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COLLEGE OF HEALTH SCIENCE

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INEQUALITY IN PERINATAL MORTALITY AND ITS COVARIATES: SECONDARY ANALYSIS OF THE ETHIOPIAN DEMOGRAPHIC HEALTH SURVEYS FROM 2005-2016

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Inequality in Perinatal Mortality and its Covariates: Secondary Analysis of the Ethiopian Demographic Health Surveys from 2005-2016

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Acronyms

ANC	Antenatal Care
BR	Birth Record File
CCI	Composite Coverage Index
CI	Concentration Index
CSA	Central Statistical Agency
EA	Enumeration Areas
EDHS	Ethiopian Demographic and Health Survey
FDRE	Federal Democratic Republic of Ethiopia
FMoH	Federal Ministry of Health
HDI	Human Development Index
ICD-PM	International Classification of Disease for Perinatal Mortality
ICPD	International Conference on Population and Development
IPV	Intimate Partner Violence
IR	Individual Record file
MH	Maternal Health Service
Mo WCA	Ministry of Women's and Children's Affairs
NGOs	Non-Governmental Organizations
NMR	Neonatal Mortality Rate

PCA	Principal Component Analysis
PHC	Population and Housing Census
PNM	Perinatal mortality
PNMR	Perinatal Mortality Rate
PNC	Post Natal Care
RMNCH	Reproductive Maternal Newborn and Child health service
SBA	Skilled Birth Attendance
SBR	Stillbirth Rate
SDGs	Sustainable Development Goals
UNIFEM	United Nations Development Fund for Women
USAID	United States Agency for International Development

Abstract

Background: Perinatal mortality is an important indicator of health and the quality of health care. Countries or regions are often compared using perinatal mortality rate. The aim of the study is to determine the trends and inequality in perinatal mortality and its covariates in Ethiopia by using the three round of Ethiopian Demographic Health Survey (EDHS) data (2005, 2011 and 2016).

Method: EDHS sample designs were stratified, clustered and two-stage probability sampling. The trend of perinatal mortality rate was computed using the annual rate of reduction and the 95% confidence interval also used to indicate statistically significant reduction. The inequality in perinatal mortality was measured by using both the simple (ratio and difference) and complex measure of inequality (relative concentration index). The concentration index was decomposed using the "decomp" package in R studio.

Result: The trend of perinatal mortality rate in Ethiopia showed slow rate of reduction with 0.72 percent reduction per annuum. Annual rate of reduction for the stillbirth rate was -1.3% whereas the early neonatal mortality was 1.5%. The ratio and difference inequality summary measure for the region showed high disparity across region with highest mortality (Oromiya) and lowest mortality (Harari region), difference (D)= -0.0070, 95% CI (-0.0117, -0.0023) and the ratio(R) = 0.7868 95% CI (0.6619, 0.9354). However, place of residence showed insignificant disparity (difference (D)= -0.0118, 95% CI (-0.0276, 0.0041) and ratio (R)= 0.7254, 95% CI (0.4962, 1.0605)). The results indicated that the concentration index for wealth-based inequality across the three survey years were 0.0158926, -0.0117815 and 0.01130234, respectively. While the concentration index for the level of maternal education over the three-survey year was (-0.00011, -0.0013 and 0.0010), respectively.

Conclusion and Recommendation: Even though trend show some rate of reduction in PNMR, the rate remains high in the country. In all survey years (2005,2011 and 2016) there was wealth and level of maternal education-based inequality in perinatal mortality. In order to minimize the inequality in perinatal mortality in Ethiopia effort should be made narrowing the economic variation within population (regions).

Keywords: Perinatal mortality, stillbirth, early neonatal mortality, inequality, trend and EDHS

1. Introduction

1.1. Background

Even though being newborn is not a disease, large numbers of children die soon after birth. (1).Despite an overall global reduction of under-five mortality, stillbirths and early neonatal mortality continue to be a huge public health challenges (2). In 2011, the global burden of third trimester stillbirths was 2.6 million death, and data reported in 2015 estimated that early neonatal mortality was ~2 million death a year (3). Sub-Saharan African countries share a large burden of perinatal mortality. According to the 2013 world health statistics report, the still birth rate was 26/1000 birth in Ethiopia, which ranked the country the top seventh from the ten country in the world and the top third from the east African country (4).

Early neonatal deaths and stillbirths have many common causes and determinants but different from those causing and contributing to post neonatal and child deaths. Early neonatal deaths and stillbirths stem from poor maternal health, inadequate care during pregnancy, inappropriate management of complications during pregnancy and delivery, poor hygiene during delivery and the first critical hours after birth, and lack of newborn care. And also several factors such as women's status in society, their nutritional status at the time of conception, early childbearing, too many closely spaced pregnancies and harmful practices are deeply rooted in the cultural fabric of societies and interact in ways that are not clearly understood (1, 5-7)

Goal by 2020; for countries with a current stillbirth rate of more than 5 per 1000 births, is to reduce their stillbirth rates by at least 50 % from the 2008 rates. For countries with a current stillbirth rate of less than 5 per 1000 births, the goal by 2020 is to eliminate all preventable stillbirths and close equity gaps (2). The Ethiopia Federal Ministry of Health (MOH) has developed newborn policies, strategies and guidelines that kept the newborn health a high-priority program. The Ministry indorsed the National Safe Motherhood, the National Newborn and Child Survival Strategy and the long-term plan like the Health Sector Development plan. These policy document provide the necessary guidance for the integrating the newborn care into various ongoing program such as the community-based Integrated Management of Childhood Illness and the Safe Motherhood

Program. The Health Sector Development Plan also gives high priority for the newborn health program (8, 9). But the perinatal mortality in Ethiopia show slow reduction.

Health inequalities are defined as systematic differences that are deemed to be unfair and unjust in health that can be avoided by appropriate policy intervention and program (10). Thus the principle of health equality begins with creating equal opportunities for people to access needed healthcare resources, irrespective of their personal characteristics and ability to pay (11). Avoidable inequalities in mortality across the life course are of global concern (12). Health inequality analysis indicate the extent of distribution of health outcome with in population sub-groups, and measuring this inequality particularly in countries with great heterogeneity is vital (13, 14). One of the mottos of SDG is no one left behind and the SDG 10 also mainly focus on reducing inequality. This provided a firm basis for the development of our objective. The objective of this study is therefore to assess the trend and inequalities in perinatal mortality and its covariates in Ethiopia using the three rounds of DHS survey.

1.2. Statement of the Problems

Globally attention was not properly directed to the millions of newborn deaths(4). Despite previous estimates showing large numbers of stillbirths (2.6 million in 2009) (15) global attention for this issue is also low. So far about half of babies born in developing countries are born at home without the support of skilled birth attendants. Even for those born in a health facility, essential newborn care is often lacking (16). In many societies, early neonatal deaths and stillbirths are not perceived as a problem, largely because they are very common. Many communities have adapted to this situation, until the newborn infant has survived the first month, they did not name the birth as complete or not name as a child. On the other hand, although about 99% of the neonatal deaths happen in low and middle income countries, yet most researches focus on the 1% perinatal deaths occurring in developed nations (17). Other authors also have pointed out that information on perinatal deaths in most low and middle income countries is scanty (17, 18). Specific to Ethiopia, there are few hospital and community-based studies.

In Ethiopia neonatal mortality has declined from 49 deaths per 1,000 live births in 2000 to 29 deaths per 1,000 births in 2016, a reduction of 41% over the past 16 years (19) but perinatal mortality rate is among the highest in Sub Saharan Africa. According to the 2016 EDHS report the perinatal mortality rate is 33 deaths per 1,000 pregnancies (19). Over the decades, both hospitals based and community-based studies did not indicate a reduction in perinatal mortality. The trend of perinatal mortality rate has been stable between 90 and 40 per 1000 total births in the hospital and community setting, respectively (20). Even if the government of Ethiopia has been trying to introduce different high impact and cost effective intervention mainly through its Newborn and Child Survival Strategy (2015-2020) (21), the perinatal mortality rate remain stagnant, the cause is also not well known; again in Ethiopia the under-five mortality is reduced but the perinatal mortality show slow reduction and found below the target.

The study of perinatal mortality is especially interesting for detecting inequalities in the access to health care during pregnancy and delivery and during the neonatal period among different population groups (22, 23). Reducing perinatal mortality rate and promoting neonatal health in health services are of utmost importance. Perinatal mortality rate is an important indicator of the health status of given society, maternal care and of maternal health and nutrition, quality of obstetric and pediatrics care available. The focus of government and partners were mostly on improving coverage, access, health infrastructure and provision of quality service and addressing inequality. Therefore, in order to address the underprivileged its crucial to investigate the extent of inequality. This study was aimed to answers the trends and level of inequality in perinatal mortality and its covariates in Ethiopia by using the Ethiopian Demographic Health Surveys series 2005 - 2016.

1.3. Significance of the Study

Neonatal mortality accounts the death of live births whereas the perinatal mortality is the sum of early neonatal mortality and stillbirths, which makes it the holistic indicators to estimates exact level of mortality at the time of delivery and the first day of birth (24, 25). Perinatal mortality and its inequality provide the information needed to improve the health status of pregnant women, new mothers and newborns. This information also allows decision-makers to identify problems, track

temporal and geographical trends and disparities and assess changes in public health policy and practice.

After its completion, this study is expected to add input on the existing knowledge regarding the trend and inequality in perinatal mortality. Both the strength and the limitations of this study may trigger further studies on the perinatal mortality. In combination with other researches this study is expected to consolidate evidence for policy makers. At the end of the study recommendation is given to the concerned bodies to fill the gaps based on the findings of this study.

2. Literature Review

2.1. Overview of Perinatal Mortality

World health organization (WHO) defines perinatal mortality for developing countries as neonatal deaths of less than seven days of age and fetal deaths after 28 weeks of gestation, which is known as perinatal mortality-I(26). Many classification systems have been used to identify the causes of perinatal deaths. According to international classification of disease for perinatal mortality (ICD-PM) (27), there are three distinct features of perinatal mortality: time of a perinatal death (in the antepartum, intra partum or neonatal period), cause of death and contributing maternal conditions with perinatal deaths. Perinatal mortality rate (PMR) is calculated as total number of perinatal deaths per total number of births (still births + live births)) × 1000 (28). The perinatal period is an extremely important phase of life. It is a sign of the quality of prenatal, obstetric, and early neonatal care that is given to mothers and new-borns (29).

2.2. Determinants of Perinatal Mortality

Women who have experienced labor complications had higher risk of perinatal mortality. Several studies have shown that complications like cord prolapse, mal-presentation, eclampsia pregnancy induced hypertension (PIH) and ante-partum hemorrhage (APH) increase the risk of perinatal mortality (30, 31). Studies conducted in Hawassa university, Ethiopia and Zimbabwe also indicated that women who experienced antepartum hemorrhage, prolonged labor, pre-eclampsia, and obstructed labor had a higher likelihood of perinatal mortality (30, 32).

Mainly obstructed labor were strongly associated with perinatal mortality with a case fatality rate of 73.5% (32). The risk of obstetric complications tends to increase with increasing parity thereby increasing the risk of perinatal mortality. Maternal parity greater than four was a risk factor for perinatal mortality (30). Studies conducted in Democratic Republic Congo, Eastern Sudan and Nigeria showed that parity > 4 increase the risk of perinatal death (33-35). In contrary to this other two studies done in Ethiopia (Hawassa and Addis Ababa) showed that parity didn't show an association with perinatal death (32, 36).

Also a previous history of neonatal mortality was a strong determinant of perinatal mortality, women who lose their newborns will try to catch up by having another child immediately after their loss, this may increase the likelihood of perinatal mortality (5). Studies from Zimbabwe and Sweden have identified that mothers with a history of neonatal mortality during their first pregnancy were 5 times more likely to experience stillbirth in the second pregnancy. Previous history of stillbirth and early neonatal mortality was one of the most predictor or risk factors for perinatal mortality for the current pregnancy (30, 37).

Maternal age at birth, mother's age at first marriage and mother's age at first pregnancy are among the predictors of perinatal mortality. Maternal age 35 and above years had more than 3 times the risk of perinatal deaths compared with the reference group 18–34 years (38). Studies conducted in rural Pakistan, Tanzania, Yemen and Ethiopia have indicated that older age (35+ years) of mothers at birth) and teenage mothers' age at first pregnancy (<18 years) were found to be among the factors significantly associated with risk of perinatal mortality (5, 29, 38, 39).

Among others educational status and types of occupation of mothers were found to be the significant socio-economic predictors of perinatal mortality. Studies conducted in different developing countries such as Marondera district, Mashonaland East Province of Zimbabwe, Ludhiana, rural Haryana, Eastern Uganda and Ethiopia showed that the highest perinatal mortality was observed among illiterate mothers (30, 40-43). Evidences from Western Iraq and other developing countries have also indicated that increased levels of mother's education were observed to be associated with improved chances of infant survival (43, 44).

Studies conducted in Ethiopia and Indonesia showed that empowerment and education had strongest inverse association with infant death, women who were more empowered were significantly less likely to experience infant mortality (45, 46). Another study conducted in Pakistan showed that women's empowerment to choose and access healthcare for themselves and their newborns during pregnancy and birth were the predictors of perinatal mortality (PNM) (47).

2.3. Interventions to Reduce Perinatal Mortality

Most intrapartum stillbirths are associated with complications that arise during labour and are potentially preventable with appropriate care. In low-income and middle-income countries, an

estimated 46% of women give birth at home without the benefit of a skilled birth attendant (48). The systematic review conducted in 195 country revealed that provision of a skilled attendant and basic and comprehensive emergency obstetric care at birth could reduce intrapartum stillbirths by about 23% and 1.61 per1000 births, respectively (49).

The global status of stillbirths was reviewed by Lancet Stillbirth Series in 2011 and provided the intervention of the triple return on stillbirth prevention that also prevents new born and maternal deaths (50). Despite this intervention, the new series suggest that to have high quality health care for the mothers, adolescents and new born high effort must be done in integrating stillbirth prevention within global and national agendas.

Reduction of stillbirth rate is one of the global agenda. For countries with current stillbirth rate of >5 per 1000 birth the goal by 2020 is to reduce their stillbirth rate by at least 50 percent from the 2008 rates. Whereas for those countries whose stillbirth rate was less than 5/1000 birth is targeted to eliminate all preventable stillbirths and close equity gaps (51). Consistent to the SDG goals, Ethiopia has also developed a health sector strategic plan to direct its health intervention through 2035. In this plan, the country aspires to be a middle income country averting unnecessary neonatal mortality (52).

Despite having enormous social and health implications for both parents, stillbirths have been invisible in policies and programmes worldwide, with little recognition of potential strategies for intervention. Moreover, most countries do not include stillbirths in their vital statistics reporting systems and, even in the countries that do, stillbirths are generally under-reported. A major reason for stillbirths not being included in the worldwide policy agenda is the notion that little can be done at scale in developing countries (49).

2.4. Trends of Perinatal Mortality

According to the Global, regional and national neonatal mortality scenario-based projections between 2018 and 2030, if each country maintains its current rate of reduction in Neonatal mortality rate (NMR), “27.8 million children will die in their first month of life”. Although substantial progress has been made in reducing neonatal mortality since 1990, increased efforts to improve progress are still needed to achieve the SDG target by 2030 (53). The estimated average

global stillbirth rate (SBR) in 2015 was 18.4 per 1000 births, down from 24.7 in 2000 (25.5% reduction). In 2015, an estimated 2.6 million babies were stillborn, giving a 19% decline in numbers since 2000 with the slowest progress in sub-Saharan Africa. 98% of all stillbirths occur in low-income and middle-income countries; 77% in south Asia and sub-Saharan Africa (54).

Ethiopia is one of the sub-Saharan countries with a high burden of early neonatal mortality with incidence rate ratio 4.8 with the highest risk of death on the first day of life (55). Despite an urgent need in reducing neonatal mortality there appears to be no significant decline in mortality rate in the first week of life in the last 20-30 years in Ethiopia. A review of studies conducted in Ethiopia between 1974 and 2013, both in hospitals and community based setting ,showed that there is no reduction in PNM (20). Another study from Hawassa University Referral Hospital, South Ethiopia, over the period 2008 - 2010 reported adjusted perinatal mortality rate of 85 per 1000 total deliveries (32), which is two times higher than the 2011 EDHS PNM report.

Perinatal deaths are seen as a natural occurrence in many societies, which consider the birth of a child accomplished only when the baby has survived the initial period. Vital registration systems usually do not record and report stillbirths (1). Household surveys are the largest source of population-based SBR data. However, the capture of stillbirths in these surveys remains of low quality. Recent evidence has highlighted the stigma and taboos around stillbirths that persist in many cultures, which might affect a woman's or family member's response to a survey question (56-58). Information on perinatal and late neonatal mortality is important to contribute to the effort towards reducing infant mortality(59). In countries where there is no civil registration system, health and demographic surveillance data will serve to examine the trend and factors affecting perinatal mortality (60).

2.5. Inequalities in Perinatal Mortality

Health inequality refers to a difference in some defined health outcome among groups, where such a difference is regarded as unfair and undesirable, assuming unavoidable biological factors are not at stake. Ethnic background, socioeconomic status, gender and place of living are the most important sources of health inequalities (24, 61).

Perinatal health inequalities are particularly important in view of the future health of a newborn as it is difficult to redress disadvantages of an unhealthy start at birth, and detrimental effects range into adulthood and beyond (62). Perinatal inequalities appear peculiar and salient in both urban and nonurban areas. The studies conducted in Washington and Netherlands showed that there is large perinatal health inequality related to place of residence, ethnicity, socioeconomic class (63, 64). Tromp et al.(65) investigated perinatal mortality between 4 distinct geographical regions in Netherlands. The result revealed that there is an increased perinatal mortality risk in the northern region. As systematic review conducted among 35 country indicated that there is social gap in perinatal mortality and stillbirth in studies identified from Finnish and Norwegian countries and majority of Denmark studies (66). Socioeconomic disadvantage, as measured by low levels of mothers' or fathers' education, occupational status or income, is associated with raised risks of stillbirth even in countries with universal insurance coverage and generous welfare provisions (67, 68).

As study conducted in Brazil from 1982-2015 showed that absolute income base inequalities were decreased over time whereas the relative inequality remains constant (69). Early neonatal mortality is a major global health issue. The systematic review conducted in 72 low and middle-income countries revealed that SES inequalities in child mortality increase with child age: inequalities are highest in under-five, infancy and neonatal period whereas its low in early neonatal period (70, 71).

Educational inequality in stillbirth has been documented in many high-income countries (72, 73). Low education was associated with higher risk of stillbirth from all causes in every period (74). In England, in 2017, the stillbirth rate in the most deprived areas was 5.5 per 1000 total births, compared with 3.0 per 1000 total births in the least deprived areas (75). Inequalities in perinatal and maternal outcome persist in women from lower socio-economic groups, from specific ethnic groups, and from those living in deprived areas (64). In Ethiopia the socioeconomic inequalities seem to increase from 2000 to 2011 for under-five and neonatal deaths, whereas they are stable or decreasing for the other indicators. So, the factor contributing the most to the observed inequalities need to be investigated (76).

Even though, we are looking for the existing variation, an important goal of health inequalities research is to understand what factors contribute to inequalities in order to provide insights into potential interventions and help as to inform policies, programs and practices to reduce difference that are unfair and unjust(13). From review of literatures, underlining forces linked with those factors producing inequalities are, the distribution of income, the gap between the rich and the poor and the concentrates of decision making power in the hands of few (advantaged group) are of the highest and the differencing characteristics of the individuals (like age, wealth status, education status, employment status) living in different area and district (the environment in which they live) also contribute to considerable regional disparity. Furthermore characteristics of the predisposing individual, resource which allow individual to use, perceived need for service, access, governance and quality of service are among factors for variation in service utilization (77, 78).

2.6. Conceptual Framework

We adapt the Mosley-Chen conceptual model used to analyze the trend and inequality in perinatal mortality in Ethiopia. The framework, first proposed by Mosley and Chen in 1984, incorporated social and biological factors which are likely to be associated with the survival of an infant. The adapted version of the Mosley and Chen framework is shown in Figure 1. Some selected potential predictors of perinatal mortality get identified for the purpose of this research. These possible predictors are a range of socio-demographic characteristics associated with a child and their parents; grouped into three broad levels, namely: 1) individual-level variables – variables from the mother, father, child and mother-child, 2) household-level variable and 3) community-level variables (79). For this specific study we included some of the selected variables: community level variables (Region and Place of residence), house hold level variables (maternal education and wealth index), maternal factor (age at birth and empowerment), delivery factor (place and mode of delivery), predelivery (ANC visit) and child factor (sex) .

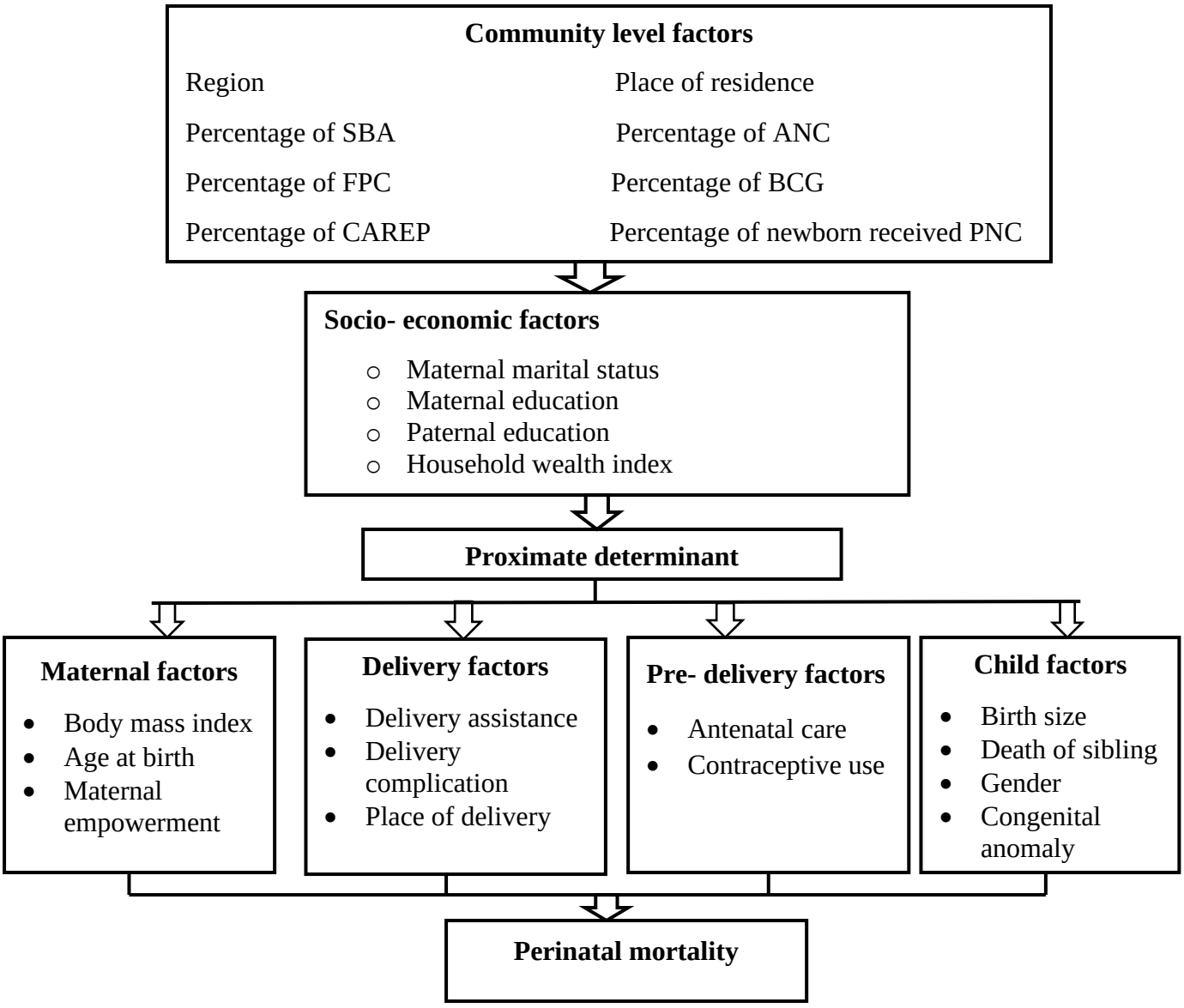

Figure 1: Conceptual Framework for the trend and inequality in perinatal mortality and its covariates in Ethiopia from 2005-2016 (79).

2.7. Research Question

1. What are the trend and level of inequality in perinatal mortality in Ethiopia?

2. What factors explains inequality in perinatal mortality in Ethiopia?

3. Objective

3.1. General Objective

- To determine the trend and inequality in perinatal mortality and its covariates in Ethiopia by using the EDHS data (2005, 2011 and 2016).

3.2. Specific Objectives

- To determine the trend of perinatal mortality by using the three rounds of EDHS data set in Ethiopia.
- To determine inequality in perinatal mortality by region, place of residence, education, wealth status, and composite coverage index by using the three rounds of EDHS data set in Ethiopia.
- To identify factor contributing to the observed inequality in perinatal mortality by using the three rounds of EDHS data set in Ethiopia.

4. Methods

4.1. Study Area and Setting

Ethiopia is one of least developed country in the world. Until the early 1960s Ethiopia had vaguely defined health policy. In the recent periods, the government established the Health Sector Development Programme (HSDP), which is a twenty-year health development strategy implemented through a four consecutive 5-year investment programmes (MOH, 2010). The HSDP gives high priority for the newborn, maternal and child health. Access to the general health services in Ethiopia has improved markedly since 2000; there has been encouraging improvements in the coverage and utilization of health services. The country has made remarkable progresses in increasing access to selected health services and improvements in certain health outcomes (80). Regardless of this, Ethiopia is still one of the countries with a very high morbidity and mortality from triple burden of diseases (8).

The four round of DHS surveys in Ethiopia, were conducted by the Central Statistical Agency (CSA) and ORC Macro for 2000, 2005 and 2011, CSA and ICF for 2016. ICF international offers the technical support which is sponsored by the United States Agency for International Development (USAID). In our study we used three of the four DHS surveys conducted in 2005, 2011 and 2016 GC. We exclude the 2000 EDH survey because there were some missing variables that we need to do our analysis, in particular information in stillbirths is missing. Since the perinatal mortality is the sum of early neonatal mortality and stillbirth divided by total births, it's impossible to compute the perinatal mortality without the stillbirth numbers.

4.2. Source Population

All women of reproductive age (15-49 years old) who had pregnancy that lasted for at least seven months (28 weeks of gestation) in preceding five years before each of the EDH surveys of 2005, 2011 and 2016 from the individual record file (IR file) and the birth file (BR file).

4.3. Study Population

All women of reproductive age (15-49 years old) who had pregnancy lasted for at least seven months (28 weeks of gestation) that sampled by EDH surveys and who reported to have had fetal or early neonatal death within the first weeks (0–6 days) after birth in the preceding five years before each of the surveys of 2005, 2011 and 2016.

4.4. Study Design

This study analyzed data from the nationwide cross-sectional survey, Ethiopia Demographic and Health Survey (EDHS) series, which is based on the nationally representative probability sample that covered the entire country.

4.5. Sampling Procedure

EDHS sample designs were stratified, clustered and two-stage probability samples drawn from an existing sample frame, usually based on the most recent census frame. Ethiopia as a whole comprise 11 geographic areas (9 regions and 2 city administrations) namely: Benishangul-Gumuz, Somali, Gambella, Amhara, Southern Nations, Nationalities and Peoples (SNNP), Oromiya, Harari, Addis Ababa, Tigray, Dire Dawa and Afar. The sampling frame used for the three round EDHS (2005, 2011 and 2016) were the corresponding Ethiopia Population and Housing Census (EPHC). The census frame contains a complete list of enumeration areas (EAs). The sampling frame contains information about the EA place, type of dwelling (urban or rural), and estimated number of residential households. The sample for the EDHS was designed to provide estimates of key indicators for the country as a whole, for urban and rural areas separately, and for each of the nine regions and the two administrative cities. The EDHS sample was selected in two stages.

4.6. Sample Size Estimation

As discussed in the sampling design, the sampling process has two stage. In the first stage: implicit stratification and proportional allocation at each lower stage of the administrative division were achieved by using the probability proportional to size selection and by sorting the sampling frame within each sampling stratum before sample selection, according to administrative units in

different levels. In the second stage, from the newly created house hold listing, fixed number of households per cluster were selected by using equal probability systematic selection. According to the DHS sampling all women age 15 - 49 who were either visitors who stayed in the household the night before the survey or permanent residents of the selected households or were eligible to be interviewed for the women file (19, 81, 82).

Table 1: Sample number of households, women respondents, and pregnancies of seven or month duration by survey year to assess trend and inequalities in perinatal mortality in Ethiopia from 2005-2016.

Characteristics	Year of the survey			
	2005	2011	2016	Total
Selected house hold	14,645	18,720	18,008	66,015
Response rate of selected H.H	98.5%	98.1%	97.6%	98.1%
Women of reproductive age (15-49 years old)	14,717	17,385	16,583	64,401
Response rate of Women of reproductive age	95.6%	95%	94.6%	97.5%
Number of women of reproductive age who had Pregnancies that lasted for 7+ months	11,280	12,076	11,070	34,428

4.7. Study Variables and Measurement

In order to assess the trend and inequality on perinatal mortality we selected the study variables based on the relevant variables reported on literatures. The identified variables were classified in to core group, which include community level factors, socioeconomic factors, delivery factors, predelivery factors, perinatal factors and child factors. The main exposure factor was the variable that measure the dimension of inequality. Based on the review of literature from the global and national perspective variable that are widely used or proposed to study inequality were used to assess inequality in perinatal mortality. For this study, the major inequity stratifiers used were region, place of residence, education and wealth status. Whereas preceding birth interval, ANC visit, birth size, place of delivery, mode of delivery, accesses to media, women decision making and previous history of terminated pregnancy were considered as explanatory variable in the decomposition analysis.

Table 2**:** Variable discerption to assess the trend and inequality in perinatal mortality in Ethiopia from 2005-2016

Variables	Description
Dependent variable	
Perinatal Mortality	Perinatal mortality is death of the fetus after 28 weeks of gestational age or death of the neonates within seven day (0-6 day) after birth Since the perinatal mortality is dichotomous coded as 1 if the death occurs within 7 day of birth after 28 weeks of gestation and zero otherwise
Independent variables	
Region	The region where the interviewed women were live (9 regions and 2 city administrations) namely: Benishangul-Gumuz, Somali, Gambella, Amhara, Southern Nations, Nationalities and Peoples (SNNP), Oromiya, Harari, Addis Ababa, Tigray Dire Dawa and Afar
Place of the residence	The usual place of residence where the women lives Urban/ Rural
Wealth status	The house hold are ranked based on the kind of consumer and good they own according to the EDHS the house hold are ranked in to five: Lowest, Second, Middle, Fourth, Highest
Maternal educational	The educational status of the respondent. According to the EDHS the education level is categorized in to four categories no education, primary, secondary and higher education.

4.8. Operational Definition

Accesses to Media: Having accesses to television, newspaper and radio at least once a week

Birth Size: Was classified as small/very small and average/large.

Maternal Empowerment: If she makes decision alone and jointly with her husband or partner

Not Empowered: If she didn't participate in the decision making

4.9. Data Collection Procedures

The Ethiopian DHS questioner are standard questionnaire which are adapted from model survey instruments developed for the MEASURE DHS project, which reflect the population and health issues relevant to Ethiopia. There are four main questionnaires in DHS surveys: A Household Questionnaire, a Woman's Questionnaire, Biomarker questionnaire and a Man's Questionnaire. In addition to this the 2016 EDHS contain the health facility questionnaire. The Household Questionnaire collects data on the characteristics of the household and lists all household members and also used to select women and men eligible for individual interviews. According to the MEASURE DHS project the Biomarker Questionnaire collects information for each eligible household member on anthropometric measurements and levels of hemoglobin, and records information about samples for biomarker testing. Eligible household members are typically children under age 5, and women and men age 15-49.

The Woman's Questionnaire also collect information about the eligible women, in addition to questions about the woman, contains a birth history that is used to list all children (alive or dead) that the respondent has given birth to, with the child's sex, date of birth, age, and survival status (83). In addition to English, the questionnaires were translated into three major languages such as Amharigna, Oromigna and Tigrigna (82). The EDHS data set is freely available from the DHS website. For this specific analysis we accessed the full data set from the website. Before the accesses of the data set, we were required to registered online and have account. In order to accesses the data there were legal procedure that has to be followed like submit the abstract about the purpose of the use of the data set, after sending the short abstract that indicate we interested on the data set for the thesis work we get the legal permission to download the full data set from the http://www.measuredhs.com website.

4.10. Data Quality and Management

The Ethiopia DHS questionnaire were based on model survey instruments developed for the international MEASURE *DHS+* project. The model questionnaires were then adapted to local conditions. Since these questionnaires are standard, they were developed in English language. In Ethiopia the questionnaires are translated in to five principal languages: - Amarigna, Oromigna,

Tigrigna, Somaligna, and Afarigna. The English version of the questionnaires were first translated into the five language then back translated to English independently and appropriate changes were made in the translation of questions when the back-translated version did not compare well with the original English version.

In order to keep the quality of data, the recruitment of people who were involved in the main fieldwork was conducted by taking due consideration of the languages of the specific areas. In order to maintain uniform survey procedures, four manuals relating to different aspects of the survey were prepared. The manual also contained information on how to weigh and measure women and children. The Supervisor's and Editor's Manual contained instructions on organizing and supervising fieldwork, maintaining and monitoring control sheets, and general rules for editing completed questionnaires and maintaining data quality. Trainers were given the Training Guidelines, which described the administrative and logistical aspects of training and data quality checks. There is also the Household Listing Manual which characterized the sampling and household listing procedures used in Demographic Health Surveys.

Before the start of fieldwork, the questionnaires were pretested in all local languages to make sure that the questions were clear and could be understood by the respondents. Debriefing sessions were held with the pretest field staff, and the questionnaires were modified based on lessons drawn from the pretest exercise. During the fieldwork, tables were generated to check various data quality parameters and specific feedback was given to the teams to improve performance.

The perinatal mortality is one of the adverse outcomes which is highly susceptible for omission and reporting error. To assure data quality the EDHS asked the women to report any pregnancy losses and duration of pregnancy, the age at death for any newborn death. EDHS also use the time cut off of five year preceding the survey, this cut off used to avoid the recall bias. For the analysis of trend and inequality in perinatal mortality the three round of EDHS data (2005, 2011 and 2016) with the particular focus on the birth history and the individual record file were used. Before the start of analysis, the completeness and accuracy of data were checked by running the frequency.

4.11. Data Analysis Plan

Data for the present trend and inequality in perinatal mortality analysis was generated from EDHS 2005, 2011, and 2016. The request was submitted to the EDHS website and the STATA format of data was received from the measuredhs.com. The variable selection for this analysis of perinatal mortality was based on known risk factors of perinatal mortality ascertained from previous research (5, 6). After the data is received the appropriate variable needed for this analysis were identified. Based on their requirement the recoding and generation of essential variable was done using Stata software version 14. To calculate the perinatal mortality, the DHS statistical guide was used, the guideline recommends the calculation of PNM as number of fetal deaths in pregnancies of seven or more months plus number of deaths of live-born children in the 0 – 6 days following births divided by still birth plus live birth in time period.

$$\text{Perinatal mortality} = ((\text{Early neonatal death} + \text{Stillbirths}) / \text{Total births})$$

Where: Total births =live births + stillbirths

For the calculation of PNM, the IR and BR file of the EDHS data series was used. Variables included in the calculation of PNM was calendar (vcal-1), the date of interview (V008), cmc_ start of the calendar (v017), month of the interview in the row position (v018), primary sampling unit (v021), stratification used in sample design (v023), duration of pregnancy (v233), date of birth of child (b3), child is alive or not (b5), age at death variables (b7) and women individual sample weight (v005). For the calculation of still birth, the DHS contraceptive calendar tutorial guideline was used. The EDHS asked the women to report any pregnancy that was aborted, miscarried and ended in stillbirth in the five years prior to the survey. For pregnancy that did not end with the live birth, the duration of pregnancy was recorded. According to the EDHS, stillbirth is defined as any pregnancy loses of seven or more completed month of gestation. The occurrence of stillbirth (response variable) is represented by the random variable M^i with binary values (1 and 0). The response variable was measured as dichotomous variable with value of M^i =1, if the mother had experienced any pregnancy losses after seven month of gestation (stillbirth) and M^i = 0 otherwise.

The EDHS also asked the mother to report death of the live born in the five years preceding the survey. For each of the death of the live birth the number of days, month and year of the newborn

survived was recorded, for those who survive less than month the number of days they survived was recorded. According to EDHS the death of the live born within the seven day was considered as early neonatal mortality. A dichotomous early neonatal mortality variable was created from a variable survived in the neonatal period. The response variable was measured as dichotomous variable with possible value of E^i =1 if the mother had experienced early neonatal mortality and E^i= 0 if no early neonatal mortality.

The response variable of this study was the occurrence of perinatal mortality among the mother of the reproductive age group (15-49). So, the total number of perinatal deaths (response variable) were computed by summing of the total number of still birth and early neonatal mortality. The response of outcome variable (perinatal mortality) was represented by variable "PN" with possible two values which was measured as a binary variable PNi = 1 if there is perinatal mortality and PNi = 0 if there is no perinatal mortality. Then the perinatal mortality rate was computed as per the recommendation of the DHS statistical guideline. This analysis was based on a weighted 11281, 12076 and 11071 women who had pregnancy that lasted for at least seven months in 2005, 2011 and 2016 EDHS data, respectively. In this particular study combination of different software was used: excel version 16, stat version 14 and R studio.

For each round of the survey the sociodemographic characteristics of the perinatal mortality was described by using the tables and graph. Descriptive statistics was done and disaggregated approach was employed to describe important characteristics. Trend in perinatal mortality rate for the period 2005, 2011, 2016 in the five years prior to each of the surveys and overall (2005-2016), were estimated from the individual record and birth history data, the finding was presented using table and graphical techniques. The trend in PNMR was stratified by region, place of residence (urban/rural), maternal educational status, maternal age at birth and wealth quantile. Additionally, 95 % confidence interval was used to indicate the period when significant difference is observed. The annual rate of reduction in perinatal mortality were calculated to describe trend in reduction per annum (84), and for this study the trend was calculated as: -

$$(r1-r2/\ r1*t) * 100$$

where: r1 = mortality rate for the year of the survey used as base line

r2 = mortality rate in the year of the final survey

t = number of years between the first and second survey

There are many dimensions of health inequality, which should be covered by the selected equity stratifiers. Ideally, health inequality should be analyzed and reported using relevant available stratifying data. According to the WHO, the acronym "PROGRESS" summarizes the equity stratifiers most frequently assessed in health inequality, but is not an exhaustive list of the stratifiers available and possibly relevant for analysis (13). These equity stratifiers are: place of residence (rural, urban, etc.), race or ethnicity, occupation, gender, religion, education, socioeconomic status and social capital or resources. In this study, four equity stratifiers were used, these are: place of residence (urban, rural), region (9 regions with two administrative city), education (no education, primary, secondary and higher education) and wealth status (lowest, second, middle, fourth, highest). Inequality is a complex and ambiguous concept that can be measured and conveyed using a variety of statistical techniques. Measures of inequality can be divided into simple and complex measures. In this specific study some of both the simple (difference and ratio) and the complex measure (concentration index) of inequality was employed based on their assumption.

The equity stratifiers like the maternal education and wealth status-based inequality in perinatal mortality was assessed by estimating the concentration index (CI) in Stata using the "conindex" command. Concentration index indicates the extent to which a health indicator is concentrated among the disadvantaged or the advantaged (85). The literature highlights that none of the inequality measures available are perfect (86). There is variety way of measure of the concentration index. We choose the measurement method based on the measurement properties of the variable of the health out come in which the inequality is tended to be measured . As the literature suggest the Erreygers concentration index measurement method was choice for the binary health outcome variable. Therefore, for this specific analysis, the Erreygers concentration index (CCI) was selected, as it corrects for several problems in the standard concentration index (86). For the perinatal mortality, variable of interest "y" the concentration index was calculated based on the following equation, the Erreygers CI can be calculated as:

$$CI(y) = 8cov\ (yi\ Ri)$$

Where: y_i: is the health sector variable in this case the dependent variable (perinatal mortality) of the individual i

Ri: is the fractional rank, with $i = 1$ for the poorest and $i = N$ for the richest

The value of the CI ranges from -1 to +1. It has **a positive** value when the health indicator is concentrated among the advantaged and **negative** value when the health indicator concentrated among the disadvantaged sub group of population. When there is no inequality, the concentration index is 0. In order to illustrate the CI, the concentration curve was used, if the concentration curve lie below the line of equality it shows the health indicator is concentrated among the advantaged; if the concentration curve lies above the line of equality it shows the health indicator is concentrated among the disadvantaged. When there is no inequality, the concentration curve lies on the line of equality (13).

In order to show the degree of inequality, the summary measure of inequality like difference (D) and ratio (R) was calculated. So, for region and place of residence (urban/rural) based inequality was summarized by using ratio and difference. The Difference (D) show absolute inequality which reflects the magnitude of difference in health between two subgroups, which was calculated by subtracting the mean value of health indicator in one subgroup from the mean value of health indicator in the other sub group. the value of Difference (D) range from -1 to +1, the value of positive indicates a higher concentration of the indicator among the disadvantaged and if negative value indicates a higher concentration among the advantaged, if there is no inequality D takes a value of 0. The ratio (R) is relative inequality measures, which show proportional differences in health among subgroups. Ratio (R) was calculated by dividing the mean value of health indicator in one subgroup by the mean value of health indicator in other subgroup and R takes only positive values (larger or smaller than 1). The further the value of R from 1, the higher the level of inequality (13).

The concentration index of a health variable can be decomposed into the contributions of individual factors to its inequality, where each contribution is the product of the sensitivity of the health variable with respect to that factor and the degree of inequality in that factor (85). The concentration index of the health variable of interest can be expressed as the sum of the contributions of the various determinants of that variable, together with unexplained residual

component. In order to identify the individual contribution of wealth to inequality in perinatal mortality decomposition analysis for the concentration index was done by using the "decomp" package in the R studio. In decomposing the CI of perinatal mortality the following step was followed (87):

Goodness of Fit of the Model

For this particular study we used the survey weighted generalized linear model with binomial family of logit link, because our outcome variable is binary and also fulfils the assumption of the generalized liner model. The goodness of fit a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how the predicted values are closer to the observed values. In statistics there are different method of testing the model fitness. Based on their assumption for this study we choose the Akaike information criterion (AIC) and The Hosmer–Lameshow(H-L) test. The basic idea behind the information criteria is penalizing the likelihood for the model complexity-the number of explanatory variables used in the model. The AIC can be defined by the equations:

$$AIC = -2logL(M) + 2p$$

where log L(M) is the maximized log likelihood for fitted model,

p = number of parameters in the model,

n = Sample size

N.B: The lower the values of AIC the best fit of the model.

A better way of assessing the fit of a logistic regression model is comparing the observed and expected numbers of positives for different subgroups of the data. The Hosmer-Lameshow goodness of fit test is useful for assessing overall model fit, particularly when we have many predictor variables. The test is similar to a $\chi 2$ goodness of fit test and has the advantage of partitioning the observations into groups of approximately equal size, and therefore there are less likely to be groups with very low observed and expected frequencies. The p-value for the Hosmer-Lameshow goodness-of-fit test greater than 0.05 imply that the model estimates are adequate to fit the data at an acceptable level. For this specific analysis we calculated the Hosmer-Lameshow and AIC value in R studio version 3.6.2 using the "**ResourceSelection"** package.

The second step was regressing the health variable against its determinant: Since the dependent variable, perinatal mortality is the binary variable with the value of 1 (there is perinatal mortality) and 0 (otherwise), the nonlinear svyglm model was used. The second step was calculating the CI for the health variable and for its determinants (and generalized CI of the error term). The concentration index for y, CI(y), can be written as follows (86):

$$CI(y) = 4\left\{\sum_k (\beta k\, \bar{xk})\, CIk + GC\varepsilon\right\}$$

Where x̄k: is the mean of dependent variable (perinatal mortality),

CIk: is the CI of the dependent variable (xk), and

GCϵ: is the generalized CI of the error term (ε).

CCI is then equal to a weighted sum of the CIs of the k regressors. The residual expresses the inequality that cannot be explained due to systematic variation in the regressors included in the analysis. The closer the residual goes towards 0, the better the fit of the model (86). In all of the above analysis the DHS stratification, house hold clustering and individual sample weight were taken in the consideration.

4.12. Ethical Considerations

This study used secondary data from the Ethiopian Demographic and Health Survey. Prior to using these data, agreement for access was secured from http://www.measuredhs.com, which allowed us to register and download the raw data from their Web Site. The Ethiopia DHS ask the consent from each respondent before the interview and the EDH survey were ethically approved by ethical committee. The ethical clearance letter was obtained from the School of Public Health, Addis Ababa University the research ethics committee (REC).

5. Results

5.1. Distribution of Perinatal Mortality Across Socio-demographic Characteristics

This analysis was carried out among total weighted 11281, 12076 and 11071 pregnancy of seven or more-month duration of five-year preceding survey 2005, 2011 and 2016, respectively. From the above number of pregnancies of seven or more-month duration, about 118, 204 and 130 were stillborn whereas 303, 347 and 236 were early neonatal mortality across the survey years, respectively. These translate to SBR of 10, 17 and 12 per 1000 total birth and ENMR of 27, 29 and 21 per 1000 live birth across the three survey years respectively. Over all the PNMR was 37, 46 and 33 in 2005, 2011 and 2016, respectively. As presented in Table 3 in the three survey years, the highest stillbirth rate was observed in rural area (11, 18 and 12) whereas early neonatal mortality rate was higher among the urban resident (36, 37 and 33) as compared to the rural area. When we compare the SBR and ENMR, the ENMR was higher than the SBR in both the urban and rural residents. There was also wide regional difference for the stillbirth rate and early neonatal mortality rate. The result indicated that the SBR was consistently higher among the four regions (Amhara, Benishangul Gumuz, Addis Ababa and Somali) whereas the ENMR was very higher among six regions (Amhara, Benishangul Gumuz, Harari, Somali, Oromiya and Tigray). Both SBR and ENMR was very high in Amhara, Benishangul Gumuz and Somali regions, while SBR was low in Dire Dawa (5, 9 and 3) region, but ENMR was low in Afar (9, 14 and 16) region in the three survey years respectively. When we view in terms of other socio demographic characteristics (wealth index and maternal education level) both the SBR and ENMR was inconsistently distributed across the three survey years.

Table 3: Distribution of Stillbirth rate, Early neonatal mortality rate and pregnancies of seven or more-month duration by socio demographic characteristics in Ethiopia from 2005-2016.

Background Characteristics		Survey Years								
		2005			2011			2016		
		SBR	ENMR	Number of pregnancies of 7+ month duration	SBR	ENMR	Number of pregnancies of 7+ month duration	SBR	ENMR	Number of pregnancies of 7+ month duration
Region	Tigray	7	14	703	17	34	766	15	21	720
	Afar	7	9	108	6	14	122	10	16	115
	Amhara	24	32	2685	23	32	2718	24	20	2105
	Oromiya	5	29	4433	17	28	5100	8	22	4856
	Somali	5	25	480	20	22	372	13	37	513
	Ben- Gumuz	16	26	107	20	38	143	6	23	122
	SNNP	7	23	2517	12	28	2523	9	18	2298
	Gambella	3	21	31	12	28	41	8	20	27
	Harari	5	20	22	3	38	29	13	27	26
	Addis Ababa	30	19	158	8	21	223	7	21	243
	Dire Dawa	5	19	38	9	14	39	3	24	47
Place of Residence	Urban	10	36	823	9	37	1543	8	33	1215
	Rural	11	26	10458	18	28	10534	12	20	9855
Level of Maternal Education	No education	12	26	8948	18	28	8377	11	21	7305
	Primary	3	32	1860	14	30	3258	14	19	2977
	Secondary	8	25	430	13	48	269	6	24	516
	Higher	13	0	44	22	4	172	11	41	272
Age at First Birth	<20	13	51	1738	19	42	1571	17	17	1317
	20-29	8	25	5775	14	23	6712	9	19	6055
	30-39	9	17	3150	16	34	3271	11	27	3243
	40-49	30	33	618	47	28	523	37	26	455
Wealth Index	Poorest	5	18	2451	18	34	2759	12	16	2654
	Poorer	13	19	2386	18	33	2708	11	17	2516
	Middle	11	40	2514	25	21	2499	12	23	2290
	Richer	13	29	2251	13	20	2301	13	26	2018
	Richest	11	29	1679	8	37	1810	10	30	1592
Overall		10	27	11281	17	29	12076	12	21	11071

5.2. Trends in Perinatal Mortality Rate

In this study, the trend in perinatal mortality rate was characterized by using the demographic characteristics such as level of maternal education, place of residence, the administrative region, wealth index and the maternal age at birth. It was described by line graph and summarized using annual rate of reduction. The result showed that the trend of SBR and PNMR were significantly increased from 2005 to 2011 survey years but the ENMR trend didn't show the significant increase because the confidence interval overlaps as shown in the Figure 2. When we compare the trend from the 2011 survey years to the 2016 survey, all outcome (SBR, ENMR and PNMR) trend showed that a significant reduction from 17, 29 and 46 in 2011 to 12, 21 and 33 in 2016 respectively (SBR, ENMR and PNMR). When we observed the trend from 2005 to 2016 the result indicated that the perinatal and early neonatal mortality rate in Ethiopia was reduced from 37 and 27 in 2005 to 33 and 21 in 2016, respectively, whereas the stillbirth rate showed a slight increment from 10 in 2005 to 12 in 2016 as shown in Figure 2.

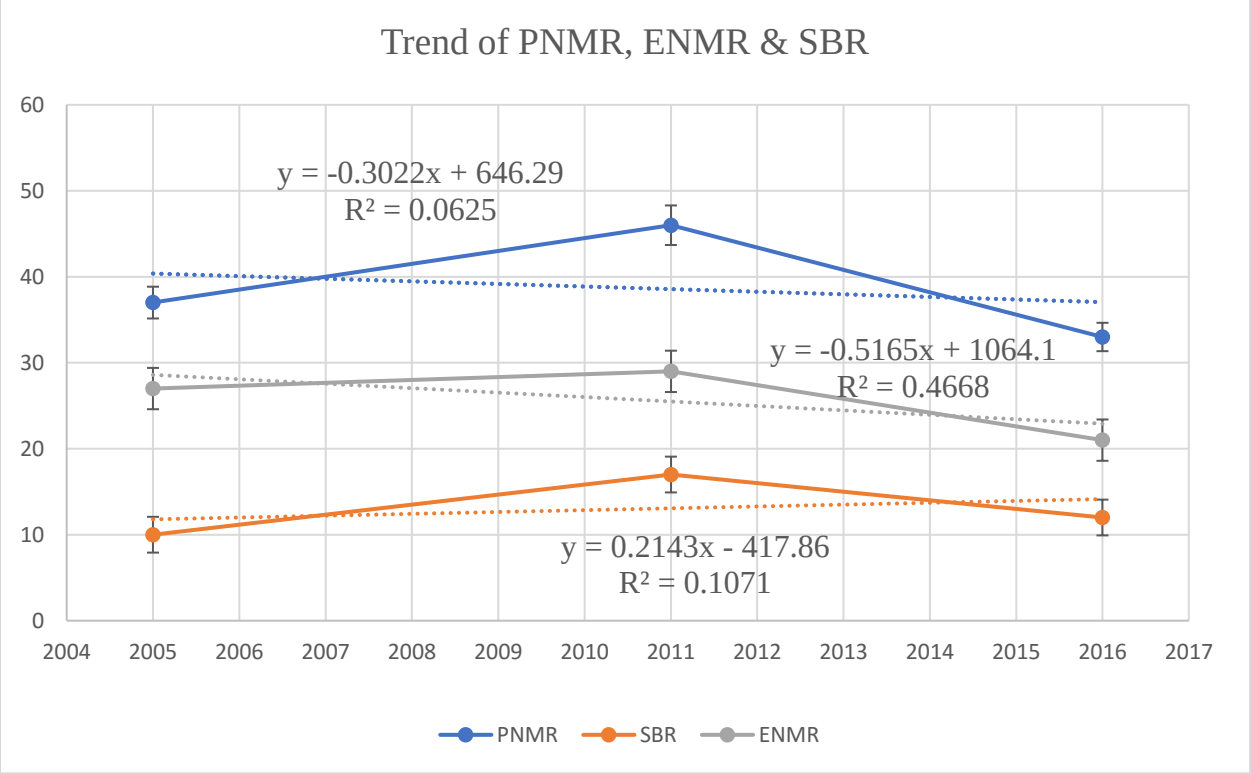

Figure 2: Trends of Stillbirth rate, Early neonatal mortality rate and Perinatal mortality rate in Ethiopia from 2005-2016.

In terms of the administrative division significant reduction of PNMR was observed among Oromia (34, 45, 20), SNNP (30, 39 and 26) and Benishangul Gumuz (42, 58 and 28) region in respective of the survey year (Figure 3). In contrast, the PNMR were significantly increased in Somali (30, 42 and 50) and afar (16, 20 and 25) regions whereas in Harari (25, 40 and 45) and Dire Dawa (24, 23 and 27) there were insignificant increment. The other two regions (Tigray and Addis Ababa) result showed an inconsistent trend over the survey years.

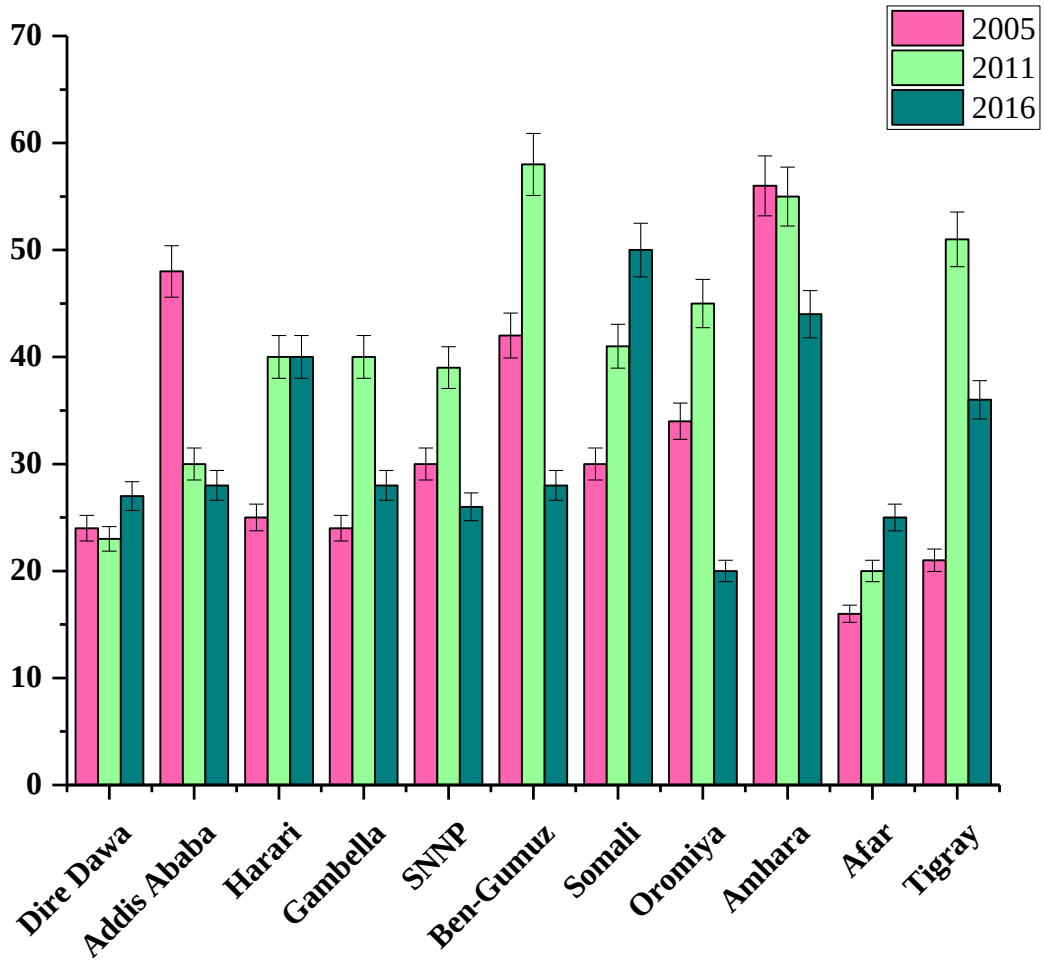

Figure 3**:** Trend of Perinatal mortality rate over administrative division in Ethiopia from 2005-2016

We also studied the trend of PNMR across the level of maternal education in the three survey years. Even though the PNMR was gradually declining among the non-educated groups, the result in Figure.4 indicated that there was significant increment of PNMR among higher level educated maternal groups (13, 26 and 52) across the three survey years respectively. When we compare the trend among mother with no education, primary and secondary level of education, PNMR showed some increment (2011) and reduction (2016) survey years as compared to the 2005 survey years, since their confidence interval overlaps there is insignificant change across the three survey years (Figure 4). The PNMR across the wealth division was also analyzed throughout the three survey years. As indicated in Table.4 the PNMR over the wealth index were significantly reduced among the middle wealth quantile (51, 46 and 35), respectively. Whereas the trend of PNMR among the poorest (22, 52 and 27) and richest (40, 45 and 40) wealth quantile group showed an inconsistent trend. In view of the poorer and richer wealth group the result indicated a reduction trend, but not statistically significant.

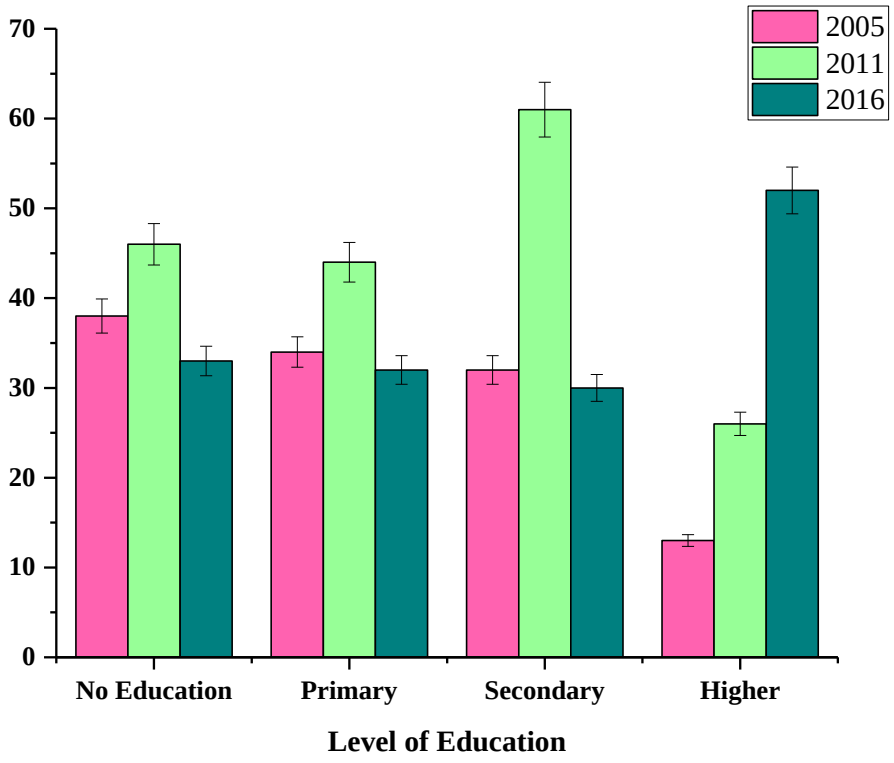

Figure 4: Trends of perinatal mortality rate across the level of maternal education in Ethiopia from 2005-2016.

In this study the trend of perinatal mortality was summarized using the annual rate of reduction. For the computation of the ARR we use the 2005 survey year result as baseline and the 2016 survey as end year. So, comparison made between the 2005 and the 2016 survey years. As indicated in Table 4, the average annual rate of reduction of PNMR in Ethiopia was 0.72 %. The result of this study showed that the rate of reduction of perinatal mortality rate was higher for Oromia region (3%/ annuum), Addis Ababa (3%/annuum) and Benishangul Gumuz (2%/annuum) region but lowest reduction rate of PNMR were observed in Tigray (-5%/annuum), Afar and Somali region (-4%/annuum). Based on maternal level of education, age at birth and wealth index classification, the annual rate of reduction of PNMR were high for mother in middle wealth quantile (2% per annuum) and maternal age at birth of less than 20 (3% per annuum). However, mother with higher education (-20%/annuum) was unexpectedly showed lowest rate of reduction. Whereas, mother with primary and secondary school, mother with the richer and richest wealth group didn't show any rate of reduction in PNMR (0/ annuum).

Table 4: Trend and average annual rate of reduction of perinatal mortality rate by selected socio demographic characteristics in Ethiopia from 2005-2016.

Socio Demographic Characteristics		Perinatal mortality rate and 95% confidence interval			
		2005	2011	2016	Average annual rate of reduction from 2005 to 2016 (%)
Region	Dire Dawa	24 (2 46)	23 (11 34)	27 (0 54)	-1
	Addis Ababa	48 (25 72)	30 (11 49)	28 (8 47)	3
	Harari	25 (10 39)	40 (24 57)	40 (23 58)	-4
	Gambella	24 (8 40)	40 (22 58)	28 (13 43)	-1
	SNNP	30 (22 38)	39 (29 49)	26 (18 35)	1
	Benishangul Gumuz	42 (27 56)	58 (45 71)	28 (16 41)	2
	Somali	30 (14 45)	41 (26 56)	50 (37 62)	-4
	Oromia	34 (24 44)	45 (34 55)	20 (19 40)	3
	Amhara	56 (43 68)	55 (42 68)	44 (31 57)	1
	Afar	16 (4 28)	20 (12 28)	25 (10 41)	-4
	Tigray	21 (12 31)	51 (37 65)	36 (24 47)	-5
Place of Residence	Urban	46 (32 60)	46 (36 57)	42 (31 53)	1
	Rural	37 (33 40)	46 (42 50)	32 (28 35)	1
Maternal Level of Education	No education	38 (34 42)	46 (42 51)	33 (29 37)	1
	Primary	34 (26 43)	44 (37 51)	32 (26 39)	0
	Secondary	32 (16 49)	61 (32 89)	30 (15 45)	0
	Higher	13 (-21 47)	26 (2 49)	52 (25 78)	-20+
Wealth Index	Poorest	22 (16 28)	52 (44 60)	27 (21 34)	-2
	Poorer	32 (25 39)	51 (43 59)	28 (22 35)	1
	Middle	51 (43 60)	46 (38 54)	35 (27 42)	2
	Richer	42 (33 50)	32 (25 39)	39 (31 48)	0.48
	Richest	40 (31 50)	45 (35 54)	40 (30 49)	0
Gender	Male	32 (28 37)	35 (30 40)	29 (24 33)	1
	Female	21 (18 25)	23 (19 27)	14 (10 17)	2
Maternal Age at Birth	<20	64 (52 76)	61 (49 73)	34 (24 44)	3
	20-29	33 (28 37)	37 (33 42)	28 (24 32)	1
	30-39	26 (20 32)	50 (43 58)	38 (31 44)	-3
	40-49	63 (44 82)	75 (52 97)	63 (40 85)	0
Nationally		37	46	33	0.72

5.3. Inequality in Perinatal Mortality

5.3.1. The Concentration Index for Wealth-based Inequality in Perinatal Mortality

Figure 5 showed that the detailed figure of concentration index of wealth, the economic status accounted for the poor- rich concentration of perinatal mortality. The results indicated that the concentration index for wealth-based inequality across the three survey years (2005, 2011 and 2016) were 0.0158926, -0.0117815 and 0.01130234, respectively and the concentration index for overall aggregated data was 0.012. The concentration index was positive for the 2005, 2016 survey years and pooled data but negative for the 2011 survey year. According to the 2005 survey year and pooled data result, the perinatal mortality was significantly concentrated among the rich subpopulation group ($p = 0.0077$ and $p= 0.004$) respectively, while in the 2011 the perinatal mortality was concentrated among the poor. For the recent survey (2016) the perinatal mortality was concentrated among the rich subpopulation but not statistically significant ($p=0.097$). The concentration index of wealth declined from about 0.0159 in (2005) to 0.0113 in the (2016). Also Figure 5 depicts the concentration curve of perinatal mortality by wealth index across the three survey years. The concentration curve lies below the equality line for the 2011, 2016 survey and overall aggregated data, while for the 2005 survey the concentration curve lies above the equality line. This indicates that the perinatal mortality was concentrated among the rich for the survey year (2011, 2016 and aggregated data) but it is concentrated among the poor for the 2005 survey year. Except the 2005 survey years the concentration curve cross the equit line and very close to the diagonal line.

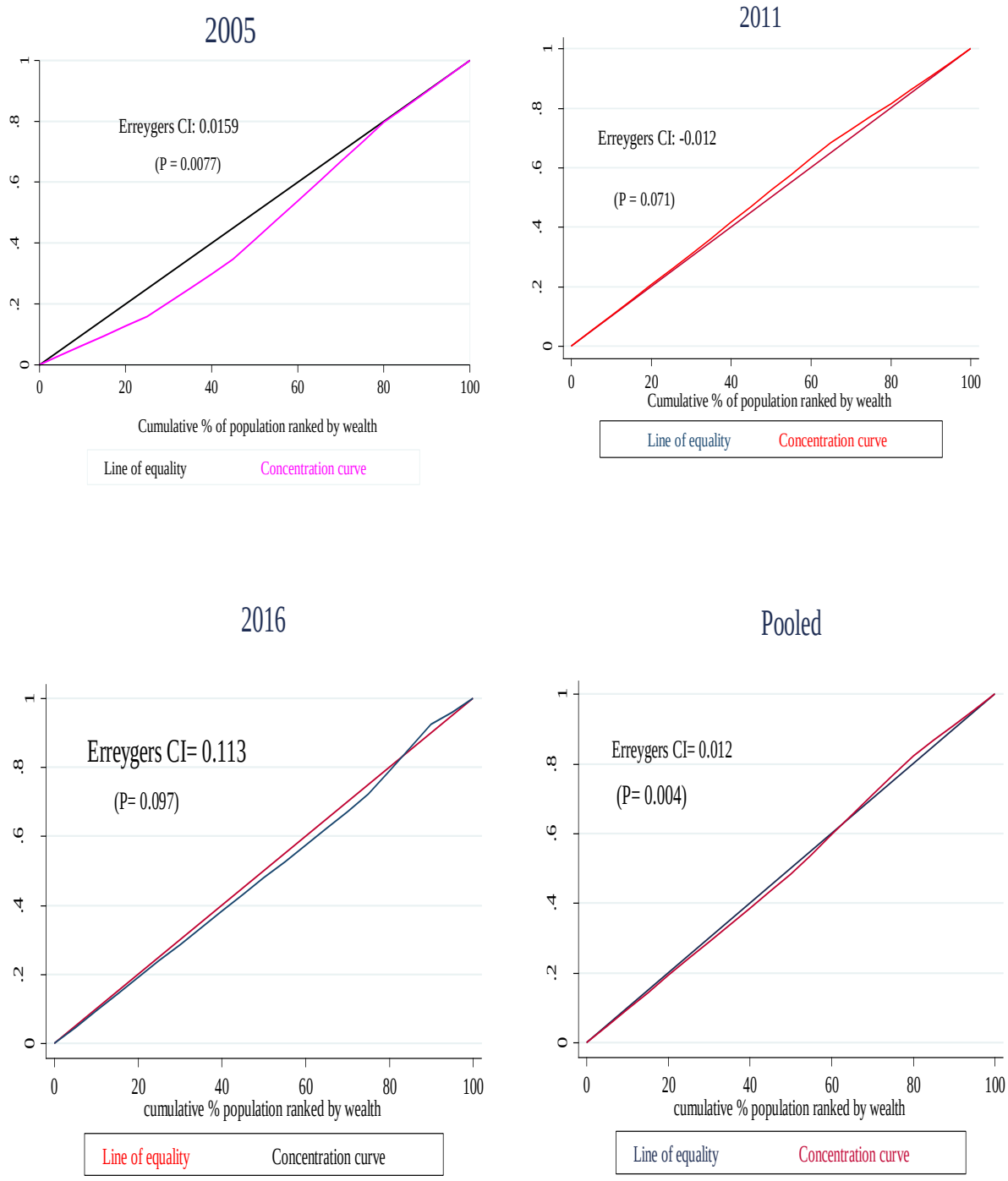

Figure 5: Concentration index for wealth-based inequality in perinatal mortality in Ethiopia from 2005- 2016.

5.3.2. The Concentration Index for Level of Education

Level of maternal education was one of the contributors for the difference in the perinatal mortality across the population. Figure 6 describes the concentration curve and index value for level of maternal education. The concentration index for the level of maternal education over the three-survey year (2005, 2011and 2016) was (-0.00011, -0.0013 and 0.0010), respectively, while for the overall aggregated data (from 2005-2016) the concentration index was nearest to zero (CI= -0.0002, P= 0.094). The concentration index was positive for the 2016 survey year which indicates that perinatal mortality was concentrated among the mother who attend the highest level of education. While, it was negative for the 2005, 2011 survey years and pooled data, which showed that the perinatal mortality is concentrated among the group of mothers who were not educated. The trend of the concentration index for level of education was slightly increased from -0.00011 in (2005) to 0.0010 in (2016). The concentration curve for perinatal mortality ranked by level of education was also indicated in Figure 6. The figure highlight that the concentration curve for perinatal mortality is close to the line of equality and sometimes cross the equity line which suggests that, there is narrow inequality and the distribution of perinatal mortality was close to diagonal line of equality.

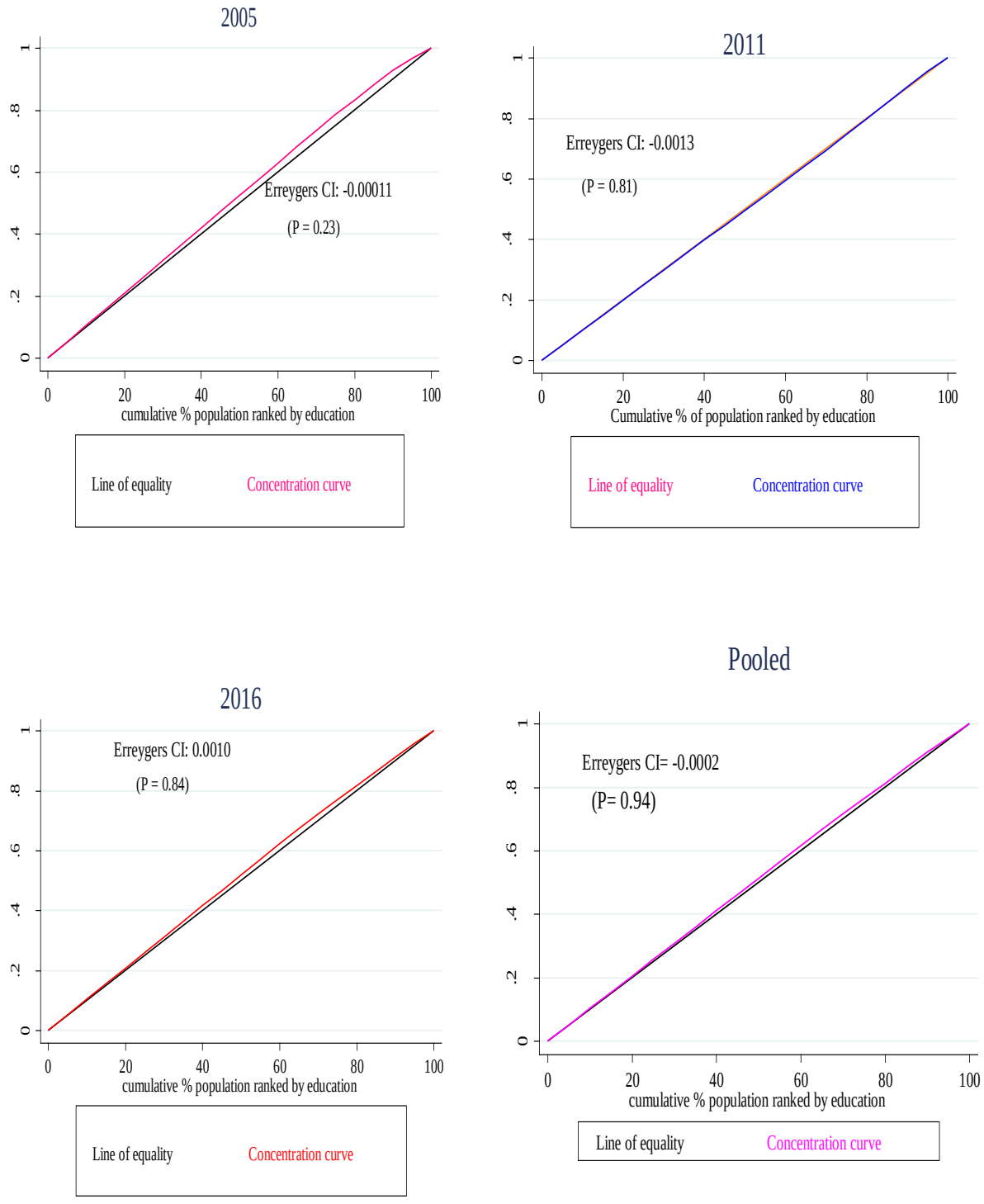

Figure 6: The concentration index for level of maternal education-based inequality in perinatal mortality in Ethiopia from 2005-2016.

5.3.3. Simple Inequality Summary Measure (Ratio and Difference) for Region

The difference in perinatal mortality was pronounced for the region. The simple inequality summary measure revealed that there was inequality in perinatal mortality across the region in each of the three survey years. From Table 5, the difference value for region based absolute inequality in perinatal mortality in Ethiopia from 2005 DHS to 2016 DHS on average was -0.0070 (-0.0117, -0.0023), the highest percent of perinatal mortality was observed Oromia region (32%) and the lowest value was in Harari region (0.1%). The absolute value (difference) for each of three survey year including the pooled data was negative, which indicates that mother with pregnancy of seven or more month who lives in the region with less perinatal mortality had less chance of facing perinatal mortality as compared to the mother who lives in region which had high perinatal mortality. The absolute value for the 2011 survey year showed that mother with pregnancy of seven or more month who lives in region with lowest perinatal mortality had 1.3 percentage point of less chance of experiencing perinatal mortality than mother who lives in region with high perinatal mortality.

The relative inequality for the region indicated that, mother with pregnancy of 7+ month who reside in region with highest perinatal mortality were more likely to experience PNM as compared to mother with pregnancy of 7+ month in region with low perinatal mortality. For survey year 2011, children born in the region that had high perinatal mortality, 66% more likely to die as compared to the region of low perinatal mortality on average (Table 5). In Ethiopia on average, the pattern of perinatal mortality across the administrative division over the three-survey year were consistent. The absolute and relative inequality for the 2005 and 2011 survey year were stable. When compared to the most recent survey (2016) with the previous survey year (2005), the relative inequality was relatively decreasing as compared to the absolute inequality.

Table 5: Simple ratio and difference-based inequality in perinatal mortality across the region in Ethiopia from 2005-2016.

Summary measure of inequality	Survey year value with 95% (CI)			
	2005	2011	2016	2005-2016
Difference (Highest-Lowest	-0.0050 (-0.0111, 0.0011)	-0.0129 (-0.0233, -0.0025) *	-0.0055 (-0.0127, 0.0017)	-0.0070 (-0.0117, -0.0023) *
Ratio (Highest/Lowest)	0.8433 (0.6787, 1.0477)	0.6641 (0.4522, 0.9754) *	0.8045 (0.5968, 1.0843)	0.7868 (0.6619, 0.9354) *

5.3.4. Simple Measure of Inequality (Difference and Ratio) for Place of Residence

Place of residence is one of the equities stratifiers used in this analysis. According to the simple measure of inequality result there was variation in perinatal mortality in rural and urban place of residence. Table 6 illustrate the difference and ratio for perinatal mortality based on place of residence. According to 2016 EDHS data, the absolute value for urban- rural were 1.2 percentage whereas for 2011, this difference was -1.7%. The point estimate for the 2005 and 2016 survey year indicated that mother with pregnancy of 7+ month duration who reside urban area had less perinatal mortality compared to the rural area. Whereas the 2011 survey year estimate showed that those mothers with pregnancy of seven or more-month duration who lives in rural area had less perinatal mortality than who lives in urban area.

The relative inequality result showed that across all survey year mother with pregnancy of 7+month who lives in rural area was more likely to experience perinatal mortality than the urban mothers. On average in Ethiopia mother in rural area were 73% more likely to had perinatal mortality than the urban mother (2005-2016 EDHS). The pattern of reduction of the absolute and relative inequality was inconsistent while comparing the most recent survey with the previous surveys. The absolute inequality in perinatal mortality for place of residence were relatively decreasing. However, the relative inequality was slightly increasing.

Table 6: Simple difference and ratio-based inequality in perinatal mortality over the place of residence in Ethiopia from 2005-2016.

Summary measure of inequality	Survey year value with 95%(CI)			
	2005	2011	2016	2005-2016
Difference (rural-urban)	0.0047 (-0.0207, 0.0300)	-0.0176 (-0.0463, 0.0111)	0.0124 (-0.0142, 0.0390)	-0.0118 (-0.0276, 0.0041)
Ratio (rural/urban)	1.1513 (0.5589, 2.3720)	0.6712 (0.3867, 1.1649)	1.4734 (0.7211, 3.0104)	0.7254 (0.4962, 1.0605)

5.3.5. Goodness of Fit of the Model

In this section the goodness of fit of the model was assessed and the statistical value was also presented in the Table 7. AIC value indicate that the selected covariate was important determinant of the perinatal mortality in Ethiopia. The overall goodness of the model was assessed using the Hosmer-Lemeshow (H-L) goodness-of-fit test. The value of H-L goodness of tests statistic and the p-value was also presented in Table7. Since the computed p-value for the three survey years and the pooled data was greater than 0.05 at 5% level of significance, we conclude that the model is adequate.

Table 7: Akaike information criterion and Hosmer-Lemeshow Goodness-of-Fit test statistics result for survey years of 2005, 2011, 2016 and pooled data.

Criterion	Survey years value			
	2005	2011	2016	Pooled data
Null deviance	1916.7	2936.2	2381.7	7251.4
Residual deviance	1757.2	2749.3	2190.5	6778.6
AIC	1823.2	2815.3	2256.5	6850.6
Hosmer and Lemeshow Goodness of Fit (GOF) Test				

X-squared	2.1813	4.6268	3.4211	6.3567
Df	3	3	3	3
P-value	0.5356	0.2013	0.3311	0.09549

5.3.6. Decomposition of the Concentration Index

We decomposed the determinant of perinatal mortality inequities using the pooled EDHS data set, from 2005 to 2016. Table 7 present result from the decomposition analysis of the contribution of the selected sociodemographic characteristics on overall concentration index. The decomposition results revealed that the largest contributor to wealth-based inequality were richer wealth division (18.7), middle (4.7%) and poorer (2.7), while the richest wealth level has the negative contribution (-20.5) which indicates that the pure effect of wealth on the inequality in perinatal mortality.

Overall result showed that the leading contributors to inequality in perinatal mortality were Afar and Gambella region (27.5) and (27), respectively, no Antenatal care visit (26.4), second birth interval (21.8), followed by primary education level (22), richer (18.7) and giving birth at home (17.8). Delivering at public facility narrow the inequality (-5.1), while home delivery exacerbate it as compared to giving birth at the private sector. In context to the maternal age at birth age group 20-29 and 40-49 reduce inequality (-11.9) and (-3.6), respectively, whereas the age group of 30-39 widen the inequality (4.2). Variable like rural place of residence, Dire Dawa, SNNP, Somali region and has no accesses to media once a week and small or very small birth size have negative contribution. This negative contribution indicating that the effect of those predictor for inequality worked by lowering wealth inequality, that is, they tended to shrink the wealth-based inequality by preventing the occurrence of perinatal mortality among these subpopulations. On the other hand, mother who delivered by SVD and mother who has previous history of terminated pregnancy increase the observed inequality in perinatal mortality (11) and (5.4), respectively. In contrary to this variable preceding birth interval of 4+ reduce these inequality (-20.4).

The decomposition residual regression error for the inequality in perinatal mortality were found 0.000007, which is very small. This indicates that the determinant factor included in the decomposition analysis explain all of the inequality. Generally, our finding indicates that there is socio economic inequality in perinatal mortality.

Table 8: The selected explanatory variables and their percentage contribution with cross ponding concentration index and the 95% confidence interval to inequality in perinatal mortality in Ethiopia from 2005-2016.

Socio-demographic Characteristics		**Pooled Data (2005 - 2016)**					
		Coefficient	**P-value**	**Contribution %**	**Concentration Index**	**95 % Confidence Interval**	
	Residual			0.000007			
Wealth Index	Poorest (Ref)						
	Poorer	0.03	0.92	2.7	0.10	0.09	0.11
	Middle	0.08	0.73	4.7	0.33	0.32	0.34
	Richer	0.17	0.45	18.7	0.55	0.54	0.56
	Richest	-0.31	0.26	-20.5	0.83	0.83	0.84
Maternal Education Level	No education (Ref)						
	Primary	0.53	0.01 *****	22	0.11	0.10	0.13
	Secondary	0.34266	0.31	11.1	0.33	0.30	0.36
	Higher	0.36383	0.73	6.5	0.65	0.62	0.67
Place of Residence	Urban (Ref)						
	Rural	0.93	0.003 *****	-43.9	-0.12	-0.12	-0.11
Region	Oromiya (Ref)						
	Tigray	0.03	0.88	1.6	0.10	0.03	0.18
	Afar	-0.25	0.32	27.5	-0.36	-0.38	-0.36
	Amhara	0.47	0.003 *****	6.2	0.23	0.04	0.42
	Somali	0.30	0.12	-5	-0.18	-0.22	-0.13
	Benishangul Gumz	0.44128	0.009 *	7.5	0.10	0.09	0.11
	SNNP	-0.08	0.59	-2.2	0.28	0.15	0.41
	Gambella	-0.24	0.56	27	-0.55	-0.56	-0.54
	Harari	0.36	0.21	11.8	0.30	0.28	0.31
	Addis Ababa	0.07	0.93	3.8	0.72	0.70	0.73
	Dire Dawa	-0.28	0.58	-4.5	0.09	0.05	0.11

Previous History of Terminated Pregnancy	Yes (Ref)						
	No	1.19	0.002*	5.4	0.03	0.01	0.06
Access to Media	Yes (Ref)						
	No	0.61	0.54	-14.3	-0.004	-0.01	0.003
Place of Delivery	Private Facility (Ref)						
	Home	-0.50	0.37	17.8	-0.09	-0.1	-0.08
	Public Facility	-0.01	0.98	-5.1	0.4	0.42	0.44
Mode of Delivery	Cesarian Section (Ref)						
	SVD	-0.55	0.16	11.0	-0.01	-0.01	-0.004
Women Decision Making	Yes (Ref)						
	No	-0.03	0.93	6.4	-0.26	-0.28	-0.24
Preceding Birth Interval	< 2 (Ref)						
	2	-1.04	0.001*	21.8	-0.04	-0.04	-0.02
	3	-1.09819	0.04 *	6.3	-0.02	-0.02	-0.0009
	4+	-0.61	0.005 *	-20.4	0.10	0.08	0.11
Birth Size	Average/Larger (Ref)						
	Small /Ver small	0.44	0.002 *	-31.3	-0.12	-0.14	-0.11
Maternal Age at Birth	< 20 (Ref)			-11.3			
	20 – 29	-0.61	0.01 *	-11.9	0.02	0.01	0.02
	30 – 39	-0.28	0.28	4.2	-0.03	-0.04	-0.01
	40 – 49	0.10	0.85	-3.6	-0.14	-0.18	-0.10
ANC Visit	Yes (Ref)						
	No	-0.19	0.40	26.4	-0.13	-0.14	-0.12
Survey Years	2005 (Ref)						
	2011	0.42	0.01 *	16.5	0.05	0.04	0.05
	2016	0.02	0.92	-4.5	-0.30	-0.31	-0.28

6. Discussion

This study focuses on perinatal mortality trend and inequality in Ethiopia using the nationally representative house hold survey of the three rounds (2005, 2011 and 2016). The result found that positive trend of reduction with low ARR for perinatal mortality rate which indicated that the overall PNMR was slowly declining with the average annual rate of reduction of 0.72% per annuum. The low ARR of perinatal mortality rate imply that there is poor quality of obstetric and pediatrics care in the country. Also, our study identified 1.5% annual reduction in early neonatal mortality rate, whereas there was negative reduction in stillbirth rate (-1.3% per annum). Even if the ARR for ENMR was positive, the rate of reduction was obtained below the neonatal and under five mortality in Ethiopia.

The result showed that there was slight increment in stillbirth rate with low reduction of early neonatal mortality which contributed to slow reduction of perinatal mortality rate. This negative reduction in the stillbirth rate probably linked with lack of nationally effective implementation maternal and newborn strategy which targeted at reducing the stillbirth rate. Different studies showed that stillbirth is mainly linked to the maternal conditions during pregnancy and other factor associated during delivery (intra and anti-partum hemorrhage, eclampsia, infection and intrauterine growth restriction) (6, 88, 89) . The lower reduction in early neonatal mortality rate may be due to lack of quality and effective neonatal care. It also implies that, even though the country (Ethiopia) tried to introduce high impact neonatal intervention in its National Newborn and Child Survival Strategy from 2005-2016, there is still the gap in full implementations at lower level. Therefore, in order to reach the SDG, it's important to develop intervention targeting reduction of early neonatal mortality and stillbirth in Ethiopia.

The study examined trend in perinatal mortality rate using different socio demographic factors. The result revealed that perinatal mortality rate was significantly lower among girl than boy and the annual rate of reduction was also higher among girl. This may be due to biologically boy are weaker than girl and they are also more susceptible for several disease (68, 90). Our finding is also consistent with the study conducted in Bangladesh (91).

Socio economic gap in perinatal mortality was also one of the problems in low- and middle-income country. The result of this study reported that significant reduction in perinatal mortality rate was observed among the middle-income wealth division sub population. In contrast to this, the study conducted in Bangladesh using the BDHS result indicated that the significant reduction in PNMR was observed among the poorest wealth quintile division group (91). This variation is probably due to the difference in the survey period and study setting. The high reduction among the middle wealth group indicated that PNMR was concentrated among the poor sub population. Even though the antenatal care, delivery and postnatal care services were delivered free of charge in Ethiopia, the disadvantaged people may lack cost for transportation and resource required for the service.

We identified that trend of PNMR were significantly increasing among mother with higher education level. This increasing trend linked with the measure of the self-assessed health in EDHS, thought to reflect better knowledge of health issues that also reflects the more the mother educated, the more she can identify the problem and access the service and diagnosed (92). Our finding showed that SBR was very high among mother who categorized under higher education. As reported by different studies stress, alcohols use, smoking and chat chew is risk factor for stillbirth. It's also expected that the mother with higher education are highly prone to the stress due to different responsibility at work and family. Again, our result indicated that the PNMR was higher among mother classified under the age group of 30-39. This may result an increasing trend of PNMR among higher educated mother. This may be due to the higher educated women spent most of her age at school and had delayed marriage.

This study also pointed out that among the four maternal age group classification, the significant reduction in the trend of perinatal mortality was observed among mother in age group of < 20 and is supported by Hossain.et.al (91), whereas mother in age group of 30-39 showed significant increase in the perinatal mortality rate with -3% ARR. This might be due to mother who lose their baby will try to catch up by having another baby immediately. The replacement decision usually results to the subsequent loses of the newborn.

Similar to other studies (20, 91, 93) sluggish reduction in perinatal mortality and inconsistent decrement in administrative division with low annual rate of reduction in perinatal mortality rate was observed in Ethiopia. This could be due to unequal distribution of the intervention service in the country (94), even if the government introduce high impact maternal and neonatal intervention there is considerable gap in reaching the sub population. The finding indicated that significant reduction in PNMR was observed among Oromiya, Benishangul, SNNP and Amhara regions, whereas two remote region (Afar and Somali) the perinatal mortality rate was significantly increasing from 2005 to 2016. This indicates that the increasing trend in these two regions would result to the slow reduction of the PNMR. The negative reduction in the two regions may be linked to unequal health service delivery. The significant reduction in Oromiya and Amhara regions probable due to relatively concentrated with population of better socioeconomic status and the health service intervention is also related with the economic level. In the other way, there is unequal distribution of health work force in Ethiopia (95).

There are several measures of inequality, which are broadly classified as simple and complex measure of inequality. In our analysis some of the simple and complex methods were employed based on their assumption. The simple summary measure of inequality is easily interpretable and understandable, they are also important to inform the policy maker and different administrative leaders (13). The ratio and difference-based inequality for region and place of residence showed that there was clear inequality in perinatal mortality. The observed significant absolute and relative inequality in perinatal mortality across administrative regions suggest that the perinatal mortality was concentrated among the disadvantaged region. This would be due to several factor like poor utilization of reproductive maternal and new born service, unequal distribution of health professional, economic difference within region and hard to reach area with specific region (20, 96, 97). The absolute and relative inequality result for place of residence also showed the gap in urban rural distribution of perinatal mortality. Insignificant difference showed that the perinatal mortality was in favor of the rural place of residence but the result was not consistent across all survey year. This may be linked with the unequal distribution of different infrastructure like sanitation facility which mainly related with mortality, health service was mainly concentrated in urban area, even if the Ethiopia introduce health extension worker, there was evidence which show there is low utilization of the RMNCH service among rural resident (96, 97).

The current study also examined inequality and factor that explain inequality in perinatal mortality by using the concentration index and decomposition of the concentration index inequality analysis methods. The concentration index (CI) is an appropriate measure of health inequity (85). In the journal of economics, the concentration index is the popular choice for the measure of the health inequality. The concentration index identifies the extent which health outcome differ among subpopulation ranked by some socio-economic indicator (98-100).

In this study the mother with pregnancy of seven or more-month duration based on their level of educational attainment was categorized in to four education group. The 2005, 2011 survey years and pooled data results showed that there was maternal education-level based inequality in perinatal mortality. Both the concentration index (negative) and concentration curve lies above the line of equality but not significant. This was supported by the study conducted in Teran by Almasi-Hashiani A, et al. (101) (mother education under diploma has the CI value of -0.448). Our finding indicated that perinatal mortality was concentrated among illiterate women. Mostly not educated women are unemployed, economically dependent and also lack awareness about the health issue (pregnancy related complication), lack decision making power and low utilization of the MNHS (96, 102, 103).

View of the wealth-based inequality in perinatal mortality, the 2005 survey year and pooled data revealed that perinatal mortality was significantly concentrated among the reach wealth index group, but it contradict with the study done in Bangladesh by Hossain M.B, et al (91), which showed that the perinatal mortality rate was significantly higher among the poor household. The concentration curve also lies below the equality line and it's also close to the diagonal equity line for the 2016 survey but not significant. The positive CI value in these three-survey years also support trend result of this study (trend of PNMR was significantly increasing among the well to do family). This indicated that the perinatal mortality is largely concentrated among the women from the wealthiest family. Even if the death is prevalent among the poor, in developing country commonly the poor report less death or illness than the advantaged and also the richer people has high likely hood of accessing the health service and diagnosed (92). This is in agreement with the finding by Gebre et al (96), the rich women more utilize the maternal and newborn health service (ANC, SBA and PNC) as compared to the poor women. This may lead to the high likely hood of reporting the perinatal mortality among the women from well to do family. Despite the positive

concentration index in the 2005, 2016 survey and the overall aggregated data, the 2011-survey result revealed that the perinatal mortality was in favor of the poor but not statistically significant. This showed that the effect of wealth on perinatal mortality inequality was not consistent across the survey years.

We found that from all variable used in the regression-based decomposition analysis; region, level of maternal education, economic status, antenatal care visit, birth interval and place of delivery have explained the biggest part of observed inequality in perinatal mortality. Compared to the other regions Gambella, Afar and Harari region of residence was found as the major determinant of inequality in PNM. These regions have negative concentration index and positively contribute to inequality in PNM which indicated that the perinatal mortality was majorly concentrated among these three regions and they also contribute to the widening of inequality. So, these regions lead to the raised socio-economic inequality in perinatal mortality. Therefore, the strategy or intervention which aim to reduce the perinatal mortality inequality has to mainly focus on these three regions. In this study Dire Dawa has negative contribution, this reduce the inequality by helping the rich region because mother who live in Dire Dawa are likely to be rich (positive concentration index). Since the perinatal mortality was concentrated among the deprived region, the poor-rich gap in perinatal mortality reduced as the mother in the deprived region start to be on the same economic level with the mother who live in advantaged region. Other important contributor to the observed disparity were decision making power, place of delivery, previous history of terminated pregnancy and accesses media. Existing evidence similarly found that previous history of terminated pregnancy contributes to the observed inequality in perinatal mortality (101, 104).

Some of the above-mentioned independent variables had positive contribution i.e., they widened the observed poor-rich inequality in perinatal mortality. This indicates that they play great role for the increased perinatal mortality in Ethiopia. Therefore, to close the equity gap in perinatal mortality effort has to be made in improving this positive contributor of inequality in PNM. The other explanatory variables have negative contribution, meaning that they reduce the disparity. For example, ANC visit contribute to the socio-economic inequality in perinatal mortality in a way that the women who had no any antenatal care visit during pregnancy was poor (negative concentration index) which is supported by the study conducted by Gebre et al ((96) (non-

utilization of ANC service was concentrated among the poor women) and was more likely to have had high perinatal mortality (positive contribution). This would be due to that poor women may not have money to cover cost of service or transportation and may not afford the payment of health service to bring her ill new born or other family. Generally, the above scenario clearly showed that the fact that variable contributes to increasing or reducing of inequality if the factor itself is unequally distributed along the socio-economic (96). In our study the contribution of wealth for perinatal mortality inequality was comparatively low.

6.1. Strength and Limitation of the Study

6.1.1. Strength of the Study

- Consideration of weight, stratum and clustering during each point of data analysis.
- The use of different inequality analysis methods (simple and complex) that helps us to clearly understand the problem more.
- The effects of the survey year are controlled during the pooled data analysis. So, the result of this study is not affected by the result of different survey years.
- The residual error in our study is very low, the inequality in our study is explained well by the variables included in the regression model.
- Denormalization of the standard weight during the pooled data analysis.

6.1.2. Limitation of the Study

Despite the above-mentioned strength this study has some limitations:

- Even if we use the five year before the survey for calculation of perinatal mortality there is some recall bias.
- Omission of the 2000 EDHS data set, because of missing variable which are needed for the calculation of the stillbirth.
- As the EDHS ask mother who alive during the interview period, and the information of children whose mother deceased was not collected.
- Under reporting, often mother not report the stillbirth or early neonatal mortality due to the socio-cultural problem.

7. Conclusion

This study points out that trend in perinatal mortality rate in Ethiopia from the 2005 - 2016 show slow reduction with very low annual rate of reduction. The rate of reduction is also varied within region, survey years and socio demographic characteristics. Although there is reduction in perinatal mortality rate still the rate has to be found very high which make unrealistic in achieving the SDG goal of reducing the neonatal mortality rate. The annual rate of reduction for the stillbirth rate was negative and very low compared to the early neonatal mortality reduction which indicate the need of strengthening the high-quality maternal health service (ANC, SBA and PNC) and effective emergency obstetric care service. As the concentration index is best measure of health inequality, we conclude the inequality based on the result of the concentration index and its decomposition. Generally, in this study we observed poor-rich inequality in perinatal mortality. The magnitude of the concentration index and the concentration curve direction also vary from survey to survey and among the equity stratifiers. The survey results clearly, show there is wealth and education-based inequality in perinatal mortality. The region, place of delivery, ANC visit, level of maternal education and birth interval found to be the major contributor for the wealth-based inequality in perinatal mortality. In this study the pure effect of wealth on inequality in perinatal mortality was found to be low which is in line with the concentration index value and concentration curve. The finding of this study signifies, the need in closing the gap in perinatal mortality has to focus on addressing the disadvantaged residence, increase the utilization of the MNH service and ensuring equal provision of health service in all residence.

8. Recommendations

Based on the finding of this study the following recommendation was forwarded.

- In order to minimize the inequality in perinatal mortality in Ethiopia effort should be made narrowing the economic variation within population (regions).
- When planning an intervention to reduce the perinatal mortality in Ethiopia due attention should be given in increasing the uptake of maternal and newborn service.
- We also recommend effort has to be made in reducing the equity gap in perinatal mortality
- Further studies are recommended for further understanding of the nature of inequality in perinatal mortality and to determine the trend of inequality in perinatal mortality in Ethiopia.
- The Author of this study cannot explain why there is unusual increase of the PNMR in 2011 survey year. Further studies are recommended to more explain and investigate why there was an increase of the perinatal mortality for the 2011 survey year.

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Declaration

I, the under signed, declare that this thesis is my original work, has not been presented for a degree in this or another university and that all sources of materials used for this thesis have been fully acknowledged.

Name of student: Abebech Demise Signature. ----------

Date of submission: ----------

This thesis work has been submitted for examination with my approval as university advisor.

Name of the primary advisor ---------- signature. ----------

Date: ----------