproductive-age women is 20.42%.

Worldwide, the prevalence of unmet need among married or in-union women is as high as 10%, whereas, it is doubled in the Africa region. Ethiopia is still among countries with low

contraceptive utilization rates even though considerable improvements have been made in the last decades. Modern contraceptive methods enable couples to enjoy sex without fear of the risk of pregnancy at any desired time (Hugh 2011; UNFPA, 2011). Modern contraceptive methods account for more than 90% of the contraceptive use worldwide. Globally in 2017, 58% of married or in-union women of reproductive age were using a modern method which accounts for 92% of all contraceptive users (Govindasamy et al., 2002; Phyu et al., 2011; Gebre and Edossa, 2020).

In Ethiopia, the 2011 Ethiopia Demographic and Health Survey showed that only 5 percent of all female adolescents between age 15-19 report current use of any modern contraceptive method (CSA, 2012; Ayalew et al., 2004). Community-based cross-sectional studies were also conducted in Gondor town, Gojam, Jima town and Goba town (Abajobir and Seme, 2012; Senafikish et al., 2012; Ayalew et al., 2004; Birhan et al., 2014). Though, sexual and reproductive health service components assessed were varies in number, adolescents who live in Gonder town had high rate service utilization (75.8%) followed by Goba town, Jima town and rural areas of Gojam zone (70.2%, 41.1% and 21.5% respectively). Regarding to Family planning service utilization, figures were different among the listed areas with 79.5% in Gonder, 71.4% in Goba town, 27.7% in Gojam and 16.3% in Jima town (Senafikish et al., 2012; Birhan et al., 2014; Abajobir and Seme, 2012; Ayalew et al., 2004).

Additionally, studies in Mekelle town which involved female and male high school students aged 14–19 years and Madawalabu University were reported (Dida et al., 2014; Selamawit et al., 2009). Utilization of reproductive health service was quite different among different settings. Among the total study participants from high school students only 22% of the study participants had visited Reproductive Health services delivery points in the past 12 months. And, 81% of University students in Madawelabu ever utilized reproductive health services. This difference between studies could be due to; the time bound for the result in first study makes the figure small whereas ‘ever use’ in the later study makes the figure large and undetermined age range in the second study can be the reason for the variation. In addition to this, university students are believed to have good knowledge, relatively free or self-directed than high school students, who are dependent on their parents or relatives. Concerning to modern contraceptive usage 16.0% of high school students obtain condom with the past 12 months prior to the study

(Selamawit et al., 2009) whereas 28% of university students have ever used modern contraceptives (Dida et al., 2014).

HIV Voluntary counseling and testing (VCT), reports indicated that the low service utilization among adolescent women in Africa. VCT was lowest in Western Africa, where 2.0–11.0% of adolescents had been tested and fall between the range 15% - 33% across the continent Africa. In Latin American and the Caribbean countries of Costa Rica, Bolivia, Haiti, Colombia, Honduras and Mexico, no more than 10% of adolescent women had had an HIV test in 2014. In the Asian countries no more than 4% of adolescent women had had an HIV test in 2014. Only in Kazakhstan (15%), Mongolia (6%) and Kyrgyzstan (6%) were amounts showed higher (Woog et al., 2014). In Ethiopia, based on reports, voluntary counseling and testing of HIV service utilization among adolescents seems similar across different places. For example, 74.1% of Madawelabu University students (Dida et al., 2014), 72.2% adolescents in Gonder town (Senafikish et al., 2012), 67.3% in Goba town (Selamawit et al., 2009) were obtained VCT service.

From 2002-2008 in the United States the use of alcohol and other substances and Reproductive Health service utilization among young women ages 15-24 years showed STI testing and treatment services usage were not more than 17% (Kelli et al., 2013).

In Africa, adolescent women are living with STI and who went to a health center was lowest in Kenya and Niger (13% each) and the highest level was in Egypt (68%) and 15% in Ethiopia. The magnitudes of adolescent women in Latin America and the Caribbean who needed treatment for an STI or STI symptoms were generally higher than that in Africa and Asia, ranging from 52% in Bolivia to 84% in Peru (Woog et al., 2014). The above study that mention Ethiopia's figure on STI treatment seeking habit have similarity with the finding that was conducted in Mekelle town (diagnosis and treatment of STI = 15%) (Birhan et al., 2014)

2.2 Theoretical literature: In sub-Saharan African (SSA) countries, where maternal health care systems are weak and not well designed, prevalence of obstetric complications and associated maternal deaths remain substantially high [WHO; 2016]. These obstetric complications arise mostly in the process of childbirth. Since childbirth is a natural event, all deliveries should ideally be spontaneous. The recourse to instrumental vaginal delivery (IVD) and cesarean section (CS) should be made only if spontaneous vaginal deliveries (SVD) are not feasible, or to prevent

maternal and perinatal mortality/morbidity [WHO, UNICEF and UNFPA;2012]. There are two extreme situations in the continuum of maternal health care: too little, too late (TLTL) and too much, too soon (TMTS) [Geleto A.; 2020]. TLTL is a situation where there are inadequate resources to provide standard care, which results in high maternal mortality. TMTS includes the unnecessary overuse of non-evidence-based interventions. As facility births increase, so does the recognition that TMTS causes harm, as this increases health costs, disrespects and abuses to the beneficiaries [WHO; 2016]. Therefore, as high rates of CS are considered TMTS, a higher rate of CS with no appropriate medical indication is not associated with a lower rate of maternal mortality [Geleto A.; 2020]. The WHO recommends an evidence-based evaluation of health care services at the hospital level "in a standardized and action-oriented manner, with the inclusion of maternal and perinatal outcomes, in order to be able to provide adequate conclusions to format policies, practices and action [WHO; 2016]. WHO recommends a cs rate of 15% and suggests CS rates above such a "target" of 15% are unnecessary [WHO, UNICEF and UNFPA; 2012].

2.1 Maternal mortality and its predictors

Maternal deaths are the results of different contributing factors, medical and also socio-demographic factors. This is shown in studies done in the area around the world. According to a systemic analysis by WHO in 2014 revealed that hemorrhage (27.1%; 95% CI 19.9–36.2), hypertensive disorders (14%; 95% CI: 11.1–17.4), and sepsis (10.7%; 95% CI: 5.9–18.6) were the major causes of maternal deaths worldwide. Finding by WHO further stated that abortion (7.9% ;95% CI: 4.7–13.2), and embolism (3.2% ;95% CI: 1.8–5.5) were also contributed to maternal deaths [Say L et al.; 2006].

A case control study by Knight in United kingdom in 2017 found that smoking during pregnancy (AOR: 2.06; 95% CI: 1.13–3.75), absence of ANC follow up (AOR; 23.62; 95% CI: 8.79–63.45), co-existing medical disease (AOR: 5.92; 95% CI: 3.56–9.86), pervious history pregnancy complications and advanced maternal age (AOR; 1.12; 95% CI: 1.02–1.22 were significantly associated with obstetric mortality [McCall SJ.; 2017].

A cohort study by Pasha and his colleagues in 6 countries on 158,205 women from middle and low income countries identified hemorrhage (38.6%), pregnancy- related infection (26.4%) and pre- eclampsia were identified as causes of maternal mortality in 2018 [Tshefu A.; 2018]**.** A

study by Diana in Indonesia on 48 pregnant mother in 2020 obtained that low nutritional status, anemia, advanced age, method of delivery, late referral and postpartum complications were the risk /eclampsia (18.2%) as determinants of obstetrics mortality[Diana S.; 2020].
According to the study done in France on 11 European countries by Wildman the most prevalent causes of death were hypertensive diseases of pregnancy (16.9%), hemorrhage (23.6%), thromboembolism (18.1%) and infection(10.6%), which together accounted for 65% of the maternal deaths. Maternal age greater than 35 years are higher mortality when compared to maternal age less than 35(67.5% vs 32.5%) [Wildman K.; 2004].

A case control study in Brazil by Pereira et al in 2016 on 73 cases and 9,221 controls found that cesarean (AOR: 2.87; 95% CI; 1.63– 5.06) than vaginal delivery and postpartum hemorrhage (AOR: 3.0; 95% CI: 1.4–6.6) were associated with maternal mortality. Their result further stated that complications of anesthesia and thromboembolism were also factors contributing to maternal mortality [Esteves-Pereira AP.; 2016].

Diallo and his colleagues conducted a case control study in Guinea to identify predictors of maternal mortality in 2020. Their result indicated that referral mother (AOR: 24.60; 95% CI: 11.32-53.46), induced labor (AOR: 4.26; 95% CI: 2.51-7.91), no use of partograph (AOR: 3.70;95% CI: 1.31-5.20), duration of labor ≥24 hours (AOR :2.87; 95% CI: 1.35-5.29), and pervious history of CS (AOR 2.54; 95% CI: 1.12-6.19) were the predictors of obstetric mortality[Diallo A.; 2020].
A study done in Intensive Care Unit (ICU) medical college with tertiary hospital facility in Mumbai India by Bendre(2015) showed that most of the obstetrics deaths were due to multiorgan dysfunction(6.6%) and Disseminated Intravascular Coagulation (DIC)(6.6%). Most common interventions done in ICU were blood and blood product transfusions (55.5%) and central venous pressure line (35.5%) [Niyogi GM.; 2015].

A case control study by Egbe in Cameroon on determinants maternal mortality in 2017 showed that severe malaria (5.6%), HIV/AIDS (5.6%), lack of ANC follow up (RR:1.87; 95% CI: 1.33-2.63), pre-existing co-morbidities (RR:1.45; 95% CI: 1.03-2.03), place of delivery(RR: 2.44;95% CI: 1.79-3.32), healthcare provider qualification(RR: 2.87; 95% CI: 2.17-3.79) and delays in

arrival at health facilities (RR:1.420; 95% CI: 1.01-2.0) were significantly associated with obstetric deaths [Egbe T.; 2016].

A study by Okafor et al (2011) in SSA identified that organ dysfunction on admission; massive hemorrhage, amniotic fluid embolism, chorioamniotis and late presentation were the predictors of obstetric mortality in ICU. Their study further stated that many mothers were died due to lack of blood products and inadequate prenatal care at health facilities [Okafor et al.; 2011].

A case control study done by Besaina(2018) in Madagascar to determine the associated factors to maternal death in postpartum hemorrhage showed that multiparity (p: 0.01; OR:2.2), absence of prenatal care (p:0.01 OR:2.2), cesarean section (p:0.00 OR:5.5); uterine atony (p=0.03, OR 2.1); the state of shock (p=0.00 OR:57.8), the need for blood transfusion (p=0.00 OR: 3.7), use of catecholamines (p=0.00, OR:17.5); delayed management (p=0.01, OR:2.2), and hemostasis hysterectomy (p=0.00 OR: 8.67) were the most common causes of maternal death [Besaina R.; 2018].

According to study done in Jimma University by Legesse et al maternal mortality ratio was 350/100,000 in 2014. The leading cause of maternal death was hemorrhage (54%) (β=0.477, 95% confidence interval (CI: 0.307-0.647), followed by pregnancy-induced hypertension (20%) (β=0.232, 95% CI: (0.046- 0.419), and anemia (12%) (β=0.110, 95% CI: (0.017- 0.204) [Legesse T et al, 2017].

A case control study on 595 obstetric patients at Mizan-Tepi University, Ethiopia by Tegene Legese et al in 2016 identified lack of ANC follow up (AOR:2.4; 95CI:(1.19- 4.83), labor duration >24hrs(AOR: 4.0 ;95% CI:(1.86-8.74), presence of obstetric complications(AOR:7.2; 95% CI:(3.08-16.72), uterine rapture (AOR:11.4; 95%CI(4.27-30.41), abortion (AOR:33.5; 95% CI:(4.98-224.98), abnormal puerperium (AOR:10.9 ;95%CI:1.96-59.97), and destructive delivery (AOR:10.9; 95%CI(2.13-56.2) to be associated with obstetric complications [Tensay et al, 2018].

Maternal age : Younger and older women are different in their usage of maternal health services including ANC services. In general, younger women are more likely to use maternal health services [Tensay et al, 2018]. In a cross-sectional survey of 7005 pregnant women from 28 districts in 14 states of India, reported that there is statistical significance in reduction of health services utilization as age increases [Alkema L.;2016]. In contrary to the above, a study done in

Bangladesh from prospective survey to assess maternal morbidity and mortality, reported that the older ages were more likely to use maternal health care services like ANC [Hall A.;2020].

A recent study in South Africa that studies the sociodemographic causes of maternal mortality showed that, the MMR increased with age throughout the period 2007 to 2015, with the highest risk of dying reaching its peak among women aged 40 years or older, noticeably demonstrating how mortality increases with age (Figure). The maternal mortality ratio starts low and rises steeply and non-linearly after age 30; the MMR curve becomes progressively steeper as age advances. Contrary to expectations, the age curve shows only a modest excess risk at ages 15–19 compared to ages 20–24.

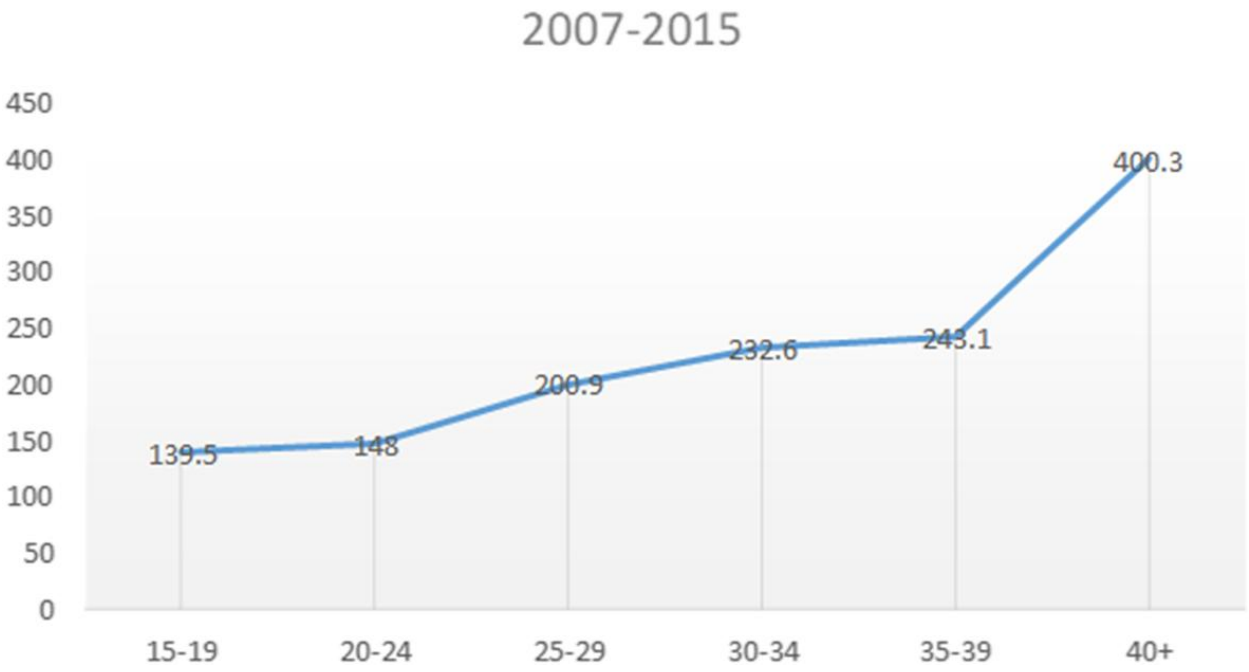

Figure: 1. Maternal mortality by socio-demographic characteristics and cause of death in South Africa: 2007–2015.

On the other hand, in Ethiopia, finding form analysis of EDHS 2016 and 2019 reported that maternal age is not a factor for utilization of maternal health services like ANC [CSA;2016]. Another community based study conducted in Addis Ababa to assess pattern of maternal deaths and preference of place of delivery, reported that maternal mortality was lower among the younger women [12].

b. Marital status: There is increased maternal health service utilization among married women [8]. In Ethiopia, finding form analysis of EDHS, 2016, identified that, there is a little difference among married and unmarried women on utilization of ANC in all nations but married women uses ANC services two-times more than unmarried women in urban areas [6].

c. Maternal Education: Education is found to be the most determinant factor for maternal and maternal health services utilization [4,8] A study done in Bangladesh from prospective survey to assess maternal morbidity, concluded that female education retains the net effect of maternal health use. Late booking is also associated with less educated mother [10]. A recent study he majority of deaths occurred among those whose educational status was unspecified (46.2%) and lowest among those with no education, primary school education and university education.

In Ethiopia, finding form analysis of EDHS, 2016, identified that, 72% of mothers with at least secondary school education received ANC compared to 45% and 21% of mothers with primary and no education respectively [6]. The EDHS, 2019 and community and family survey conducted in SNNPR to assess maternity care utilization, also reflected the above situation [3,7]. On the other hand study done in Addis Ababa, did not show significant association of ANC utilization and educational status of the mother [12].

d. Occupation: In Bangladesh 35.4% of women who involved in grateful gain of work utilized ANC compared to 25.3% of mothers who did not work [10]. In Ethiopia, finding form analysis of EDHS, 2019, described that, work status of mother did not show any statistical differences in utilization of ANC [7].

e. Family income: Household economic status has influence on maternal health service utilization [7]. In Bangladesh, women whose husbands involved in business/services have positively associated with utilization of ANC 33.4% than those husbands involved in agricultural and labor activities [10]. In another qualitative study conducted in cape Town, South Africa, the reason given for delay to ANC was financial constraints in which mother delay to accumulate user's fee [10]. According to EDHS, 2016, women with highest wealth quintiles use ANC five times greater than women with lowest wealth quintiles [6]. The finding from Addis Ababa is also similar with the above finding [12].

f. Residence: Being an urban or rural residence can significantly determine the use maternal health. Generally urban dwellers are more likely utilize ANC than the rural [4]. In Ethiopia, finding form analysis of EDHS, 2016, identified that, place of residence was found one of the determinant factors for maternal health service utilization. Addis Ababa and other urban women are ten times and four times respectively use ANC service more likely than women in rural areas [6].

g. Access to service: Many literature supports access to health service significantly increase maternal health service utilization [8, 9, 10, 11]. The exception is the study conducted in India that concluded maternal health utilization has no association with accessibility [9].

2.2.2 Obstetrics History

a. Parity: Parity is also found associations with early initiation of ANC utilization. There is significant reduction in maternal health service utilization and early booking with increase parity [12, 13]. Study done in Bangladesh, reported that parity seems U-shaped [10]. There is an increase in utilization of ANC at begging and high parity but decline at the medium numbers of parity. According to EDHS, 2016, 34% of mothers with first birth order use ANC service compared to 22% of six and high birth order [6]. A community based survey in SNNPR, reported that parity is one of the factors for utilization of ANC and consistent with the above ideas in urban areas but not in rural cases [11]. Another study in Addis Ababa, reported that as parity increase there is a decline in ANC utilization [12].

b. Mothers child birth experience Mother's previous experience of undesired birth outcome is also one of the positive determinants for maternal health service utilization and early booking [7]. While study done in India revealed that ANC utilization has no association with previous birth outcome [13].

2.2.3 Past Experience

a. Pervious utilization of service: Pervious utilization of care is thought to be one of the factors for utilization of maternal health care [7]. But other reviewed literature did not reported pervious uses of the service as a factor for maternal health service utilization and/or early or late booking of ANC.

***2.3.4 Knowledge on pregnancy related complication*:** Knowledge on pregnancy related complications has positive association with early utilization of ANC [9]. Mothers who were experienced a life-threatening condition use ANC early two times more likely than the others [13]. In Nigeria, one study reported that 24.1% of mothers provide reason for timely booking was due to the occurrences of complications in the previous pregnancies [17].

Conceptual framework:

The figure below is a conceptual framework developed through a review of various literatures to illustrate various variables that may be associated with maternal mortality among delivering mothers.

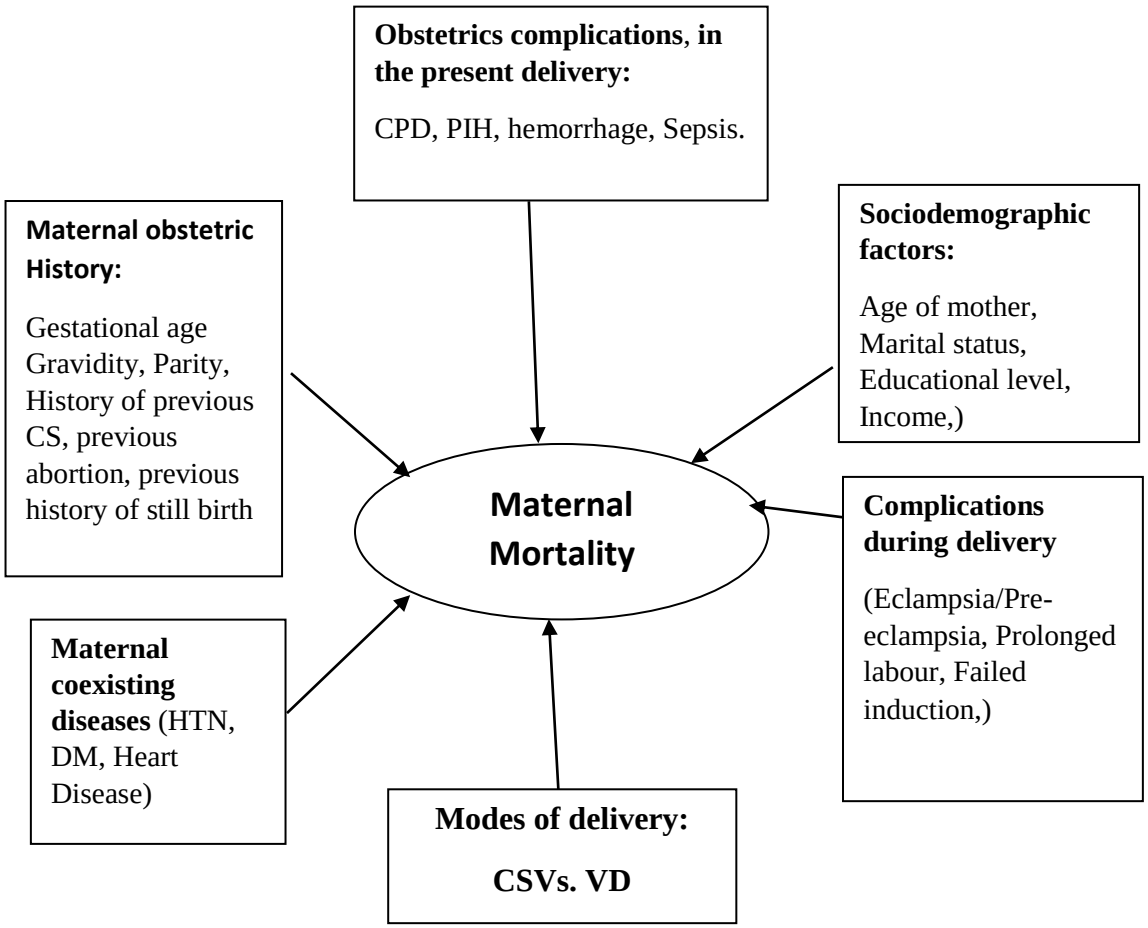

Figure 2: Conceptual framework developed by the investigator after reviewing the different literatures [Egbe T.; 2016, Alkema L;2016; Diana S;2020].

3. Method and Materials

3.1 Research approach/design, study area and period: A quantitative research approach with an institution-based unmatched case-control design in the form of a retrospective document review was conducted in selected public hospitals in Addis Ababa from May1- May 30/2022. The study was conducted at tertiary hospitals in Addis Ababa, namely St. Paul Hospital Millennium Medical College, Zewditu Memorial Hospital, and Ghandi hospitals. Pregnant mothers attending ANC and giving birth at these public hospitals come from various parts of the country but the majority of them are from the capital city, Addis Ababa and its vicinity. The city covers an area of 530 km^2 and is divided into 10 administrative sub-cities and 99 districts. Based on the United Nations- World Population Prospect, the current metro area population of Addis Ababa in 2020 is estimated total 4,794,000 a 4.4% increase from 2019. According to the 2007 (EFY) Health and Health Related Indicators publication by FMoH, Addis Ababa has 52 Hospitals- 12 of them state run and more than 40 private and there are about 100 Health Centers in Addis Ababa city administration [FMOH; 2015].

St. Paul Hospital Millennium Medical College is one of the regional referral hospitals under the umbrella of Ministry of Health and Ministry of Education. It gives service for 600 people per day as an outpatient and has 280 beds for inpatient. MCH center is one of the nine departments for service in the hospital, which has been providing antenatal care and delivery services.

Zewditu Memorial Hospital is serving more than 5 million people in the catchment area. The hospital has 9 departments and 6 units and has 265 beds. It provides comprehensive emergency obstetric care (CEmOC) and attends to more than 10, 000 deliveries per year.

Gandhi Memorial Hospital is a referral maternity hospital and is a catchment hospital for 40 health centers and other health facilities. Today the Hospital is operated by the Ministry of Health and it has a total of 22 physicians, 140 nursing and 45 Midwife staff. It provides comprehensive emergency obstetric care (CEmOC) and attends to more than 17 000 deliveries per year. Gandhi Hospital is the only hospital that has opened the first Maternal Intensive Care Unit (ICU) in the country yet. As a first maternal ICU, the hospital began the service with three bedrooms and mechanical ventilators three years ago.

3.2. Study Population

The study population were all women delivered in past three years in the selected public hospitals in Addis Ababa.

Case constituted women delivering in the selected hospitals in past three years and who died within the 42 days postpartum.

Controls constitutes- women delivering in the selected hospitals in past three years and who survived/who left the hospital alive post-delivery.

3.3. Inclusion and exclusion criteria:

Inclusion: the records of the women who gave birth in the selected hospitals with the complete information were included in the study.

Exclusion: Incomplete notes in which pertinent variables missed from the records were excluded

3.4. Sample size determination

The sample size for this unmatched case control has been calculated using Epi info software version 7.2.2.6 by using double population proportion formula. Considering 95% confidence interval and 90% power, case to control ratio of 1:4 and proportion of CS delivery (exposure) among the cases is 46.8% and among the control is 19.4% (12). Then, after adding 20% non-response rate, the required sample size was 245(49 cases and 196 controls)**.**

3.5 Sampling techniques:

Multiple probability sampling techniques were used in this study. The hospitals included in the study were selected by simple random sampling techniques from the governmental referral hospitals in Addis Ababa. Cases and controls were proportionately allocated to the selected hospitals based on the delivery records they have in their obstetrics and gynecology logbooks. Consequently, Cases were proportionally allocated to each hospital based on the maternal death records and taken consecutively from each hospitals. Four controls were included for one case from the selected hospitals and selected by Systematic Random Sampling (SRS) method.

3.6 Data collection tool, techniques and procedures

Data were collected from delivery registration logbook, ICU registration logbook, maternal chart (card) and Health Management Information Systems (HMIS), death reports and referral papers. Data were collected from the selected case notes using tailored structured formats developed for the study. WHO maternal near miss diseases specific criteria (obstructed labor, hemorrhage, pregnancy induced hyper- tension, septic abortion, sepsis/infection and other pregnancy related complications) were used to identify maternal death cases from randomly selected case notes. Data were extracted from the case notes by trained midwife nurses. Furthermore, each data collection format were reviewed daily by the principal investigator to check for completeness and consistency of the collected data. Case notes of mothers who delivered and received care at department of gynecology and obstetrics of the selected referral hospitals over the three years period were reviewed. The data were collected by two trained mid wife nurses using a data abstraction form prepared after reviewing literatures and the delivery ward log book/medical charts of mothers available in the hospitals. Study was conducted using available data of deliveries conducted form 1st January 2019 to 30th December 2021.

3.7 Variables and Measurement

Dependent variable=Maternal Mortality(outcome)

Independent variables

Predictors: - sociodemographic characteristics (Age of the mother, marital status, education),

- obstetric characteristics (Gravidity, parity, gestational age, history of abortion, birth attendant, ANC attendance),

- pregnancy-related complications like hemorrhage, pregnancy induced hypertension, obstructed labor/ prolonged labor, sepsis.

- Mode of delivery, which is categorized in to Caesarean Section (CS) and Normal/vaginal delivery.

3.8 Data management and analysis:

The collected data was entered in to SPSS (statistical analysis software) version 25 for windows for analysis. Descriptive statistics were employed to assess how the cases and controls were

different with respect to the categories of the predictors and to observe the patterns of maternal mortality in the past three years in the selected public hospitals. The cases comprised all intrapartum and postpartum maternal deaths recorded during the study period. The controls were selected by random sampling from patients discharged alive following hospitalization due to vaginal delivery or cesarean section. Descriptive analysis using the frequency, percentages and mean with standard deviations of continuous variables were done to describe the data. Binary logistic regression model was fitted to assess possible association between the modes of deliveries of the mothers and other predictors with the dependent variable (maternal death). Strength of associations, and statistical significance was measured using odds ratio at 95% confidence interval and p- value<0.05.

The results are presented in the form of texts, tables, and figures. Finally, conclusion and recommendations are forwarded according to the findings of the study.

3.9 Data Quality Assurance

Data extraction format was prepared by English language. The format was pretested on 5% of the sample size in Alert hospital one week before the actual data collection to check for data availability and completeness, and checked the accessibility of some of the variables on the delivery logbook. Questions that could not be accessed from the charts were excluded from the questioner.

Training and orientation about the objectives and relevance of the study on each items included in the study tools and the whole process of data collection was provided for data collectors and supervisor. During data extraction, regular supervision and follow up was undertaken. Supervisors checked each filled out format daily with further cross check together with the principal investigator for completeness and consistency of data.

3.10 Ethical consideration

Ethical clearance was obtained from Addis Ababa Public Health Research and Emergency Management Directorate (AAPHREM). After approval of the research objectives, then letter of cooperation from Addis Ababa Public Health Research and Emergency Management Directorate (AAPHREM) was communicated to the selected hospitals, to the respective departments/case team. Written consent from study subject was not necessary as data collection was done in form

of chart review of the hospital patient records where cooperation have been obtained from these hospitals.

3.11Dissemination plan

The final results will be disseminated to Addis Ababa Public Health Research and Emergency Management Directorate (AAPHREM) and will be presented and submitted to AAU, College of development studies as a requirement for the partial fulfilment of a Masters degree in public health in Reproductive health. Possible efforts will be made to publish the results of the study on reputable international Journal.

4. Result

4.1 Sociodemographic characteristics:

Among the 245 study participants enrolled in this study, 49 were cases and 196 were controls. The mean age of cases was 32.6(±SD3.5) and that of controls was 27.5(±SD4.3) years. Thirty-four (69.4%) of cases and 169 (86.2%) of controls were married, while 7(14.2%) of cases and 10(5.1%) of controls were singles. A higher number of participants, 33 (67.3%) of cases and 135 (68.9%) of controls were from urban areas. Majority of cases 26 (53.1%) and controls 150 (76.5%) body weighed 50-75 kgs(Table 1).

Table1: Socio-demographic characteristics of mother who gave birth in the public hospitals of

Variable	Category	Cases	(%)	Controls	(%)
Age	<20	6	12.2	11	5.6
	20-24	12	24.5	40	20.4
	25-34	15	30.6	77	39.3
	>35	16	32.7	68	34.7
Current marital status	Married	34	69.4	169	86.2
	Single	7	14.2	10	5.1
	Divorced/separated	4	8.2	10	5.1
	Widowed	4	8.2	7	3.6
Residence	Urban	33	67.3	135	68.9
	Rural	16	32.7	61	31.1
Weight of the mother in kg	<50	10	20.3	15	7.7
	50-75	26	53.1	150	76.5
	75-100	9	18.4	25	12.7
	100+	4	8.2	6	3.1
Blood pressure at admission(category)	Hypertensive	12	24.5	10	5.1
	Normotensive	33	67.3	180	91.8
	Hypotension	4	8.2	6	3.1

Addis Ababa, Ethiopia, 2022 (n=245)

4.2 Obstetric and medical history

Among cases, 21 (42.9%) were grand multiparous having more than 5 children whereas only 23 (11.7%) of controls were grand multiparous. History of abortion 12 (24.5%) of cases and 10(5.1%) controls and history of still birth 5(10.2%) of cases and 3 (1.5%) of controls were seen in higher proportion among cases as compared to the controlls. Unlike cases, the majority of controls 135(68.9%) have adhered to their ANC follow up during their pregnancy (Table 2).

Almost a quarter of the cases (24.5%) had some kind of chronic illnesses, while this is seen on 34

(17.3%) of the controls group. Majority of the cases 22(44.9%) have sustained complications during their latest pregnancy, as compared to small number of mothers 16(8.2%) in the controls group who had complications in their last pregnancy. Hyperemesis gravidarum was the most common form of pregnancy complications encountered by the mothers among both the case and the controls groups (Table 2).

Table 2: Obstetric and medical characteristics of mother who gave birth in the public hospitals of Addis Ababa, Ethiopia, 2022 (n=245).

Variable	Category	Cases	(%)	Controls	(%)
Parity (total number of children born alive)	≤2	12	24.5	81	41.4
	3-5	16	32.6	92	46.9
	>5	21	42.9	23	11.7
History of previous abortion	Yes	12	24.5	10	5.1
	No	37	75.5	186	94.9
Previous still birth	Yes	5	10.2	3	1.5
	No	44	89.8	193	98.5
ANC follow up in last pregnancy	Yes	33	67.3	135	68.9
	No	16	32.7	61	31.1
ANC started timing(***n=33 cases, and 135 controls***)	1st trimester of pregnancy 2nd trimester of pregnancy 3rd trimester of	12 12 9	36. 4 36. 4 27.3	10 85 40	7.4 63.0 29.6

	pregnancy				
No. of ANC visits in last pregnancy(***n=33 cases, and 135 controls***)	<4 ≥4	21 12	63.6 36.4	80 55	59.3 40.7
Chronic coexisting disease	Yes	12	24.5	34	17.3
	No	37	75.5	162	82.7
Maternal coexisting diseases	Hypertension	5	10.2	6	17.6
	Diabetes Mellitus	4	8.2	4	11.8
	Hear disease	10	20.4	8	23.5
	Pulmonary disease	12	24.5	14	41.2
	Others	4	8.2	5	14.7
Complications during pregnancy	Yes	22	44.9	16	8.2
	No	27	55.1	180	91.8
Types of pregnancy complications	Hyperemesis	15	51.0	10	62.5
	PROM	7	14.3	2	12.5
	APH	2	4.1	2	12.5
	PIH	7	14.3	4	25.0
	Threatened abortion	3	6.1	2	12.5
	Others	4	8.2	2	12.5

4.3 Obstetric history of the study subjects:

The study revealed that 22(44.9%) of the cases and 41 (20.9%) of the controls were referred from other facilities, from these 5(22.7%), 10(45.4%) and 7(31.8%) of the cases and 16(39%), 18(43.9%) and 7 (17.1%) of the controls were referred from private hospitals/clinics, from public health centers and government hospitals respectively. Prolonged labor (labor that stayed ≥24 hours till delivery) was seen in excess percentage among the controls 76 (38.8%) than the cases 9(18.8%) (Table 3).

Table 3: Delivery related characterstics of mothers who gave birth in the public hospitals of Addis Ababa, Ethiopia, 2022.

Variable	Category	Cases	(%)	Controls	(%)
Referral status	Yes	22	44.9	41	20.9
	No	27	55.1	155	79.1
Referred from where	From private hospital/clinic	5	22.7	16	39.0
	From public health center	10	45.4	18	43.9
	From public hospital	7	31.8	7	17.1
How long labor stayed (till delivery, in hours)	<24	40	81.6	120	61.2
	≥24	9	18.4	76	38.8
complication during labor in the last delivery	Yes	33	67.3	35	68.9
	No	16	32.7	161	31.1
Type of complications during labor:	Prolonged labor	12	36.4	10	28.6
	Hemorrhage	14	42.4	12	34.3
	Eclampsia	8	24.2	5	14.3
	Retained placenta	6	18.2	4	11.4
	Abnormal presentation of child	9	27.3	3	8.6
	Others, specify	4	12.1	2	5.7
Birth attended by	Midwife nurse	20	40.8	139	70.9
	Physician	10	20.4	30	15.3
	Obstetrician	15	30.6	19	9.7
	Emergency surgeon	4	8.2	8	4.1
Gestational age at labor (in weeks)	<36	15	10.2	6	3.1
	36-40	20	81.6	180	91.8
	>40	14	8.2	10	5.1
Type of pregnancy	Singleton	32	65.3	156	79.6
	Multiple pregnancy	17	34.6	40	20.4
Mode of delivery	SVD	30	61.2	165	84.2

	C/S	17	34.7	16	8.2
	Instrumental	2	4.1	15	7.6
If C/S, type of C/S	Emergency C/S	10	58.8	8	50.0
	Elective C/S	7	41.2	8	50.0
If C/S, indication	Prolonged labor	8	47.1	7	43.7
	Abnormal presentation	9	35.2	11	68.7
	Eclampsia	8	47.1	5	31.3
	Placental previa	5	29.4	5	31.3
	Failed induction	7	41.2	7	43.7
	Maternal request	8	47.1	5	31.3
Birth outcome	Alive baby	38	77.5	188	95.9
	Still birth	11	22.5	6	4.1

4.4 Observed causes of death among women who had delivery

Among the cases the causes of maternal deaths were also counted as mentioned on the charts of the mothers. The main observed causes of maternal death included postpartum hemorrhage (22%), retained placenta (16.5%), sepsis (10 %), and eclampsia (9%), obstructed labor (1.4%), and indirect causes like anaemia (21%) post operative complications (8.9%).

4.5 Determinants of Maternal mortality

A two step logistic regression analysis was run to identify the factors that determine the maternal mortality. In the first step of bivariable logistic regression analysis, maternal age, educational status, residence, marital status, referral status, parity, gravidity, ANC follow up, mode of delivery and presence of chronic illness in the mother were found to be associated with maternal mortality at a p-value <0.2 cut off. The candidate variables were then entered to the multivariable logistic regression analysis with the aim of controlling for confounders.

Accordingly, in the multivariable logistic regression analysis, C/S delivery was found to be a significant risk factor for maternal mortality (AOR=4.86, 95% CI(1.18-14.94) when compared with vaginal delivery.

Other predictors of maternal mortality include maternal age 35 and above (AOR=2.11, 95% CI(1.15-7.10)), being referred from other facility(AOR=3.16, 95% CI(1.87-7.76), No ANC follow up (AOR=3.65, 95% CI(1.53-13.34) and having chronic illness (AOR=9.54, 95% CI(6.54-17.38).

Table 4: Logistic regression analysis output of factors associated with maternal mortality among pregnant mothers who gave birth in public hospitals of Addis Ababa, Ethiopia, 2022 (n=245).

Variables	Cases	Controls	COR(95% CI)	AOR(95%CI)	P Value
Age of the mother					
<25	14(28.6%)	55(28.1%)	1	1	
25-34	15(30.6%)	77(39.3%)	0.76(0.67-3.22)	1.31(0.85-9.90)	0.453
35 and above	20(40.8%)	64(32.6%)	1.22(0.94-2.81)	2. 11 (1.15-7.10)	0.003
Marital status of mother					
Married	34(69.4%)	169(86.2%)	1	1	
Single (Divorced/Widowed/Separated) *	15(30.6%)	27(13.8%)	2.76(1.23-5.27)	4.65(0.96-6.76)	0. 060
Parity (total number of children born alive)					
≤2	12(24.5%)	81(41.3%)	1		
3-5	16(32.7%)	92(47.0%)	1.52(0.99-3.08)	0.90(0.42-3.81)	0.921
>5	21(42.8%)	23(11.7%)	6.16(2.99-13.21)	3.90(0.92-6.81)	0.065
Referral status					
Yes	22(44.9%)	41(20.9%)	3.08(2.64-12.48)	3.16(1.87-7.76)	**0.017**
No	27(55.1%)	155(79.1%)	1	1	
No. of pregnancies (Gravidity)					
Primigravida	20(40.8%)	40(20.4%)	1.11(0.93-3.34)	0.90(0.60-4.96)	0.220
Multigravida(2-4)	16(32.7%)	127(64.8%)	0.28(0.16-0.81)	0.96(0.87-7.76)	0.075
Five and more than five	13(26.5%)	29(14.8%)	1	1	
ANC in last pregnancy					
Yes	33(67.3%)	135(68.9%)	1	1	
No	16(32.7%)	61(31.1%)	1.07(0.60-6.71)	3.65(1.53-13.34)	**0.001**
Mother have any chronic illness					**0.000**
Yes	19(38.8%)	26(13.3%)	4.14(2.58-8.61)	9.54(6.54-17.38)	
No	30(61.2%)	170(86.7%)	1	1	
Mode of delivery					
C/S	17(34.7%)	16(8.2%)	5.98(2.19-9.17)	4.86(1.18-14.94)	0.005
Vaginal delivery	32(65.3%)	180(91.8%)	1	1	

4.2 Discussion

This study was conducted in the public hospitals of Addis Ababa to investigate the epidemiological risk factors associated with maternal mortality using a case control study approach.

In our study the mode of delivery was found to be an important predictor of maternal mortality. Mothers who gave birth by Cesarean delivery were around 5 times at odds of maternal mortality as compared to those who gave birth by vaginal delivery. This was also shown in other study in India by Kamilya et al.(32), which showed that cesarean section was associated with a 3.01-fold increase in the risk of maternal mortality compared with vaginal birth. In the UK, Hall et al.(15) found an OR of 2.84 (95% CI 1.72-4.7) for elective cesarean section and 8.84 (95% CI 5.60–13.94) for emergency cesarean section compared with vaginal birth.

Moreover, Souza et al.(20), in Africa, Asia and Latin America, found an association between cesarean section and risk of death, as well as admission to the intensive care unit, blood transfusion and hysterectomy for both antepartum cesarean section without medical indications (adjusted OR= 5.93, 95% CI 3.88to 9.05) and intrapartum cesarean section without medical indications (adjusted OR=14.29, 95% CI 10.91 - 18.72). Also a case control study found that cesarean (AOR: 2.87; 95% CI; 1.63– 5.06) than vaginal delivery and postpartum hemorrhage (AOR: 3.0; 95% CI: 1.4–6.6) were associated with maternal mortality. Their result further stated that complications of anesthesia and thromboembolism were also factors contributing to maternal mortality(22).

The finding of our study is also supported by another Canadian retrospective cohort study comparing otherwise low-risk women who delivered by planned CS because of breech position in women with planned Vaginal delivery (16). The authors found that planned CS deliveries were associated with increased risk of specific severe postpartum complications but not increased risk of maternal death, which was only higher for emergency CS (16). However, the focus of the study was severe maternal morbidity and the number of women with elective CS was too limited to relevantly test the association with maternal mortality, given the very low ratio of maternal mortality in this country (16).

Our study also identified other determinants of maternal mortality. Accordingly maternal age, being referred from other facility, lack of ANC follow up and having chronic illness were also shown a statistically significant association with maternal mortality.

This was also indicated in other studies. Diallo and his colleagues conducted a case control study in Guinea to identify predictors of maternal mortality in 2020. Their result indicated that referral mother (AOR: 24.60; 95% CI: 11.32-53.46), was the predictors of obstetric mortality(23). This can be due to the risk of delay to take obstetric measures while transporting the mother to the the next health facility with comprehensive care. A case control study by Knight in United kingdom in 2017 also showed absence of ANC follow up (AOR; 23.62; 95% CI: 8.79–63.45), co-existing medical disease (AOR: 5.92; 95% CI: 3.56–9.86), pervious history pregnancy complications and advanced maternal age (AOR; 1.12; 95% CI: 1.02–1.22 were significantly associated with obstetric mortality (19)**.** According to the study done in France on 11 European countries by Wildman Maternal age greater than 35 years were linked to higher mortality when compared to maternal age less than 35(67.5% vs 32.5%)(21)**.** Another case control study in Brazil by Pereira et al in 2016 on 73 cases and 9,221 controls found that cesarean (AOR: 2.87; 95% CI; 1.63– 5.06). A case control study by Egbe in Cameroon on determinants maternal mortality showed lack of ANC follow up (RR:1.87; 95% CI: 1.33- 2.63), pre-existing co-morbidities (RR:1.45; 95% CI: 1.03-2.03) and delays in arrival at health facilities (RR:1.420; 95% CI: 1.01-2.0) were significantly associated with obstetric deaths (25).

A possible reason for high risk of maternal death by the age above 35 may be due to weakened uterus, anemia, being pregnant in women more than 35years old by itself is risk for maternal death, and majority of women in this age were not educated. A case control study on 595 obstetric patients at Mizan-Tepi University, Ethiopia by Tegene Legese et al in 2016 identified lack of ANC follow up (AOR:2.4; 95CI:1.19- 4.83) was also a predictor for obstetric complication and death (28)..

The maternal mortality rate (MMR) in our study area was found to be 837/100,000 live births and the major causes of maternal death were found to be postpartum hemorrhage (22%), retained placenta(16.5%), sepsis (10 %), and eclampsia (9%), obstructed labor (1.4%), and indirect causes like anaemia (21%) post operative complications (8.9%). This was also shown in a study done in Jimma University by Legesse et al. maternal mortality ratio was 350/100,000, which is much

lower than our finding. This is due to our study focuses on health facility maternal deaths and compares MMR risk difference by modes of delivery. This study also showed leading cause of maternal death was hemorrhage (54%) (β=0.477, 95% confidence interval (CI: 0.307, 0.647), followed by pregnancy-induced hypertension (20%) (β=0.232, 95% CI: 0.046, 0.419), and anemia (12%) (β=0.110, 95% CI: 0.017, 0.204) (8).which is comparable to our study finding. The data, particularly those of PPH and sepsis, are comparable to those reported elsewhere [5,12,13]. However, as per the report of the EDHS, hemorrhage has been reported to be 38%, which is much higher than our estimate. Since EDHS included all maternal deaths irrespective of the outcome of pregnancy, i.e., including abortions and stillbirths, against ours, which has considered only those maternal deaths where the outcome of pregnancy was only live birth; hence the former estimates are likely to be higher than ours.

4.3 Conclusion and Recommendation

In conclusion, delivering by C/S is associated with risk of maternal mortality. Maternal age, being referred from another facility, having history of no ANC in previous delivery and having any chronic illness were also other determinants of maternal mortality. The maternal mortality rate in our study finding was unacceptably high.

Health education campaigns on promotion of ANC follow up, proper indication for decision on the modes of delivery; chronic illnesses prevention and control shall be designed.

As some of these factors were behavioral and modifiable, identifying risky groups and designing targeted interventions must be given emphasis by stake holder.

The factors can be modified through a better access to medical and maternity care, scaling up of antenatal care, improve in infrastructure to fulfill referral chain from primary level to secondary and tertiary health care levels, and health education to pregnant women.

Preventive measures which could help to reduce maternal mortality include

- mass education about the importance of antenatal registration and regular checkups and
- more focus on training of health extension workers to identify high risk mothers.
- Existing health services should be improved and emergency obstetrical care should be available to all women round the health facilities.

- Literacy rate should be improved so that awareness about reproductive health and use of available health resources could be optimized.

- Further community based case control study should be done.

- Further, since the present study was conducted in the Addis Ababa city administration, where institutional facilities and transport are more easily available than in the rural areas, women should be encouraged to go for institutional deliveries to reduce maternal mortality at the community level.

Strength and limitations:

Our study has some limitations. First, we had information about mortality and morbidities only until discharge from hospital; some outcomes might therefore have been underestimated, especially for women delivering vaginally who are usually discharged earlier than women having caesarean section.

The calculated odds ratio might overestimate the risk of caesarean section. Although we had adjusted for many potential confounding factors, there might be some other factors that we did not have information about and could not adjust for.

Second, data were abstracted from the patients' records. We were not able to confirm the absence of some of the risk factors if they had not been recorded.

Third, our survey included only hospitals with caesarean facilities having 1000 or more deliveries every year. The results therefore cannot be generalized to smaller facilities. The results, especially rates of caesarean section, should not be regarded as representative rates and outcomes for entire countries or regions.

In view of the strengths and the limitations, our results are corroborated by other observational studies assessing the risks of caesarean section for mothers and infants from different settings.

We conclude that caesarean section should be done only when there is a medical indication to improve the outcome for the mother or the baby.

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Annexes:

Data collection tools to assess association between mode of delivery and Maternal Mortality in MCHs of SPHMMC, Ghandi memorial Hospital and Zewditu Hospital in Addis Ababa Ethiopia, 2020/21.

Medical Registration No: _____

Code no.	**Questions**	**Responses**	**Skip**
	Sociodemographic factors		
101	Age by years	_____	
102	Marital status of the mother	1. Married 2. Single 3. Divorced/**Widowed/separated**	
103	Weight of the mother	_____Kg	
104	Vital sign(Blood pressure) at admission	_____mmHg	
105	Total number of children born alive	_____	
106	Total number of previous pregnancies	_____	
107	Previous abortion If yes, how many…….	1. Yes 2. No	
108	Previous still birth If yes, how many……	1. Yes 2. No	
109	ANC follow up in the last pregnancy If yes, how many visits…….	1. Yes 2. No	
110	Maternal Coexisting disease	1. Hypertension 2. Diabetes Miletus 3. Heart diseases 4. pulmonary diseases 5.other(specify)……	
111	Referral status	**1. Yes 2. No**	If no, go to Q113

112	If, yes, referred from where	1.From private hospital/clinic 2.From public health center 3.From public hospital	
113	How long labor stayed (till delivery, in hours)	…….	
114	Was there any complication during labor in the last delivery	**1. Yes 2. No**	If no, go to Q116
115	If yes, What was the complications during labor	**1. Prolonged labor** **2. Hemorrhage** **3. Eclampsia** **4. Others, specify**	
116	Birth attended by	**1. Midwife nurse** **2. Physician** **3. Obstetrician** **4. Emergency surgeon**	
117	Gestational age at labor,	_____Weeks	
118	Type of pregnancy	**1. Singleton** **2. Multiple pregnancy**	
119	Mode of delivery	**1. SVD** 2. C/S 3. Instrumental	
120	Birth outcome	**1. Alive baby** **2. Still birth**	
121	Pregnancy related complications(Multiple answers can be possible)	1.Obstetrics hemorrhage 2.PIH 3.Peurpral Sepsis 4.Amniotic fluid Embolism 5.Other(specify)…….	
122	Was there ICU admission	1. Yes 2. **No**	If no, go to Q128
123	Reason for ICU Admission	a. Organ failure b. Shock	

		c. For monitoring d. Others(specify)……	
124	Patient Status During admission	A.GCS……. B. B/P……. C.HR…… D.RR…… E. Oxygen Saturation……	
125	Treatment given at ICU (Multiple answers can be possible)	A. Mechanical Ventilation B. Oxygen Supplementation C. Vasopressor D. Antibiotics E. Blood Transfusions F. Hemodialysis G. Feeding G. Other……	
126	Was there Complications in ICU	a. Yes b. No	
127	Durations of ICU Stay (in days)	……..	
128	Outcome	a. Death b. Survived	

Name of data collector _____ signature_____

Name of supervisor(s) _____signature _____

Information sheet

This information sheet is prepared with the aim of explaining the research project.

Title: Assessment of the pattern of maternal mortality and its association with mode of delivery in of Addis Ababa Public Hospitals (A case control Study)

Name of Principal Investigator: Mihret Abebayehu (BSC)

Name of advisors: Wondimye Ashenafi (PhD)

Name of the Organization: Addis Ababa University, College of Development studies, Department of Population studies

Purpose of the Research Project

To assess predictors of Maternal Mortality in MCHs of SPHMMC, Ghandi memorial Hospital and Zewditu Hospital

Incentive

There is no incentive or payment to be gained by taking part in this project. The information collected from this research project will be kept confidential and only accessed the researcher and research assistant only. This research project will be reviewed and approved by ethical committee of Addis Ababa University College of Development studies.

Confidentiality

Except the principal investigator, no one will have access to the collected data, name or anything taken from your chart. The data will be kept coded and locked with no labeling specifying anyone participating in the research.

Whom to contact

This research project was received and approved by Ethical Committee of Addis Ababa University CHS, Department of population studies.

If any question, contact any of the following individuals and may ask at any time wanted:

Mihret - principal investigator, department of population studies, Addis Ababa University,

Tel: +251 924064889

Data safety assuring sheet

Code

s.no	Tools Checked	yes	No	Data entry
1	Are the inclusion and exclusion criteria done appropriately	yes		

Data Accuracy check sheet

Code

S.no	Tools	Yes	No
1	Are all questions on socio-demographic data filled appropriately	yes	
2	Are all data on admission diagnosis filled appropriately	yes	
3	Are all data during delivery filled appropriately	yes	