ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

TREND AND INEQUALITIES IN NEONATAL MORTALITY AND ITS COVARIATES: ANALYSIS OF THE ETHIOPIA DEMOGRAPHIC AND HEALTH SURVEYS BETWEEN 2000 AND 2016

BY: YODIT HAILEMICHAEL (BSc)

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES ADDIS ABABA UNIVERSITY SCHOOL OF PUBLIC HEALTH IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE MASTERS DEGREE OF PUBLIC HEALTH WITH SPECIALITY IN REPRODUCTIVE HEALTH AND FAMILY HEALTH

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This thesis, by Yodit Hailemichael is accepted in its present form by the board of examiners as fulfilling for the degree of Masters of Public Health in Reproductive and Family Health.

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ABRIVATIONS AND ACRONYMS

ANC	Antenatal care
CCI	Composite Coverage Index
CSA	Central Statistics Agency
EDHS	Ethiopian Demographic and Health Survey
EmONC	Emergency Obstetric and Newborn Care
FMOH	Federal Ministry of Health
FPC	Family Planning Coverage
HSTP	Health Sector Transformation Plan
LMICs	Lower- and Middle-Income Countries
MDG	Millennium Development Goals
NMR	Neonatal Mortality Rate
EPHC	Ethiopian Population and Housing Census
RMNCH	Reproductive, Maternal & Newborn Child Health
SBA	Skilled Birth Attendant
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
UHC	Universal health Coverage
U5MR	Under-five Mortality Rate
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

ABSTRACT

Background: Neonatal mortality in low-and middle-income countries has shown slow decline and marked disparities across regions and countries. In Ethiopia, despite making overall progress in child survival, deaths among newborn babies still remain high at 29 deaths per 1,000 live births. Evidence on trend and inequalities in neonatal mortality in Ethiopia is scarce and yet, such evidence is important to contribute to the effort towards reducing neonatal mortality.

Objectives: This study aims to assess the trend and inequalities in neonatal mortality by the five equity stratifiers, namely region, place of residence, wealth status, maternal education and composite coverage index (CCI) using the four Ethiopia Demographic and Heath Survey (EDHS) rounds.

Methods: Using the four nationally representative survey conducted in 2000, 2005, 2011 and 2016, direct estimate of neonatal mortality rate were computed from birth history information provided by mothers. The trend in neonatal mortality were measured using annual rate of reduction and 95% CI to indicate the period when significant difference was observed. Once the data from the four rounds pooled together, we used both absolute and relative inequality measures to measure inequality in neonatal mortality. Concentration index was computed for the socioeconomic inequality and for area-based inequality, difference and ratio were calculated. We further did decomposition analysis for the wealth-based inequality to understand individual percentage influence to the observed inequality in neonatal death of the commonly known factors of neonatal death. A p-value of < 0.05 and 95% CI was reported as a measure of magnitude of significance.

Result: Overall trend in neonatal mortality rate was slowly declining with the annual rate of reduction of 1.98 percent per annum between 2000 and 2016, and also great variation in average decline by selected equity stratifiers. Well served regions in reproductive maternal and child health service had comparatively lower mortality rate than underserved regions. In all the survey years there is wealth and education-based inequality in neonatal mortality, however the levels were not significant except for the 2011. An estimate of concentration index indicates (-.002, .009, -.012, .012) for wealth and (-.011, -.001, -.009, -.003) for education with p-value of (0.68, 0.07, 0.02, 0.05) and (0.00, 0.67, 0.00, 0.53) respectively. The absolute and relative inequalities in terms of regions showed greatest inequalities between regions with the highest mortality(Amhara) and

regions with lowest mortality(Addis Ababa) with a difference = 0.0141, 95% CI (0.0059, 0.0222) and Ratio = 1.55 with 95% CI (1.1584, 2.0767) were as for place of residence (rural Vs urban) it showed non-significant, Difference = -0.0089 (-0.0222, 0.0045) and Ratio = 0.8054 (0.5972, 1.0863) respectively. The major contributors for observed wealth-based inequalities were different levels of wealth status, underserved regions and rural residence.

Conclusion: Trend in neonatal mortality have showed slow decline and it was not uniform among the selected equity stratifiers, progress in annual rate of reduction was also sluggish. Across the survey years, though mortality is concentrated among socioeconomically disadvantaged, the levels of wealth and education-based inequalities were significant only for the 2011 survey. Furthermore, estimates of absolute and relative inequalities for regions shows significant inequalities. It is recommended to maintain improvement in Reproductive, Maternal & Newborn Child Health (RMNCH) services and scaling up of interventions that directly act on leading determinants of neonatal mortality by focusing on the general population in addition to targeting the disadvantaged society, rural residents and underserved regions.

Keywords: neonatal mortality, inequality, disparity, trend, variation.

1. INTRODUCTION

1.1 Background

Neonatal period, the period during the first 28 days carry one of the highest risk of death in the history of human life(1) As of January 2018, globally around 386,000 births occur daily, 90 % of them are born in less developed region and over half of these births are estimated to take place in nine countries that includes Ethiopia(2).While many babies will survive, some will not make it past their first day and 7000 neonates died every day(3). Neonatal deaths encompass early neonatal death which occur during first seven days and late neonatal death which occur after seventh day but before 28^{th} day(4).

Neonatal mortality is an important indicator of a country's socioeconomic development and quality of life and it is defined as number of live born infants per year dying before 28 completed days of age per 1000 live births and neonatal mortality rate is the probability of dying during the first 28 days of life per 1,000 live births(5).

Out of 2.5 million newborn deaths that occurred in 2017,most of which occurred in the first week (1 million dying on the first day and close to 1 million on the next six days)(6). More than 98% of these neonatal deaths occurred in low and middle-income countries (LMICs),two regions only accounts for almost 80 per cent of the newborn deaths (sub-Saharan Africa, and Southern Asia) and half of all neonatal deaths are concentrated in five countries, namely, India (24 per cent), Pakistan (10 per cent), Nigeria (9 per cent), the Democratic Republic of the Congo (4 per cent) and Ethiopia (3 per cent)(6).

Among Global regions Sub-Saharan Africa has the highest NMR (28/1,000 LBs)(6). From newborns in sub-Saharan Africa, about 1 child in 36 dies in the first month, while in the world's high-income countries the ratio is 1 in 333 (7). Each year in Africa, about 1.16 million babies die in their first month of life and up to half in their first day(8). In Ethiopia deaths among newborn babies are also still high at 28 deaths per 1,000 live births and about 1 in every 35 dies in the first month(9).The new UNICEF report indicates that in 2016 alone, 90,000 newborn babies died in Ethiopia, ranking the country among 10 high burden countries globally(10).

There were also significant across country and within country inequalities in neonatal mortality in different dimensions of inequality globally(11).The larger being in sub Saharan Africa(12).in which Ethiopia has the highest share. Health inequalities are defined as systematic differences in health that can be avoided by appropriate policy intervention and that are therefore deemed to be unfair and unjust(13).and inequality in neonatal mortality is the variability in the distribution of mortality between populations living in geographically-defined regions(14).

During the Millennium Development Goal (MDG) era, many countries in Africa achieved marked reductions in under-5 and neonatal mortality. However the pace of progress toward these goals substantially varied at the national level(15). The decline in the neonatal mortality rate was also slow compared to that of children aged 1-59 months (15) Recognizing this, multiple high impact interventions has been documented to reduce neonatal mortality (16)and international and national communities also sustained an effort; to finish commitments handed down (left unfinished by) from the MDG agenda, and they agreed on the new global roadmap called Sustainable Development Goals (SDGs) and neonatal mortality reduction has been used as a key indicator to monitor the progress(17).

In Ethiopia, despite significant achievements in child health improvement nationally, the gains are not so equitable(18). Addressing this inequity gap remains as a priority task during the era of the sustainable development goals(17). and as highlighted in the 2015-16 Health Sector Transformation Plan (HSTP), where in maternal and Newborn health is considered as priorities for the Government of Ethiopia and the goal of the program is to reduce neonatal mortality rate to 10 per 1,000LBs by 2020(19).The Ethiopian reproductive health strategy which is aligned with the vision of HSTP also highlighted reduction in neonatal mortality rate under the primary target(20).

Health inequality analysis intend to indicate the extent of distribution of health out come with in population sub-groups, and measuring this inequality particularly in countries with great heterogeneity is vital since national average is misleading(21, 22). and can be avoided with effective low-cost interventions(11).The commitment to close the gap (universal health coverage) and SDG 10 reducing inequality provide a firm basis for our objective and this study was aimed

to assess the trend and inequalities in neonatal mortality and its covariates in Ethiopia using the four rounds of DHS survey.

1.2 Statement of the problem

Neonatal mortality continues to be a public health problem, especially in sub Saharan Africa and despite proven high impact interventions reducing neonatal mortality remains a challenge for decades(1, 23). As there is a highest number of death encountered during neonatal period with modest reduction compared to post neonatal, the share of neonatal death among under five also increased globally(3).

Even though reducing neonatal mortality to as low as 10 per 1000 LBs is the target for SDGs(17),findings indicate that progress towards this goal has been modest (3) with marked variation across regions and countries(24). Though, the level of inequalities and their development over time differ, studies have shown that in all settings, inequalities in neonatal mortality are influenced by individual level, demographic, socioeconomic, environmental and health care system factors (11, 25, 26) which could be readily preventable or treatable with proven, cost-effective interventions(6).

In Ethiopia, despite the commitment to accelerate newborn survival (Newborn and Child Survival Strategy 2015-2020)(27), and the country's flagship community health program (the health extension program) which contributes greatly to increase primary health care coverage at the community level(28), it is not clear why neonatal mortality stay high (at 28 deaths per 1000 LBs) and the cause for the pronounced regional variation in neonatal mortality (18 in Addis Ababa and 47 in Amhara)(9). Even if, the target for under five mortality rate was achieved, the target for infant and neonatal mortality rate (with a reduction of 61% and 63%, respectively) were just below the MDG 4 (67%) (18) and regional performance shows, quite severe and significant disparities in health outcomes, Nevertheless the role of local factors leading to these disparities are not well studied(29).

Identifying inequality level and trend by different dimension are of particular importance in populous countries like Ethiopia, to contribute to the effort towards reducing neonatal mortality. However, there is paucity of information in inequalities in neonatal mortality in Ethiopia, which significantly limits our understanding of the extent of inequalities. Therefore, this study attempts to answer the question on: - the trend and level of inequalities in neonatal mortality in Ethiopia and factors associated with it.

1.3 Rationale and significance

The highest mortality rate and large number of neonatal death in the world occurs in Sub-Saharan African countries (1), and also sub-national variability of neonatal mortality in sub-Saharan Africa is large(6). Neonatal mortality is mostly monitored at the national level, especially in low and middle- income countries. As estimates from the Global burden of disease studies rely on nationally representative surveys, little attention is given about within country distribution of neonatal mortality(30).

Focusing on national neonatal mortality rate as the main metric for monitoring progress is likely to be inadequate for understanding where and why children are still dying (8) and in countries with high level of inequality in health, declines in mortality rates at the national level might be misleading(31).Identifying patterns and discrepancies across different populations serve as a valuable way to examine why inequalities are larger in some populations than in others(32).

Since most low- and middle-income countries failed to reach the targets of the MDGs by 2015(33), maternal, newborn and child health goals continued as sustainable development goals (SDGs) 3.1 and 3.2, to be achieved by 2030(17).

On the other hand to promote nationwide inclusive social development and improve evidence based targeted intervention, health outcomes should be distributed more equitably across all regions and socioeconomic groups, Thus, producing evidence to support government and development agencies to address constraints is an important step, and analyzing and understanding disparities in health outcome enables the unmasking disparities across regions and other socioeconomic strata thereby enabling deeper understanding of both the severity of disparities and inequality in access and provision of health services.

So that tracking the levels and changes in health inequalities is vital for health programs to allocate resources to those who are disadvantaged and have greater needs. Also, to resolve the equity gap strategies that are directed at the areas with greatest need, including most marginalized and disadvantaged populations, should requires generating more robust and granular data for geographic areas, population groups and socioeconomic status.

Additionally inequalities in health outcome are not static, but change over time, looking at changes and improvements over a period of time and reporting gains that were faster in disadvantaged sub group is desired for the reduction of inequalities(34).and also monitoring inequalities based on regions is useful to unmask geographical differences in health, to generate important evidence and to support targeting of health programs and policies especially when disparities are large(32).

To respond to the above issues, to determine whether actions in the health sector are successful in reducing inequalities, and to identify population subgroups that are underserved by health services and overburdened by mortality, sub-national assessment of neonatal mortality were considered very necessary and this study aims to assess the trend and inequalities in neonatal mortality and factors contributed to disparity using data from the four rounds of Ethiopia Demographic and Heath Survey(EDHS).

Additionally, findings of the study will serve as an input for other related studies in the future and inform the launch of equitable strategies to help end the unfair within country inequality in the occurrence of neonatal death.

2. LITERATURE REVIEW

2.1. Global overview of neonatal mortality

Globally the burden of neonatal death is unevenly distributed across regions and countries and out of 3 million neonatal deaths that occur each year, approximately 2.4 million deaths occurs in developing countries (7). Even though every region in the world is experiencing large proportion of neonatal death, the burden is highest in low income countries especially in sub Saharan Africa were the risk of dying is nine times higher than high income countries(6).

Neonatal death globally are a complication of preterm birth, intrapartum related causes and infections(23). however there is existed effective interventions that can reduce neonatal mortality in high mortality low resource setting by targeting the leading cause of neonatal mortality but the uptake of these low cost interventions has remained low in many setting and vary according to settings over time(23).

The study of neonatal mortality has been attracting nationwide attention because of considerable reduction of population during neonatal period, which has a major contribution on child mortality. Different global researches on various aspects of neonatal mortality have identified many of the proximate determinants as maternal factors, environmental factors and health system factors and assess trend in neonatal mortality(35-38).

2.2. Trend in neonatal mortality

Neonatal mortality declined globally and, in all regions, also progress in reducing mortality has been accelerated. The annual rate of reduction in neonatal mortality increased from 1.8 in 1990-2000 to 3.1 in 2000-2017, but more slowly than children aged 1–11 months. Despite this, marked disparities in neonatal mortality exist across regions and countries Worldwide(3).

The global neonatal mortality rate fell from 37 deaths per 1,000 live births in 1990 to 18 in 2017, a 51% reduction. Among the regions, the largest declines since 1990 occurred in Eastern Asia with an 84 per cent reduction followed by Europe with a 64 per cent reduction. From 5.4million under five deaths that occurred globally in 2017, 2.5 million deaths occur in the first month of life, which constitutes 47% of under five deaths(3).

Empirical evidence from many studies globally shows mortality has a decreasing trend; however, disparities still exist across countries and regions and the rate of reduction is also getting lower. In spite of improvements at national level there was marked and increasing inter-state and urban rural difference. Generally, urban areas experienced larger reduction than rural. For instance, in countries like United States mortality rate decreased as urbanization increased but in contrast, in India where the highest morality rate encountered, the reduction of neonatal mortality is slow despite urbanization and high income states(39-42).

A systematic analysis of progress, projections, and priorities for 193 countries show over the 20 year from 1990 to 2009, an estimated 79 million babies died in the first 4 week of life. Of these, the vast majority (98%) died in LMIC, with 31 million in Southeast Asian LMIC, and 21 million in African LMIC. There were 1 million deaths in HIC. Between 1990 and 2009, even though the proportion of child deaths in the neonatal period increased in all regions of the world, the global NMR declined by 28% (from 33.2 deaths per 1,000 live births to 23.9).While NMRs were halved in some regions of the world, Africa's NMR only dropped by 17.6% (43.6 to 35.9)(43).

In sub Saharan Africa despite 41% reductions (46-27) in NMR from 1990-2017, marked disparities in neonatal mortality existed. Even though the rate declined in 23 countries, the number of neonatal deaths did not decline from 1990 to 2017 and also the burden of newborn deaths stagnated in the region (around 1 million deaths per year). Study from Nigeria, where the highest number of deaths occurred in Africa, shows that there is a wide disparity in child mortality rates among the six geopolitical zones, the 36 states and the Federal Capital Territory Abuja (8, 44).

In Ethiopia over the past decade, however, the country witnessed an unprecedented decline in under-5 mortality; the extent of decline varies among the component rates that combine to form the under-five mortality. Between 1990-2013 (over 23years), neonatal and post-neonatal mortality rates fell by 52% (62.1 deaths/1000 live births to 29.9) and 64% (64.7 deaths/1000 live births to 23.3 deaths) respectively, and from recent data neonatal mortality 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(9, 45).

Analysis from 2000, 2005 and 2011 EDHS in 2013 indicates that all the under-five childhood mortality indicators have been gradually declining over the last years but the trend in neonatal

mortality rate showed a slow decline of 1.9% per annum during the period. The highest mortality decline is observed in children 12 months to 47 months old which declined from 77 deaths per 1000 live births in 2000 to 31 deaths per 1000 live births in 2011, a 60% decline. Infant mortality also declined from 97 deaths per 1000 live births in 2000 to 77deaths in 2005 and to 59 deaths in 2011, a decline of 40 percent. Similarly, under-five mortality has shown a continuous reduction from 166 deaths per live births in the 2000 to 123 deaths in 2005and 88 deaths in 2011, a decline of 47 per cent. However, Neonatal mortality rates have not decreased to the same extent; the decline was just around 20 per cent(35, 46).

The trend for the overall neonatal mortality rate tilted heavily toward the trend of the early neonatal mortality rate because over 70% of the neonatal deaths occur in the first week of life. The relative contribution of the early neonatal mortality to the overall neonatal mortality increased from approximately 70% in 1995–2000 to 79.5% in 2006–2010. Therefore, the modest declining trend noted for the overall neonatal mortality in the country is mainly attributable to the decline in the post neonatal period and this show that, declining trend for neonatal mortality in Ethiopia is inadequate and faster decline in neonatal mortality is needed(35).

In general, overall trend in neonatal mortality globally shows modest decline, based on the current trends, 56 million children under 5 years of age are projected to die between 2018 and 2030, half of them will be newborns. Data from global health observatory (GHO) report on situations and trends in neonatal mortality, more than 60 countries will miss the SDG target of reducing neonatal mortality to at least as low as 12 deaths per 1000 live births by 2030; about half of them will not reach the target by 2050. These countries carry about 80 % of the burden of neonatal deaths in 2016. If countries falling behind would achieve the SDG target on child survival by 2030, 10 million lives of children under age 5 could be saved(3).

In our country, explanation for observed different trend is unclear. Reaching the SDG under-5 mortality target will require faster progress rate, but addressing those bottlenecks to bring much fastest progress on decreasing neonatal mortality has continued as a challenge. So that our primary reason to conduct this study is to measure and disclose inequality trend in neonatal mortality among sub group population and produce more robust information for policymakers, programmers and practitioners to identify where action is needed.

2.3 Inequalities in neonatal mortality

Global figure in neonatal mortality indicates that there are improvements at national level in many countries, however, across and within country inequality existed according to different dimension of inequality and there is also large variation in the level of within country inequalities (41, 47, 48). Many studies have shown that inequality in neonatal mortality is influenced by a number of socio-economic, demographic, maternal health service factors. In all setting changes in neonatal mortality were accompanied by social inequality, showing a reduction only for women with intermediate and higher education and household's with richest or rich wealth score. The contributions of observed determinants to neonatal mortality inequality also remained unchanged. They emphasized that besides achieving the desired average level in NMR, correction of unequal distribution of neonatal death across society is of high priority(25, 49-51).

Regarding geographic location, study in Poland analyzed death in rural and urban areas and found that both in urban and rural areas neonatal deaths were more frequently observed (70.8% and 70.7%, respectively) than post-neonatal (29.2% and 29.3%, respectively). But neonatal death rate among vulnerable group was significantly higher in rural areas than in urban areas. Similarly, in India, mortality inequality declined in urban areas but remained unchanged or increased in rural areas. They revealed presence of substantial regional and urban-rural disparity during 1970-2011. NMR is stagnant even in the era of health system reforms. The needs to intensify activities aimed at improving access among women in rural areas are considered(40, 50, 52).

In Brazil, between 1991 and 2000 inequality trend across 5,507 municipalities based on their socio-economic status, shows poorer municipalities still have much higher rates of neonatal mortality than richer municipalities and this problem has not been changed over time. The importance of monitoring progress at sub-national level and measuring inequality gaps to accurately target health and inter-sectorial policies were highlighted particularly in developing countries and countries with large socioeconomic inequalities(32).

Additionally, neonatal mortality inequalities could be affected by effective intervention coverage. Fenn et al. (2007) carried out study by obtaining data from DHS of eight countries, to determine the extent of within-country inequities in neonatal mortality and effective intervention coverage. In all countries, inequities in neonatal mortality and intervention coverage were evident. Low

coverage of interventions tended to show top inequity patterns whereas high coverage of intervention tended to show bottom inequity patterns(53).

A prospective cohort study conducted in Bangladesh in two adjacent intervention and government-service area by emphasizing whether health intervention programs reduced socioeconomic inequalities of neonatal mortality and whether the inequalities have changed overtime. In both the intervention areas, poor-rich ratio of neonatal mortality has widened overtime this implies usual health intervention programs (non-targeted) do not reduce poor-rich gap since they will initially reach those who are already better off. The coverage of effective interventions, especially among the poor (targeted), needs to be increased if a decline in the number of neonatal deaths was expected (54).

When we come to regional level, inequalities in sub Saharan region thought to be large and local factors play bigger part in explaining variation. Multicounty analysis of 24 low-income and middle-income countries in the past two decade shows socioeconomic inequality in neonatal mortality has decreased. However, a substantial survival advantage remains for babies born into wealthier households with a high educational level in most countries(12, 30, 55).

Also, while comparing inequalities in neonatal mortality across cities in Africa, significant inequalities across all cities were observed, but the level of inequalities and their development over time differ. In the most recent survey, significant inequalities were found in Kinshasa, Luanda, Abidjan, and Addis Ababa. Particularly in Addis Ababa and Accra, the concentration curves from earlier and later years cross, making it more difficult to determine whether inequalities increased or decreased over time. They recommends further study to understand why some countries have increased NMR inequalities and research examining determinants of inequalities(11, 12).

Other studies in 2016 across 28 African countries shows inequalities were spreading since the 1980s and it is closely linked with economic inequality in many countries, and perhaps with differential use of child health service. The consistent result in Sub-Saharan Africa countries strongly support Sub-national measures of mortality could provide a more accurate, and potentially more actionable, interpretation of where and why children are still dying than can national statistics(30, 56).

In Ethiopia, disparities in neonatal mortality by region is associated with a combination of several factors, indeed regional variation in neonatal mortality is considerably large. Neonatal mortality varied between 18 per 1000 live births in Addis Ababa and 47 per 1000 live births in Amhara – a difference of 29 neonatal deaths. Ambel et al. (2017) found that pro-rich inequality in certain health status outcomes including neonatal health. In addition, in both health status and health services, there is substantial wealth-related inequality (9, 57).

The level and the distribution of health outcomes and coverage for key services in Ethiopia, and their association with socioeconomic and geographic determinants also assessed using 2000, 2005 and 2011 Ethiopian Demographic and Health Survey and result show that there is unequal socioeconomic and geographic distribution of health and access to key services in Ethiopia. There are widening inequalities for some of the indicators, although the health achievement indices improved for most indicators from 2000 to 2011 with the exception of neonatal deaths. 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. The factor contributing the most to the observed inequalities need to be investigated(58).

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(21). 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 (59, 60) .

Limited number of researches done on inequalities in our country while searching on different journal. Since neonatal mortality inequalities are substantial in the region, understanding of the

share of sub national factors will help to identify and provide necessary information for policy, program and decision makers in order to develop evidence-based intervention strategies.

Additionally, since sub national regional distribution in neonatal death is unequal in our country, addressing the inequality gap needs deeper understanding of where and why neonates die, and disclosing gaps between population sub group helps to recognize how progress in national average is realized. So that this study asses the trend and level of inequality in neonatal mortality by different dimension of inequality and factors contributed to the observed inequality in Ethiopia, to make equity related (fair, right, acceptable) policies, programs and practices can best implemented.

2.4 Conceptual frame work

The conceptual fame work presented below is adapted from Mosley and Chen 1984 classical frame work(61).That describes factors contributed to neonatal mortality and highlights the interrelationship between the variables considered in this study. This study considers neonatal mortality as outcome variable and the socioeconomic factors that affect outcome variable through proximate determinants namely; maternal factors, environmental factors and health service factors are considered as independent variable. We were not considered the other factors in this model in our analysis because as our study focus on inequality, factors that have potential to explain and proposed to study inequality was only considered.

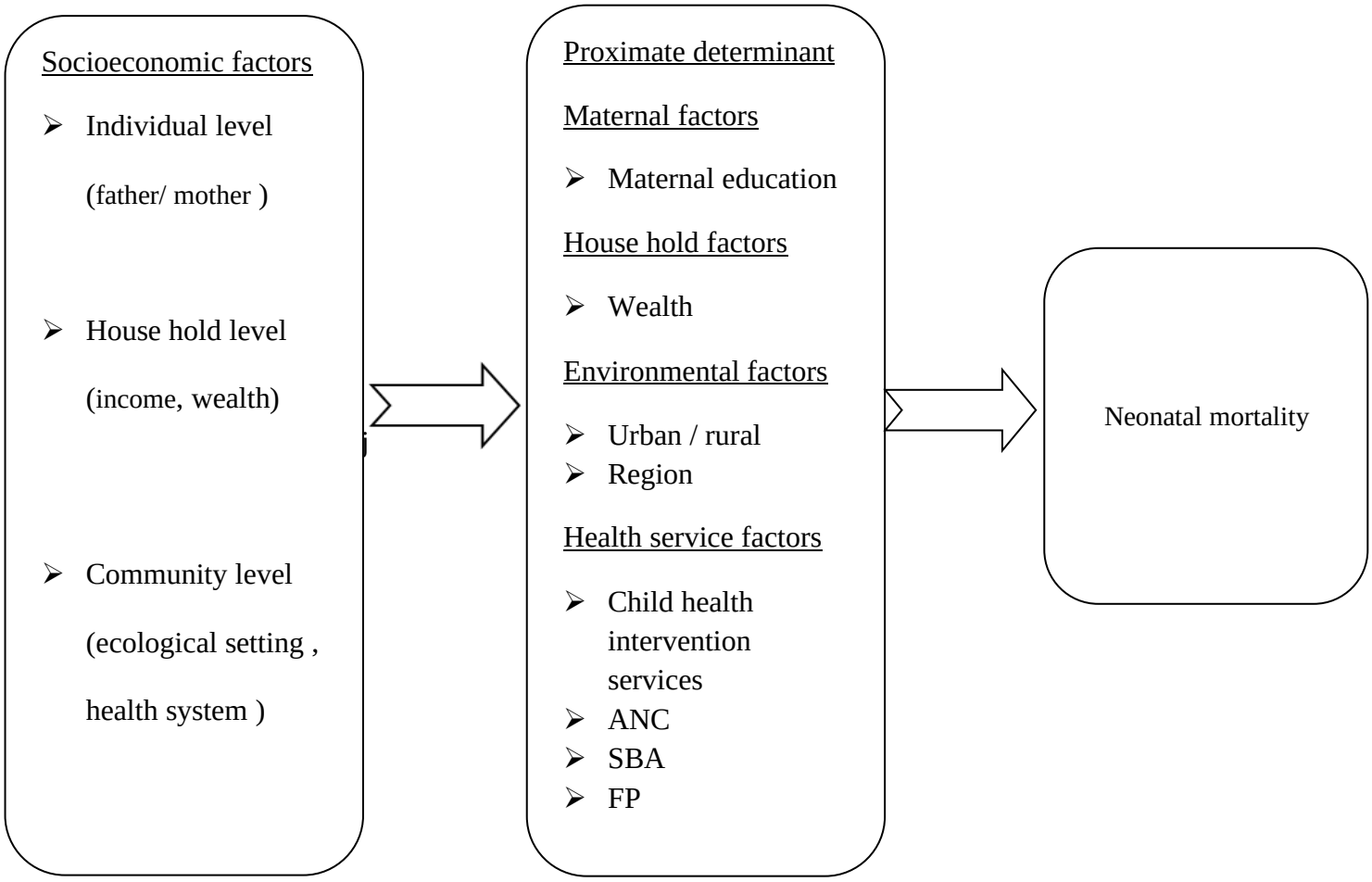

Figure 1. Conceptual frame work adapted from mosley and chen 1984 classical frame work describing factors contributed to neonatal mortality.

2.5 Research question

- What is the trend and level of inequalities in neonatal mortality by selected equity stratifiers?

- Does a region with low reproductive health service coverage have increased risk of neonatal death?

3. OBJECTIVES

3.1 General objectives

The main objective of this study is to assess the trend and inequalities in neonatal mortality and its covariates in Ethiopia using data from the four rounds of Ethiopia Demographic and Heath Survey.

3.2 Specific objectives

1. To assess trend and inequalities in neonatal mortality by region, place of residence, wealth status, maternal education and composite coverage index (CCI) in Ethiopia.
2. To identify factors contributed to observed inequalities in neonatal mortality.

4. METHODS

4.1 Study setting

Ethiopia is a very big landlocked country consisting of nine regional states including Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities Peoples Region (SNNPR), Gambella and Harari regional states and Addis Ababa and Dire Dawa city administrations. Administratively, each of the 11 geographic regions in Ethiopia is divided into zones and each zone is divided into lower administrative units called Woredas. Each Woreda is then further subdivided into the lowest administrative unit which is a village, called a Kebele in Ethiopia. The terrain is ragged and it is geographically wide, ranging from mountainous highlands to tropical forests. It is the second largest country in Africa with an estimated total population of 102, 374million in 2017, out of which 13 million are under five years of age (62).

General health service in Ethiopia has improved markedly since 2000; there has been encouraging improvements in the coverage and utilization of health services. As a result of its robust health policy and innovative strategies, the country has made huge progresses in increasing universal access to health services and improvements in health outcomes(19). Despite this, Ethiopia is still one of the countries with a very high morbidity and mortality from triple burden of diseases(63). Maternal, child and reproductive health service coverage were also unevenly distributed and the coverage for the key child health indicator were unequal according to different dimension of equality(31).

4.2 Study design and Study period

In Ethiopia, there have been four DHS survey conducted by the Central Statistical Agency (CSA) and ORC Macro for 2000, 2005 and 2011 and CSA and ICF for 2016 at the request of the Federal Ministry of Health (FMoH). ICF international provide technical support which is funded by the United States Agency for International Development (USAID). This study was used the four rounds of EDHS series to analyze trend and assess inequalities in neonatal mortality.

We analyzed data from nationwide repeated cross-sectional survey, Ethiopian Demographic and Health survey (EDHS) series, which is based on nationally representative probability sample that covered the entire country. And the data analysis was conducted in the period of December 2018 to May 2019. The surveys included the entire administrative regions as well as both the urban and rural areas. All women age 15-49 and all men age 15-59 who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible to be interviewed. Participants were interviewed in-person using set of structured questionnaires and collected several data on household and respondents socio-economic and demographic characteristics as well as a comprehensive birth history for each woman from antenatal care and delivery attendance through child survival and vaccination.

4.3 Source population

All live births born from interviewed women with in the five- and ten-year's period preceding each survey of 2000, 2005, 2011 and 2016.

4.4 Study population

Neonates within 0-30 days after birth in five and ten years preceding each survey (2000-2016)

Table 1. The number of live births born to the interviewed women's in the period of five and ten years preceding the date of the survey by survey year, nationally and by regions to assess the trend and inequalities in neonatal mortality in Ethiopia 2018/2019.

Weighted total number of live births born to interviewed women in preceding five and ten years nationally and by region.								
	EDHS 2000		EDHS 2005		EDHS 2011		EDHS 2016	
	Five years	Ten years	Five years	Ten years	Five years	Ten years	Five years	Ten years
National	12144	23617	11040	22522	11766	23873	10833	22592
Tigray	776	1554	692	1373	746	1490	702	1403
Afar	125	254	106	241	120	238	113	218
Amhara	3177	6340	2583	5327	2623	5389	2036	4329
Oromia,	4952	9234	4373	8669	4985	9817	4767	9830
Somali,	140	301	473	1026	360	748	500	991
Benishangul-Gumuz	122	244	103	207	138	276	119	246
SNNPR	2578	5143	2467	5167	2467	5245	2259	4953
Gambella	28	57	31	64	40	80	27	54
Harari	25	48	22	41	29	58	25	50
Addis Ababa	179	363	152	332	220	453	239	422
Dire Dawa	40	81	37	74	39	78	46	96

4.4 Sample size determination and procedure

DHS used enumeration areas (EAs) of the 1994 census as a sampling frame for drawing the sample for 2000 and 2005 EDHS and the 2007 population and housing census conducted by CSA as a sampling frame for 2011 and 2016 survey. The sampling was a two-stage cluster sampling process; each region was stratified into urban and rural areas; samples of enumeration areas were selected independently in each stratum with probability proportion to size allocation and EAs were the sampling unit for the first stage, followed by equal probability systematic sampling to select households in these CEAs. From listed households in enumeration areas fixed number of households (28-30) from each cluster selected with probability systematic selection.

The sample for each survey designed to provide estimates for reproductive, maternal, new-born, child and adolescent health 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. And since it is conducted for fourth it provides valuable information on trends of key health indicators.

In EDHS 2000, using systematic sampling with probabilities proportional to size, 539 EAs (138 in urban areas and 401 in rural areas) were selected then representative sample of 14642 households (HHs) selected and of this households 14072 were successfully interviewed in which eligible women of 15716 identified and full interview were conducted with 15367 women aged 15-49 years, yielding the response rate of 97.8%(64).

The EDHS 2005, sample included 540 EAs (145 in urban areas and 395 in rural) and representative sample of 14645 households selected, of this 13721 HHs successfully interviewed and eligible women of 14717 identified and full interviews were conducted for 14070 women age 15-49 yielding the response rate of 96%(65).

Besides, the EDHS 2011, sample included 624 EAs (187 in urban areas and 437 in rural areas) and a representative sample of 17817 households was selected and of these households 16,702 were successfully interviewed in which 17,385 eligible women were identified for individual interview; full interviews were conducted with 16,515 women age 15-49 yielding response rate of 95%(66).

Moreover, the EDHS 2016 sample includes a total of 645 EAs (202 in urban areas and 443 in rural areas) and representative sample of 18008 households selected and of this households 16650 were successfully interviewed from which 16583 eligible women identified and full interview were conducted for 15683 women age 15-49 yielding the response rate of 95%(9).

The sample for this specific study was drawn from all live births within the last five years which is 12144, 11040, 11766 and 10833 respectively and all live births with in the last ten years 23617, 22522, 23873 and 22592 born from 15367, 14070, 16515 and 15683 women's respectively prior to the date of each survey (2000-2016).

Table 2. Sample number of households, women respondents, and live births by survey year to assess trend and inequalities in neonatal mortality in Ethiopia 2018/2019.

	EDHS 2000	EDHS 2005	EDHS 2011	EDHS 2016
Sample number of households	14642	14645	17817	18008
Successfully interviewed HHS	14072	13721	16702	16650
Response rate from sampled HHs	99.3%	98.5%	98%	97.6
Eligible women identified	15716	14717	17385	16583
Number of respondents age 15-49 full interview was conducted	15367	14070	16515	15683
Response rate from eligible women (%)	97.8%	96%	95%	95%
Number of live births born to interviewed women's in preceding five and ten years	12144/23617	11040/22522	11766/23873	10833/22592
Approximate time frame covered	1995-1999	2000-2004	2005-2010	2011-2015

4.5 Variables and measurements

To assess inequality from different dimension selection of appropriate inequality stratifiers is important, so that variables that are widely used and proposed to study the level of inequalities were selected based on the review of earlier studies at global and national level and they are expected to be correlated with inequality in health indicator, therefore region, place of residence, education, wealth status are the main stratifiers inequality in LMICs(34).

These variables were routinely used to monitor health inequalities and likely to reflect unfair difference between groups that could be corrected with appropriate policy.

Table 3. Variable description and measurements to assess the trend and inequalities in neonatal mortality in Ethiopia 2018/2019 G.C.

Variables	Descriptions	Measurements
Dependent variable		
Neonatal mortality	Neonatal mortality is death of live born infants within the first month of life (0-30days). The use of 30 days rather than 28 day for this study is because of how neonatal mortality is calculated in DHS.	Neonates died within 0-30 days after birth considered as neonatal death as perceived from the mother. Since it is dichotomous coded as 1 if death has occurred inside 0-30 days and 0 otherwise.
Independent variables / Equity stratifiers		

Composite coverage index	A weighted average of the percentage coverage of six services along the continuum of care and calculated using the following formula: - $CCI = 0.25\left(FPC + \frac{ANC1 + SBA}{2} + BCG + \frac{ORT + CAREP}{2}\right)$	Composite coverage index was used to measure weighted average percentage coverage of reproductive, maternal and child health service using standard indicator. The services are: 1. Family planning coverage (FPC) 2. At least one antenatal care visit by a skilled provider (ANC1) 3. Skilled birth attendant (SBA) 4. Bacilli Calmette-Guerin (BCG) vaccination 5. Oral rehydration therapy (ORT) for diarrhea 6. Care seeking for childhood pneumonia
Region	The region where the woman lives	Two city administrations (Addis Ababa and Dire Dawa) and 9 regional states (Tigray, Amhara, Oromiya, SNNPR and others). (de jure)
Place of residence	The usual place of residence where the woman lives	Urban / rural Residents who are usual member of selected HH (de jure)

Wealth status	Households are given scores based on the number and kinds of consumer goods they own ranging from a television set to a bicycle or car, in addition to housing characteristics such as source of drinking water, toilet facilities, and flooring materials.	Ranked in to three (tercile) categories (poor, middle and rich).
Maternal education	Level of education attained by the respondent	Categorized in to four categories including, no education, primary, secondary and higher education.

4.6 Data collection procedure and source of data

Study instruments(tool) used in each DHS were a set of standardized questionnaires, namely the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire and for the 2016 the Biomarker Questionnaire and the Health Facility Questionnaire were used in addition to existing one. These questionnaires were adapted from model survey instruments developed for the MEASURE DHS project to reflect the population and health issues relevant to Ethiopia. Issues were identified at a series of meetings with the various stakeholders. In addition to English, the questionnaires were translated into three major languages—Amharigna, Oromiffa, and Tigrigna.

To maintain data quality CSA recruited and trained team of supervisors, field editors, interviewers, secondary editors, and reserve interviewers. Data collection was done using paper-based approach in some rounds and electronically in others. Pretests were conducted in place that was not included in the survey. Electronic data files were transferred to the CSA central office in Addis Ababa every few days via the secured IFSS and data processing was done through office editing, coding of open-ended questions, data entry, and editing computer-identified errors. Data entry and editing were accomplished using the CSPro software.

For this study the 2000, 2005, 2011 and 2016 EDHS, which was conducted by Central Statistical Agency of Ethiopia from February-June 2000, April-August 2005, December 2010–June 2011and January 18, to June 27, 2016 respectively were used as data source. The data to study trend and inequality in neonatal mortality was obtained from retrospective Full Birth Histories (FBH) section of women's questionnaire, and the appropriate data file used for this study was Birth Recode file (dataset code BR), which comprises all birth history information of interviewed women five and ten years preceding each survey.

Data on neonatal mortality (2000-2016) used for this study are openly available from EDHS series data-base, and downloaded from ICF international website at: http://www.measuredhs.com. after a consent on the purpose of use of the data is submitted and permission is granted.

4.7 Data processing and analysis

After the EDHS data series were downloaded filled in STATA format from measuredhs.com website the variables appropriate for this study were identified and their completeness were assessed by running frequencies to check the missing values. Most of the variables were either recoded and new variables are computed as they are required for the further analysis.

Analysis was conducted based on 12144, 11040, 11766 and 10833 live born infants prior to each survey for the last five-year period and based on 23617, 22522, 23873 and 22592 live born infants for the last ten-year period. A combination of different software including STATA version 14, EXCEL and R studio were used to compute different summery measures.

The DHS statistical guide recommends the calculation of neonatal mortality rate as the number of deaths to children aged 0-30 days in the last five years preceding the date of survey per live births in specified age and time period. The variables included in the calculation were the date of interview, date of birth of child, child is alive or not, and age at death variables following filtering those censored. Due to the sample issue neonatal mortality for socioeconomic and back ground characteristics were calculated for the last 10 years' period.

Also, variables representing each indicator that is used to construct composite coverage index (reproductive, maternal and child health service coverage) were calculated based on the guide. Composite coverage index (CCI) is an approach to obtain a summary measure of intervention coverage and it is useful for monitoring progress in coverage, since it is estimated at the group level from the coverage of eight indicators, together represent all four stage in the continuum of care for maternal and child health and provides a broader picture of coverage(67).

For this specific study the composite coverage index is calculated from six indicators that are available in all of the four surveys. Moreover, because the two indicators DPT and Measles vaccine are given after neonatal period we dropped them from the calculation to compute CCI.

As described here under other variables needed for the calculation of CCI were also computed. Thus, to calculate family planning coverage, percentage of all women age 15-49 (currently married and sexually active unmarried women) who use any contraceptive method were used, and for ANC (Antenatal Care) percentage coverage, at least one antenatal care visits by a skilled provider

(doctor, nurse, midwife and public health officer) were used. And to calculate SBA (skilled birth attendant) were considered if service is provided by doctor, nurse, midwife and public health officer. For BCG vaccination coverage, percentage of living children between ages 12-23 month at the time of survey who received BCG vaccination were used.

Oral rehydration therapy (ORT) for diarrhea was calculated from percentage of living children under five with diarrhea who were given oral rehydration therapy in the two weeks preceding the date of interview and care seeking for childhood pneumonia were calculated from living children with symptoms of ARI (if the child had cough, short rapid breath) and percentage for whom treatment was sought from specific source in the last two weeks preceding the date of interview.

After percentage coverage for each indicator was calculated in each survey round, composite coverage index was calculated for each round of EDH survey based on the formula provided and finally CCI was calculated at national and regional level using an Excel sheet.

As the wealth index which is one of our predictor variables is not presented in 2000 survey data, we constructed wealth index by using the principal component analysis (PCA) using variables available in the data set and presenting household assets and utility services. The variables included in the PCA were source of drinking water, type of toilet facility, toilet facility shared, main floor material, roof material, type of cooking fuel, has electricity, has radio, TV, bicycle, motorcycle/scooter, car/truck and telephone and to increase variable number we braked up those variables with multiple response(68).

Descriptive statistics were done and disaggregated approach was employed to describe important characteristics. Trend in neonatal mortality rate and composite coverage index for the period 2000 – 2016 in the five years prior to each survey was directly estimated from the birth history data and presented using table and graphical techniques. additionally, 95 % confidence interval was used to indicate the period when significant difference was observed. The annual rate of reduction in neonatal mortality was also calculated to describe trend in reduction per annum (69). and for this study calculated as: -

$$\frac{r1-r2}{r1*t} * 100$$

were

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

Wealth and education based inequalities in neonatal mortality were assessed by estimating their concentration index.(CI quantifies magnitude of inequality across all wealth quintile and education level and becoming the standard tool for measurement, it indicates the extent to which a health indicator is concentrated among the disadvantaged or the advantaged, it has a negative value when the health indicator is concentrated among the disadvantaged (for example, the poor or less educated); and has a positive value when the health indicator is concentrated among the advantaged (for example, the rich or more educated). When there is no inequality, the concentration index is 0. Also, concentration curves are used to illustrate how one variable is distributed across the population ranked by another variable, a normalized version of CI that is Erreygers index was calculated (70-72).

After pooling the data from four round of the survey, logistic regression model was run and by controlling confounders absolute and relative measure of inequalities like Difference (D) and Ratio (R) was done to measure geographic-related inequalities. (Difference is an expression of the absolute inequality that exists between two subgroups; that is, the mean value of a health indicator in one subgroup subtracted from the mean value of that health indicator in another subgroup. Ratio is an expression of the relative inequality that exists between two subgroups; that is, the mean value of a health indicator in one subgroup divided by the mean value of that health indicator in another subgroup). If there is no inequality D takes a value of 0 and R takes a value of 1. Greater absolute values indicate higher levels of inequality and if positive indicates a higher concentration of the indicator among the disadvantaged and if negative value indicate a higher concentration among the advantaged. For R, it takes only positive values (larger or smaller than 1). The further the value of R from 1, the higher the level of inequality(73, 74). a p-value of < 0.05 and 95% CI was reported as a measure of magnitude of significance.

Regression based decomposition analysis was also done to identify relative contribution of socioeconomic and demographic factors to inequalities in neonatal mortality. (A decomposition analysis allows one to estimate how determinants proportionally contribute to inequality (e.g. the gap between poor and rich) in a health variable)(75).

The DHS stratification, household clustering as well as sampling weights were taken in to account in all the analysis.

4.8 Ethical consideration

As the DHS data set is available to the public domain registering to the DHS website (www.measuredhs.com) is enough to settle with ethical issues concerning use of the data set. However, Ethical clearance was secured from research ethics committee (REC) of the School of Public Health, College of Health Science of Addis Ababa University.

4.9 Dissemination of results

After completion, the final result document will be submitted through soft and hard copy to Addis Ababa University School of public health where the study was conducted, and after presentation the final result will be communicated to policy, programs and decision makers who are working on neonatal and child health issues at each level and submitted to scientific conferences like Ethiopian Public Health Association, Symposia, or Workshops and Finally to be published in an international peer reviewed journal.

5. RESULT

5.1 General characteristics of study populations

In this study a weighted 12144, 11040, 11766 and 10833 neonates born to interviewed women's in the five years prior to 2000, 2005, 2011 and 2016 survey were included. Table 4. presents distribution of neonates by selected socio-demographic characteristics in Ethiopia, 2000 – 2016.

Across the survey years, around one-third of neonates 4953, 4373, 4985 and 4766 were from Oromiya and 3177, 2583, 2623 and 2036 were from Amhara and 2579, 2467, 2467 and 2259 were from SNNPR and 776, 693, 746 and 702 were from Tigray respectively by survey year. Regarding their place of residence more than half were from rural areas 10880, 10228, 10250 and 9638 respectively in the year 2000, 2005, 2011 and 2016.

Table 4. Distribution of neonates by socio-demographic characteristics in Ethiopia, 2000-2016.

Variable	Category	Total number of neonates (weighted)			
		2000	2005	2011	2016
		Frequency (n)	Frequency(n)	Frequency(n)	Frequency(n)
Region	Tigray	776	693	746	702
	Afar	125	106	119	113
	Amhara	3177	2583	2623	2036
	Oromiya	4953	4373	4985	4766
	Somali	140	473	360	500
	Benishangul-Gumuz	122	103	139	119
	SNNPR	2579	2467	2467	2259
	Gambela	29	31	40	27
	Harari	25	21	28	26
	Addis Ababa	179	152	220	239

	Dire Dawa	40	37	39	46
Place of residence	Urban	1264	812	1516	1195
	Rural	10880	10228	10250	9638
Maternal education	No education	9971	8736	8154	7154
	Primary	1578	1834	3181	2908
	Secondary	567	426	264	504
	Higher	28	42	168	267
Wealth status	Poor	6181	4737	5317	5059
	Medium	2794	2458	2415	2237
	Rich	3169	3844	4035	3537

5.2 Trends in Neonatal mortality rate

The number of neonatal deaths per 1000 live births was slightly decreasing between 2000 and 2016. Of the total weighted 12144, 11040, 11766 and 10833 neonates born from interviewed women's in the five years prior to each survey, 584, 431, 436 and 311 neonates died before reaching their first month yielding a neonatal mortality rate of 48, 39, 37 and 29 per 1000 live births respectively in the year 2000, 2005, 2011 and 2016, with the annual rate of reduction of 1.98 percent per annum, but the decrement shown in disaggregate data was not distributed consistently to different socio-economic groups.

To estimate trend in neonatal mortality rate by socio-demographic characteristics we calculated mortality rate for the last ten years period prior to the survey to ensure that there are sufficient cases to produce statistically reliable estimate, and from the total weighted 23617, 22522, 23873 and 22592 neonates born from interviewed women's in the last 10 years 1370, 919, 1002 and 841 neonates died before reaching their first month respectively in the year 2000, 2005, 2011 and 2016. Table 5 presents the trend data in neonatal mortality rate by selected equity stratifiers and the annual rate of reduction between the period 2000 to 2016.

Trend in neonatal mortality rate according to regions shows relatively decreasing for some regions like Tigray (53,27,42 and 27 neonatal deaths per 1000live births), Oromiya (53,38,34 and 28 neonatal deaths per 1000live births), SNNPR (40,34,34 and 25 neonatal deaths per 1000live births), Gambela (53, 47, 38 and 37 neonatal deaths per 1000live births) and Addis Ababa (28,26,23 and 21 neonatal deaths per 1000live births), whereas in all others it shows inconsistent result, Figure 2. Shows Trend in neonatal mortality rate by regions 2000-2016.

The rate of reduction is greatest for neonates in Addis Ababa region (2.8% per annum) and for mothers with highest education level (2.7 % per annum), for Tigray region (2.5% per annum) and for medium wealth level (2.3% per annum). Unexpectedly neonates from urban areas (0.5% per annum) living in Dire Dawa region (0.8% per annum) show low average annual rate of reduction and also substantially low average reduction for a child born from richest wealth level (-12.9 % per annum) and to mothers with secondary education (-2.4% per annum).Table 5 presents annual rate of reduction by selected equity stratifiers.

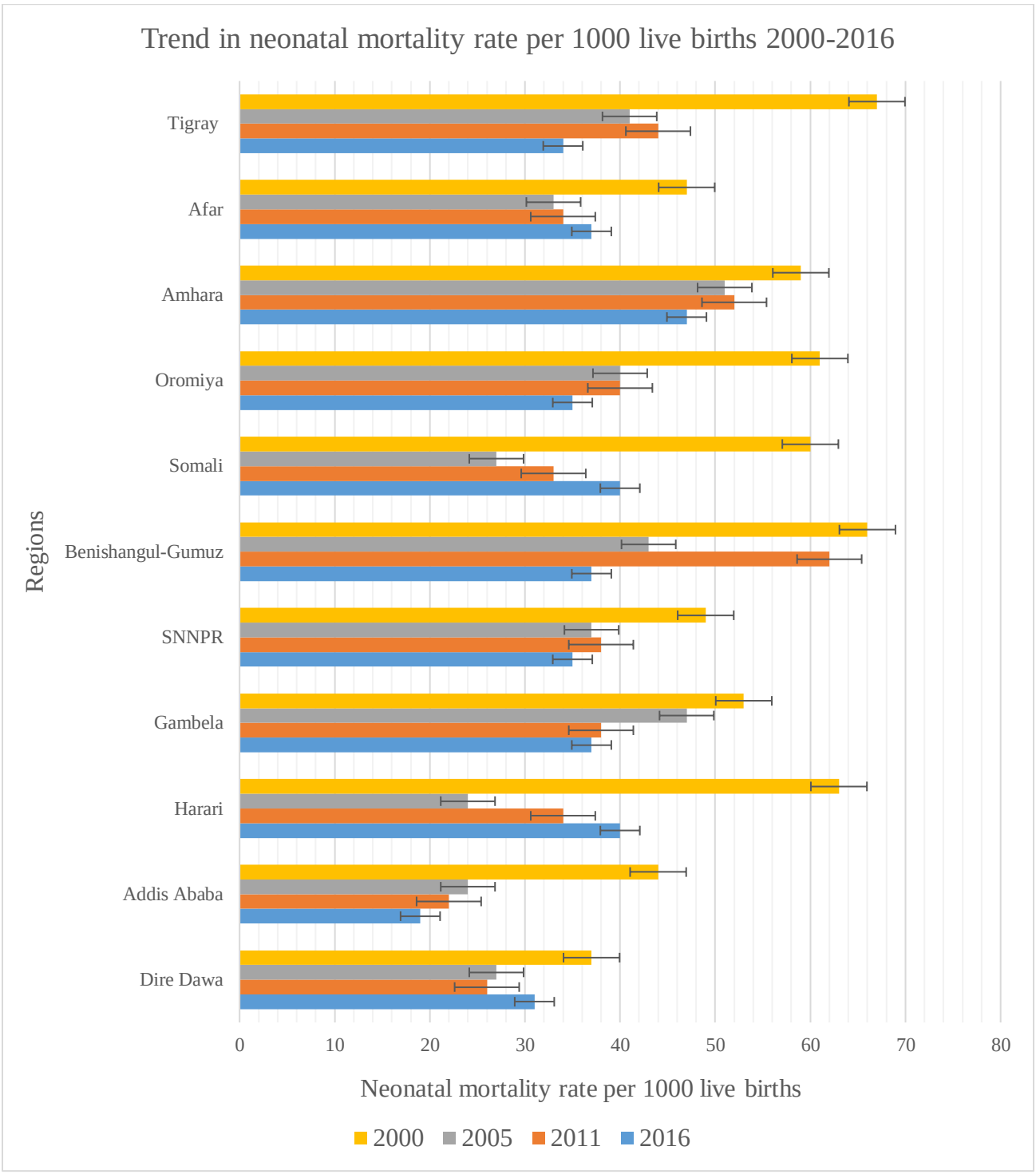

Figure 2. Trend in neonatal mortality rate by regions 2000-2016.

Across the survey years, the trend in neonatal mortality rate by wealth showed average annual decline of 2.3% between 2000 and 2016 for the medium wealth tercile as shown in Fig 3.

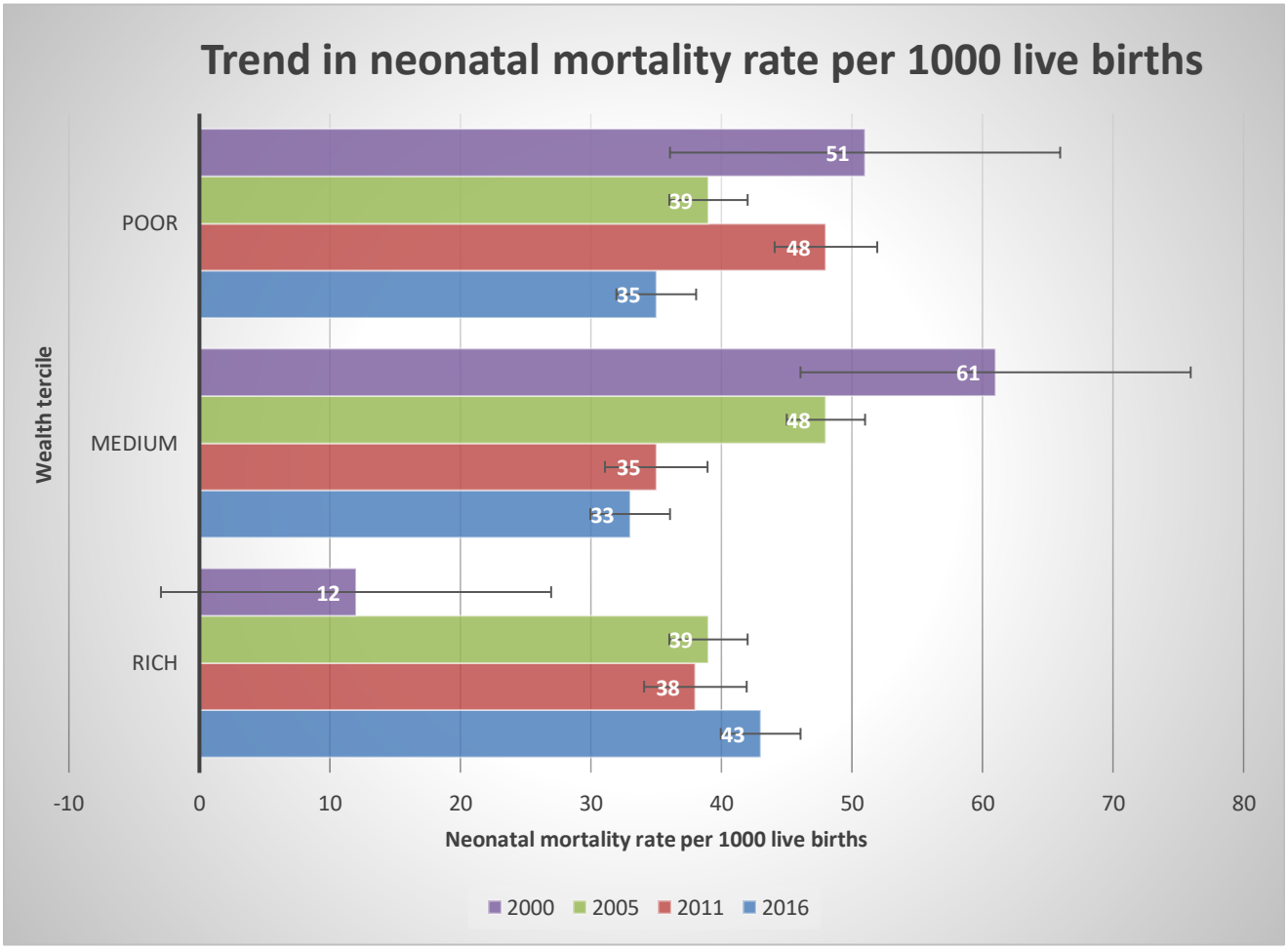

Figure 3. Trend in neonatal mortality rate by wealth tercile 2000-2016.

Table 5 Neonatal mortality rate per 1000 live births for the ten-years period preceding the survey by socio-demographic characteristic and average annual rate of reduction 2000-2016.

Variables	Category	Neonatal mortality rate per 1000 live birth by survey year [weighted]				Annual rate of reduction
		2000	2005	2011	2016	2000 –2016
Region	Tigray	67	41	44	34	2.5
	Afar	47	33	34	37	1.06
	Amhara	59	51	52	47	1.01
	Oromiya	61	40	40	35	2.1
	Somali	60	27	33	40	1.7
	Benishangul-Gumuz	66	43	62	37	2.2
	SNNPR	49	37	38	35	1.4
	Gambela	53	47	38	37	1.5
	Harari	63	24	34	40	1.8
	Addis Ababa	44	24	22	19	2.8
	Dire Dawa	37	27	26	31	0.8
Place of residence	Urban	46	34	41	41	0.5
	Rural	59	41	42	37	1.9
Maternal education	No education	61	41	45	38	1.9
	Primary	46	45	36	36	1.08
	Secondary	21	22	30	31	-2.4
	Higher	77	10	10	35	2.7
Wealth status	Poor	51	39	48	35	1.6
	Medium	61	48	35	33	2.3
	Rich	12	39	38	43	-12.9
Nationally	Ethiopia	48	39	37	29	1.98

5.4 Composite coverage index and neonatal mortality

As we obtained the coverage data for each indicator from the survey and calculated based on the formula, composite coverage index for the respective survey were 21 %, 25%, 33% and 40% and it has an increasing trend over the last 20 years, it shows neonatal mortality is declining while CCI is increasing Fig.3 presents trend in CCI and neonatal mortality rate for the period 2000-2016.

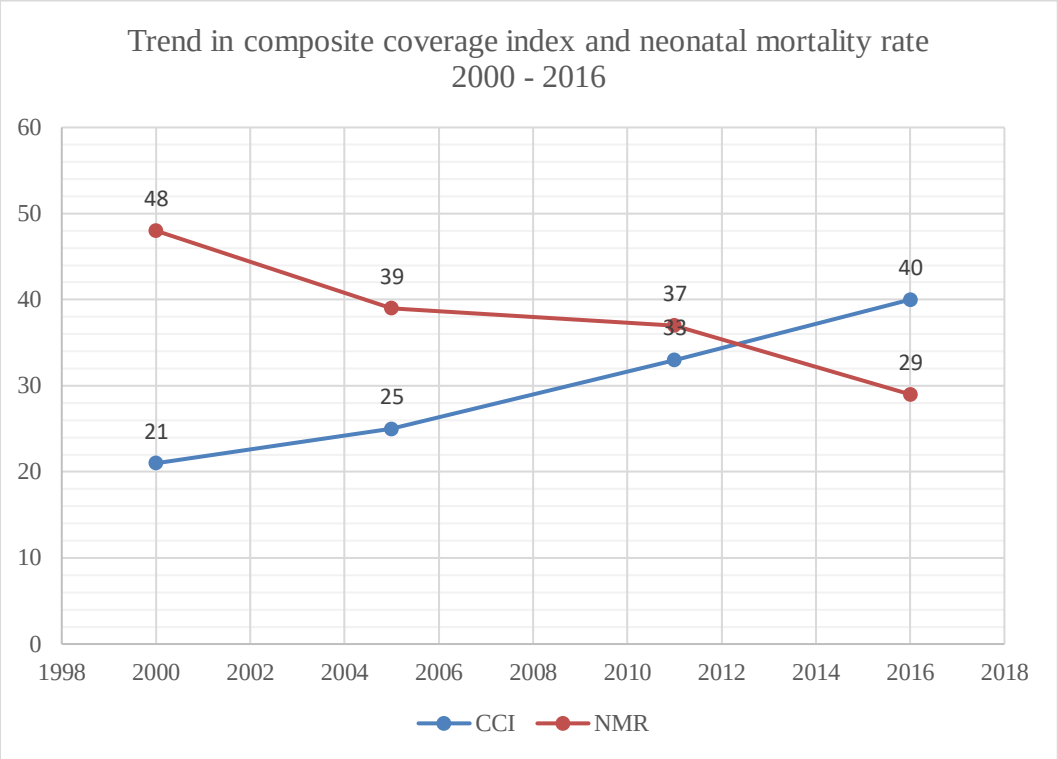

Figure 4. Estimated percentage coverage (CCI) and neonatal mortality rate per 1000 live births by survey year.

When disaggregated by region, across all the survey year the highest CCI was in Addis Ababa and lowest in Somali region. For the most recent survey (2016) it showed 54.9 % for Tigray, 28.7 % for Afar, 44 % for Amhara, 32.7 % for Oromiya, 28 % for Somali, 49.6 % for Benishangul-Gumuz, 44.9 % for SNNPR, 49 % for Gambela, 41 % for Harari, 74.7 % for Addis Ababa and 57.3 % for Dire Dawa.

Regions with low coverage like Somali, Afar, Amhara, and Benishangul_gumuz have shown higher neonatal mortality rate than regions with better coverage like Addis Ababa and Dire Dawa. Tigray, Benishangul-gumz, SNNPR and Gambela showed progress in coverage and particularly in recent survey as the coverage increase mortality rate showed a decrease. However, the two city administrations, Addis Ababa and Dire Dawa has a better service coverage and progress, but neonatal mortality rate didn't show much decrement particularly for Addis Ababa. Table 6 presents percentage coverage of CCI and NMR by regions and survey years.

Table 6 weighted percentage coverage of six intervention (CCI) and NMR by region and survey year.

Region	CCI and NMR by region and survey year							
	2000		2005		2011		2016	
	CCI	NMR	CCI	NMR	CCI	NMR	CCI	NMR
Tigray	30	67	32	41	41	44	55	34
Afar	16	47	11	33	24	34	29	37
Amhara	18	59	26	51	35	52	44	47
Oromiya	20	61	24	40	30	40	33	35
Somali	25	60	9	27	20	33	28	40
Benishangul-Gumuz	21	66	23	43	36	62	50	37
SNNPR	19	49	25	37	33	38	45	35
Gambela	29	53	28	47	44	38	49	37
Harari	39	63	40	24	41	34	41	40
Addis Ababa	64	44	69	24	76	22	75	19
Dire Dawa	43	37	57	27	50	26	57	31

5.5 The concentration index for wealth status and maternal education

Across the survey years the estimate of concentration index for wealth status shows a value of -.00243894, .0098104, -.01282021 and .01216099 with p value of 0.6826, 0.0722, 0.0278 and 0.0541 respectively for the year 2000, 2005, 2011 and 2016. The negative value (2000, 2011) indicates neonatal mortality is concentrated among poor and a positive value (2005, 2016) indicates that neonatal mortality is concentrated among rich, however except for 2011 survey p-value showed non-significant. Table 7 presents result of the concentration index for wealth status by survey year.

The concentration curve also lies above the equality line for 2000 and 2011 survey and below equality line for 2005 survey which shows the concentration of neonatal mortality is among the poor(2000, 2011, 2016) and among rich (2005) but in support of significance level it is close to line of equality suggesting there is narrow inequality and the distribution is almost equal to all ordered population Fig.5, 6, 7, 8 shows the concentration curve for neonatal mortality by wealth across the survey years.

With regard to education status the concentration index value for 2000, 2005, 2011 and 2016 showed -.01162562, -.00122149, -.00928313 and -.00307574 with p-value of 0.0007, 0.6756, 0.0071 and 0.5383 respectively. The negative index value across all the survey years indicates that neonatal mortality is concentrated among non-educated with statistically significant influence for survey year 2000 and 2011 but not significant for 2005 and 2016 survey. Table 7 presents result of the concentration index for maternal education by survey year. However, the concentration curve lies very close to equality line and sometimes cross, it suggests that the distribution could be highest to all ranked population. Fig.9, 10, 11, 12 shows the concentration curve for neonatal mortality by education across the survey years.

Table 7. Result of concentration index for wealth status and maternal education by survey year, 2000-2016.

Variable	Index	No. of obs.	Index value	Stand. error	p-value
Wealth status					
2000	Erreyg. norm.CI	10761	-.00243894	.00595879	0.6826
2005	Erreyg. norm.CI	9749	.0098104	.00543553	0.0722
2011	Erreyg. norm.CI	11533	-.01282021	.00581371	0.0278*
2016	Erreyg. norm.CI	10469	.01216099	.00630198	0.0541
Maternal education					
2000	Erreygers norm.CI	21479	-.01162562	.00340341	0.0007*
2005	Erreygers norm.CI	20047	-.00122149	.00291551	0.6756
2011	Erreygers norm.CI	23460	-.00928313	.00343592	0.0071 *
2016	Erreygers norm.CI	21367	-.00307574	.00499513	0.5383
Overall CI 2000-2016					
Wealth status	Erreygers norm.CI	42514	.00162666	.00302183	0.5904
Maternal education	Erreygers norm.CI	42514	-.00467872	.00253783	0.0654

*p-value < 0.05

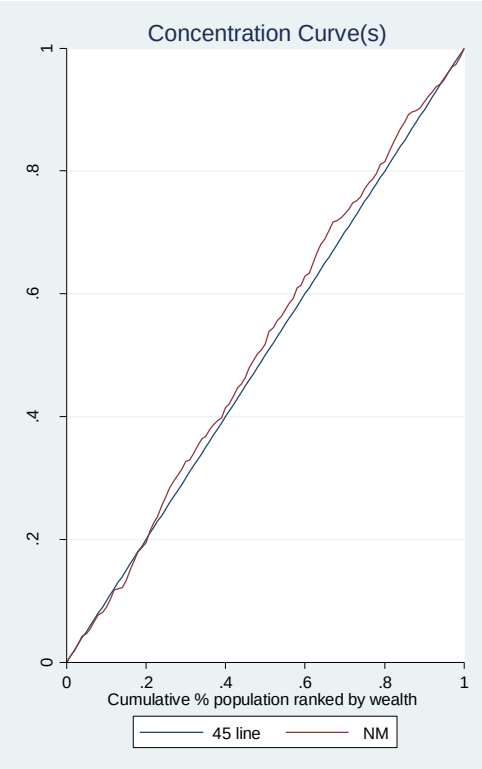

Figure 5. Concentration curve for neonatal mortality 2000.

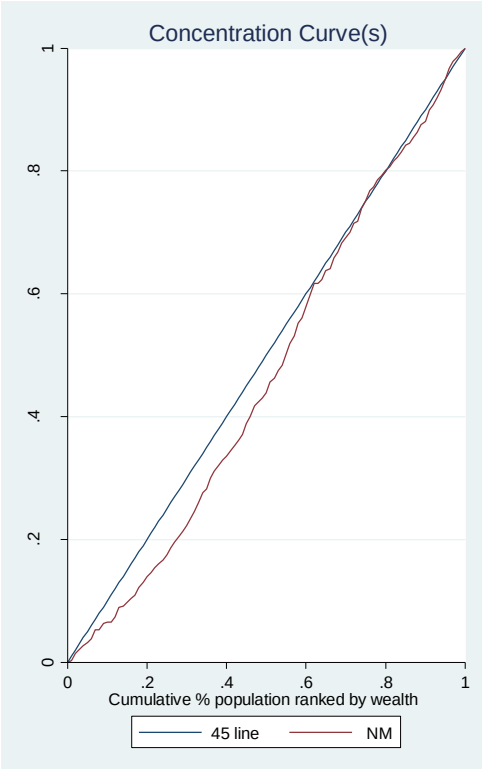

Figure 6. Concentration curve for neonatal mortality 2005.

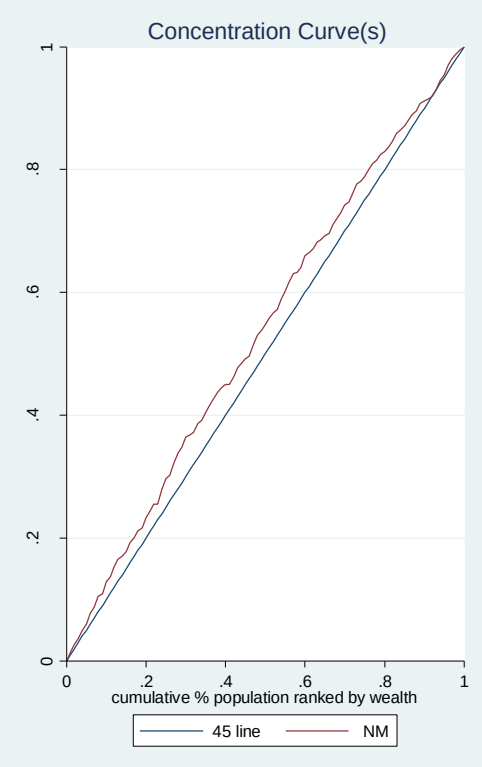

Figure 6. Concentration curve for neonatal mortality 2011.

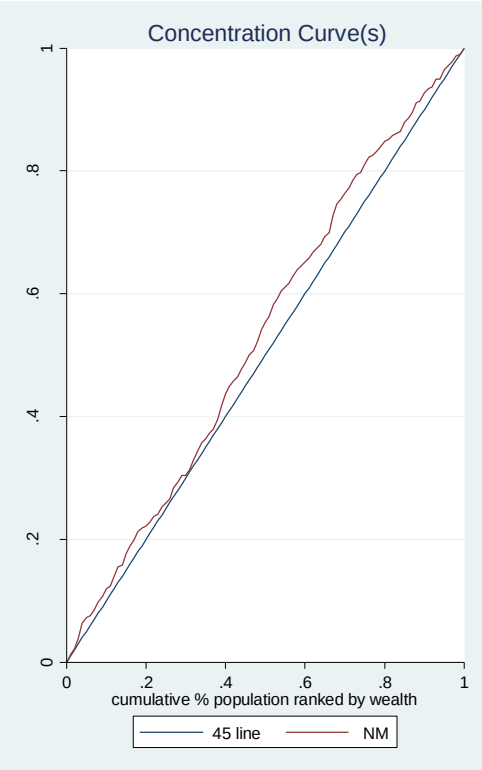

Figure 7. Concentration curve for neonatal mortality 2016.

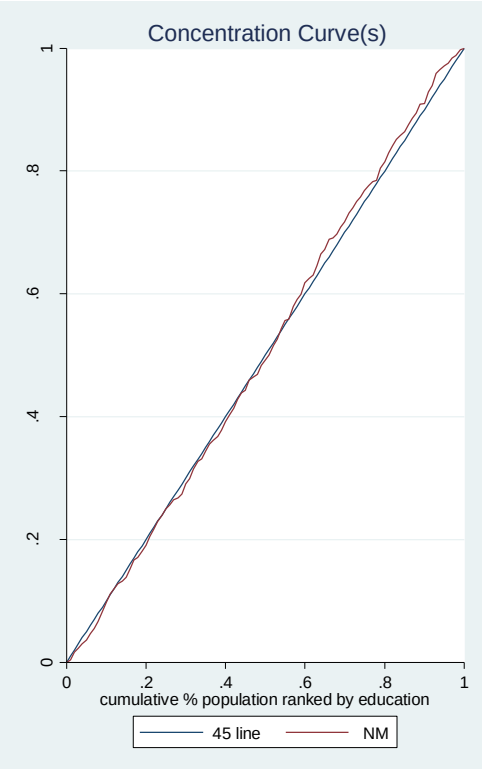

Figure 8. Concentration curve for neonatal mortality 2000.

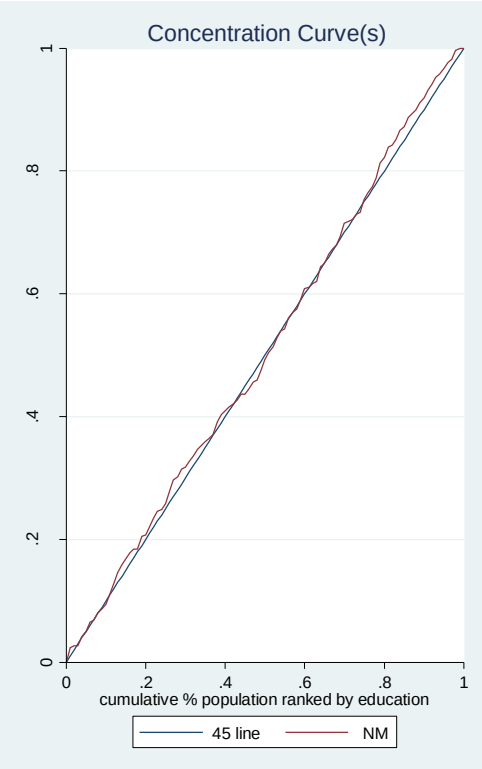

Figure 9. Concentration curve for neonatal mortality 2005.

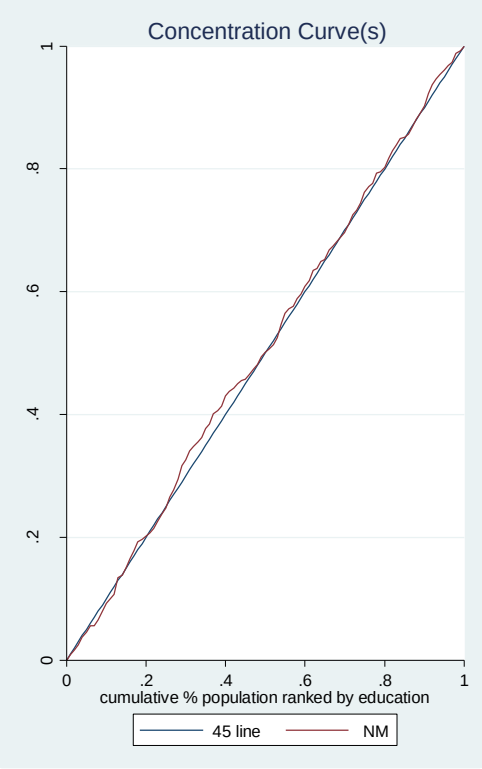

Figure 10. Concentration curve for neonatal mortality 2011.

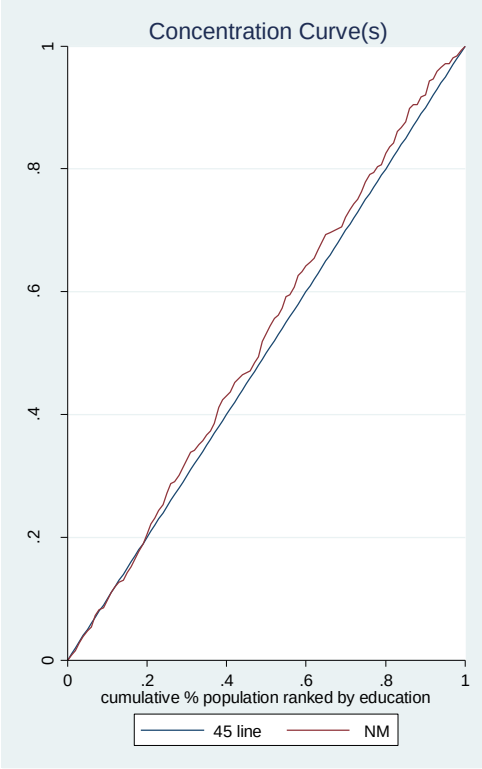

Figure 11. Concentration curve for neonatal mortality 2016.

5.6 Absolute inequalities based on Difference

Difference in neonatal mortality were pronounced for regions, the point estimates show that 0.0141 with 95% CI (0.0059, 0.0222) between the regions with highest (Amhara) and lowest (Addis Ababa) neonatal mortality. Children born in regions having higher mortality, on average have mortality 1.4 percentage points more often than Children born in regions with lowest neonatal mortality and statistically significant. For place of residence it showed -0.0089 with 95% CI (-0.0222, 0.0045) indicating children born in rural areas had -0.89 percentage points less mortality compared to urban and this is statistically not significant since the 95% CI includes 0. Table 8 shows result of absolute inequalities in neonatal mortality.

5.7 Relative inequalities based on Ratios

Relative inequalities in neonatal mortality for regions show 1.5510 with 95 % CI (1.1584, 2.0767) indicating Children born in regions having higher mortality, on average 55% more likely to die, and statistically significant, since the 95 % CI does not include 1. For Place of residence shows 0.8054 with 95 % CI (0.5972, 1.0863) indicating children born in rural area were 80.5% more likely to survive compared to urban but it is not significant, Table 5 presents result of absolute inequalities in neonatal mortality.

5.8 Change over time

Based on the variables assessed the pattern in reduction of absolute and relative inequalities in neonatal mortality were consistent. When we compare the first and the most recent survey absolute inequality in neonatal mortality were relatively decreasing compared to relative inequalities table 5 shows absolute and relative inequalities in neonatal mortality across the survey years.

Table 8 Absolute and relative level of inequalities in neonatal mortality and change over time by Region and place of residence.

Measure of inequality	Value (95% CI)				
	2000	**2005**	**2011**	**2016**	**2000-2016**
Region					
Difference (Highest-lowest)	0.0216 (-0.0087, 0.0519)	0.0179 (0.0039, 0.0320) *	0.0101 (0.0007, 0.0195) *	0.0104 (-0.0060, 0.0268)	**0.0141 (0.0059, 0.0222) ***
Ratio (Highest/lowest)	1.6639 (0.7382, 3.7506)	1.7455 (1.0373, 2.9373) *	1.4111 (0.9476, 2.1014)	1.5200 (0.7214, 3.2028)	**1.5510 (1.1584, 2.0767) ***
Place of residence					
Difference (rural – urban)	-0.0054 (-0.0350, 0.0241)	-0.0067 (-0.0338, 0.0204)	-0.0254 (-0.0579, 0.0072)	-0.0030 (-0.0234, 0.0173)	-0.0089 (-0.0222, 0.0045)
Ratio (rural/ urban)	0.8974 (0.5117, 1.5739)	0.8525 (0.4655, 1.5614)	0.5781 (0.3311, 1.0091)	0.9034 (0.4690, 1.7402)	0.8054 (0.5972, 1.0863)

*statistically significant

5.9 Decomposition analysis

The decomposition result revealed that largest contributor to observed-wealth based inequality in neonatal mortality were medium wealth level with a contribution of 8.05%, and rich ones with 5.44% contribution, which is pure effect of wealth on the total inequality, adjusting for other factors. Ben-Gumuz and Afar regions account for 7. 37% and 5.08% of inequalities and also rural residents showed a 5.5% contribution. Those with higher and primary education, year 2011, SNNPR and Addis Ababa have a negative contribution of -9.88, -6.48, -7.16, -7.90, -5.79 respect ively. This negative contribution indicating that the effect of those predictor for inequality worke d by lowering wealth inequality, that is, they tended to shrink the wealth-based inequality by prev enting the occurrence of neonatal death among these subpopulations.

The residual inequalities not explained by systematic variation in explanatory variables were 2.39%. Table 8 shows result of decomposition analysis of percentage contribution of region, plac e of residence, maternal education, wealth status and survey year to inequality in neonatal mort ality.

Table 9. percentage contribution of region, place of residence, maternal education, wealth status and survey year to inequality in neonatal mortality 2000-2016. Result of decomposition analysis.

Predictor	Contribution %	Concentration index	95%CI
Region			
Tigray	Ref	Ref	Ref
Afar	5.08	-0.139600428	-0.246897384 -0.03230347
Amhara	1.97	-0.074332371	-0.081838666, -0.06682608
Oromiya	-4.36	0.008621223	0.004348577, 0.01289387
Somali	1.92	-0.143639100	-0.185456890 -0.10182131
Benishangul-Gumuz	7.37	-0.040368776	-0.175008679, 0.09427113
SNNPR	-7.90	0.030317745	0.021873148, 0.03876234
Gambela	-5.06	0.038693498	-0.432143850, 0.50953085
Harari	-3.12	0.379738241	-0.091974660, 0.85145114
Addis Ababa	-5.79	0.706730703	0.684086525, 0.72937488
Dire Dawa	-4.86	0.284784092	-0.025582452, 0.59515064
Place of residence			
Urban	Ref	Ref	Ref
Rural	5.49	-0.074413463	
Maternal education			
No education	Ref	Ref	Ref
Primary	-6.48	0.231406673	0.221926682, 0.24088667
Secondary	-1.79	0.540386787	0.519419470, 0.56135410
Higher	-9.88	0.782220940	0.760010651, 0.80443123
Wealth status			
Poor	Ref	Ref	Ref
Medium	8.05	0.140680107	0.132721827, 0.14863839
Rich	5.44	0.677906799	0.674394507, 0.68141909
Year			
2000	Ref	Ref	Ref
2005	1.36	-0.081895414	-0.091387398, -0.07240343
2011	-7.16	0.078892208	0.069837328, 0.08794709
2016	-1.40	0.259219501	0.252237389, 0.26620161
Residual	2.39	NA	NA

6. DISCUSSION

The study found that the trend in overall neonatal mortality rate was slowly declining at a rate of 1.98% per annum, however it was not uniform among the selected equity stratifiers. When we compute for the composite coverage index, an increase in a trend was associated with a decrease in neonatal mortality rate. In assessing inequalities in neonatal mortality, the levels of wealth and education-based inequalities were significant only for the 2011 survey. Moreover, estimates of absolute and relative inequalities for regions shows significant inequalities. Different level of wealth status, regions and rural residents were found to be major contributor for observed wealth-based inequality.

The sluggish decline in neonatal mortality rate and the inconsistent decrement for population sub groups with lower annual rate of reduction in neonatal mortality in Ethiopia (1.98 percent per annum) compared to SSA region (2.4 percent per annum) and the global average (3.1 percent per annum) between 2000-2017(3) found in this study is similar with previous studies conducted in Ethiopia and India which shows pronounced variation in neonatal mortality and the decrement was also slow (40, 45) This could be due to unequal distribution of intervention services in the country(31), those low performing regions and those disproportionally suffered from mortality holds back the progress. Additionally, even if the government sets key high impact interventions for newborn survival (76) there is considerable gap on reaching sub populations.

The other finding is that, the higher the composite coverage index (CCI) the lower mortality rate, but the decline in mortality was lower, which is in line with previous studies examining changes in maternal and child health inequalities in Ethiopia, which found that over the last two decades there has been considerable improvements in MNCH services and decline in mortality(57). This finding suggests that since the government invested on health infrastructure and increased number of health professional, gain have been achieved on making health service accessible but the lower level of reduction could be the poor quality of care since the three most common causes of neonatal mortality are prematurity, intrapartum related and sepsis which needs highly qualified professionals(69).

Additionally, we have seen that even though the reduction was modest for neonatal mortality rate, Addis Ababa and Dire Dawa regions had better intervention coverage, this may reflect that

interventions were directly related with economic level since this two regions are relatively concentrated with population of better socioeconomic status, and this is supported by studies conducted in Brazil and from national survey of eight countries(32, 53).

The study also demonstrates relatively narrowing wealth and education-based inequalities, even though, in majority of the survey the concentration index result was negative which indicates neonatal mortality is concentrated among disadvantaged it is not statistically significant except for 2011. The concentration curve also lies close or sometimes cross to the equity line which is in line with previous study in Ethiopia which found the lowest degree of socioeconomic inequality for neonatal death and that there is no obvious pattern or trend in the concentration curve (57, 58). This finding suggests the pattern in neonatal mortality rate is not clear when it is evaluated in population ranked by wealth and education as all children irrespective of their socioeconomic status suffering from mortality. It appears that at all level, prevention of neonatal deaths does not respond to available interventions.

However, the significant pro-poor wealth and education-based inequalities observed in 2011 survey is in line with the study in ten major Africa cities including Ethiopia which revealed that for Ethiopia Significant socioeconomic inequalities were found for 2011 (12). This implies the fact that survival status of children is negatively influenced by women's socioeconomic status, luck of education and wealth limits their ability to explore knowledge regarding their health and access to better health care.

The observed significant region based absolute and relative inequalities in neonatal mortality indicates neonatal mortality were concentrated among disadvantaged. This is consistent with studies done in Indonesia which computed difference and ratio for geography-related equity marker and the estimate suggest that the absolute and relative inequalities in neonatal mortality showed widened inequality (41). This could be due to several factors that operates including use of RMCH services, education and wealth related with specific geographic area. The non-significant difference in absolute and relative inequality for place of residence in our result could be due to intervention in sanitation and infrastructure that may directly influence the reduction of mortality among rural and the higher mortality in the urban could be due to an increase in the

report system compared to rural areas or lack of affordable health services to economically disadvantaged people living in urban areas.

The different level of wealth status, regions and rural residents found as a major contributor for observed wealth-based inequality in this study is in line with previous studies decomposing socioeconomic inequalities in neonatal mortality that found household economic status and region of residence were the largest contributor to inequality in child morality (49, 50, 77). This show how unequal distribution of socioeconomically better society influence mortality. It has an impact on child survival through the ability of an individual to improve or maintain their family health. The contribution of wealth in our study was comparatively lower, as wealth and education-based inequalities were relatively narrow.

Strengths

- One of the strengths of this study is using publicly available data of EDHS series which is nationally representative and comparable, to see trend and magnitude of inequality and its contributing factor.
- Combining data set from four round to get large sample and increase precision and since the sample weight in each data set was not valid for pooled data, we need to denormalized and that was managed in this study.
- Use of a combination of different methods for assessing inequalities, which leads to a better understanding of the current situation.
- In the pooled data, the effect of year has been controlled, and its results are not affected by the different survey years i.e. the effect of one year is independently represented and is not affected by the results of different survey years.

Limitations

- When disaggregated to the equity stratifiers, the sample size that we get from the DHS survey becomes smaller which could affect the power of the study.
- Due to sample size issue, mortality rate for socioeconomic and background characteristics were calculated for the last ten year, this produce sample overlap.
- The other limitation could be on getting complete data, as the data acquisition relies on interviewing mothers who are alive during the survey, children of deceased mother may be underreported. It is also faced with a recall bias besides mothers may not report their dead neonates due to sociocultural reason.

7. CONCLUSION

This study found that overall trend in neonatal mortality and the trend for the selected equity stratifiers was slowly declining and progress in annual rate of reduction was also sluggish which makes unrealistic in achieving the ambitious SDG goal of reducing neonatal mortality of 10 per 1000 live births by 2020.

Improvements in coverage of RMNCH services have a role in declining mortality, maintaining improvement in RMNCHS and scaling up of high impact interventions that directly act on leading determinants of neonatal mortality exhaustively to underserved regions is of high priority.

Across the survey years even though mortality is relatively concentrated among socioeconomically disadvantaged, level of inequalities was lowest and there is no clear pattern when mortality is seen in population ranked by wealth and education. The health delivery system (the quality) of current existed intervention should be investigated to clearly understand the cause of such uniform mortality irrespective of wealth and educational status.

For geographic related equity marker, absolute and relative inequalities for region were pronounced, signifying the need for closing the gap by focusing on those disadvantaged residing in specific regions. Were as for place of residence it showed insignificant, suggesting neonatal mortality were evident for both. Different level of wealth, region and residence were found to be a major contributor for the observed wealth-based inequalities. it seems that prevention of neonatal deaths does not respond to available interventions.

8. RECOMMENDATION

Policy makers

Since the degree of inequality and its pattern across the survey year were not pronounced focusing in general population (the whole population approach) in addition to targeting the disadvantaged society and underserved regions may help to reduce neonatal mortality.

As one of the goals of the SDG is to narrow the gap in inequalities, scheduled monitoring and reporting of the inequalities at a sub-population level is recommended as part of the interventions.

For Reproductive Health Programmers

As the result from both summery measures on inequality in neonatal mortality for selected equity marker were staying narrow and all assessed population sub group were suffered from mortality, it is difficult to conclude the existed interventions have a role in reducing or increasing inequality. Furthermore, it doesn't help on reducing the number of neonatal deaths among sub populations as expected. We recommend investigating the health delivery system and monitoring implementation of quality high impact intervention services should be given high priority

In addition, rigorous efforts should be made to encourage the uptake of RMCNH services in all regions so that no region will be left behind.

Researchers

The health inequality study requires larger data to adequately assess inequality and it is recommended if the next surveys have a better sample size that allows to conduct inequality study for population sub-groups.

9.REFERENCE

1. Lawn JE, Cousens S, Zupan J, Team LNSS. 4 million neonatal deaths: when? Where? Why? The lancet. 2005;365(9462):891-900.
2. Brearley L, Marten R, O'Connell T. Universal health coverage: a commitment to close the gap. London: Save the Children. 2013.
3. Estimation UNI-aGfCM, Hug L, Sharrow D, Zhong K, You D, Unicef, et al. Levels & Trends in Child Mortality: Report 2018, Estimates Developed by the: United Nations Children's Fund; 2018.
4. WHO. Neonatal mortality,www.searo.who.int/entity/data/chi.
5. Organization WH. Making every baby count: audit and review of stillbirths and neonatal deaths. 2016.
6. Hug L, Sharrow D, You D. Levels & trends in child mortality: report 2017. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. 2017.
7. United Nations DoEaSA, Population Division. World Mortality Report 2015 - Highlights. 2015;(ST/ESA/SER.A/382).
8. Lawn J, Kerber K. Opportunities for Africas newborns: practical data policy and programmatic support for newborn care in Africa. 2006.
9. Ethiopia. Ethiopia Demographic and Health Survey, 2016: ICF International, c entral Statistical Agency, uly 2017.; 2012.
10. unicef for evry child. annual report on newborn mortality. ethiopia 2018.
11. McKinnon B, Harper S, Kaufman JS, Bergevin Y. Socioeconomic inequality in neonatal mortality in countries of low and middle income: a multicountry analysis. The Lancet Global Health. 2014;2(3):e165-e73.
12. Quentin W, Abosede O, Aka J, Akweongo P, Dinard K, Ezeh A, et al. Inequalities in child mortality in ten major African cities. BMC medicine. 2014;12(1):95.
13. Whitehead M, Dalghren L. A discussion paper on concepts and principles for tackling social inequities in health. Studies on social and economic determinants of population health WHO Copenhagen, Denmark. 2006.
14. Hosseinpoor AR, Bergen N, Barros AJ, Wong KL, Boerma T, Victora CG. Monitoring subnational regional inequalities in health: measurement approaches and challenges. International journal for equity in health. 2016;15(1):18.
15. Golding N, Burstein R, Longbottom J, Browne AJ, Fullman N, Osgood-Zimmerman A, et al. Mapping under-5 and neonatal mortality in Africa, 2000–15: a baseline analysis for the Sustainable Development Goals. The Lancet. 2017;390(10108):2171-82.
16. Organization WH. Every newborn: an action plan to end preventable deaths. 2014.
17. Colglazier W. Sustainable development agenda: 2030. Science. 2015;349(6252):1048-50.
18. Assefa Y, Van Damme W, Williams OD, Hill PS. Successes and challenges of the millennium development goals in Ethiopia: lessons for the sustainable development goals. BMJ global health. 2017;2(2):e000318.
19. Health FDRoEMo. HSTP Health Sector Transformation Plan 2015/16-2019/20 (2008-2012 EFY). Federal Democratic Republic of Ethiopia Ministry of Health; 2015.
20. FMOH E. National Reproductive Health Strategy.: FMOH; 2016-2020.
21. Organization WH. Handbook on health inequality monitoring: with a special focus on low-and middle-income countries: World Health Organization; 2013.
22. WHO. World Health Statistics 2016: monitoring health for the SDGs. World Health Organization Geneva; 2016.
23. Blencowe H, Cousens S. Addressing the challenge of neonatal mortality. Tropical medicine & international health. 2013;18(3):303-12.

24. Kayode GA, Grobbee DE, Amoakoh-Coleman M, Ansah E, Uthman OA, Klipstein-Grobusch K. Variation in neonatal mortality and its relation to country characteristics in sub-Saharan Africa: an ecological study. BMJ global health. 2017;2(4):e000209.
25. Fonseca SC, Flores PVG, Camargo Jr KR, Pinheiro RS, Coeli CM. Maternal education and age: inequalities in neonatal death. Revista de saude publica. 2017;51:94.
26. Bedane AS, Asena TF, Shamenna AT, Abshoko AD. Variations in Under-five Child Mortality among Regional States of Ethiopia: A Multi-level Modelling Approach. British Journal of Applied Science & Technology. 2016;15(2):1.
27. FMOH E. National Strategy for Newborn and Child Survival in Ethiopia. . In: MCH Directorate, editor. Addis Ababa.2015.
28. Wang H, Tesfaye R, NV Ramana G, Chekagn CT. Ethiopia health extension program: an institutionalized community approach for universal health coverage: The World Bank; 2016.
29. Samuel Bwalya SE, and Selamawit Alebachew, Junior Economist, . Analyzing regional performance and disparities in health outcomes in Ethiopia,. UNDP Ethiopia., Unit. PaA; 2012.
30. Burke M, Heft-Neal S, Bendavid E. Sources of variation in under-5 mortality across sub-Saharan Africa: a spatial analysis. The Lancet Global Health. 2016;4(12):e936-e45.
31. (FMOH). FMoH. State of Equity in the utilization of Maternal, Child and Reproductive Health in Ethiopia. Addis Ababa, Ethiopia.2018.
32. Sousa A, Hill K, Dal Poz MR. Sub-national assessment of inequality trends in neonatal and child mortality in Brazil. International journal for equity in health. 2010;9(1):21.
33. Victora CG, Requejo JH, Barros AJ, Berman P, Bhutta Z, Boerma T, et al. Countdown to 2015: a decade of tracking progress for maternal, newborn, and child survival. The Lancet. 2016;387(10032):2049-59.
34. Organization WH. State of Inequality: Reproductive Maternal Newborn and Child Health: Interactive Visualization of Health Data: World Health Organization; 2015.
35. Mekonnen Y, Tensou B, Telake DS, Degefie T, Bekele A. Neonatal mortality in Ethiopia: trends and determinants. BMC public health. 2013;13(1):483.
36. Kayode GA, Ansah E, Agyepong IA, Amoakoh-Coleman M, Grobbee DE, Klipstein-Grobusch K. Individual and community determinants of neonatal mortality in Ghana: a multilevel analysis. BMC pregnancy and childbirth. 2014;14(1):165.
37. Kolola T, Ekubay M, Tesfa E, Morka W. Determinants of neonatal mortality in North Shoa Zone, Amhara regional state, Ethiopia. PloS one. 2016;11(10):e0164472.
38. Al Kibria GM, Burrowes V, Choudhury A, Sharmeen A, Ghosh S, Mahmud A, et al. Determinants of early neonatal mortality in Afghanistan: an analysis of the Demographic and Health Survey 2015. Globalization and health. 2018;14(1):47.
39. Ely DM, Driscoll AK, Matthews T. Infant mortality rates in rural and urban areas in the United States, 2014: US Department of Health and Human Services, Centers for Disease Control and …; 2017.
40. Saikia N, Shkolnikov VM, Jasilionis D, Chandrashekhar. Trends and sub-national disparities in neonatal mortality in India from 1981 to 2011. Asian Population Studies. 2016;12(1):88-107.
41. Hodge A, Firth S, Marthias T, Jimenez-Soto E. Location matters: trends in inequalities in child mortality in Indonesia. Evidence from repeated cross-sectional surveys. PLoS One. 2014;9(7):e103597.
42. Moradi-Lakeh M, Bijari B, Namiranian N, Olyaeemanesh A-R, Khosravi A. Geographical disparities in child mortality in the rural areas of Iran: 16-years trend. J Epidemiol Community Health. 2013;67(4):346-9.
43. Oestergaard MZ, Inoue M, Yoshida S, Mahanani WR, Gore FM, Cousens S, et al. Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. PLoS medicine. 2011;8(8):e1001080.

44. Anyamele OD, Akanegbu BN, Ukawuilulu JO. Trends and disparities in infant and child mortality in Nigeria using pooled 2003 and 2008 Demographic and Health Survey data. SAGE Open. 2015;5(4):2158244015611936.
45. Deribew A, Tessema GA, Deribe K, Melaku YA, Lakew Y, Amare AT, et al. Trends, causes, and risk factors of mortality among children under 5 in Ethiopia, 1990–2013: findings from the Global Burden of Disease Study 2013. Population health metrics. 2016;14(1):42.
46. Negera A, Abelti G, Bogale T, Gebreselassie T, Pearson R. An analysis of the trends, differentials and key proximate determinants of infant and under-five mortality in Ethiopia. Further analysis of the 2000. 2005:3-5.
47. Nguyen K-H, Jimenez-Soto E, Dayal P, Hodge A. Disparities in child mortality trends: what is the evidence from disadvantaged states in India? The case of Orissa and Madhya Pradesh. International journal for equity in health. 2013;12(1):45.
48. Mishina H, Hilton JF, Takayama JI. Trends and variations in infant mortality among 47 prefectures in Japan. Journal of evaluation in clinical practice. 2013;19(5):849-54.
49. Rarani MA, Rashidian A, Khosravi A, Arab M, Abbasian E, Morasae EK. Changes in socio-economic inequality in neonatal mortality in Iran between 1995-2000 and 2005-2010: an Oaxaca decomposition analysis. International journal of health policy and management. 2017;6(4):219.
50. Chalasani S. Understanding wealth-based inequalities in child health in India: a decomposition approach. Social science & medicine. 2012;75(12):2160-9.
51. Stiyaningsih H, Wicaksono F. Impact of Women's empowerment on infant mortality in Indonesia. Kesmas: National Public Health Journal. 2017;11(4):185-91.
52. Genowska A, Zalewska M, Jamiolkowski J, Stepaniak U, Szpak A, Maciorkowska E, et al. Inequalities in mortality of infants under one year of age according to foetal causes and maternal age in rural and urban areas in Poland, 2004-2013. Annals of Agricultural and Environmental Medicine. 2016;23(2).
53. Fenn B, Kirkwood BR, Popatia Z, Bradley DJ. Inequities in neonatal survival interventions: evidence from national surveys. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2007;92(5):F361-F6.
54. Razzaque A, Streatfield PK, Gwatkin DR. Does health intervention improve socioeconomic inequalities of neonatal, infant and child mortality? Evidence from Matlab, Bangladesh. International Journal for Equity in Health. 2007;6(1):4.
55. Anastasi E, Ekanem E, Hill O, Oluwakemi AA, Abayomi O, Bernasconi A. Unmasking inequalities: Sub-national maternal and child mortality data from two urban slums in Lagos, Nigeria tells the story. PloS one. 2017;12(5):e0177190.
56. Brockerhoff M, Hewett P. Inequality of child mortality among ethnic groups in sub-Saharan Africa. Bulletin of the World Health Organization. 2000;78:30-41.
57. Ambel AA, Andrews C, Bakilana AM, Foster EM, Khan Q, Wang H. Examining changes in maternal and child health inequalities in Ethiopia. International journal for equity in health. 2017;16(1):152.
58. Skaftun EK, Ali M, Norheim OF. Understanding inequalities in child health in Ethiopia: health achievements are improving in the period 2000–2011. PLoS One. 2014;9(8):e106460.
59. Desai S, Wu L. Structured inequalities—factors associated with spatial disparities in maternity care in India. Margin: The Journal of Applied Economic Research. 2010;4(3):293-319.
60. Dabla-Norris ME, Kochhar MK, Suphaphiphat MN, Ricka MF, Tsounta E. Causes and consequences of income inequality: A global perspective: International Monetary Fund; 2015.
61. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. Population and development review. 1984;10(0):25-45.
62. internate. POPULATION OF ETHIOPIA , February 23, 2017. [2018.].

63. Federal Democratic Republic of Ethiopia Ministry of Health. HEALTH SECTOR TRANSFORMATION PLAN-I,ANNUAL PERFORMANCE REPORT. Ethiopia, EFY 2009 (2016/17).
64. Macro. CSAEaO. Ethiopia Demographic and Health Survey 2000. . Addis Ababa, Ethiopia and Calverton, Maryland, USA: : Central Statistical Authority and ORC Macro.; 2001. .
65. Macro O. Central Statistical Agency: Ethiopia demographic and health survey 2005. ORC Macro, Calverton, Maryland, USA. 2006.
66. ICF C. Central Statistical Agency [Ethiopia] and ICF International. Ethiopia Demographic and Health Survey. 2011.
67. Wehrmeister FC, Restrepo-Mendez M-C, Franca GV, Victora CG, Barros AJ. Summary indices for monitoring universal coverage in maternal and child health care. Bulletin of the World Health Organization. 2016;94(12):903.
68. Rutstein SO, Johnson K, MEASURE OM. The DHS wealth index: ORC Macro, MEASURE DHS; 2004.
69. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. The Lancet. 2012;379(9832):2151-61.
70. Wagstaff A, Paci P, Van Doorslaer E. On the measurement of inequalities in health. Social science & medicine. 1991;33(5):545-57.
71. O'Donnell O, O'Neill S, Van Ourti T, Walsh B. conindex: Estimation of concentration indices. The Stata journal. 2016;16(1):112-38.
72. Erreygers G. Correcting the concentration index. Journal of health economics. 2009;28(2):504-15.
73. Norton EC, Miller MM, Kleinman LC. Computing adjusted risk ratios and risk differences in Stata. The Stata Journal. 2013;13(3):492-509.
74. Organization WH. Health Equity Assessment Toolkit (HEAT): Software for exploring and comparing health inequalities in countries. Built-in database edition Version.1.
75. Speybroeck N, Konings P, Lynch J, Harper S, Berkvens D, Lorant V, et al. Decomposing socioeconomic health inequalities. International journal of public health. 2010;55(4):347-51.
76. Maternal and Child Health DirectorateFederal Ministry of Health National Strategy for Newborn and Child Survival in Ethiopia,

. 2015/16 - 2029/20.
77. Kraft AD, Nguyen K-H, Jimenez-Soto E, Hodge A. Stagnant neonatal mortality and persistent health inequality in middle-income countries: a case study of the Philippines. PLoS One. 2013;8(1):e53696.

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: Yodit Hailemichael 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: ----------