2016

Socioeconomic Status-Related Inequities on Maternal Health Services: Trends, Associations, and Outcomes

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Abstract

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by

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MPH, Pretoria University, 2002

B.Sc., Addis Ababa University, 1990

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

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Abstract

Maternal Mortality Rate (MMR) in Ethiopia remains one of the highest in the world due in part to very limited use of maternal health services. However, the underlying factors for limited use of the services and hence the high MMR are not well known. The purpose of this study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks, and to measure the magnitude and trends in inequity. Behavioral-cultural and structural theories of health inequalities were used to frame the study. Research questions included whether there were trends of inequity in use of maternal health services, if sociodemographic characteristics were associated with use of the services, and whether inequities in use of the services were associated with maternal health risks. The study design was quantitative and used data collected through Demographic and Health Surveys (DHS) conducted in 2000, 2005, and 2011. DHS had employed stratified 2-stage cluster design; this analysis used logistic regression method, odds ratio chi-square test, and correlation measures. The findings indicated statistically significant inequities on use of antenatal care and skilled birth attendant services associated with women's residence, level of education, income, administrative region, distance to a health facility, out-of-pocket payment for health services, and involvement in decision making. Based on the findings, it is recommended to design maternal health policies and programs that improve access and use of the services, specifically for women in rural areas, with no education and with limited economic capacity. Further research is also recommended for regions where sample size was limited. Maternal health policies and programs designed to reach the most disadvantaged women could increase service use and improve maternal health, leading to positive social change.

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Dedication

I dedicate this dissertation to my late mother Bosena Alemayehu and my late father

Gobezie Workneh. I cannot return anything against their inexpressible love and

support except to say that I have my all life and this dissertation dedicated to them.

Acknowledgements

I would like to thank my extraordinary dissertation committee, Dr. Loretta Cain (Committee Chair), Dr. Shingairai Feresu (Committee member), and Dr. Mary Lou Gutierrez (University Research Reviewer) for persevering with me throughout the process to completion. Dr. Cain, thank you so much for you incredible wisdom, guidance, support and encouragement in each step of the dissertation work – from prospectus development to the final stages. Dr. Feresu, many thanks for your timely support and great guidance specifically on subject matters. Dr. Mary Lou Gutierrez, your guidance and feedback was always very helpful and encouraging. I would like to thank Mr. Joseph Gredler for his timely review and detailed guidance on forms and style of the dissertation. From Mr. Gredler's guidance, I have learned a lot on writing skills and more on APA style. I would also like to thank all my classmates from whom I learned a lot through the classroom discussions.

Finally, I would like to thank my family; specifically my wife, Betelehem A. Alemayehu, for the great amount of work taking care of our children and myself; and to my wonderful children – Yohannes, Fikirte, Arsiema and Maya - for always making me smile and for their understanding when I was working on my study instead of playing with them.

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Chapter 1: Introduction to the Study

Maternal mortality rate (MMR) in Ethiopia is very high, even compared to its peer developing countries (Thomas et al., 2014; World Health Organization, 2014a), and it is not showing much decline (Central Statistical Agency, 2005, 2011; World Bank, 2014). Based on Demographic and Health Survey (DHS), the 2011 MMR was estimated at 676 per 100,000 live births, which was not statistically different from the 2005 level (CSA, 2005, 2011). The World Bank (2014) modeled estimates showed that MMRs in Ethiopia were 500 and 420 per 100,000 live births in 2009 and 2014, respectively. Both the national level surveys and modeled estimates show that MMRs in Ethiopia are twice the average in other developing countries, which is 230 per 100,000 live births (Thomas et al., 2014; WHO, 2014a).

In addition, there is evidence that inequity in the use of maternal health services is among the highest in Ethiopia (Barros et al., 2012). This inequity is potentially one of the factors contributing to the high level of MMR in the country (Ruhago, Ngalesoni, & Norheim, 2012; Zere et al., 2010). In this regard, Ethiopia is rated as one of the most inequitable countries in utilization of maternal health services (Barros et al., 2012; WHO & UNICEF, 2013). In general, socioeconomic status (SES) associated inequities are major obstacles to improve maternal health and reduce MMR (Ruhago et al., 2012; Victoria et al., 2012; Zere et al., 2010).

Therefore, studying inequity trends on the use of maternal health services and identifying the associated factors would help to inform policies and programs and refocus resources to women who are most disadvantaged in accessing maternal health services such as attended delivery and antenatal care. About 52% of females in Ethiopia never attended school, three-quarters of the population live in rural areas

where access to maternal health services is limited and the level of income is much lower as compared to in urban settings (CSA, 2011). Therefore, analyzing the magnitude of inequity in accessing maternal health services and understanding the factors limiting the use of services at national and subnational levels would benefit the disadvantaged women in Ethiopia and contribute to positive social change.

The evidence generated through this research could help to inform maternal health policies and programs designed at national and local levels. The evidence generated through this study may show which specific groups of women are most disadvantaged in using the services, the factors limiting use of the services, and the implications (maternal health risks) associated with not having access to the services. The evidence could help the national and local governments to design programs that target the most disadvantaged women and alleviate factors that are limiting use of the services. These efforts could expand use of maternal health services by all Ethiopian women, improve maternal health, and bring positive social change.

The main sections of this chapter include a background that briefly summarizes the research literature related to the scope of the study, the knowledge gaps the study attempted to fill, and why the study was important. The chapter also presents the problem statement and purpose of the study. The research questions and hypotheses are included and the theoretical framework is briefly described. Nature of the study, study variables, assumptions, scope, delimitations, limitations and significance of the study are also included.

Background

Available literature shows that, as compared to other developing countries, MMR in Ethiopia is one of the highest, and the country is ranked among the top on inequity in accessing maternal health services. Modeled MMR in Ethiopia, estimated

at 420 per 100,000 live births, is twice the level in other developing countries (World Bank, 2014). Ethiopia is also classified as one of the most inequitable countries in the use of maternal health services (specifically on attended delivery and antenatal care) that are associated with income, education, and residence (Barros et al., 2012; WHO, 2014b). Despite increases in health service coverage in the country from 49% in 2001 to 90% in 2009 (Haile Mariam, 2011), there has been very limited progress in utilization of essential maternal health services; for example, births attended by skilled health personnel increased from 6% in 2005 to only 10% in 2011 (CSA, 2005, 2011). This evidence indicates that the expansion of health services did not adequately account for the specific needs and conditions of women who are not able to use the services. Literature also shows that in order to improve health, including maternal health, it is critical to close the health inequity gaps between and within countries (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). Addressing health inequities is a matter of social justice and an ethical imperative (WHO, 2013).

The major gaps in the literature on inequity in the use of maternal health services in Ethiopia include: (a) inequity analysis and evidence are at the national level, (b) evidence is based on small-scale studies, which limits conclusiveness and generalization, (c) evidence is largely cross-sectional, and (d) factors associated with maternal health risks are largely assessed from a clinical perspective and not from a social, behavioral, and cultural aspect. This research was conducted to contribute to fill these knowledge gaps. The study could help to inform the design of appropriate policies and programs that address locality-specific SES factors that constrain women from using maternal health services. The evidence generated could help to explain why MMR in Ethiopia remains high. The study could also contribute to improve

maternal health and reduce maternal mortality among the most disadvantaged women in Ethiopia.

Problem Statement

According to the World Health Organization (WHO, 2012), about 800 women die every day from preventable causes related to pregnancy and childbirth, and 99% of these deaths occur in developing countries. Ethiopia is one of the countries in sub-Saharan Africa with the highest MMR, estimated at 676 per 100,000 live births (CSA, 2011; WHO, 2012), and modeled MMR estimated at 420 per 100,000 live births (World Bank, 2014). In comparison to Ethiopia, MMRs are 240 per 100,000 live births in developing countries and only 16 per 100,000 live births in developed countries (WHO, 2012). According to national level demographic and health surveys conducted in Ethiopia in 2005 and 2011, MMR has not shown a decline between 2005 and 2011. In fact, MMR has slightly increased from 663 per 100,000 live births in 2005 to 676 per 100,000 live births in 2011 (CSA, 2005, 2011). However, a modeled estimate by the World Bank (2014) indicated that MMR estimates in Ethiopia were 500 and 420 per 100,000 live births in 2009 and 2014, respectively. Both the national survey results and model estimates indicate that maternal mortality in Ethiopia is one of the highest in the world. Even the lower modeled estimate by the World Bank (2014) shows that MMR in Ethiopia is about two-times higher than the average for developing countries, which is 230 per 100,000 live births (Thomas et al., 2014; WHO, 2014a).

Access to and use of maternal health services (such as antenatal care and attended delivery) has important implications on maternal health and mortality. There is also evidence showing the negative impact of inequity in accessing services to maternal health. For example, Tanzania and Namibia faced serious challenges in

progressing toward the millennium development goal on maternal health due to inequity issues in using maternal health services (Ruhago et al., 2012; Zere et al., 2010). While the overall health services coverage increased significantly in recent years (from 49% in 2001 to 90% in 2009) in Ethiopia, utilization of the services remained at 0.3% (Haile Mariam, 2011). In addition, attended delivery only increased from 6% in 2005 to 10% by 2011 (CSA, 2005, 2011).

Ethiopia is classified as one of the most inequitable countries (associated with income, education, and residence) in the use of maternal health services, specifically attended delivery and antenatal care services (Barros et al., 2012; WHO, 2014b). Among 54 developing countries assessed on equity in skilled birth attendance, Ethiopia ranked first as the most inequitable country associated with wealth (Barros et al., 2012). In least developed countries like Ethiopia, where the majority of the population falls in the low SES category in terms of education, income, and residence, equity matters most in order to achieve national level targets on maternal health. Based on a review of survey data from 35 developing countries, Victoria et al. (2012) demonstrated that addressing SES-associated disparities in health services increases national level maternal health service coverage and hence improves maternal health.

Despite the alarming condition of MMR and of inequality in use of maternal health services in Ethiopia, little research has been conducted in the country to know how SES-associated disparities in using the health services evolved over time. The issue has not been tracked and analyzed to inform policies and programs in the country. The limited studies available are cross-sectional and are either aggregates at the national level or they are based on data from few districts, towns, or zonal administrations limiting generalizability or conclusiveness. In addition, the few studies available on maternal health risk factors such as stillbirth, abortion, and

miscarriage only addressed clinical dimensions and not the social, behavioral, and cultural perspectives.

I attempted to fill these research gaps through a quantitative analysis of the national level demographic health survey data of Ethiopia collected in 2000, 2005, and 2011. The knowledge gained through this research would provide additional information to understand whether the high level of maternal mortality could be explained by the SES-associated inequities in the use of maternal health services.

Purpose of the Study

The purpose of the study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks; and to measure the magnitude and trends in inequity. These areas have been identified based on the knowledge gap in Ethiopia on inequity trends at national and sub-national level, associated factors, and linkages with maternal health risks. Ethiopia has high MMR at 420 per 100,000 live births (The World Bank, 2014), very low use of maternal health services (CSA, 2011), and high level of inequity in using maternal health services (Barros et al., 2012). However, the literature showed major knowledge gaps on the magnitude of inequity in use of maternal health services, factors associated with use of maternal health services, and association of inequities with maternal health risks such as miscarriage, abortion, and stillbirth.

Knowledge gained through this study could inform national and subnational level maternal health policies and programs that include goals to improve the health of women in the most disadvantaged groups (poor, with limited or no education, and/or living in rural areas). National and local level maternal health programs could use the evidence generated in this study to identify SES factors limiting use of

maternal health services and maternal health implications of inequities. Maternal health programs designed to reach the most disadvantaged groups and to address the factors restricting use of the services could increase use of maternal health services nationally and improve maternal health.

Research Questions and Hypotheses

The study had three main research questions. The research questions and corresponding hypotheses were the following.

First Research Question and Hypothesis

1. Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education, or wealth status?

- Ho1: There are no trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

- Ha1: There are trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

The first research question (RQ1) measures whether there are inequities on the use of maternal health services (particularly antenatal care and attended delivery) according to where women live, their level of education, and their household income category. This measure was conducted for each of the years (2000, 2005, and 2011) for which national survey data (DHS) was available.

Second Research Question and Hypothesis

2. Are sociodemographic characteristics including income, education level, urban/rural residence, distance to health facility, out-of-pocket payment for services,

and decision-making power significantly associated with use of maternal health

services by Ethiopian women?

- Ho2: Use of maternal health services (antenatal care and attended delivery) are not

  associated with sociodemographic characteristics including income, education

  level, urban/rural residence, distance to health facility, out-of-pocket payment for

  services, and decision making power).

- Ha2: Use of maternal health services (antenatal care and attended delivery) are

  associated with socio-demographic characteristics including income, education

  level, urban/rural residence, distance to health facility, out-of-pocket payment for

  services, and decision making power).

Third Research Question and Hypothesis

3. Are inequities in maternal health service use associated with differences in

maternal health risks such as miscarriage, abortion, and stillbirth?

- Ho3: Inequities in maternal health service use are not associated with differences

  in maternal health risks such as miscarriage, abortion, and stillbirth.

- Ha3: Inequities in maternal health service use are associated with differences in

  maternal health risks such as miscarriage, abortion, and stillbirth.

<div align="center">Theoretical Framework</div>

Behavioral, cultural, and structural theories of health inequality (McCartney,

Collins, & Mackenzie, 2013) formed the basis of this study. According to the cultural

and behavioral theories, differences between groups in relation to health-seeking

behaviors and practices and cultural practices have important impact leading to health

inequalities. However, for health behavior and culture to be causal for observed health

inequalities, socioeconomic differences/factors play important intermediary roles.

According to the structural theory, differences in the socioeconomic circumstances of social groups (including differences in income, wealth, power, environment, and access) at all stages of the life course cause differences in health outcomes (McCartney et al., 2013).

The theories selected relate to the methodological approach and research questions. Evidence indicates the importance of addressing social inequalities in health in order to improve maternal health (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). Graham (2014) also argued that addressing socioeconomic inequalities in health requires addressing the underlying factors including behavioral factors or living standards leading to such inequalities. In this regard, properly identifying and monitoring the underlying factors is important in order to address inequalities in health services and outcomes (Graham, 2014; Phelan, Link, & Tehranifar, 2010). Therefore, in measuring inequalities in using maternal health services (ANC and attended delivery) in Ethiopia, it was necessary to measure the inequity levels in the factors that determine use of maternal health services.

Nature of the Study

A quantitative approach was appropriate to answer the research questions, which required quantitative analysis for measuring inequities in using maternal health services, inequity trends over time, significant socioeconomic characteristics, and associations between the use of maternal health services and maternal health risks. The three datasets (DHS 2000, 2005, and 2015) were accessed through the DHS Program. There were two dependent variables for this study, i.e., use of antenatal care services and attendance of delivery by skilled health personnel. Independent variables included level of education of women, household income, residence (urban/rural), administrative region, women's decision-making power, distance to health facility,

out-of-pocket payment for health services, and maternal health risk (terminated pregnancy).

In order to judge on whether there were inequities in use of maternal health services, I compared different groups of women according to region, residency, level of education, and income category on their use of maternal health services (antenatal care and skilled birth attendance). Proportions and ratios are some of the methods used for assessing inequities (McKinnon, Harper, Kaufman, & Bergevin, 2014; Regidor, 2004b) and also applied in this study. I used odds ratio chi-square test to answer the first research question.

To answer to the second research question, I constructed logistic regression models and identified factors associated with use of maternal health services (antenatal care and skilled birth attendance). To answer the third research question, I compared different groups of women grouped by region, residency, level of education, and income category to identify patterns in use of maternal health services and maternal health risks. This was done by comparing odds ratios in the different groups of women on their use of maternal health services with corresponding maternal health risks.

Definition of Variables

Below are the operational definitions of the main variables included in this study:

- *Inequity*: Scholars do not fully agreed on standard definitions for inequity; some use inequity, inequality, and disparity interchangeably (Braveman, 2006). In this study, inequity and inequality are also used interchangeably and refer to a statistically significant difference between two groups of women as measured by a

variable of interest. For example, if the percentage of births attended by a skilled health personnel by women residing in Region 1 is statistically different (at α = 0.05) from the percentage attended in Region 2, then there is inequity between the regions.

- *Use of antenatal care service*: This refers to at least one visit to a health facility for antenatal care service for the last pregnancy.

- *Skilled birth attendance*: Refers to delivery of a women attended by skilled health personnel for the last pregnancy.

- *Region*: Refers to the administrative region where women are residing. In Ethiopia, there are 11 regions including nine administrative regions (Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations Nationalities and Peoples [SNNP], Gambela, and Harari) and two city administrations (Addis Ababa and Dire Dawa).

- *Income category*: Refers to the wealth quintile (lowest to highest) as measured by the three DHS. In the three DHS, households were classified into five wealth quintiles using principal component analysis.

- *Level of education of a woman*: Refers to one of six categories as defined in the DHS: no education, some primary, completed primary, some secondary, completed secondary, and more than secondary (CSA, 2000, 2005, 2011).

Assumptions

The three DHS surveys were designed in such a way that population level estimates at national and regional level were possible. Despite this, some generalizability concerns were observed for specific regions in which the sampling could not include specific clusters for various reasons. Specifically, the 1997 census

in Afar and Somalia regions did not include some nomadic areas; hence, the areas were not included in the sampling frames for the 2000 and 2005 DHS (CSA, 2000, 2005). In the 2011 DHS, some areas in Somalia region were not included in the survey due to security concerns (CSA, 2011). Therefore, the estimates for Afar and Somalia need to be interpreted with caution; and an assumption is made that the data from these regions provides a fair estimate of the situation in the two regions.

Scope and Delimitations

The study was delimited to data available through the three national level population and health surveys in Ethiopia: DHS 2000, 2005, and 2011. The study focused specifically on the inequity aspects of use of maternal health services (antenatal care and attended delivery), which have important implications on maternal mortality and morbidity. On the other hand, I attempted to identify factors associated with use of maternal health services (antenatal care and attended delivery). In addition, I analyzed the possible linkages between inequity in the use of maternal health services and maternal health risks including miscarriage, abortion, and stillbirth. The information generated from the study would help inform national and regional maternal health policies and programs that would improve equity in the use of maternal health services and reduce maternal morbidity and mortality.

Limitations

The analysis was dependent on the data collected through the three national level surveys conducted in 2000, 2005, and 2011. Therefore, this study did not identify all possible factors associated with use of maternal health services; variables not collected through the DHS surveys were not analyzed. For example, government budget allocations to the regions for maternal health as well as infrastructural development may have implications on the use of maternal health services and hence

contribute to inequity. However, these data were not gathered through the DHS surveys and hence were not included in this study.

On the other hand, the DHS reports documented some limitations in the sampling process in two regions: Afar and Somalia. The 2000 and 2005 DHS did not include certain geographic areas (specifically nomadic areas) in the sampling frame (CSA, 2000, 2005). In addition, in the 2011 DHS, some geographic areas (enumeration areas) in the Somalia region were not included in the study for security reasons (CSA, 2011). Therefore the generalizability of the estimates in service coverage and inequity measures in these two regions (Afar and Somalia) would need to be interpreted with caution.

Significance

Inequities in accessing maternal health services in Ethiopia have not been studied using nationally representative data and analyzing inequity trends over time. The significance of the study relates to its social change implications in improving maternal health. The study would provide knowledge helpful in designing maternal health programs and policies. Knowledge as to how inequities in accessing maternal health service evolved over time would help government and partners take policy actions and design/implement programs targeted to reach women who are most disadvantaged. This would contribute to reduce the unbearable level of MMR at the national level and hence lead to positive social change.

Summary and Transition

In Ethiopia, MMR estimated at 420 per 100,000 live births (Word Bank, 2014) is among the highest in the world, and inequality in using maternal health services such as ANC and attended delivery is also among the highest (Barros et al., 2012). Despite the expansion of health services in the country from 49% in 2001 to 90% in

2009, utilization was very low (Haile Mariam, 2011). For example, attended delivery increased from 6% in 2005 to only 10% in 2011. Evidence indicates the need to close inequity gaps in order to improve overall health, including maternal health (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). However, closing the equity gaps requires an appropriate measure and understanding of the levels of inequity, including trends over time and the factors associated with inequity.

Analysis of the current literature indicates major knowledge gaps regarding inequity in the use of maternal health services in Ethiopia. The limited studies available are aggregates at national levels and do not show subnational levels, are cross-sectional and do not show trends in inequity over time, or are limited in scale/coverage and hence unable to inform national/subnational level maternal health policies and programs. Therefore, this study was intended to fill this knowledge gap using available data from three national level demographic and health surveys conducted in 2000, 2005, and 2011. This quantitative study was intended to generate evidence that could inform maternal health policies and programs targeted to reach the most disadvantaged women in Ethiopia (poor, with limited or no education, and/or residing in rural areas with limited access to health facilities).

Chapter 2 provides an overview of most recent literature addressing inequity in health and specifically in maternal health, the knowledge gaps that necessitated this study, a review of the theories that formed the basis of this study, and the methodological approaches including the variables studied.

Chapter 2: Literature Review

The purpose of the study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks; and to measure the magnitude and trends in inequity. Despite international calls and efforts, maternal mortality remains a significant challenge, especially in developing countries including Ethiopia (Akalu, Gudeta, Tamiru & Haile Mariam, 2012; WHO, 2012; World Bank, 2014). About 800 women die every day from preventable causes related to pregnancy and childbirth, and 99% of these deaths occur in developing countries (WHO, 2012). In developing countries, MMR is estimated at 230 per 100,000 live births as compared to 16 per 100,000 live births in the developed world (Thomas et al., 2014; WHO, 2014a).

Specifically, maternal health in Ethiopia is alarming. MMR in Ethiopia in 2011, based on the national Demographic and Health Survey (DHS), was estimated at 676 per 100,000 live births; this was not statistically different from the MMR level in 2005 (CSA, 2005, 2011). The 2009 and 2014 modeled estimates, which considered several factors for a more accurate estimate, indicated MMRs in Ethiopia were 500 and 420 per 100,000 live births, respectively (World Bank, 2014). Both the national survey results and model estimates indicate that maternal mortality in Ethiopia is much higher than the average MMR for developing countries, which is 230 per 100,000 live births (Thomas et al., 2014; WHO, 2014a).

The 1948 UN Declaration on Human Rights, the 1978 Alma-Ata declaration for achieving "Health for All," the 1994 International Conference on Population Development (ICPD), WHO's Commission on Social Determinants of Health

(established in 2005), and the Millennium Declaration in 2000 are some of the

international calls emphasizing the importance of closing the health equity gaps

between and within countries in order to achieve better health (including maternal

health). The international calls have created shared visions and actions to close the

equity gaps and improve overall health and development (Bishaw, 2012; Thomas et

al., 2014; WHO, 2013).

In Ethiopia, despite the increasing trend in health service coverage nationally,

utilization of the services remains very low, which is contributing to the high level of

MMR in the country. While health service coverage in the country increased from

49% in 2001 to 90% in 2009, utilization of the services remained unchanged and

unacceptably very low at 0.3% (Haile Mariam, 2011). In addition, Ethiopia has been

rated as one of the most inequitable countries in utilization of maternal health services

(Barros et al., 2012; WHO & UNICEF, 2013). Inequity associated with

socioeconomic status (SES) in accessing maternal health services is documented to be

a serious obstacle in improving maternal health (Ruhago et al., 2012; Victoria et al.,

2012; Zere et al., 2010).

Despite the alarming levels of inequity and low coverage in accessing

maternal health services in Ethiopia, there is little research in the country that

provides evidence as to how SES-related inequities in use of maternal health services

have progressed over the years. Although Ethiopia has a Federal system, the existing

11 regional admirations are autonomous regarding policy and program decisions in

their respective locality. The limited researches available are national level and does

not provide local level inequity trends on use of maternal health services such as

attended delivery and antenatal care. Factors associated with use of maternal health

services (including how the factors evolved over time) are also not researched in a

regional/local context. The limited research that is available in Ethiopia is cross-sectional, very broad/national level, based on limited local data (few districts, villages or towns), or the methodologies applied for measuring inequity are variable. These gaps limit a comprehensive picture on the level and progress on equity in using maternal health services, and hence constrain the strength of evidence that can influence or initiate relevant policy and program actions in the country, specifically at local/regional level.

Therefore, this study was conducted to fill these gaps and add knowledge specifically on SES-associated inequities in using maternal health services in Ethiopia. The study addressed how the inequities have evolved between 2000 and 2011 for which three national level maternal health survey data are available. The study also identified factors associated with use of maternal health services, specifically on attended delivery and antenatal care. Finally, the study was done to explain how inequities in accessing maternal health services may predict inequities in maternal health risks including miscarriage, stillbirth, and abortion.

Chapter 2 presents the literature search strategy including the databases, search engines, terms, and other sources used to access relevant materials for review. The chapter also presents the theoretical framework that formed the basis of this study, the origin or source of the theories, and a description of the theoretical propositions. The chapter also includes a section that describes how the research questions relate to the theories identified and how the findings of the research may build upon or contribute to the chosen theories.

The chapter also has a section that presents the most widely applicable definitions of health inequity, followed by a presentation of the studies that dealt with similar areas of research. The methodological approaches employed in the study,

including the strengths and limitations of the approaches, are also addressed. The chapter also presents the main variables included in the study, including the rationales for inclusion, an overview of what is known about the variables, and the knowledge gaps that this research was attempting to fill. The chapter also has a section that provides a synthesis of studies related to the research questions, followed by a summary and conclusion.

Literature Search Strategy

A number of strategies and library databases were used for accessing literature on maternal health, use of maternal health services, inequity issues, inequity measurement approaches, the socioeconomic variables related to maternal health and inequity, and the theories that grounded the study. The Walden University library databases were the main sources for this search. From the Walden library, I primarily used Thoreau, which has the capacity to search literature from multiple databases. In addition, Google Scholar was used. In both approaches, the key search terms included one or a combination of the following: *maternal health*, *health inequity*, *health equity*, *health inequality, health equality*, *health disparity*, *maternal health inequity*, *maternal health equity*, *maternal health inequality*, *maternal health equality*, *maternal health disparity*, *global health*, *maternal health in developing countries*, *maternal health in sub-Saharan Africa*, *maternal health in Ethiopia*, *health services utilization*, *maternal health services utilization*, *theories of health inequality, miscarriage*, *abortion*, and *stillbirth*.

To comply with the requirement that most literature needed to be recent, preferably with the previous 5 years, most searches were limited to peer-reviewed journal articles published in 2010 or later. However, when an adequate number of studies was not found, the search included went as far back as 2003. In searching for

literature on the theoretical foundations for this study, including origin or source of the theories, and to know about previous international calls and programs of action on maternal health, the starting year for the search was left open.

Another strategy I used for the search was to look for the materials that were referenced in the articles that I was able to find with the search methods mentioned above. In addition, specific journals that were related to the area of research were accessed for articles using the search terms indicated above. The journals accessed included *Health Policy*, *Social Science and Medicine*, *New England Journal of Medicine*, *Journal of Health and Social Behaviour*, *Journal of Epidemiology & Community Health*, *Lancet*, *Journal of Personality and Social Psychology*, *International Journal of Epidemiology*, *British Medical Journal*, *American Journal of Epidemiology*, *PLoS Medicine*, *American Journal of Public Health*, the *Journal of the American Medical Association* (JAMA), *International Journal of Health Services*, and the *Ethiopian Journal of Health Development*.

Websites of organizations that are closely working on maternal health were searched for relevant literature including reports, declarations, and programs of action. These included the WHO website to access reports and calls for action of the Commission on Social Determinants for Health; Countdown 2015, which tracks and reports on progress in achieving the health-related Millennium Development Goals in 75 developing nations; and the United Nations Population Fund (UNFPA), for example, the ICPD.

Theoretical Foundation

Behavioral-cultural and structural theories of health inequality (McCartney et al., 2013) formed the basis of this study. The origin of these theories is the 1980 Black Report, which presented social inequalities in health and attempted to explain the

potential causes of such differences in Britain (Macintyre, 1997; McCartney et al., 2013). The Black Report identified four key theories to explain how social inequalities in health arose in the country in the 1980s. These theories were artifact, health selection (including natural and social selection), structural factors, and behavioral-cultural (Macintyre, 1997; McCartney et al., 2013).

According to the artifact theory, observed social inequalities in health are mere explanations of differences in measurement methods and processes, and there is no real health inequality associated with social class. Health selection theory indicates that health status determines social class, but not the other way around. According to the selection theory, people who are healthier have opportunities to move to higher social classes while those who are ill can easily slide down to lower social classes. The behavioral-cultural theory asserts that SES-related health inequalities are explained by health related behavioral/cultural differences between the socioeconomic classes (Macintyre, 1997; McCartney et al., 2013).

According to the behavioral-cultural theory, differences between the socioeconomic classes in their behavior or practice of using health facilities contribute to differences in health outcomes between the classes. Similarly, differences between the socioeconomic classes in risky sexual behavior can lead to differences in HIV prevalence between the different groups/classes. On the other hand, the structural theory indicates that differences in the socioeconomic circumstances of social groups (including differences in income, wealth, power, environment, and access) at all stages of the life course cause differences in health outcomes. In the structural (also called materialist) theory, income is the primary driver that creates access and opportunities for access to goods and services such as education, which contributes to better health (Bambra, 2011; Macintyre, 1997; McCartney et al., 2013).

The Black Report of 1980 was prepared by a working group set up in 1977 by the Secretary of State for Health in the Labor Government, and chaired by Sir Douglas Black. When analyzing the report, Macintyre (1997) revealed some differences in thoughts in the development processes of the theories to explain the underlying factors for social inequalities in health in Britain. Macintyre classified the differences along each of the theories into hard and soft versions. The hard version of the artifact theory indicated that there is no relation between class and mortality, while the soft version of the theory asserted that differences in social inequalities in health are a factor of the measurement of both health and class.

In the selection theory, the hard version explains that health determines class position, while the soft version indicates that health is only a contributory factor for class position. Similarly, the hard version of the structural theory indicates that differences in material and physical condition fully explain social inequalities in health, while the soft version asserts that differences in material and physical conditions contribute to social inequalities in health. Finally, the hard version of the behavioral/cultural theory indicates that risky behaviors (e.g., smoking) that are adopted by individuals do not explain social inequalities in health, and the soft version asserts that selection of a risky behavior to health has a social gradient and this contributes to social inequalities in health (Macintyre, 1997).

The Working Group of the 1980 Black Report rejected the hard versions of the artifact (selection and behavior-cultural explanations), but accepted both the hard and soft versions of the structural theory (Macintyre, 1997). On the other hand, McCartney et al. (2013) noted that the artifact and selection theories have been widely rejected because both do not explain health inequalities, and classified structural theory provides the best explanation for health inequalities.

Rationale for the Choice of the Theories

A number of sources and international calls for improving overall and maternal health accentuate the need for addressing and monitoring social inequalities in health (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). The importance of closing the gap in health equity between and within countries in order to progress toward the global health development was also highlighted when the WHO-led Commission on Social Determinants of Health was established in 2005. The Commission is tasked with gathering and monitoring global and country-specific evidence on the social inequalities in health and proposing actions that promote health and close the inequity gaps (WHO, 2008).

While monitoring social inequalities in health over time remains an important task, understanding underlying factors (such as behavioral, cultural, and structural) contributing to such inequalities is critically important in order to design policies and programs that address the underlying causes. Along this line, Graham (2014) noted that in attempts to address socioeconomic inequalities in health, it is vital to plan for addressing the underlying factors leading to such inequalities such as behavioral factors or living standards, and inequities between social groups at these underlying factor levels need to be monitored. Phelan et al. (2010) supported Graham's idea that an important strategy in addressing heath inequities is contextualizing the risk factors (i.e., documenting/identifying the underlying factors and addressing them).

Therefore, in measuring inequity level and trends in using maternal health services (including ANC and attended delivery) in Ethiopia, it was fundamental to measure the inequity levels in the factors that determine use of the services. As the existing studies in Ethiopia revealed, important factors contributing to use of maternal health services are behavioral, cultural, or structural—such as education, residence

(urban/rural), income, distance from health facility, out-of-pocket payments for health services, and quality of service delivery (Akalu et al., 2012; Aliy & Haile Mariam, 2012; Haile Mariam, 2011; Mehari & Wencheko, 2013). In this regard, the behavioral-cultural and structural theories of health inequality (McCartney et al., 2013) described in the previous section appear appropriate as a basis for this study to measure inequity trends of use of maternal health services and identify the underlying factors.

Research Questions in Relation to Existing Theory

This study attempted to answer three main research questions: i) whether there are trends of inequity in maternal health service use among Ethiopian women by administrative region, residence (urban/rural), and education or income; ii) identify socio-demographic characteristics that are significantly associated with use of maternal health services; and iii) whether inequities in using maternal health services (including antenatal care and delivery attendance) are associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

The research questions were adequately related to the behavioral-cultural and structural theories of health inequalities. At the heart of the behavioral-cultural theory is health differences between socioeconomic classes are associated with behavioral and cultural differences between the socioeconomic classes. Applying this theory to the study, the third research question, for example, attempted to answer whether inequalities in maternal health outcomes (in this case miscarriage, abortion and stillbirth) between the different classes of women (e.g., rich & poor or educated & those with no education) can be explained by differences in their health behavior/practices or culture - such as behavior of attending antenatal care, behavior

of seeking for attended delivery, or women's decision making power to seek for health services.

Further expanding on the answer to the third research question, the first research question looked at trends over the years (2000, 2005, and 2011) of inequities in the specific health behaviors/practices (such as behavior of attending antenatal care or seeking for attended delivery) by region, residence (urban-rural), education or income. The second research question explored deeper information trying to identify the explanatory factors (socioeconomic and demographic) associated with use of maternal health services (such as antenatal care and attended delivery). Therefore, the second research question is closely linked to the structural theory, which asserts that socioeconomic differences are key factors for health inequality.

The behavioral-cultural and structural theories of health inequalities originated from the 1980 Black Report of Britain in an attempt to explain the underlying causes of health inequities observed in Britain during that time (Macintyre, 1997; McCartney et al., 2013). These theories were used as foundations to answer to the research questions of this study. In addition, the study revealed information helpful to assess to what extent the theories can remain applicable to the Ethiopian context and in other African settings.

Literature Review Related to Key Variables and Concepts

This section starts with definition of inequity and then presents literature review on the variables and concepts in the area of study, how previous researchers approached inequity studies, methodological approaches, and their strengths and weaknesses. The section presents the main variables that were included in the study, including rationale for selection of the variables; as well as a description of what is

known about the variables. Finally, a synthesis of studies related to the research questions is included.

Inequity Definitions

Inequity (definitions from literature): There were not fully agreed definitions on inequity; and some used inequity, inequality and disparity interchangeably (Braveman, 2006). However, as Braveman (2006) mentioned, it was important to have clear and specific definition of these terms as the definitions had important implication as to how they were measured and interpreted. Braveman used the definition by Margaret Whitehead in the 1990s, i.e., equity in health care refers to an "equal access to available care for equal need, equal utilization for equal need, and equal quality of care for all" (p. 168). On the other hand, Graham (2004) referred that health inequality, health inequity and health disparity "all refer to the systematic differences in the health of groups and communities occupying unequal positions in society" (p. 101). However, the inequity definition by WHO appeared the most common that was cited in many of the literatures reviewed. According to WHO (2013), "where systematic differences in health are judged to be avoidable by reasonable action they are, quite simply, unfair. It is this that we label health inequity" (p. 7). WHO also added that "addressing health inequity, which is due primarily to social factors, is a matter of social justice and an ethical imperative" (p. 7).

Inequity (operational definition): In this research, I used inequity and inequality interchangeably. In the research questions and during the measurement of inequity, the following operational definition were applied:

> *Inequity* refers to a statistically significant difference between two groups of women on a variable measured. For example, if the percentage of births attended by a skilled health personnel by women residing in Region 1 is

statistically different (at $\alpha = 0.05$) from the percentage attended in region 2, this was considered there is inequity between the two regions. The region with lower percentage of births attended by skilled health personnel has inequity as compared to the other region.

Methodological Approaches

The data sources for this research were the three national level Demographic and Health Surveys (DHS) in Ethiopia; conducted in 2000, 2005, and 2011. Supported by the United States Agency for International Development (USAID), DHS are pretty much standard and nationally representative surveys that have been implemented over the last 25 years in more than 90 countries; and to date, more than 300 such surveys were implemented (USAID, 2014b; K4Health, 2014). The DHS datasets are publicly available (at http://www.dhsprogram.com) and are accessible upon approval by the DHS Program/USAID. The DHS datasets were used for multiple types of research on health (USAID, 2014b).

More details on methodological approaches of DHS surveys in Ethiopia are included in Chapter 3. This section provides a brief overview of the DHS survey methodology employed in Ethiopia. All the three DHS surveys in Ethiopia (2000, 2005, and 2011) employed the standard methodological approach for DHS, i.e., a stratified two-stage cluster design. In the first stage, enumeration areas (EAs) from previously conducted population and housing censuses were selected (stratified by urban/rural), and then cluster of households selected from each EA (CSA, 2000, 2005, 2011; USAID, 2014b). Through these surveys, the number of women (15-49) interviewed in Ethiopia was 15,367 in 2000; 14,070 in 2005 and 16,515 in 2011.

Measurement Approaches

Regidor (2014a) indicated distinctions between a measure of health inequality and a measure of social inequalities in health; and the measurement methods differed depending on which type of inequality was being assessed. Measures of health inequality, which are univariate, show overall distribution of health in a population without making comparison between social groups or classes. For example, the gini index measures the difference between the observed distribution of a health issue in a given population and the health distribution in a hypothetical population where everyone has same health condition/status. The limitation of such univariate measures is they do not compare health inequity by the different social groups (Braveman, 2006; Regidor, 2004a).

A measure of social inequalities in health compares health status between different social groups. Depending on the objective of the study, some of the measures of social inequalities in health include frequency ratio, the index of dissimilarity, odds ratio, absolute difference in frequencies, regression coefficient, Pearson's correlation coefficient, population attributable proportion, concentration index, relative index of inequality (RII), and slope index of inequality (SII) (McKinnon et al, 2014; Regidor, 2004b). The objective of this research was closely related to measure socioeconomic inequalities in health and hence appropriate measures for this type of study were applied.

For example, to answer to the first research question, percentage of attended delivery was compared by type of residence (urban/rural) - a bivariate measure - and this inequality measure was repeated for each year (2000, 2005, and 2011) to see the trend. To answer to the second research question (factors associated with use of maternal health services such as antenatal care or attended delivery), a multivariate

analysis using logistics regression was conducted. For the third research question, i.e., whether inequalities in use of maternal health services are associated with inequalities in maternal health risks (such as miscarriage, abortion and stillbirth), odds ratios were used. The specific measurement methods for this research are elaborated in Chapter 3.

Another important consideration in measuring inequality was determining how the comparisons were established. The most common approach is by comparing status in the most advantaged group (e.g., richest or highest wealth quintile) to the least advantaged group (i.e., poorest or lowest wealth quintile) (Braveman, 2003, 2006). According to Braveman (2003, 2006), such comparisons between the two extreme groups can be in absolute or relative terms. The absolute term shows the difference in rates of a health condition (or associated health risk or factor) in the two groups; while the relative term refers to a ratio of the rates between the two groups. For example, if delivery attendance in the poorest and wealthiest quintiles are 5% and 20%, respectively, then, the absolute difference will be 15% (i.e., 20%-5%); and the relative difference will be 4 (i.e., 20%/5%). A disadvantage of relying on comparing the inequities only between the two extremes – the most and least advantaged groups - is that the level of inequities in the other groups in between will be ignored (Braveman, 2003).

Another approach of measuring inequity was comparing health condition (or associated health risk or factor) in a group (e.g., lowest wealth quintile/poorest) with the average condition/status of the whole population (e.g., national average). For example, if the attended delivery of women in the lowest wealth quintile is 5%, and national average is 10%, then the comparison on inequity will be between 5% and 10%. However, both comparison of all other groups with the most advantaged groups (rather than a national average) was recommended as the health condition or status

reached by the most advantaged groups shows what is possible to be achieved by all other groups. For this same reason, the U.S. National Centre for Health Statistics also made preference to use this approach of comparison, i.e., comparison of inequality each group with the most advantaged or "best" group (Braveman, 2006).

In place of comparing two groups (such as between richest and poorest; or between poorest and national average), there are other methods that measure inequity levels between the different population groups. These include concentration index (curve), the relative index of inequality (RII), slope index of inequality (SII), population attributable risk, index of dissimilarity, odds ratio, absolute difference in frequencies, regression coefficient, and Pearson's correlation coefficient (Braveman, 2003, 2006; McKinnon et al., 2014; Regidor, 2004b). Population attributable risk and index of dissimilarity are aggregate measures of inequality, which are valuable in providing a summary picture on the overall inequality between the different groups. However, interpretation of these measures were problematic for policy makers as there were no specific details of inequality by social group (Braveman, 2003, 2006).

For this research, the analytical strategies applied were odds ratio (using chi-square test) and regression coefficients. In measuring inequities, comparisons between the different groups of women with the most advantaged as well as national averages were conducted. The specific type of measures that were used are elaborated in Chapter 3.

Selected Variables and What Is Known About Them

In this research, the maternal health service areas about which inequities in using the services were assessed over time (2000, 2005, and 2011) included delivery attendance by skilled health personnel and antenatal care. The dimensions along which inequities were measured included the 11 regional regions in the country; residential area (urban/rural); level of education; and wealth status. The research also studied factors associated with use of maternal health services; and whether inequalities in use of maternal health services were associated with differences in maternal health risks such as miscarriage, stillbirth and abortion. This section presents what was known about these variables and study areas in the context of Ethiopia and the knowledge gap this study attempted to fill in.

Skilled Birth Attendance

Skilled birth attendance in Ethiopia is low and did not show improvement over the years. While births attended by skilled health personnel in 2005 was 6%, this 'progressed' to 10% in 2011 (CSA, 2005, 2011). In sub-Saharan Africa, only 12 million out of 30 million pregnancies (i.e., only 40%) are attended each year by skilled health personnel (Adjiwanou & LeGrand, 2014), which is low but 4-times higher than the case in Ethiopia. Inequity in use of services is also alarming in the country. In this regard, income related inequity analysis among 54 developing countries demonstrated that Ethiopia is the most inequitable country associated with income on skilled birth attendance (Barros et al., 2012).

Evidence from the most recent report on the World Health Statistics (WHO, 2014b) supports Barros' findings. Accordingly, level of inequity in births attended by skilled health personnel in Ethiopia is 5% for rural women as compared to 52% in the urban settings; 2% for women in the lowest income group as compared to 46% in the

highest wealth quintile; and 5% among women with no education compared to 74% for women with high school or higher level education. These evidence are useful at the national level, but did not show locality specific inequities to inform policies and programs at sub-national levels. Region specific evidence is important in a Federal country like Ethiopia where regional administrations have their own autonomy for policies and programs in their respective region. In addition, region specific information is important to understand in which areas inequities are of highest concern. On the other hand, existing evidence does not provide enough knowledge on factors are associated with the very low coverage and inequality in using delivery services in Ethiopia (including how the associated factors might have evolved over time).

Antenatal Care

Coverage and inequality on antenatal care services in Ethiopia is also worrying, though may not be at the same level as attended delivery. Antenatal care coverage (at least four visits) in Ethiopia ranges between 8% in the poorest wealth quintile to 46% in the highest wealth quintile; the coverage ranges between 14% in rural areas to 46% in urban areas; and from 12% for women with no education to 65% among women who completed high school and higher level of education (WHO, 2014b). The analysis Barros et al. (2012) conducted supports the WHO findings. As Barros et al. documented, inequity analysis among 54 developing countries demonstrated that Ethiopia is one of the most inequitable countries on antenatal care services. However, the evidence did not provide region specific information or trend over time; and there was no much knowledge on the underlying factors contributing to the low coverage and inequities on use of ANC services.

Income, Level of Education and Place of Residence

Income, level of education of women and residency (urban/rural) are key factors along which health inequity measures are reported globally and per country by the World Health Organization (WHO, 2014). The 2014 World Health Statistics presented inequity in accessing antenatal care and births attended by skilled health personnel. The evidence indicated unacceptable level of inequality in service coverage (for both antenatal care and attended delivery) by place of residence, income level and educational level of women (WHO, 2014b). Similarly, other sources also evidenced that Ethiopia is one of the most inequitable countries, specifically by wealth/income, on delivery of skilled birth attendance and antenatal care (Barros et al., 2012).

Despite these evidence, a number of areas were not well unknown, including how inequalities progressed over time and the magnitude of inequity by region. Knowledge on inequity trends are important to make judgment on linkages with health policies and programs implemented in the past. If, for example, the inequity trend showed a widening gap over the years, one of the recommendations could be further review and analysis of health policies and programs that existed in the past. Ethiopia is a Federal state where the existing 11 administrative regions have autonomy on their programs that can be implemented in their respective regions. In this regard, region specific evidence are important to draw practical recommendation applicable to each regional context.

Factors Associated with Use of Maternal Health Services

Place of residence, income and education level of women are important factors associated with use of maternal health services (specifically attended delivery and antenatal car) (WHO, 2014b). Studies conducted at community level also reveal

similar results. A study conducted in two districts of Ethiopia (Meskan and Merenko districts in Butajira Zone) found that place of residence (urban/rural), income level, and distance to a health facility were significantly associated with use of antenatal care services (Aliy & Haile Mariam, 2012). Akalu et al. (2012) also analyzed the negative impact of out-of-pocket expenditures on the poor women in accessing maternal health services in 10 randomly selected villages (locally called kebeles) of Ethiopia. Haile Mariam (2011) also highlighted the influence of quality of health care delivery on utilization of health services in general. Zewdneh, W/Michael and Kebede (2011) supported Haile Mariam's assertion on concerns about quality of care by revealing deficiencies in physician-patient interactions in one of the biggest hospitals in the country.

A study in Ghana, Kenya, Tanzania and Uganda found the significant impact of women's decision-making power within the household and intimate partner violence on use of antenatal care and skilled birth attendance (Adjiwanou & LeGrand, 2014). A qualitative study in the northern part of Ethiopia (Gondar town) revealed tolerance or social acceptance of violence within marriage (Yigzaw, Berhane, Deyessa & Kaba, 2010), which suggested further analysis for its association with the practice of seeking for antenatal care or to use skilled health personnel at the time of delivery.

Available evidence provided a good understanding of the main factors associated with use of maternal health services. However, the evidence was largely generated based on specific localities (districts or villages), which are not generalizable at national or regional level. The evidence, however, were used in identifying the factors included to the logistic regression model in this study. The main factors included to the model were: income, educational level of women,

residence (urban/rural), distance to a health facility, out-of-pocket payment for health care, whether women had experienced termination of pregnancy, and women's decision making power on health care, contraception and spending.

Miscarriage, Abortion, and Stillbirth.

Miscarriage, abortion and still birth have important impact on maternal mortality and morbidity. It is estimated that about 14% of maternal deaths are accounted by abortion in Sub-Saharan Africa, while one in 27 Ethiopian women die from complications of pregnancy or childbirth (Gebrehiwot & Liabsuetrakul, 2009; Gebreselassie et al., 2010). Abortion rate in Ethiopia is 23 per 1,000 women of reproductive age, which is lower than the Sub-Saharan Africa regional estimate of 29 per 1000 women of reproductive age (Prata, Bell, Holston, Geräts, & Melkamu, 2011; Sedgh, Henshaw, Singh, Åhman, & Shah, 2007). In 2008, about 382,000 induced abortions were performed in Ethiopia; of which up to 42% were estimated to have had moderate or severe morbidity likely related to unsafe abortion (Gebreselassie et al., 2010; Singh et al., 2010). From the 2011 DHS in Ethiopia, perinatal mortality rate (i.e., number of stillbirths and deaths in the first week of life per 1000 live births) was estimated at 46 per 1000 live births; as compared to 56 per 1000 live births in Sub-Saharan Africa, and 10 per 1000 total births in developed nations (Andargie, Berhane, Worku, & Kebede, 2013).

Tarekegn (2012) found that miscarriage, abortion and stillbirth are explained by the high number of children a woman has, multiple sexual partnership, and higher age of the women. Andargie et al (2013) showed that, in North West of Ethiopia, previous still birth, twin birth, not receiving tetanus toxoid vaccine during the index pregnancy, short birth interval (less than 24 months), and maternal illiteracy were major explanatory factors for perinatal mortality, i.e., stillbirths and deaths in the first

week of life. Kelly et al (2010) studied a rural hospital in Ethiopia and showed the effect of quality of care on both maternal mortality and still birth; i.e., for women admitted though a waiting area, stillbirth rate was 17.6 per 1000 births as compared to 191.2 per 1000 births for women who were directly admitted.

A retrospective case-control study in Iran (using data for 1999-2008) showed that preterm delivery and preeclampsia are highly associated with still birth (Karimollah, Seddegheh & Ghazaleh, 2014). In West Mexico, using a logistics regression analysis, urinary tract infection, caesarean delivery, spontaneous preterm delivery, and deficient prenatal care were found to explain still birth (Perez-Molina, Quezada-Lopez, Panduro-Baron & Castro-Hernandez, 2012). A cross-sectional study in Ghana, using logistics regression, found that women's age (being young), poverty and lack of partner support are significantly associated with women's desire for abortion (Sundaram, Juarez, Bankole, & Singh, 2012). As study in rural South Africa found that education, and length of recall of pregnancy, spraying pesticides during the first three months of a pregnancy are all associated with spontaneous miscarriage (Saloshn, Leslie, Alex, & Rajen, 2011).

The studies in different countries reveal varying evidence on factors associated with maternal risk. This explained need for country specific study to identify the specific factors in the context of Ethiopia. Studies available to understand the factors associated with maternal risks from a social and behavioral perspective were limited in Ethiopia. In addition, the available studies in Ethiopia did not show trend how those factors might have evolved over time, and the evidence was not specific to inform policy and programs at sub-national level in Ethiopia.

Studies Related to Inequity in Use of Maternal Health Services

The first research question of this study was whether there are trends of inequity in the use of maternal health services (antenatal care and attended delivery) among Ethiopian women by region, residence (urban/rural), education or income. Related to this, staring from 2005, WHO published global and country specific data on health inequality (including on antenatal care and attended delivery) – specifically by residence (urban/rural), level of education, and income. The last report released was in 2014 – the World Health Statistics (WHO, 2014b). The WHO evidence on the level of inequity in Ethiopia regarding antenatal care and attended delivery were also supported by (Barros et al., 2012). Barros used data from country level national surveys - Demographic Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS). However, the evidence did not provide details in which administrative regions inequities are highly prevalent. Such an information is vital for a country like Ethiopia where Regional Administrations are autonomous on policies and programs designed and implemented in their respective localities.

The second of research questions attempted to identify the socio-demographic characteristics that are significantly associated with use of maternal health services. There were some studies in Ethiopia, focused on selected districts and villages and using cross-sectional survey data that attempted to identify factors associated with use of maternal health services (Akalu et al., 2012; Aliy & Haile Mariam, 2012; Haile Mariam, 2011; Yigzaw et al., 2010; Zewdneh et al., 2011). Other similar studies were also conducted in other African countries (e.g., Ghana, Kenya, Tanzania and Uganda) using DHS data (Adjiwanou & LeGrand, 2014). The main gaps on existing studies in Ethiopia included that the evidence was not comprehensive as it did not cover all administrative regions in the country; and also the evidence was cross-sectional and

did not show how factors associated with use of maternal health services evolved over the years.

The third research question tried to answer whether inequities in using maternal health services (including antenatal care and attended delivery) are associated with differences in maternal health risks including miscarriage, abortion and stillbirth. There were limited studies related to this research question in general, and on Ethiopia in particular. The studies available were more of clinical explanations on the causes to the risk factors; and limited in understanding the risk from a social and behavioral perspective; and limited in providing region specific evidence and in showing how associated factors evolved over the years. In this regard, answering to the third research question of the study would contribute to fill this knowledge gap.

Summary and Transition

Ethiopia is one of the countries with the highest maternal mortality, the MMR in Ethiopia is almost twice the average for developing countries (Thomas et al., 2014; WHO, 2014b). One of the major contributory factors for high maternal mortality in Ethiopia is the very limited use of maternal health services. In this regard, births attended by skilled health personnel was estimated at 10% in 2011, showing only a slight 'increase' from the 6% estimated in 2005 (CSA, 2005, 2011). While health service coverage in Ethiopia increased significantly over the last years (from 49% in 2001 to 90% in 2009), utilization of the services remained at 0.3% (Haile Mariam, 2011). In this regard, use of maternal health services and its impact on maternal morbidity and mortality remained an important health problem in the country.

Evidence and a number of international calls emphasized the importance of closing health inequity gaps between and within countries in order to achieve better

health (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). In addition, health inequities are primarily social factors which are avoidable; and addressing them is a matter of social justice and an ethical imperative (WHO, 2013). Despite this, Ethiopia is one of the most inequitable countries (associated with income, education and residence – urban/rural) on attended delivery and use of antenatal care services (Barros et al., 2012; WHO, 2014b). In this regard, better understanding of the underlying factors associated with inequities in using maternal health services, how inequity levels progressed over the years, and understanding inequity levels by specific administrative regions in the country were fundamental to inform policies and programs at local level. Region/local specific evidence and recommendations are vital in Ethiopia where regional administrations have their own autonomy for policies and programs.

The literature review evidenced that studies for understanding national and regional/local level inequities in use of maternal health services, inequity trends over time and associated factors for inequity in Ethiopia were very limited. The main gaps included: i) inequity evidence were aggregated at national level and did not provide in which regions of the country inequities were wider and where greater attentions should be provided; ii) inequity evidence was presented based on small scale studies – few districts, towns or villages – which limited generalizability at national or regional level; iii) the evidence was largely cross-sectional and not trends over time; and iv) factors associated with maternal health risks were assessed from a clinical angle and not from social, behavioral, and cultural perspectives. Therefore, this research attempted to contribute to fill these knowledge gaps.

The research could also build on or contribute to the existing behavioral-cultural and structural theories of health inequity. These theories, which originated

from the 1980s Black Report, provided a broader framework and good basis for

designing the research approach. By applying the theories in the context of Ethiopia

revealed information to what extent the theories could be applied more widely in the

Africa context and how adaptations to the theories could be made.

Chapter 3 provides greater detail on methods applied to answer the three

research questions: i) inequity trends in the use of attended delivery and antenatal

care services by region, residence (urban-rural), education and income; ii) the factors

associated with the use of maternal health services; and ii) whether inequities in using

maternal health services are associated with differences in maternal health risks

(miscarriage, abortion and stillbirth).

Chapter 3: Methodology

The purpose of the study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks; and to measure the magnitude and trends in inequity. Knowledge gained through this study would provide valuable input in the design of maternal health policies and programs in Ethiopia that are aimed at reducing the currently high level of maternal mortality in the country. Maternal health services this study focused on included use of antenatal care services and attendance of deliveries by skilled health personnel, which have important impact on maternal morbidity and mortality. There were four socioeconomic dimensions along which inequity levels and trends in the use of maternal health services were measured. These dimensions included the 11 administrative regions in Ethiopia, level of education of women, rural/urban residency, and household income. Inequity trends covered years 2000, 2005, and 2011 for which nationally representative data were available from the three DHS surveys in the country.

The sections covered in this chapter include research design, methodology, data analysis plan, and limitations of the study. The research design section indicates the study variables linked to each of the three research questions the study attempted to answer. Then, the research designs applied to answer each of the three research questions are described. I also explain how the choice of the design may contribute to advance knowledge in the health inequity study. In the methodology section, I define the target population of the study and the estimated population size. The methodology section also provides background on the methodological approach employed by the

three DHS studies in Ethiopia: 2000, 2005, and 2011. This chapter presents sampling

procedures, instrument/questionnaire development and piloting of the instruments,

data collection, data quality assurance processes, and overall survey coordination

processes.

Research Design and Rationale

The study was quantitative and included data from three national level

Demographic and Health Surveys (DHS) conducted in Ethiopia in 2000, 2005, and

2011. Using the available data set through the three surveys, I employed quantitative

research designs to answer all three research questions. To answer to the first research

question, which addressed trends of inequity in the use of maternal health services

among Ethiopian women, I focused on two important variables that determine

maternal health: (a) use of antenatal care services and (b) attendance of delivery by

skilled health personnel. Use of these two maternal health services, measured in

percentages of women who have used the services, was compared among the different

women groups, which were formed based on administrative regions in the country,

urban/rural residency, women's level of education, and household income category.

For measuring inequity, Braveman (2006) suggested comparing groups with

the most advantaged group (rather than a national average) because the health

condition or status reached by the most advantaged groups shows what is possible to

be achieved by all other groups. Therefore, use of maternal health services by the

different groups of women in Ethiopia was compared to the regions that were

performing best. However, levels of use were also compared to average maternal

health service use at the national level. Odds ratios, which are among the appropriate

test statistics to measure inequity (McKinnon et al., 2014; Regidor, 2004b), using chi-

square test were used to measure existence and the magnitude of inequity in the use of maternal health services in Ethiopia.

The research design to answer the second research question, which addressed SES factors associated with the use of maternal health services, was a logistics regression model, which is appropriate when the dependent (or outcome) variable is categorical. To answer the second research question, there were two dependent variables: (a) whether a women had used at least one antenatal care service (yes/no), and (b) whether a woman had been attended by skilled health personnel at the time of her delivery (yes/no). Two regression models were constructed, one for each dependent variable. In both models, the independent variables included level of education, household income category, residence (urban/rural), age, and decision-making power. The choice of the independent variables was based on studies indicating that these variables have important implications on use of maternal health services (Ruhago et al., 2012; Victoria et al., 2012; Zere et al., 2010).

The design to answer the third research question, which addressed whether inequities in the use of maternal health service use are associated with differences in maternal health risks (miscarriage, abortion, and stillbirth), resembled the approach for answering the first research question. Specifically, existence of inequality on maternal health risks (miscarriage, abortion, and stillbirth), measured as the percentage of women who experienced terminated pregnancy, was compared between the different women groups against the women groups with the lowest risk (best performing group), as suggested by Braveman (2006). The different women groups were formed based on administrative regions in the country, urban/rural residency, level of education, and household income category. I then compared if inequities

observed in use of maternal health services resembled inequities on maternal health risks.

The research design was consistent with the suggested scientific approaches for measuring health inequality (McKinnon et al., 2014; Regidor, 2004b). In addition, the study was expected to advance knowledge in the discipline. Specifically, answering the three research questions would help to explain, to some extent, whether the high rate of maternal mortality in the country could be linked to the inequality trends and identified factors. The inequality measures at national, subnational (i.e., administrative regions in the country) and different women groups would help to advance knowledge in defining national and locality-specific maternal health policies and program actions.

Settings and Sampling

Population

The target population of the study was all women ages 15-49 in Ethiopia. According to the Population Reference Bureau's (PRB) mid-2014 estimates, the total number of women ages 15-49 in Ethiopia was about 22.3 million while the total population size of the country was about 96 million (PRB, 2015). This study was based on data collected in three Demographic and Health Surveys (DHS) conducted in 2000, 2005, and 2011, which included a nationally representative population of women ages 15-49. In these surveys, the number of women age 15-49 interviewed was 15,367 in 2000; 14,070 in 2005 and 16,515 in 2011 (CSA, 2000, 2005, 2011; USAID, 2014b). Therefore, the findings of this study were generalizable to the target population of women ages 15-49 in Ethiopia.

Sampling Procedures

I used archival data, specifically three DHS data collected in 2000, 2005, and 2011. According to USAID (2014b), DHS are standard and nationally representative surveys that have been implemented over the last 25 years in more than 90 countries; to date, more than 300 surveys have been implemented. As the tools and methodologies are standard, the results of the surveys are comparable across countries. However, countries can make adjustments to collect additional information applicable to their local context (K4Health, 2014; USAID, 2014b).

All three DHS surveys in Ethiopia (2000, 2005, and 2011) included the standard methodological approach: a stratified two-stage cluster design. In the first stage, enumeration areas (EAs) from previously conducted population and housing censuses in the country were selected (stratified by urban/rural). In the first stage, EAs were selected using systematic sampling proportional to size. For the 2000 and 2005 DHS, the sampling frame used in the selection of EAs was the 1994 census of Ethiopia; the 2011 DHS used the 2007 census of Ethiopia as the sampling frame in the selection of EAs (CSA, 2000, 2005, 2011; USAID, 2014b).

In the second stage, cluster of households were selected from each the EAs selected in the first stage of sampling. In the second stage of sampling, all conventional households that existed in the EAs selected in the first stage were fully listed. In all three surveys, the listing of households excluded institutional living arrangements such as army barracks, hospitals, police camps, and boarding schools. In the 2000 Ethiopia DHS, 27 households were selected from each EA. In the 2005 Ethiopia DHS, between 24 and 32 households in each EA were systematically selected for participation in the survey (CSA, 2005). In the 2011 DHS, a fixed number of 30 households per EA were systematically selected (CSA, 2011). All three surveys

were designed in such a way that both national and regional level population estimates for population and health indicators were possible (CSA, 2000, 2005, 2011).

Selection of Individuals Within Households

For all three surveys, the household questionnaire was completed for all households selected in the second stage of sampling. Household questionnaire enumerated all people residing in the household at the time of the survey, including usual residents and visitors who stayed in the household the previous night of the data collection date. Information completed in the household questionnaire (specifically sex and age of household members) was used to identify the individuals (women age 15-49, and men age 15-59) who were eligible for interview and to complete the women and men questionnaires. The women questionnaire was used to collect information from all women in the reproductive age group of 15-49 who were residing in all selected households at the time of the survey. The men questionnaire was administered for all men in the reproductive age group of 15-59 and included men in every fifth selected household (CSA, 2000, 2005, 2011).

Materials and Instrumentation

DHS questionnaires.

Based on the model survey instruments developed for international use by MEASURE DHS, the 2000, 2005, and 2011 Ethiopia DHS had three questionnaires: the household questionnaire, the women's questionnaire, and the men's questionnaire (CSA, 2000, 2005, 2011). The international level questionnaires were adapted to local context, specifically to reflect population and health issues relevant to Ethiopia. The 2000 DHS questionnaires were translated from English to five local languages (Amharic, Oromiffa, Tigrigna, Somaligna, and Afarigna); the 2005 and 2011 DHS questionnaires were translated from English to three main local languages (Amharic,

Oromiffa, and Tigrigna). In all three DHS surveys, the questionnaires were pilot tested prior to their full rollout. In the 2000 Ethiopia DHS, a pretest of all three questionnaires was conducted in the five local languages; the 2005 and 2011 DHS did the pretests in the three local languages in which the questionnaires were translated (CSA, 2000, 2005, 2011).

The household's questionnaire.

This was used to collect information on characteristics of persons in the household (such as sex, age, education, marital status, relationship to household head, and height and weight of eligible men, women, and children under 5 years of age) and characteristics of the household's dwelling units, such as source of water, type of toilet facilities, and ownership of durable goods (CSA, 2000, 2005, 2011).

The women's questionnaire.

This was used to collect information on background characteristics of women (such as age, education, and media exposure), birth history and childhood mortality; knowledge and use of family planning methods; fertility preferences; antenatal, delivery, and postnatal care; breastfeeding and infant feeding practices; vaccinations; childhood illnesses; marriage; sexual activity; women's work; husband's background; awareness and behavior around HIV and STIs; and adult mortality (including maternal mortality) (CSA, 2000, 2005, 2011).

The men's questionnaire.

This was used to collect information on male respondent's characteristics, reproduction, contraception, contraceptive knowledge and use, marital status, fertility preferences, attitudes about family planning, and knowledge about HIV/AIDS.

DHS survey coordination and funding.

For all three DHS surveys, the Federal Ministry of Health was the overall

coordinator, and the Central Statistical Authority of Ethiopia was the actual

implementer of the survey with technical support from Macro International Inc. (ORC

Macro) through its MEASURE DHS program. All three surveys involved key

partners and rigorous methodological processes. Partners involved in the planning and

implementation of the surveys included the Ministry of Health of Ethiopia, Central

Statistical Authority of Ethiopia (CSA), Ethiopian Health and Nutrition Research

Institute (EHNRI), Population and Housing Census Commissions Office (PHCCO) of

Ethiopia, UNFPA, UNICEF, USAID, CDC and ORC Macro. Funding for the DHS

surveys were largely from USAID, the Government of Ethiopia, UNFPA, UNICEF,

Dutch and Irish Governments, and the United Kingdom for International

Development (DFID) (CSA, 2000, 2015, 2011).

DHS ethical clearances.

The study was a secondary data analysis using three DHS surveys of Ethiopia

conducted in 2000, 2005, and 2011. The DHS datasets are publicly available at

http://www.dhsprogram.com and accessible via request to the DHS program/USAID.

To access to any country's DHS dataset, one has to register and submit an online

application at http://www.dhsprogram.com/data/new-user-registration.cfm. For this

study, access to the Ethiopia DHS survey data (2000, 2005, and 2011) was possible

following this same process. For all three DHS surveys, data were initially collected

with informed consent; the survey protocols had received ethical clearances from the

Ethiopian Health, Nutrition and Research Institution (EHNRI) Review Board, the

National Research Ethics Review Committee (NRERC) at the Ministry of Science

and Technology of Ethiopia, the International Review Board of ICF International, and the CDC (CSA, 2005, 2011; Worku, Tessema, & Zeleke, 2015).

DHS data collection, preparations, and data entry.

Data collection, supervision, and quality control of the three DHS surveys were conducted by 30-38 teams composed of interviewers, editors, and supervisors. For each of the surveys, all team members received 4-5 weeks of training on the questionnaires, interviewing techniques, supervision, and editing. In addition to the field teams, representatives from different organizations including ICF International, CSA, PHCCO, CDC, and USAID participated in fieldwork monitoring. The field level data collection took from 4 months in the 2000 DHS to 6 months in the 2011 DHS (CSA, 2000, 2005, 2011).

Appropriate data cleaning and quality control measures had been followed during data entry. The 2000 and 2005 DHS data were entered and edited using microcomputers and the Integrated System for Survey Analysis (ISSA) program developed for DHS surveys; data entry and processing for the 2011 DHS was conducted using Census and Survey Processing System (CSPro software). The number of data entry operators ranged from 22 in the 2000 DHS to 32 in the 2011 DHS (CSA, 2000, 2005, 2011).

Procedures for Gaining Access to DHS Data and Permission Received

Supported by USAID, DHS surveys have been implemented over the last 25 years in more than 90 countries; and more than 300 such surveys have been implemented globally (K4Health, 2014; USAID, 2014b). The DHS datasets were publicly available at http://www.dhsprogram.com and accessible via request to the DHS program/USAID. To access to any country's DHS dataset, one had to register and submit an online application at http://www.dhsprogram.com/data/new-user-

registration.cfm. The application needed to explain the intended purpose of accessing the data set. Up on review of the request, the DHS program granted me access to the 2000, 2005, and 2011 Ethiopia DHS data sets.

The Study Data Analysis Plan

Statistical Package for the Social Sciences (SPSS) and an online statistical tool called Vassar Stats, available at http://vassarstats.net/odds2x2.html, were used for analysis. The 2000, 2005, and 2011 Ethiopia DHS datasets were publicly available at the USAID DHS Program (at http://dhsprogram.com/data) in different formats. For this study, the DHS data sets in SPSS system file format were used. The variables relevant for the study were selected, including use of antenatal care service (at least one visit), attendance of delivery by skilled health personnel, level of education of women, age of women, household income, residence (rural/urban), region, terminated pregnancy and women's decision making power.

Statistical analysis plan for the first research question.

1. Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education or wealth status?

Under the first research question, the following hypothesis was tested for each year DHS data has been collected (2000, 2005, and 2011):

- Ho1: There are no trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status

- Ha1: There are trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status

For testing Ho1, odds ratio chi-square test was used, which also measured the magnitude of inequality as compared to the 'best' performing region as well as in comparison with national average on proportion of women using maternal health services (i.e., antenatal care or attended delivery). Comparing health condition in a specific group with the national average is one way of measuring inequity. However, it was preferred to compare against the most advantaged group as status reached by the most advantaged ('best') group shows what is possible to be achieved by all other groups (Braveman, 2006). Therefore, this study measured inequality in the use of maternal health services by comparing women groups with the group performing best in service coverage. However, as an additional information, the comparisons were also done with national averages on use of maternal health services.

To answer the first research question (RQ1), the following tests were conducted:

a) For each women SES group (formed by region, geography – urban/rural, income and level of education) and for each year, test if the % of women using maternal health services (i.e., antenatal care or attended delivery) was statistically different from the percentage achievement for the best performing women group for the year (test statistic: odds ratio chi-square test); and

b) For each women SES group (formed by region, residence, income and level of education) and for each year, test if the % of women using maternal health services (i.e., antenatal care or attended delivery) was statistically different from the national average (test statistic: odds ratio chi-square test)

Statistical analysis plan for the second research question.

2. Are socio-demographic characteristics (including income, educational level of women, residence - urban/rural, distance to a health facility, out-of-pocket payment

for services, and women's decision making power) significantly associated with use of maternal health services by Ethiopian women?

To answer the second research question, the following null hypothesis was tested for each of the years for which DHS data has been collected (2000, 2005, and 2011):

- Ho2: Use of maternal health services (antenatal care and attended delivery) are not associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

- Ha2: Use of maternal health services (antenatal care and attended delivery) are associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

To answer the second research question (RQ2), logistics regression was used. The two dependent variables in the regression model refer to use of antenatal care (at least first visit) and delivery attended by skilled health personnel. Two logistics regression models were be fitted, one per dependent variable for each of the years - 2000, 2005, and 2011.

Independent variables: The independent variables included in the model were: level of education of women, household income category, residence (urban/rural), age category of women, distance to health facility, out of pock payment for health services, terminated pregnancy and women decision making power (participation in decision making). The dependent variables were selected based on the literature review (chapter 2) on the influence of the variables on use of maternal health services.

Dependent variables: (a) Antenatal care - the dependent variable (Y) refers to attendance of antenatal care (at least first visit). (b) Attended delivery - the dependent variable (Y) refers to whether or not a women was attended by skilled health personnel at the time of delivery. The logistics regression models identified the significant factors associated with use of maternal health services; and also measured the odds of using maternal health services – antenatal care and attended delivery.

Statistical analysis plan for the third research question.

3. Are inequities in maternal health service use associated with differences in maternal health risks such as miscarriage, abortion and stillbirth?

To answer the third research question, for each of the years for which DHS data was collected (2000, 2005, and 2011), the following null hypothesis was tested. Maternal health risks (miscarriage, abortion and stillbirth) were measured in the three DHS surveys using terminated pregnancy variable.

- Ho3: Inequities in maternal health service use are not associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

- Ha3: Inequities in maternal health service use are associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

To answer RQ3, there were four women groups along which inequity patterns on use of maternal health services and maternal health risks were observed. The groups were: region (all 11 administrative regions in the country), residence (urban/rural setting), educational level, and wealth status. The comparison by region, for example, analyzed if percentage of maternal health risks were significantly high in the regions where inequity in the use of maternal health services were high. The statistical test used to answer RQ1 and RQ3 is odds ratio chi-square test.

IRB Approval

On 27 August 2015, I have received a communication from the Institutional Review Board (IRB) confirming that my doctoral capstone meets Walden University's ethical standards. The IRB approval number is 08-26-15-0198569.

Summary and Transition

This chapter presented the research design, rationale and methodology of the study. The methodology section presented background how the three DHS surveys had been designed and implemented. The DHS was a standard survey implemented over the last 25 years in more than 90 countries; and more than 300 surveys were implemented globally. Ethiopia was one of the countries where three DHS surveys were implemented – in 2000, 2005, and 2011. DHS data were publicly available at http://www.dhsprogram.com and accessible through permission from the DHS program/USAID. For this study, the DHS program granted me access to the 2000, 2005, and 2011 Ethiopia DHS data sets. The methodology section of this chapter listed the hypothesis tested to answer the three research questions. The section also indicated the statistical methods applied. Chapter 4 strictly followed the methodologies outlined in Chapter 3.

Chapter 4: Results

Study Purpose, Research Questions, and Hypotheses

The purpose of the study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks; and to measure the magnitude and trends in inequity. The study included three research questions presented below with corresponding hypotheses.

First Research Question and Hypothesis

1. Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education or wealth status?

- Ho1: There are no trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

- Ha1: There are trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

Second Research Question and Hypothesis

2. Are socio-demographic characteristics (including income, educational level of women, residence - urban/rural, distance to a health facility, out-of-pocket payment for services, and women's decision making power) significantly associated with use of maternal health services by Ethiopian women?

- Ho2: Use of maternal health services (antenatal care and attended delivery) are not associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

- Ha2: Use of maternal health services (antenatal care and attended delivery) are associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

Third Research Question and Hypothesis

3. Are inequities in maternal health service use associated with differences in maternal health risks such as miscarriage, abortion and stillbirth?

- Ho3: Inequities in maternal health service use are not associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

- Ha3: Inequities in maternal health service use are associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

Organization of the Chapter

In addition to the purpose of the study, research questions, and hypotheses, this chapter presents a brief overview of the primary data collection process followed by a presentation of the results, including descriptive statistics and statistical findings organized by research question. Finally, the chapter presents answers to the three research questions.

Data Collection

This study included archival data from three nationally representative Demographic and Health Surveys (DHS) conducted in Ethiopia in 2000, 2005, and 2011. For all three surveys, data were collected on a nationally representative population of women ages 15-49. To ensure representativeness, the surveys applied probability sampling methodologies, specifically a stratified two-stage cluster design. In the first stage, enumeration areas (EAs) from previously conducted population and housing censuses in the country were selected (stratified by urban/rural). EAs were selected using systematic sampling proportional to size. In the second stage, clusters of households were selected from each of the EAs selected in the first stage of sampling. Data were collected from all women in the reproductive age group of 15-49 who were residing in all selected households in the clusters. Through these surveys, the number of women age 15-49 interviewed were 15,367 in 2000; 14,070 in 2005; and 16,702 in 2011. Among eligible women age 15-49, the response rates were 97.8%, 95.6%, and 95 in the 2000, 2005, and 2011 DHS, respectively (CSA, 2000, 2005, 2011; USAID, 2014b). The proportion of rural women in the sample was over 76% in all three surveys, which was similar to the overall residence characteristics of the Ethiopian population, which is largely rural.

Results

The main variables of study for analyzing existence and trends of inequity were use of antenatal care (ANC) services and attendance of delivery by skilled health personnel. The main characteristics in which inequities in these two areas were analyzed included women's residence (urban/rural), level of education, household income, and administrative region. The descriptive statistics presented below provide

an overall picture of women's practice in using ANC services and skilled birth attendance by residence, level of education, household income, and region.

The Ethiopian population is largely rural, and data from the three surveys reflected this. Women ages 15-49 residing in rural areas accounted over three-quarters of the total women population over the three survey periods (2000, 2005, and 2011). The urban women population slightly increased from 18% in 2000 to 24% in 2011. Women with no education constituted the largest population in the country. The three DHS survey results showed that women with no education equaled 75% in 2000; however, this percentage declined to 66% in 2005 and 50% in 2011. Based on the 2007 census in Ethiopia, the regions of Oromiya, Amhara, and SNNP accounted for slightly more than 80% of the total population in Ethiopia (Ethiopia Population Census Commission, 2008). Consistent with this, in all three surveys the women population in these three regions was 82-85% of the total study population in the country. Based on an analysis of the DHS survey data, ANC use (at least one visit) at the national level increased from 27% in 2000 to 43% in 2011 (Table 2). In addition, skilled birth attendance doubled between 2000 and 2011 from 6% to 12%, but was still very low (Table 3).

Table 1

Number of Women (15-49) Included in the Sample for DHS Surveys

Interviews with women age 15-49	DHS 2000		DHS 2005		DHS 2011	
	Number	%	Number	%	Number	%
Number of eligible women	15,716	--	14,717	--	17,385	--
Number of eligible women interviewed	15,367	--	14,070	--	16,515	--
Eligible women response rate (%)	97.8%	--	95.6%	--	95.0%	--
Residence						
Urban	2,791	18%	2,499	18%	3,947	24%
Rural	12,576	82%	11,571	82%	12,568	76%
Total	15,367	100%	14,070	100%	16,515	100%
Education						
No education	11,551	75%	9,271	66%	8,278	50%
Primary	2,425	16%	3,123	22%	5,858	35%
Secondary	1,304	8%	1,481	11%	1,395	8%
More than secondary	87	1%	194	1%	984	6%
Total	15,367	100%	14,070	100%	16,515	100%
Wealth index						
Poorest	2,117	14%	2,428	17%	2,986	18%
Poorer	2,287	15%	2,643	19%	3,041	18%
Middle	2,398	16%	2,732	19%	3,031	18%
Richer	2,293	15%	2,647	19%	3,215	19%
Richest	2,488	16%	3,621	26%	4,242	26%
System missing	3,784	25%				
Total	5,367	100%	14,070	100%	16,515	100%
Region						
Tigray	969	6.31%	919	6.53%	1,103	6.68%
Affar	178	1.16%	146	1.04%	144	0.87%
Amhara	3,820	24.86%	3,482	24.74%	4,435	26.85%
Oromiya	5,937	38.63%	5,010	35.60%	6,010	36.39%
Somali	175	1.14%	486	3.46%	329	1.99%
Benishangul-Gumuz	160	1.04%	124	0.88%	174	1.05%
SNNP	3,285	21.38%	2,995	21.28%	3,236	19.59%
Gambela	40	0.26%	44	0.31%	69	0.42%
Harari	41	0.26%	39	0.27%	49	0.30%
Addis Ababa	684	4.45%	756	5.38%	897	5.43%
Dire Dawa	79	0.52%	69	0.49%	69	0.42%
Total	15,367	100.00%	14,070	100.00%	16,515	100.00%

Table 2

ANC Use, at Least One Visit During Last Pregnancy

	DHS 2000 (n = 7,978)			DHS 2005 (n = 7,277)			DHS 2011 (n = 7,880)		
	Number of women who had at least one pregnancy	Number and % of women who had at least one ANC visit during last pregnancy		Number of women who had at least one pregnancy	Number and % of women who had at least one ANC visit during last pregnancy		Number of women who had at least one pregnancy	Number and % of women who had at least one ANC visit during last pregnancy	
		Number	Percent		Number	Percent		Number	Percent
Residence									
Urban	908	616	68%	630	439	70%	1,167	893	77%
Rural	7,070	1,573	22%	6,647	1,613	24%	6,713	2471	37%
Total	7,978	2,189	27%	7,277	2,052	28%	7,880	3364	43%
Education									
No education	6,550	1,421	22%	5,712	1,278	22%	5,249	1,779	34%
Primary	1,003	461	46%	1,200	477	40%	2,266	1,252	55%
Secondary	401	287	72%	327	260	80%	226	202	89%
Higher	25	20	80%	38	37	97%	141	132	94%
Total	7979	2,189	27%	7,277	2,052	28%	7,882	3,365	43%
Wealth index									
Poorest	1,548	236	15%	1,518	205	14%	1,737	436	25%
Poorer	1,589	289	18%	1,547	298	19%	1,694	593	35%
Middle	1,596	339	21%	1,581	406	26%	1,626	616	38%
Richer	1,516	413	27%	1,441	443	31%	1,494	704	47%
Richest	1,213	744	61%	1,189	699	59%	1,330	1,016	76%
Total	7,462	2,021	27%	7,276	2,051	28%	7,881	3,365	43%
Region									
Tigray	537	199	37%	479	179	37%	529	341	64%
Affar	85	24	28%	67	10	15%	78	27	35%
Amhara	2,223	421	19%	1,851	495	27%	1,972	794	40%
Oromiya	3,060	859	28%	2,713	684	25%	3,116	1,232	40%
Somali	85	14	16%	287	22	8%	198	50	25%
Benishangul-Gumuz	81	21	26%	67	16	24%	92	37	40%
SNNP	1,694	493	29%	1,624	506	31%	1,631	660	40%
Gambela	22	11	50%	23	9	39%	31	18	58%
Harari	16	8	50%	15	6	40%	19	11	58%
Addis Ababa	148	123	83%	126	111	88%	191	180	94%
Dire Dawa	27	16	59%	24	13	54%	26	16	62%
Total	7,978	2,189	27%	7,276	2,051	28%	7,883	3,366	43%

Table 3

Skilled Birth Attendance at Last Delivery

	DHS 2000 (*n* = 7,976)			DHS 2005 (*n* = 7,300)			DHS 2011 (*n* = 7,903)		
	Number of women who had at least one	Number & % of women whose last delivery was attended by skilled health personnel		Number of women who had at least one	Number & % of women whose last delivery was attended by skilled health personnel		Number of women who had at least one	Number & % of women whose last delivery was attended by skilled health personnel	
Description	delivery	Number	Percent	delivery	Number	Percent	delivery	Number	Percent
Residence									
Urban	908	334	37%	633	306	48%	1,187	638	54%
Rural	7,068	157	2%	6,667	202	3%	6,716	294	4%
Total	7,976	491	6%	7,300	508	7%	7,903	932	12%
Education									
No education	6548	165	3%	5,728	156	3%	5,266	247	5%
Primary	1003	121	12%	1,205	129	11%	2,270	417	18%
Secondary	401	187	47%	328	190	58%	225	164	73%
More than secondary	24	18	75%	40	33	83%	143	105	73%
Total	7976	491	6%	7,301	508	7%	7,904	933	12%
Wealth index									
Poorest	1548	15	1%	1,516	12	1%	1,737	35	2%
Poorer	1589	18	1%	1,551	23	1%	1,694	51	3%
Middle	1596	25	2%	1,587	30	2%	1,628	56	3%
Richer	1514	39	3%	1,451	74	5%	1,494	120	8%
Richest	1213	339	28%	1,196	370	31%	1,350	670	50%
Total	7460	436	6%	7,301	509	7%	7,903	932	12%
Region									
Tigray	537	34	6%	481	37	8%	530	72	14%
Affar	85	6	7%	69	4	6%	78	7	9%
Amhara	2,224	84	4%	1,856	84	5%	1,990	214	11%
Oromiya	3,059	142	5%	2,719	162	6%	3,116	294	9%
Somali	85	7	8%	287	19	7%	198	21	11%
Benishangul-Gumuz	81	9	11%	68	4	6%	92	9	10%
SNNP	1,693	85	5%	1,630	77	5%	1,632	127	8%
Gambela	22	5	23%	23	4	17%	31	9	29%
Harari	16	5	31%	14	5	36%	19	7	37%
Addis Ababa	148	104	70%	129	104	81%	192	160	83%
Dire Dawa	27	10	37%	25	8	32%	26	13	50%
Total	7,977	491	6%	7,301	508	7%	7,904	933	12%

Statistical Assumptions

To answer the first and third research questions, odds ratios using a chi-square test were used. The two main assumptions for applying a chi-square test are (a) each observation is independent of each other and (b) all expected counts are greater than 10 (Lakehead University, 2015). When expected counts are less than 10 and greater than 5, it is suggested to apply Yate's correction factor for continuity. However, when expected counts are less than 5, Fisher's Exact test is applied (Lakehead University, 2015). As described in the methodology section, women included in the DHS sample were randomly selected using a stratified two-stage cluster design; inclusion of a woman in the sample was not dependent on inclusion or exclusion of others. This fulfils the first assumption for applying a chi-square test. As regards to the second assumptions, during the analysis when cell counts were less than 10, the software applied Yate's correction factors. Similarly, when cell counts were less than 5, Fisher's exact test was used.

To answer the second research question, binary logistic regression analysis was used. The main assumptions for using a binary logistic regression analysis are (a) the dependent variable should be binary, (b) the model should be fitted correctly by including variables that are meaningful, (c) observations should be independent, and (d) a large sample size—at least 10 observations per independent variable in the model—is needed (Statistics Solutions, 2015). These assumptions were considered in this study. Responses to each of the two dependent variables (use of ANC and skilled birth attendance services) had only two possible responses: "yes" a woman had used the service or "no" a woman did not use the service. The variables included in the regression model were also based on previous studies, and care was taken not to include variables without such evidence. As described in the methodology section,

women included in the sample were randomly selected using a stratified two-stage cluster design; therefore, observations were independent of each other. Finally, the sample size for analysis at the national level had adequate sample size for binary logistic regression analysis (observations included for analysis ranged from 6,435 to 7,727). However, for regional level analysis, some regions (including Benishangul-Gumuz, Gambela, Harari, and Dire-Dawa) had inadequate sample sizes for conducting logistic regression analysis, and these are described in the Limitations section of Chapter 5.

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Statistical Analysis Findings

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Inequity in Use of Maternal Health Services

The first Research Question (RQ1) asked the following: Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education, or wealth status? The hypotheses were the following:

- Ho1: There are no trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

- Ha1: There are trends of inequity in maternal health service use among Ethiopian women by region, geography (urban/rural), education level, and wealth status.

RQ1 addressed potential inequities in the use of maternal health services (antenatal care and attended delivery) along four main dimensions: residence (urban/rural), level of education, household income category, and administrative region. The analysis was conducted for each of the years (2000, 2005, and 2011) for which national survey data (DHS) are available.

The statistical test for testing Ho1 was chi-square, which measures significance of differences between groups of women using ANC and skilled birth attendance services. Odds ratios were calculated to measure the magnitude of inequity as compared to a region where ANC and skilled birth attendance services are relatively better. Inequities were also measured in comparison to average use of ANC and skilled birth attendance services at the national level. The four main dimensions along which inequities were assessed were women's residence (urban/rural), level of education, household income level, and administrative region.

For the chi-square test (including p-value and odds ratio calculation), I used SPSS to produce the counts and expected values for each category of women. Then, I used Vassar Stats, available at http://vassarstats.net/odds2x2.html, to calculate the chi-square test for each group, including computation of significant test (p-values) and odds ratios (with 95% confidence intervals). Outcomes of the chi-square test are presented in tables 4-7 and figures 1-8.

ANC Use by Residence, Education Level, and Income.

Table 4 presents results from analysis of the three DHS survey data on odds

ratios of not using ANC service by women's residence (urban/rural), women's level

of education and household income category.

Table 4

Odds Ratio of Not Using ANC: by Residence, Level of Education and Income

DHS	Category	OR	95% CI LL	95% CI UL	P-value	OR	95% CI LL	95% CI UL	P-value
	Residence (Urban/Rural)								
		Reference: Urban				*Reference: National*			
2011	Urban	1.00	--	--	--	0.23	0.20	0.26	<.0001
	Rural	5.60	4.84	6.46	<.0001	1.28	1.20	1.37	<.0001
	National	4.38	3.79	5.05	<.0001	1.00	--	--	--
2005	Urban	1.00	--	--	--	0.17	0.14	0.20	<.0001
	Rural	7.17	6.00	8.58	<.0001	1.23	1.14	1.32	<.0001
	National	5.85	4.90	6.99	<.0001	1.00	--	--	--
2000	Urban	1.00	--	--	--	0.18	0.15	0.21	<.0001
	Rural	7.37	6.34	8.57	<.0001	1.32	1.23	1.42	<.0001
	National	5.58	4.81	6.47	<.0001	1.00	--	--	--
	Women's Education Level								
		Reference: Higher Education				*Reference: National*			
2011	No education	28.61	14.53	56.34	<.0001	1.45	1.35	1.56	<.0001
	Primary	11.88	6.02	23.45	<.0001	0.60	0.55	0.66	<.0001
	Secondary	1.740	0.79	3.87	0.23	0.09	0.06	0.14	<.0001
	Higher	1.000				0.05	0.03	0.10	<.0001
	National	19.69	10.01	38.73	<.0001	1.00			
2005	No education	128.37	17.60	936.55	<.0001	1.36	1.26	1.48	<.0001
	Primary	56.78	7.76	415.23	<.0001	0.60	0.52	0.68	<.0001
	Secondary	9.530	1.28	70.76	0.01	0.10	0.08	0.13	<.0001
	Higher	1.000				0.01	0.00	0.08	<.0001
	National	94.21	12.92	687.13	<.0001	1.00			
2000	No education	14.44	5.41	38.54	<.0001	1.36	1.26	1.47	<.0001
	Primary	4.70	1.75	12.63	<.001	0.44	0.39	0.51	<.0001
	Secondary	1.59	0.58	4.34	0.50	0.15	0.12	0.19	<.0001
	Higher	1.000				0.09	0.04	0.25	<.0001
	National	10.58	3.97	28.23	<.0001	1.00			
	Household Income Category								
		Reference: Richest				*Reference: National*			
2011	Poorest	9.66	8.17	11.41	<0.0001	2.22	1.98	2.50	<0.0001
	Poorer	6.01	5.11	7.06	<0.0001	1.38	1.24	1.54	<0.0001
	Middle	5.31	4.51	6.23	<0.0001	1.22	1.09	1.36	0.0004
	Richer	3.63	3.09	4.27	<0.0001	0.84	0.75	0.93	0.0017
	Richest	1.00				0.23	0.20	0.26	<0.0001
	National	4.34	3.80	4.97	<0.0001	1.00			
2005	Poorest	9.14	7.58	11.02	<.0001	2.51	2.15	2.94	<.0001
	Poorer	5.98	5.04	7.10	<.0001	1.65	1.44	1.89	<.0001
	Middle	4.13	3.51	4.85	<.0001	1.14	1.00	1.29	0.05
	Richer	3.21	2.74	3.77	<.0001	0.88	0.78	1.00	0.05
	Richest	1.00				0.28	0.24	0.31	<.0001
	National	3.63	3.20	4.12	<.0001	1.00			
2000	Poorest	8.82	7.36	10.56	<.0001	2.06	1.78	2.39	<.0001
	Poorer	7.14	6.01	8.48	<.0001	1.67	1.46	1.92	<.0001
	Middle	5.88	4.98	6.95	<.0001	1.38	1.21	1.57	<.0001
	Richer	4.24	3.60	4.98	<.0001	0.99	0.88	1.12	0.92
	Richest	1.00				0.23	0.21	0.27	<.0001
	National	4.27	3.76	4.85	<.0001	1.00			

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper limit. CI = Confidence Interval

ANC Use by Women's Residence

Analysis of the 2011 DHS survey data showed that women in rural areas were 5.6 times more likely not to use ANC services as compared to women living in urban areas ($p<0.0001$). As compared to national average, women living in rural areas were 1.3 times more likely not to use ANC ($p<0.0001$). Analysis of the 2005 DHS survey data showed that women in rural areas were 7.2 times more likely not to use ANC as compared to women living in urban areas ($p<0.0001$). As compared to national average, women living in rural areas were 1.2 times more likely not to use ANC ($p<0.0001$). Analysis of DHS 2000 survey data also showed similar results to 2005 and 2011. In this regard, in 2000, women in rural areas were 7.4 times more likely not to use ANC service as compared to women living in urban areas ($p<0.000$). As compared to national average, women living in rural areas were 1.3 times more likely "not to use ANC" ($p<0.0001$). (Table 4).

These results showed existence of statistically significant inequities related to women's residence in the use of ANC services. Specifically, women in rural areas were more disadvantaged as compared to those in urban areas and as compared to the national average on ANC use. The 95% confidence intervals on the magnitude of inequity (as measured by odds ratio) by residence for the three data points overlapped (Figure 1). Therefore, the magnitude of inequity by residence over the three years (2000, 2005, and 2011) did not show statistically significant difference ($p>0.05$); i.e., while statistically significant inequities by residence existed for each of the three years, there were no statistically significant differences on the magnitude of inequity from one year to the other (Table 4 and Figure 1).
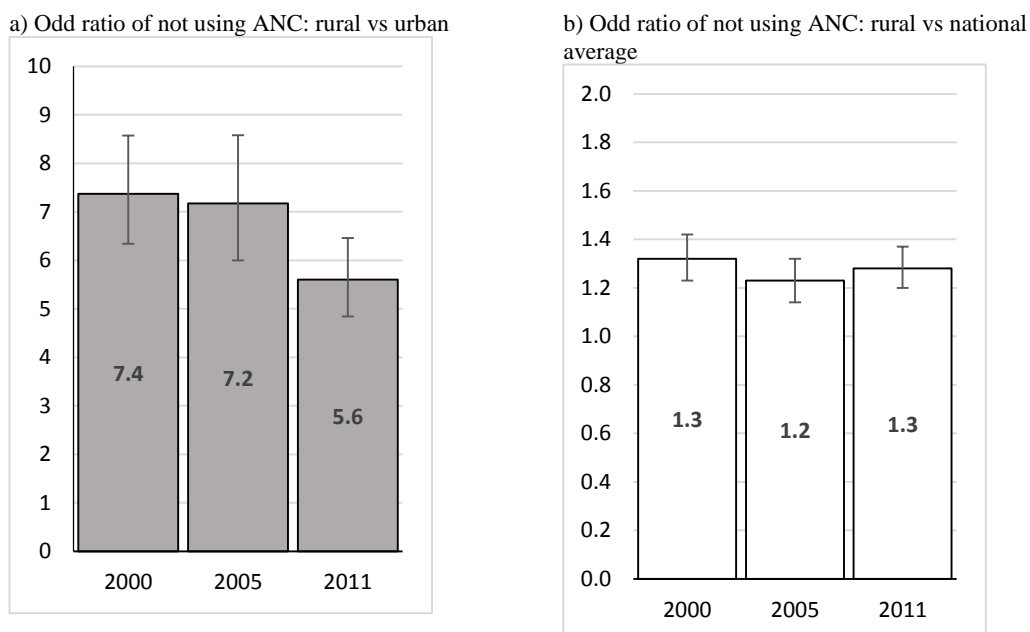
Figure 1. Odds ratio of not using ANC: a) rural women as compared to urban women; b) rural women as compared with national average.

ANC Use by Women's Level of Education

In all three DHS surveys, there were four categories on which women's level of education were classified based on their responses. The categories were: women with no education, women who completed primary education, women who completed secondary education, and those with higher education. Analysis of the 2011 DHS showed that women with no education and with primary education were, in their respect, 29 and 12 times more likely not to use ANC services as compared to women with higher education ($p<0.0001$). As compared to the national average, women with no education were 1.5 times more likely not to use ANC ($p<0.0001$). In 2011, as compared to women with higher education, average ANC use at the national level was 20-times lower ($p<0.0001$). As compared to 2011, the level of inequity appeared wider in 2005 but lower in 2000 (Table 4). However, such differences between the three data points were not statistically significant as described below.

Over the three years, compared to women with higher education, there were no statistically significant variations in the magnitude of inequity in use of ANC by education ($p>0.05$). Similarly, as compared to the national average in use of ANC services, magnitude of inequity for women with no education did not show statistically significant variation between the three data points ($p>0.05$). However, as compared to the national average, the magnitude of inequity for women with primary education increased by about 50% in 2005 and 2011 from 2000 ($p<0.05$). (Table 4 and Figure 2)
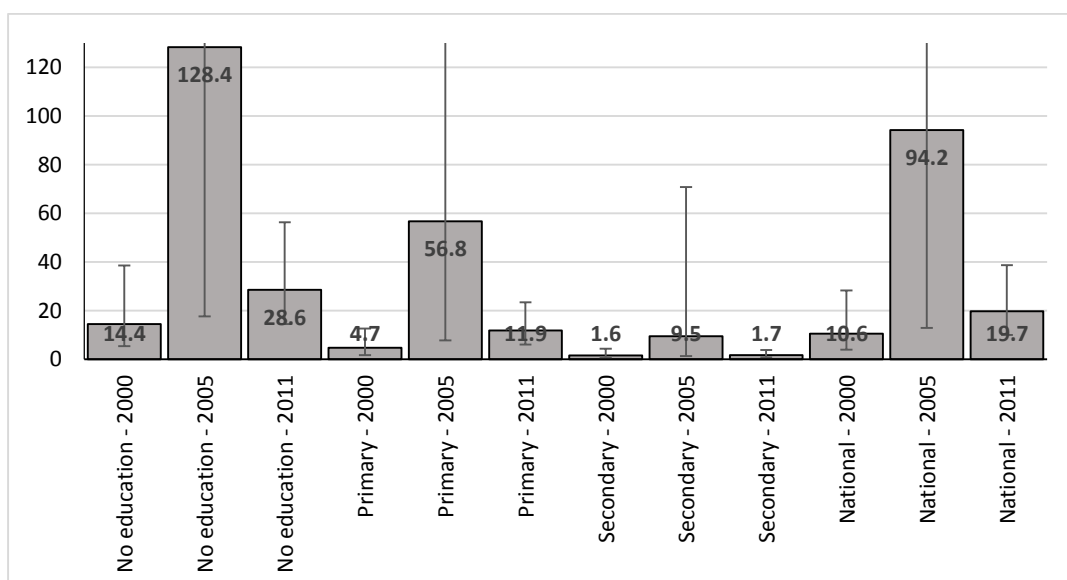
Figure 2. Odds ratio of not using ANC: women with no education as compared to women with higher education.

ANC Use by Household Income Category

The three DHS surveys used wealth quintiles to classify household income to 5 categories (from lowest to highest) based on household asset data via a principal components analysis (CSA, 2000, 2005 & 2011). The 2011 DHS data showed statistically significant inequities linked to household income in use of ANC. Women in the poorest household income category were about ten times more likely not to use

ANC services as compared to women in the richest income category ($p<0.0001$)
(Table 4). Women in second lowest income category ('poorer') were about six times
more likely no to use ANC services as compared to women in the richest income
category ($p<0.0001$). As compared to women in the richest income category, average
ANC use at the national level was 4.3 times lower ($p<0.0001$) (Table 4).

The level of inequity in 2005 was closely similar to 2011. In 2005, women in
poorest household income category were about nine times more likely not to use ANC
services as compared to women in the richest income category ($p<0.0001$). Poorer
women were about six times more likely not to use ANC services as compared to
those in the richest income category ($p<0.0001$). As compared to women in the richest
income category, average ANC use at the national level was 3.6 times lower
($p<0.0001$) (Table 4).

The 2000 level of inequity by income level in using ANC services was closely
similar to 2011 and 2005. In 2000, women in poorest household income category
were about nine times more likely not to use ANC services as compared to women in
the richest income category ($p<0.0001$). Poorer women were about seven times more
likely not to use ANC services as compared to women in the richest income category
($p<0.0001$). As compared to women in the richest income category, average ANC use
at the national level was 4.3 times lower ($p<0.0001$) (Table 4).

Overall, inequity level by household income category in using ANC services
did not show much difference between 2000 and 2011 ($p>0.05$). This case was true
when reference group was women in higher education or national average in use of
ANC. However, for each year, inequity level was significantly high, specifically for
women with no or primary education (Table 4 and Figure 3).
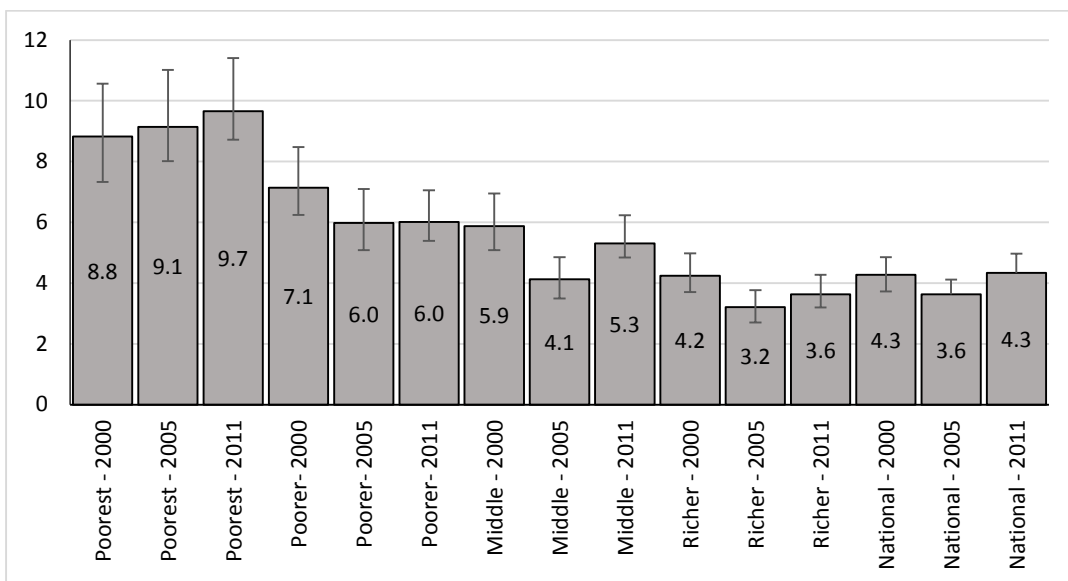
Figure 3. Odds ratio of not using ANC: women in the different income categories as compared to women in the highest income category.

ANC Use by Administrative Region

Table 5 presents odds ratios of ANC use by the 11 administrative regions of the country where women lived in at the time of the DHS surveys.

Table 5

Odds Ratio of Not Using ANC: by Administrative Region

DHS	Region	Reference: Region				Reference: National			
			95% CI				95% CI		
		OR	LL	UL	P-value	OR	LL	UR	P-value
2011		*Reference Region: Tigray*				*Reference: National*			
	Tigray	1.00				0.41	0.34	0.49	<0.0001
	Affar	3.43	2.08	5.64	<0.0001	1.41	0.88	2.25	0.19
	Amhara	2.69	2.20	3.29	<0.0001	1.11	1.00	1.22	0.05
	Oromiya	2.77	2.29	3.36	<0.0001	1.14	1.05	1.24	0.00
	Somali	5.37	3.72	7.75	<0.0001	2.13	1.54	2.95	<0.0001
	Benishangul-Gumuz	2.70	1.71	4.24	<0.0001	1.11	0.73	1.68	0.71
	SNNP	2.67	2.18	3.27	<0.0001	1.10	0.98	1.22	0.10
	Gambela	1.31	0.63	2.73	0.60	0.54	0.26	1.10	0.12
	Harari	1.32	0.52	3.34	0.73	0.54	0.22	1.35	0.27
	Addis Ababa	0.11	0.06	0.21	<0.0001	0.05	0.02	0.08	<0.0001
	Dire Dawa	1.13	0.50	2.55	0.92	0.47	0.21	1.03	0.08
	National	2.43	2.03	2.92	<0.0001	1.00			
2005		*Reference Region: Gambela*				*Reference: National*			
	Tigray	1.08	0.46	2.54	1.00	0.66	0.54	0.80	<0.0001
	Affar	3.66	1.25	10.72	0.02	2.24	1.14	4.39	0.02
	Amhara	1.76	0.76	4.09	0.27	1.08	0.96	1.21	0.23
	Oromiya	1.91	0.82	4.43	0.20	1.16	1.05	1.29	0.00
	Somali	7.74	3.01	19.89	<0.000	4.73	3.05	7.33	<0.0001
	Benishangul-Gumuz	2.05	0.75	5.62	0.25	1.25	0.71	2.20	0.52
	SNNP	1.42	0.61	3.30	0.55	0.87	0.77	0.97	0.02
	Gambela	1.00				0.61	0.26	1.41	0.35
	Harari	0.96	0.26	3.65	0.78	0.59	0.21	1.66	0.00
	Addis Ababa	0.09	0.03	0.24	<0.000	0.05	0.03	0.09	<0.0001
	Dire Dawa	0.54	0.17	1.74	0.46	0.33	0.15	0.74	0.01
	National	1.64	0.71	3.79	0.35	1.00			
2000		*Reference Region: Gambela*				*Reference: National*			
	Tigray	1.70	0.72	3.99	0.31	0.64	0.54	0.77	<.0001
	Affar	2.54	0.97	6.64	0.09	0.96	0.60	1.55	1.00
	Amhara	4.28	1.84	9.94	<0.05	1.62	1.44	1.82	<.0001
	Oromiya	2.56	1.11	5.93	0.04	0.97	0.88	1.06	0.52
	Somali	5.07	1.84	13.97	0.00	1.92	1.08	3.41	0.03
	Benishangul-Gumuz	2.86	1.08	7.55	0.06	1.08	0.66	1.78	0.86
	SNNP	2.44	1.05	5.66	0.06	0.92	0.82	1.03	0.17
	Gambela	1.00				0.38	0.16	0.87	0.03
	Harari	1.00	0.28	3.63	0.74	0.38	0.14	1.01	--
	Addis Ababa	0.20	0.08	0.52	0.00	0.08	0.05	0.12	<.0001
	Dire Dawa	0.69	0.22	2.14	0.72	0.26	0.12	0.56	0.00
	National	2.64	1.14	6.11	0.03	1.00			

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper limit. CI = Confidence Interval

When comparing inequity by region, the reference region considered was one with better ANC use as compared to the other regions. When comparing by region, care was taken so that regions with largely urban population (and where ANC use is normally high) are not taken as a reference group. In this regard, Addis Ababa, Dire Dawa and Harari regions, where urban population accounted close to 60% or above as compared to 24% or less nationally, were not used as reference regions. Inequities were also measured by comparing ANC use in each region with national average.

Analysis of the 2011 DHS data set showed that in the mostly rural type administrative regions excluding Addis Ababa, Harari and Dire Dawa, women in Tigray Region had better use of ANC services (64%) (Table 2). As compared to Tigray region, six regions (Afar, Amhara, Oromiya, Somalia, Benishangul-Gumuz, and SNNP) had statistically significant lower use of ANC services ($p<0.0001$) (Table 5). Women in these six regions were 3-5 times more likely not to use ANC services as compared to women Tigray region ($p<0.0001$) (Table 5). Average ANC use at the national level was 2.4 times lower than in Tigray region ($p<0.0001$) (Table 5). Most of the regions except Tigray, Oromiya, Somalia, and, Addis Ababa did not show much difference from national average in using ANC services. Addis Ababa and Tigray region had better use of ANC services while Oromiya and Somalia showed lower use as compared to the national averages ($p<0.0001$) (Table 5).

In 2005, in the mostly rural type regions excluding Addis Ababa, Harari and Dire Dawa, women in Gambela Region had better use of ANC services (39%). As compared to Gambela region, all the rural-type regions except Afar and Somalia did not show statistically significant difference in the use of ANC services (Table 5). Women in Afar and Somalia regions, in their respect, were 3.7 and 7.7 times more likely not to use ANC services as compared to Gambela region ($p<0.05$). As

compared to the national average, eight regions showed statistically significant difference in ANC use. Tigray, SNNP, Harari, Addis Ababa and Dire Dawa showed better use of the service; while Afar, Oromiya, and Somalia had lower likelihoods of using ANC services as compared to the national average ($p<0.05$).

Similar to 2005, in 2000, women in Gambela region had relatively better use of ANC services (50%) (Table 2) as compared to the other rural type administrative regions. In 2000, as compared to Gambela region, Amhara, Oromiya and Somalia were 4.3, 2.6 and 5.1 times more likely not to use ANC, respectively ($p<0.05$) (Table 5). Women in Addis Ababa were 5 times more likely to use ANC services ($p<0.05$) (Table 5). For all other regions, there was no statistically significant variation in the use of ANC services as compared to women in Gambela region. As compared to the national average, Tigray, Gambela, Addis Ababa and Dire Dawa regions showed better use of ANC services; while Amhara and Somalia regions showed relatively lower use of the service ($p<0.05$) (Table 5).

In summary, inequity by region expanded geographically; i.e., as compared to a relatively better performing region in use of ANC services, inequity level reached more regions (six) in 2011 as compared to three regions in 2000. In 2000, women in three regions (Amhara, Oromiya and Somalia) had inequity issues as compared to six regions (Afar, Amhara, Oromiya, Somalia, Benishangul-Gumuz and SNNP) in 2011 (Table 5). As compared with average use of ANC services at the national level, there was no increase in the number of regions with inequity issues (Table 5).

Compared to national average, the number of regions with inequity issues in ANC use were two in 2000 (Amhara and Somalia) and two in 2011 (Oromiya and Somalia). In four regions (Tigray, Amhara, Somalia and SNNP), the magnitude of inequity significantly differed between the three data points: 2000, 2005, and 2011

(Table 5 and Figure 4). In Tigray and Amhara regions, in their respect, equity levels

on ANC use improved by 36% and 31% in 2011 as compared to 2000 ($p<0.05$)

(Figure 4). In Somalia region, equity level on ANC use improved by 55% in 2011 as

compared to 2005 ($p<0.05$). On the other hand, in SNNP region, inequity level in

ANC use worsened by 36% in 2011 as compared to 2005 ($p<0.05$). (Table 5 and

Figure 4).
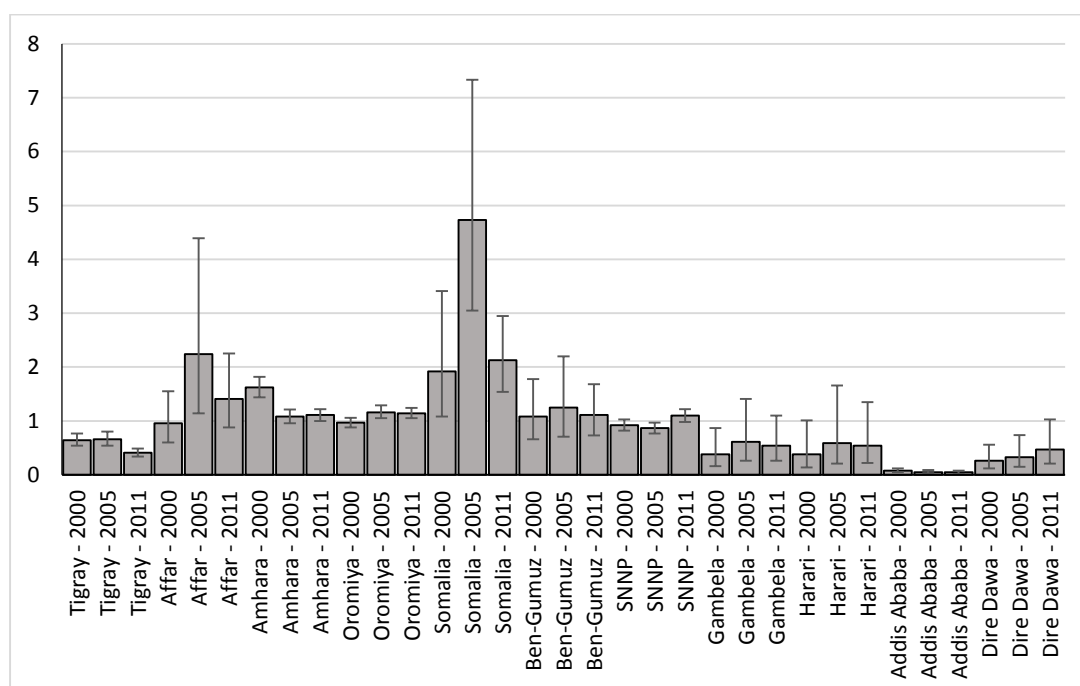
Figure 4. Odds ratio of not using ANC with 95% CI – service use in each region as compared to national average.

Despite the observed inequities, ANC use increased nationally in 2011 as

compared to 2000 ($p<0.0001$). In Tigray, Amhara, Oromiya, SNNP and Addis Ababa

regions, ANC use increased 3.1, 2.9, 1.7, 1.7, and 3.3 times the 2000 level,

respectively ($p<0.05$). For all the remaining regions (Afar, Somalia, Benishangul-

Gumuz, Gambela, Harari and Dire Dawa), there were no changes in ANC use in 2011

from the 2000 level.

Skilled Birth Attendance by Residence, Education Level, and Income

Table 6 presents results from analysis of the three DHS survey data on odds ratios of not using skilled birth attendance services by women's residence (urban/rural), women's level of education and household income category.

Table 6

Odds Ratio of Not Using Skilled Health Personnel at the Time of Delivery: by Residence, Level of Education and Income

DHS	Category	OR	95% CI LL	95% CI UL	P-value	OR	95% CI LL	95% CI UL	P-value
	Residence (Urban/Rural)								
		Reference: Urban				*Reference: National*			
2011	Urban	1.00	--	--	--	0.11	0.10	0.13	<.0001
	Rural	27.15	22.92	32.16	<.0001	2.98	2.59	3.43	<.0001
	National	9.12	7.95	10.46	<.0001	1.00	--	--	--
2005	Urban	1.00	--	--	--	0.08	0.07	0.10	<.0001
	Rural	29.77	24.12	36.74	<.0001	2.38	2.02	2.82	<.0001
	National	10.43	14.98	<.0001	<.0001	1.00	--	--	--
2000	Urban	1.00	--	--	--	0.11	0.09	0.13	<.0001
	Rural	25.24	20.42	31.18	<.0001	2.81	2.34	3.38	<.0001
	National	8.98	7.59	10.61	<.0001	1.00	--	--	--
	Women's Level of Education								
		Reference: Higher Education				*Reference: National*			
2011	No education	63.78	41.84	97.22	<.0001	2.77	2.38	3.22	<.0001
	Primary	13.70	9.05	20.74	<.0001	0.59	0.52	0.68	<.0001
	Secondary	1.12	0.68	1.84	0.75	0.05	0.04	0.07	<.0001
	Higher	1.00				0.04	0.03	0.07	<.0001
	National	23.04	15.35	34.59	<.0001	1.00			
2005	No education	168.22	73.27	386.21	<0.05	2.66	2.21	3.20	<.0001
	Primary	39.10	16.95	90.20	<.0001	0.62	0.50	0.76	<.0001
	Secondary	3.47	1.49	8.08	0.00	0.05	0.04	0.07	<.0001
	Higher	1.00				0.02	0.01	0.04	<0.05
	National	63.22	27.83	143.62	<0.05	1.00			
2000	No education	120.66	47.25	308.14	<0.05	2.58	2.15	3.11	<.0001
	Primary	22.46	8.74	57.74	<0.0001	0.48	0.39	0.60	<.0001
	Secondary	3.38	1.31	8.70	0.01	0.07	0.06	0.09	<.0001
	Higher	1.00				0.02	0.01	0.05	<0.05
	Household Income Category								
		Reference: Richest				*Reference: National*			
2011	Poorest	50.87	35.42	73.05	<.0001	6.51	4.58	9.26	<.0001
	Poorer	31.78	23.54	42.90	<.0001	4.07	3.05	5.42	<.0001
	Middle	31.09	22.97	42.08	<.0001	3.98	2.98	5.32	<.0001
	Richer	12.32	9.85	15.43	<.0001	1.58	1.28	1.94	<.0001
	Richest	1.00	--	--	--	0.13	0.11	0.15	<.0001
	National	7.81	6.85	8.91	<.0001	1.00	--	--	--
2005	Poorest	55.52	31.04	99.28	<.0001	9.26	5.21	16.46	<.0001
	Poorer	29.43	19.15	45.24	<.0001	4.91	3.22	7.48	<.0001
	Middle	23.01	15.71	33.71	<.0001	3.84	2.64	5.57	<.0001
	Richer	8.49	6.50	11.09	<.0001	1.42	1.10	1.83	0.01
	Richest	1.00	--	--	--	0.17	0.14	0.19	<.0001
	National	6.00	5.14	6.99	<.0001	1.00	--	--	--
2000	Poorest	43.50	24.83	76.24	<.0001	6.93	3.98	12.07	<.0001
	Poorer	32.54	20.09	52.70	<.0001	5.18	3.22	8.34	<.0001
	Middle	23.26	15.35	35.25	<.0001	3.71	2.47	5.57	<.0001
	Richer	14.03	9.96	19.78	<.0001	2.24	1.60	3.12	<.0001
	Richest	1.00	--	--	--	0.16	0.14	0.19	<.0001
	National	6.28	5.34	7.39	<.0001	1.00	--	--	--

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper limit. CI = Confidence Interval

Skilled Birth Attendance by Women's Residence

Analysis of the 2011 DHS survey data showed that, as compared to women in urban areas, women living in rural areas were 27 times more likely their deliveries were not attended by skilled health personnel ($p<0.0001$) (Table 6). As compared to the national average, women in rural areas were three times more likely their deliveries were not attended by skilled health personnel ($p<0.0001$). The level of inequity between urban and rural areas on skilled birth attendance was much wider in 2005 as compared to 2011. In 2005, as compared women in urban areas, women living in rural areas were 30 times more likely their deliveries were not attended by skilled health personnel ($p<0.0001$). On the other hand, as compared to the national average, women in rural areas were 2.4 times more likely that their deliveries were not attended by skilled health personnel ($p<0.0001$) (Table 6).

In 2000, level of inequity between urban and rural area on skilled birth attendance was much higher than in 2005 and 2011. In 2000, as compared to women in urban areas, women living in rural areas were 25 times more likely that their deliveries were not attended by skilled health personnel ($p<0.0001$) (Table 6). As compared to the national average, women in rural areas were 2.8 times more likely that their deliveries were not attended by skilled health personnel ($p<0.0001$) (Table 6). In Summary, as compared to regions with better use of the service, inequality in the use of skilled birth attendance between urban and rural settings was very high (odds ratio over 25) on all three data points (Table 6). However, a review of odds ratio trends over time and the 95% confidence interval, shows there were no statistically significant differences in inequity levels by residence over the three time periods ($p>0.05$) (Table 6 and Figure 5).

a) Odds ratio of not using skilled birth attendance: rural vs urban

b) Odds ratio of not using skilled birth attendance: rural vs national average
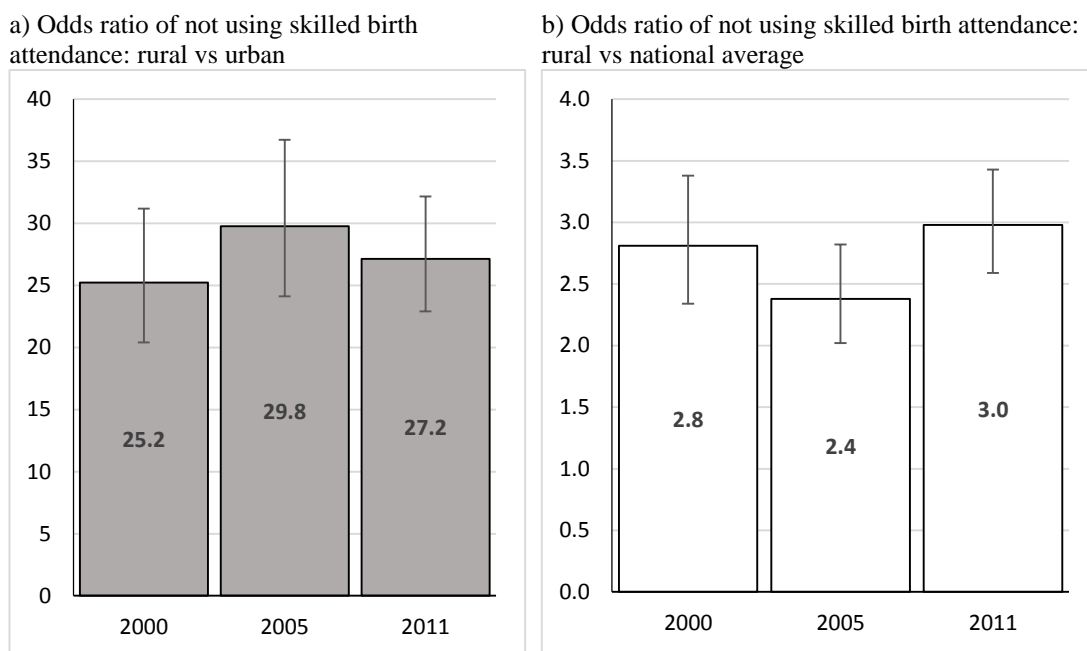
Figure 5. Odds ratio of not using skilled health personnel at the time of delivery: a) rural women as compared to urban women; b) rural women as compared to national average

Skilled birth attendance by women's level of education

Analysis of the 2011 DHS showed that women with no education and with primary education were, in their respect, 64 and 14 times more likely not attended by skilled health personnel at the time of delivery as compared to women with higher education ($p<0.0001$) (Table 6). As compared to the national average, women with no education were 2.8 times more likely not attended by skilled health personnel ($p<0.0001$). At the national level, women were 23 times more likely not attended by skilled health personnel as compared to women with higher education ($p<0.0001$). As compared to the national average, women with no education were 2.8 times more likely not attended by skilled health personnel ($p<0.0001$) (Table 6).

In 2005, inequity on skilled birth attendance associated with women's level of education was wider than 2011. In 2005, women with no education and with primary education were, in their respect, 168 and 39 times more likely not attended by skilled

health personnel at the time of delivery as compared to women with higher education ($p<0.05$) (Table 6). At the national level, women were 63-times more likely not attended by skilled health personnel as compared to women with higher education or above ($p<0.05$). As compared to the national average, women with no education were 2.7 times more likely not attended by skilled health personnel ($p<0.0001$) (Table 6).

In 2000, inequity on skilled birth attendance associated with women's level of education was wider than the 2011 level but slightly better than 2005. In 2000, women with no education and with primary education were, in their respect, 121 and 23 times more likely not attended by skilled health personnel at the time of delivery as compared to women with higher education ($p<0.05$) (Table 6). At the national level, women were 47-times more likely not attended by skilled health personnel as compared to women with higher education or above ($p<0.05$). As compared to national average, women with no education were 2.6 times more likely not attended by skilled health personnel ($p<0.0001$) (Table 6).

Within each education category, a review of trend on the magnitude of inequity over the three years did not show statistically significant variations ($p>0.05$) (Figure 6). This case was true when reference groups for comparison were women in higher education or national average on use of skilled birth attendance. However, for each year, the inequity level remained significantly high ($p<0.0001$), specifically for women with no education or with primary education. (Table 6 and Figure 6).
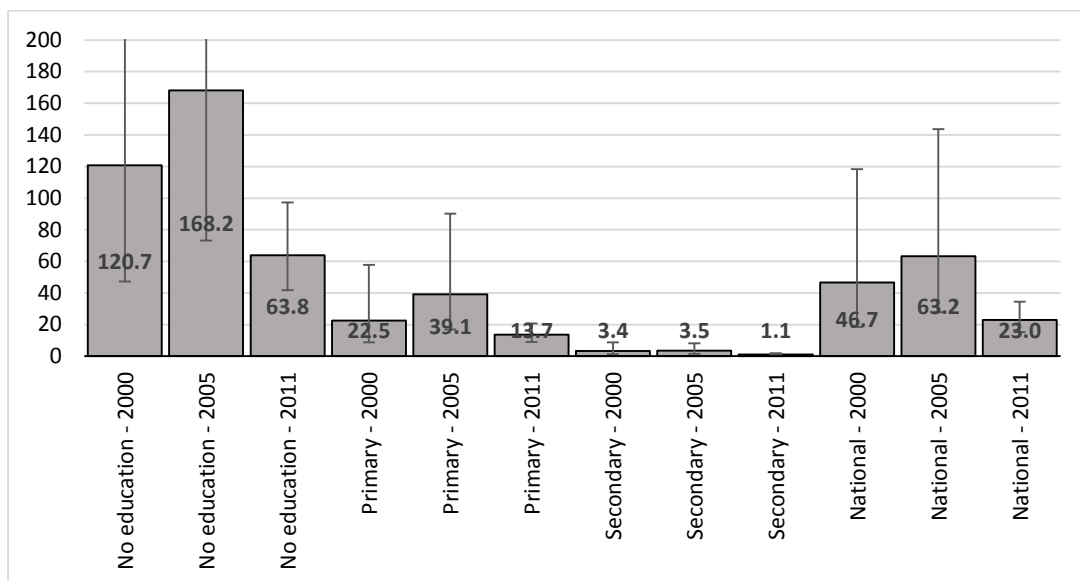
Figure 6. Odds ratio of not using skilled health personnel at the time of delivery: women with no education as compared to women with higher education.

Skilled birth attendance by household income

In 2011, there were significantly high inequities on skilled birth attendance that are associated with household income. Women in the poorest household income category were 51 times more likely not attended by skilled health personnel at the time of delivery as compared to women in the richest income category ($p<0.0001$) (Table 6). Women in second lowest income category ('poorer') were 32 times more likely not attended by skilled health personnel at the time of delivery as compared to women in the richest income category ($p<0.0001$). As compared to the national average, women in the poorest income category were 6.5 times more likely not attended by skilled health personnel at the time of delivery ($p<0.0001$) (Table 6).

In 2005, women in poorest and poorer household income categories were 56 and 29 times more likely not attended by skilled health personnel at the time of delivery as compared to women in the richest income category ($p<0.0001$). As compared to the national average, women in the poorest income category were nine

times more likely not attended by skilled health personnel at the time of their last

delivery ($p<0.0001$) (Table 6).

In 2000, similar to 2005 and 2011, there was high level of inequity on skilled

birth attendance related to household income. Women in poorest and poorer

household income categories were 44 and 33 times, in their respect, more likely not

attended by skilled health personnel at the time of delivery as compared to women in

the richest income category ($p<0.0001$) (Table 6). As compared to the national

average, women in the poorest income category were6.9 times more likely not

attended by skilled health personnel at the time of delivery ($p<0.0001$) (Table 6).

In summary, inequity on skilled birth attendance associated with household

income remained very high at all times. However, there were no statistically

significant differences in the magnitude of inequity associated with income over the

years ($p>0.05$). This case was true when reference groups for comparison were

women in richest income category or national average on use of skilled birth

attendance (Table 6 and Figure 7).
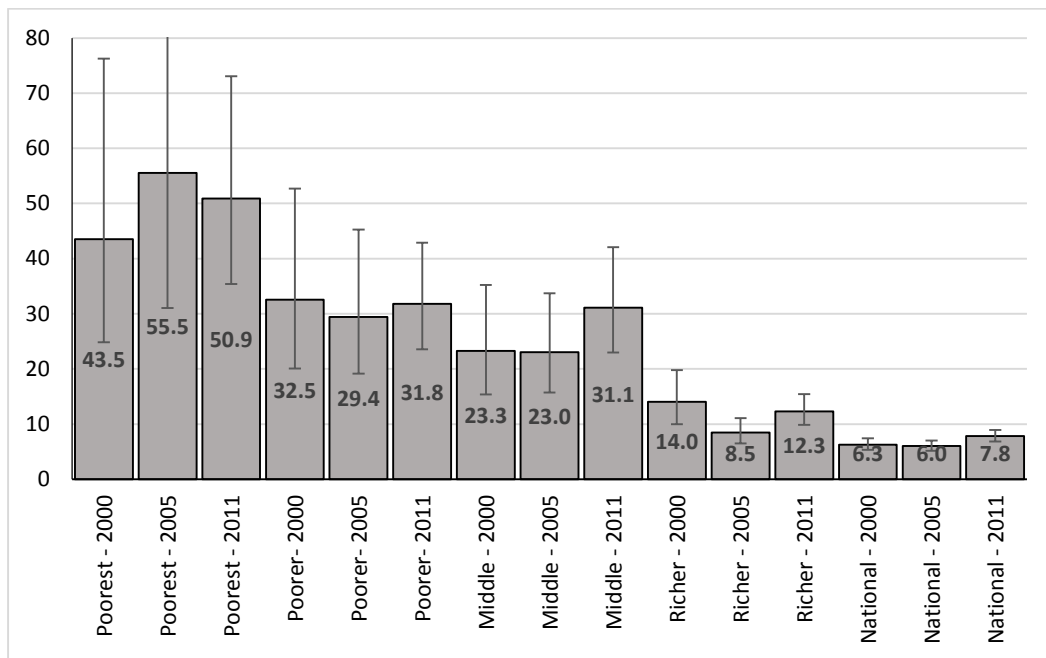
Figure 7. Odds ratio of not using skilled health personnel at the time of delivery: women in the poorest income category as compared to women in the highest income category.

Skilled birth attendance by administrative region

Table 7 presents results from analysis of the three DHS survey data on odds

ratios of not using skilled health personnel at the time of delivery by women who

resided in the 11 administrative regions of the country at the time of the surveys.

Table 7

Odds Ratio of Not Using Skilled Health Personnel at the Time of Delivery: by
Administrative Region

DHS	Region	Reference Region: Gambela				Reference: National			
			95% CI				95% CI		
		OR	LL	UL	P-value	OR	LL	UL	P-value
2011	Tigray	2.66	1.13	6.29	0.03	0.87	0.66	1.13	0.33
	Affar	4.67	1.45	15.03	0.01	1.52	0.66	3.51	0.42
	Amhara	3.35	1.46	7.70	<0.05	1.09	0.93	1.28	0.31
	Oromiya	4.00	1.74	9.16	<0.05	1.30	1.13	1.50	0.00
	Somali	3.66	1.42	9.44	0.01	1.19	0.74	1.93	0.54
	Benishangul-Gumuz	3.60	1.23	10.50	0.03	1.17	0.59	2.34	0.78
	SNNP	4.85	2.09	11.25	<0.05	1.58	1.29	1.93	<.0001
	Gambela	1.00				0.33	0.14	0.74	<0.05
	Harari	0.69	0.20	2.37	0.75	0.22	0.09	0.57	<0.05
	Addis Ababa	0.08	0.03	0.20	<.0001	0.03	0.02	0.04	<.0001
	Dire Dawa	0.63	0.19	2.14	0.66	0.14	0.06	0.31	<0.05
	National	3.07	1.35	6.99	<0.05	1			
2005	Tigray	2.50	0.81	7.73	0.11	0.89	0.63	1.25	0.55
	Affar	3.42	0.78	14.99	0.19	1.21	0.44	3.34	>0.05
	Amhara	4.39	1.46	13.19	<0.05	1.56	1.23	1.97	0.00
	Oromiya	3.30	1.11	9.82	<0.05	1.17	0.97	1.41	0.10
	Somali	3.13	0.96	10.19	0.07	1.11	0.68	1.81	0.76
	Benishangul-Gumuz	3.26	0.74	14.31	0.20	1.16	0.42	3.19	>0.05
	SNNP	4.29	1.42	12.91	<0.05	1.52	1.19	1.94	0.00
	Gambela	1.00				0.35	0.12	1.05	>0.05
	Harari	0.38	0.08	1.76	0.25	0.13	0.04	0.40	<0.05
	Addis Ababa	0.05	0.02	0.16	<.0001	0.02	0.01	0.03	<.0001
	Dire Dawa	0.42	0.11	1.66	0.32	0.15	0.06	0.35	<0.05
	National	2.82	0.96	8.33	<0.05	1			
2000	Tigray	4.75	1.63	13.78	0.01	0.97	0.67	1.41	1.00
	Affar	4.06	1.10	14.95	0.04	0.83	0.36	1.92	0.84
	Amhara	8.27	2.95	23.13	<0.05	1.70	1.33	2.16	<.0001
	Oromiya	6.51	2.35	18.03	<0.05	1.33	1.10	1.62	0.00
	Somali	3.44	0.97	12.21	0.06	0.70	0.32	1.54	0.51
	Benishangul-Gumuz	2.70	0.78	9.34	0.14	0.55	0.26	1.16	>0.05
	SNNP	5.96	2.13	16.68	<0.05	1.22	0.96	1.56	0.11
	Gambela	1.00				0.21	0.07	0.56	<0.05
	Harari	0.69	0.16	2.95	0.72	0.14	0.05	0.41	<0.05
	Addis Ababa	0.13	0.04	0.38	0.00	0.03	0.02	0.04	<.0001
	Dire Dawa	0.59	0.16	2.14	0.63	0.12	0.05	0.27	<0.05
	National	4.88	1.78	13.37	0.05	1	--	--	--

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper limit. CI = Confidence Interval

In the three periods (2000, 2005, and 2011), in the mostly rural type

administrative regions, women in Gambela Region had better skilled birth attendance.

As compared to Gambela, seven regions (Tigray, Afar, Amhara, Oromiya, Somalia,

Benishangul-Gumuz, and SNNP) had lower skilled birth attendance (*p*<0.05) (Table

7). These seven regions were 3-5 times more likely not attended by skilled health personnel at the time of delivery as compared to Gambela region ($p<0.0001$). As compared to the national average, Oromiya and SNNP had lower use of skilled health personnel ($p<0.05$), while Gambela, Harari, Addis Ababa and Dire Dawa showed a relatively better use of the service ($p<0.05$). (Table 7).

As compared to Gambela region, in 2005, three regions (Amhara, Oromiya and SNNP) had lower skilled birth attendance ($p<0.05$). (Table 7). These three regions were 3.3 to 4.4 times more likely not attended by skilled health personnel at the time of delivery as compared to Gambela region ($p<0.05$). As compared to the national average, Amhara and SNNP had lower use of skilled health personnel ($p<0.05$), while Addis Ababa and Dire Dawa showed a relatively better use of the service ($p<0.05$).

In 2000, as compared to Gambela, five regions (Tigray, Afar, Amhara, Oromiya and SNNP) had lower skilled birth attendance ($p<0.05$). The five regions were 4.1 to 8.3 times more likely not attended by skilled health personnel at the time of delivery as compared to Gambela region ($p<0.05$). Compared to the national average, Amhara and Oromiya regions had lower use of skilled health personnel ($p<0.05$), while Gambela, Harari, Addis Ababa and Dire Dawa showed a relatively better use of the service ($p<0.05$)

Analysis of inequity trends on skilled birth attendance by region as compared to the national average showed that in all regions (except in Amhara), magnitude of inequity did not show statistically significant differences between the three data points - 2000, 2005, and 2011 (Figure 8). In Amhara Region, as compared to the national averages, the magnitude of inequity on skilled birth attendance had declined by 36% in 2011 from the 2000 level ($p<0.05$) (Figure 8). As compared to the national average,

inequity issues were observed in two regions in 2000 (Amhara and Oromiya) and two in 2011 (Oromiya and SNNP) (Table 7). Oromiya, the region with the largest population size in the country (Ethiopia Population Census Commission, 2008), remained inequitable in both 2000 and 2011. As compared to regions with relatively better use of the service, inequity had expanded from five regions in 2000 (Tigray, Afar, Amhara, Oromiya, and, SNNP) to seven regions in 2011 (Tigray, Afar, Amhara, Oromiya, SNNP, Somalia, and, Benishangul-Gumuz) (Table 7).
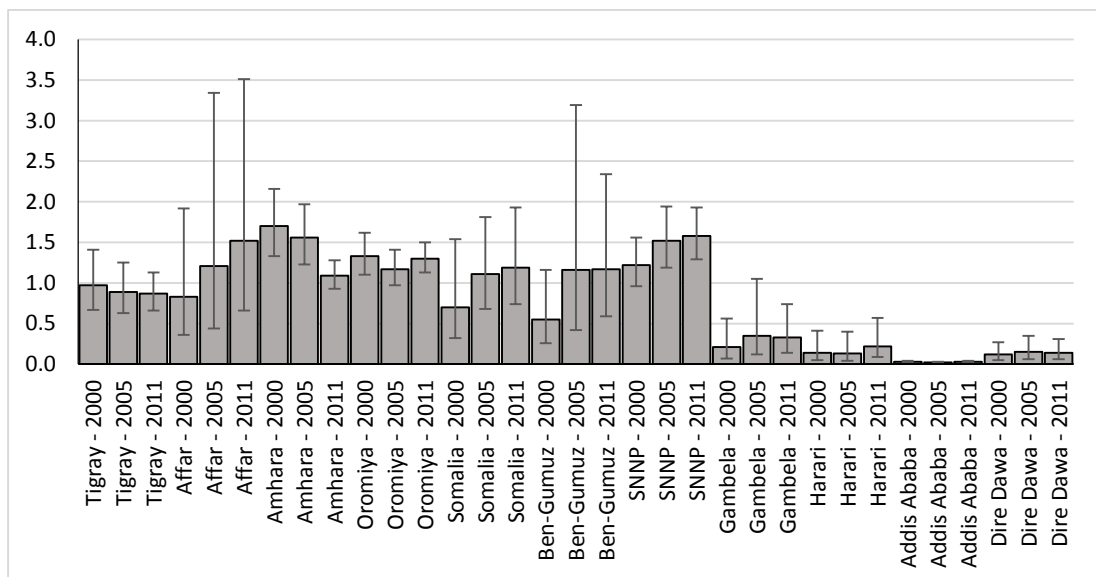
Figure 8. Odds ratio of not using skilled health personnel at the time of delivery: service use in each region as compared to national average.

Factors Associated With Use of Maternal Health Services

The second Research Question (RQ2) referred to "are socio-demographic characteristics (including income, educational level of women, residence - urban/rural, distance to a health facility, out-of-pocket payment for services, and women's decision making power) significantly associated with use of maternal health services by Ethiopian women?" The hypothesis tested was:

- Ho2: Use of maternal health services (antenatal care and attended delivery) are not associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

- Ha2: Use of maternal health services (antenatal care and attended delivery) are associated with socio-demographic characteristics (that include income, educational level of women, residence (urban/rural), distance to a health facility, out-of-pocket payment for services, and women's decision making power).

To answer to the second research question, I used logistic regression model to identify factors that were associated with use of maternal health services (i.e., antenatal care and skilled birth attendance). In this analysis there were two dependent variables: i) whether a women has used antenatal care service, at least one visit (Yes/No), and ii) whether a woman was attended by a skilled health personnel at the time of her last delivery (Yes/No).

As presented in Chapter 2, based on previous studies, the independent variables included in the logistics regression model were: place of residence (urban/rural), level of education, household income category, distance to a health facility, out-of-pocket money for medical help, and decision making power (in seeking medical care, contraception and spending of earnings). During the analysis stage, terminated pregnancy was also included as an independent variable to see if women's practice or experience with termination of pregnancy had impact to use or

not to use maternal health services. The variables included in the logistics regression, descriptions and possible values are summarized in the table below.

Table 8

Dependent and Independent Variables Included in the Logistic Regression Analysis

Variables	Description
Dependent variables	
Y1: ANC use (at least one visit)	Y1: ANC use, i.e., at least one visit during last pregnancy (0, 1) 0 – ANC not used during last pregnancy 1 – At least one ANC visit during last pregnancy
Y2: Attended delivery (for the last delivery)	Y2: Last delivery attended by skilled health personnel (doctor, nurse or midwife) 0 – Delivery not attended by skilled health personnel 1 – Delivery attended by skilled health personnel
Independent variables	
X1: Residence (urban/rural)	X1: Place of residence of women 1 - Urban 2 – Rural
X2: Women's level of education	X2: Highest educational level of women 0- No education 1- Primary 2- Secondary 3- Higher
X3: Income	X3: Household income category/wealth index 1- Poorest 2- Poorer 3- Middle 4- Richer 5- Richest
X4: Distance to a health facility	X4: For getting medical help for self, is distance to health facility a big problem? 1- Yes, it is a big problem 2- No, it is not a big problem
X5: Out-of-pocket payment for services	X5: For getting medical help for self, is getting money a big problem? 1- Yes, it is a big problem 2- No, it is not a big problem
X6: Women's decision making power, contraception	X6: Who is the decision maker for using contraception? 0 - Mainly husband, partner, or other (i.e., woman not involved in decision making) 1- Mainly woman, or joint decision (i.e., woman involved in decision making)
X7: Women's decision making power, spending	X7: Person who usually decides how to spend respondent's earnings 0- Husband/partner alone or someone else (i.e., woman not involved in decision making) 1- Woman alone, woman and husband/partner, or respondent and other person (i.e., i.e., woman involved in decision making)
X8: Women's decision making power, health care	X8: Person who usually decides on respondent's health care 0- Husband/partner alone, someone else or other (i.e., woman involved in decision making) 1- Woman alone, woman and husband/partner, or woman and other person (i.e., woman not involved in decision making)
X9: Terminated pregnancy	X9: Ever had a terminated pregnancy 0 - No 1 – Yes

For each dependent variable (Y1 and Y2), a logistics regression model was run by including the nine independent variables listed above. "Forward Stepwise (Wald)" method was used to generate logistics regression models on each dependent variable. The logistics regression model was run at two levels – i) at the national level; and ii) for each administrative region to identify the factors associated with the two dependent variables within each region. However, it is worth mentioning that logistics regression models could not be fitted for some regions with small population size and hence smaller sample size (Harari, Dire Dawa, and, Gambela regions). The results of the logistics regression model are presented in Tables 9 to 12.

Factors Associated with ANC Use

Table 9 presents results from logistics regression analysis of the three DHS survey data on factors associated with use of ANC services.

Table 9

Factors Associated with Use of ANC service (at Least One ANC Visit)

				95% CI for Exp (B)	
Variables in the equation	B	Sig.	Exp (B)	LL	UL
DHS 2011					
X1 (0) Residence, rural (reference)					
X1 (1) Residence, urban	.469	.000	1.598	1.283	1.990
X2 (0) No education (reference)		.000			
X2 (1): Primary education	.530	.000	1.699	1.524	1.895
X2 (2): Secondary education	1.710	.000	5.530	3.516	8.695
X2 (3) Higher education	1.834	.000	6.261	3.098	12.655
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.400	.000	1.491	1.283	1.733
X3 (2): Income, Middle	.475	.000	1.608	1.382	1.870
X3 (3): Income, Richer	.654	.000	1.923	1.646	2.247
X3 (4): Income, Richest	1.179	.000	3.251	2.579	4.097
X4 (2): Distance to a health facility, not a big problem (reference)					
X4 (1): Distance to a health facility, a big problem	-.292	.000	.747	.664	.839
X6 (0): Decision making on contraception, women not involved (reference)		.000			
X6 (1): Decision making on contraception, women involved	.529	.035	1.698	1.039	2.775
X7 (0): Decision making on spending, women not involved (reference)		.000			
X7 (1): Decision making on spending, women involved	.308	.050	1.361	1.001	1.850
X8 (0): Decision making on health care, women not involved (reference)		.000			
X8 (1): Decision making on health care, women involved (reference)	.267	.000	1.306	1.160	1.471
Constant	-1.323	.000	.266		
DHS 2005					
X2 (0) No education (reference)		.000			
X2 (1): Primary education	.510	.000	1.665	1.445	1.919
X2 (2): Secondary education	1.487	.000	4.423	3.264	5.993
X2 (3) Higher education	3.787	.003	44.104	3.563	545.950
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.374	.000	1.454	1.194	1.770
X3 (2): Income, Middle	.698	.000	2.009	1.663	2.428
X3 (3): Income, Richer	.856	.000	2.355	1.946	2.850
X3 (4): Income, Richest	1.463	.000	4.320	3.508	5.320
X4 (2): Distance to a health facility, not a big problem (reference)					
X4 (1): Distance to a health facility, a big problem	-.500	.000	.607	.537	.686
X7 (0): Decision making on spending, women not involved (reference)		.000			
X7 (1): Decision making on spending, women involved	1.177	.020	3.245	1.207	8.728
Constant	-1.905	.001	.149		
DHS 2000					
X1 (0) Residence, rural (reference)					
X1 (1) Residence, urban	.674	.000	1.963	1.553	2.481
X2 (0) No education (reference)		.000			
X2 (1): Primary education	.709	.000	2.031	1.738	2.374
X2 (2): Secondary education	.936	.000	2.549	1.927	3.372
X2 (3) Higher education	.926	.088	2.523	.873	7.297
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.218	.025	1.243	1.027	1.504
X3 (2): Income, Middle	.391	.000	1.479	1.228	1.781
X3 (3): Income, Richer	.626	.000	1.869	1.558	2.243
X3 (4): Income, Richest	1.208	.000	3.346	2.650	4.224
X5 (2): Out-of-pocket payment for services, a big problem (reference)					
X5 (1): Out-of-pocket payment for services, not a big problem	.397	.000	1.488	1.268	1.745
Constant	-1.170	.006	.310		

Notes.
LL=Lower limit. UL = Upper limit. CI = Confidence Interval
For all three DHS survey data regression analysis, forward stepwise (Wald) method was used
DHS 2011 model summary: Step 7, Nagelkerke R Square: 0.210; Hosmer & Lemeshow Test: Step 7, significance: 0.061 (>0.05)
DHS 2005 model summary: Step 5, Nagelkerke R Square: 0.196; Hosmer & Lemeshow Test: Step 5, significance: 0.096 (>0.05)
DHS 2000 model summary: Step 6, Nagelkerke R Square: 0.204; Hosmer & Lemeshow Test: Step 6, significance: 0.744 (>0.05)

Factors associated with ANC use, 2011

Logistics regression analysis of the 2011 DHS data showed place of residence (urban/rural), level of education, household income, distance to a health facility, and involvement in decision making on contraception, health care and spending of earnings were important predictors in use of ANC services ($p<0.05$). The regression model fitted with these variables was a good fit, based on Hosmer and Lemeshow Test, which was greater than 5%. Based on the model summary outcomes (Nagelkerke R Square of 0.210), the model could explain about 21% of the variation on ANC use.

The model also showed that, controlling for all other factors included in the analysis, women residing in urban areas were 1.6 times more likely to use ANC services than women in rural areas; women with higher education were 6.3 times more likely to use ANC services than women with no education; women in the richest income category were3.3 times more likely to use ANC services than women in the poorest income category; and women who were involved in decision making on contraception were 1.7 times more likely to use ANC services than those who were not involved in such decisions ($p<0.0001$).

Factors associated with ANC use, 2005

Similar to results from logistics regression analysis of the 2011 DHS, analysis of the 2005 DHS data showed that level of education, household income, distance to a health facility and involvement in decision making on spending were important explanatory factors in use of ANC services ($p<0.05$). However, unlike DHS2011 results, the 2005 data did not identify residence and involvement in decision making on contraception and health care as important explanatory variables for ANC use. The regression model fitted with these variables was a good fit, based on Hosmer and

Lemeshow Test (significance > 0.05). Based on the model summary outcomes (Nagelkerke R Square of 0.196), the model could explain about 20% of the variation on ANC use.

Factors associated with ANC use, 2000

Analysis of the 2000 DHS identified four variables, namely, residence (urban/rural), level of education, household income and, out-of-pocket payment for services, as main factors that explain use of ANC services ($p<0.05$). Unlike the results from DHS 2005 and 2011, analysis of DHS2000 data did not support distance to health facility and women's decision making power as explanatory variables in use of ANC services. The regression model fitted with these variables was a good fit, based on Hosmer and Lemeshow Test (significance > 0.05). Based on the model summary outcomes (Nagelkerke R Square of 0.204), the model could explain about 20% of the variation on ANC use.

In summary, women's residence (urban/rural), level of education, household income, distance to a health facility and involvement in decision on spending were identified in at least two of the three DHS surveys as statistically significant explanatory variables on use of ANC. The region specific analysis also revealed that, in the three regions (Amhara, Oromiya and SNNP), which account about 80% of the total population in Ethiopia (Ethiopia Population Census Commission, 2008), education and household income were identified as explanatory variables on ANC use in all three DHS surveys ($p<0.05$). Some variables were consistently significantly associated with ANC use in all three surveys for specific regions. For example, in SNNP region, involvement in decisions on spending was a statistically significant factor associated with ANC use. For Oromiya region, involvement in decisions on contraception was significantly associated with ANC use ($p<0.05$). In Afar and Dire

Dawa regions, residence (urban/rural) was an important explanatory factor in the three

surveys ($p<0.05$).

Table 10

Region Specific Factors Associated with Use of ANC - Outcomes from Logistics Regression Analysis

National or Region	DHS	Residence (urban/rural) (X1)	Women's level of education (X2)	Income (X3)	Distance to a health facility (X4)	Out-of-pocket payment for services (X5)	Women's decision making power, contraception (X6)	Women's decision making power, spending (X7)	Women's decision making power, health care (X8)	Terminated pregnancy (X9)
National	2000	P<0.05	P<0.05	P<0.05		P<0.05				
	2005		P<0.05	P<0.05	P<0.05			P<0.05		
	2011	P<0.05	P<0.05	P<0.05	P<0.05		P<0.05	P<0.05	P<0.05	
Tigray	2000	P<0.05				P<0.05				
	2005		P<0.05	P<0.05	P<0.05			P<0.05		
	2011		P<0.05	P<0.05						
Affar	2000	P<0.05								
	2005	P<0.05								
	2011	P<0.05								
Amhara	2000	P<0.05	P<0.05	P<0.05		P<0.05				
	2005		P<0.05	P<0.05	P<0.05					
	2011		P<0.05	P<0.05			P<0.05		P<0.05	
Oromiya	2000		P<0.05	P<0.05		P<0.05	P<0.05			
	2005		P<0.05	P<0.05		P<0.05	P<0.05		P<0.05	P<0.05
	2011	P<0.05	P<0.05	P<0.05	P<0.05		P<0.05		P<0.05	P<0.05
Somali	2000			P<0.05						
	2005	P<0.05								
	2011	P<0.05						P<0.05		
Ben-Gumuz	2000				P<0.05					
	2005	P<0.05								
	2011						P<0.05			
SNNP	2000	P<0.05	P<0.05	P<0.05			P<0.05	P<0.05		
	2005	P<0.05	P<0.05	P<0.05	P<0.05			P<0.05		
	2011		P<0.05	P<0.05	P<0.05		P<0.05	P<0.05		
Gambela	2000									
	2005									
	2011									
Harari	2000									
	2005									
	2011									
Addis Ababa	2000		P<0.05				P<0.05			
	2005	P<0.05							P<0.05	
	2011			P<0.05					P<0.05	
Dire Dawa	2000	P<0.05								
	2005	P<0.05								
	2011	P<0.05								

Note. P<0.05 shows that variable is significantly associated with ANC use

Factors associated with skilled birth attendance

Table 11 presents results from logistics regression analysis of the three DHS survey data on factors associated with use of skilled health personnel at the time of delivery.

Table 11

Factors Associated with Use of Skilled Health Personnel at the Time of Delivery

Variables in the equation	B	Sig.	Exp (B)	95% CI for Exp (B) LL	UL
DHS 2011					
X1 (0): Residence, rural (reference)					
X1 (1): Residence, urban	1.676	.000	5.342	4.088	6.982
X2 (0): No education (reference)		.000			
X2 (1): Primary education	.866	.000	2.378	1.944	2.908
X2 (2): Secondary education	2.275	.000	9.732	6.585	14.384
X2 (3): Higher education	2.218	.000	9.193	5.696	14.835
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.345	.130	1.413	.904	2.208
X3 (2): Income, Middle	.289	.208	1.335	.852	2.091
X3 (3): Income, Richer	.775	.000	2.171	1.444	3.265
X3 (4): Income, Richest	1.750	.000	5.756	3.729	8.884
X8 (0): Decision making on health care, women not involved (reference)		.000			
X8 (1): Decision making on health care, women involved	.447	.001	1.563	1.198	2.039
Constant	-3.485	.000	.031		
DHS 2005					
X1 (0): Residence, rural (reference)					
X1 (1): Residence, rural	1.439	.000	4.215	3.123	5.687
X2 (0): No education (reference)		.000			
X2 (1): Primary education	.732	.000	2.078	1.585	2.726
X2 (2): Secondary education	1.863	.000	6.446	4.591	9.050
X2 (3): Higher education	2.600	.000	13.470	5.378	33.735
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.548	.124	1.729	.861	3.472
X3 (2): Income, Middle	.637	.065	1.891	.961	3.721
X3 (3): Income, Richer	1.582	.000	4.865	2.636	8.977
X3 (4): Income, Richest	2.363	.000	10.622	5.724	19.708
Constant	-5.192	.000	.006		
DHS 2000					
X1 (0): Residence, rural (reference)					
X1 (1): Residence, urban	1.352	.000	3.867	2.733	5.471
X2 (0): No education (reference)		.000			
X2 (1): Primary education	.852	.000	2.345	1.739	3.163
X2 (2): Secondary education	1.625	.000	5.079	3.646	7.076
X2 (3): Higher education	2.609	.000	13.589	4.955	37.267
X3 (0): Income, poorest (reference)		.000			
X3 (1): Income, poorer	.309	.401	1.362	.662	2.799
X3 (2): Income, Middle	.571	.100	1.770	.896	3.497
X3 (3): Income, Richer	.907	.006	2.477	1.304	4.703
X3 (4): Income, Richest	1.954	.000	7.059	3.720	13.397
X5 (2): Out-of-pocket payment for services, a big problem (reference)					
X5 (1): Out-of-pocket payment for services, not a big problem	.774	.004	2.169	1.285	3.659
X6 (0): Decision making, contraception, women not involved (reference)		.000			
X6 (1): Decision making, contraception, women involved	1.562	.002	4.768	1.760	12.918
Constant	-6.380	.000	.002		

Notes.
LL=Lower limit. UL = Upper limit. CI = Confidence Interval
For all three DHS survey data regression analysis, forward stepwise (Wald) method was used
DHS 2011 model summary: Step 5, Nagelkerke R Square: 0.490; Hosmer & Lemeshow Test: Step 5, significance: 0.174 (>0.05)
DHS 2005 model summary: Step 4, Nagelkerke R Square: 0.432; Hosmer & Lemeshow Test: Step 4, significance: 0.905 (>0.05)
DHS 2000 model summary: Step 5, Nagelkerke R Square: 0.419; Hosmer & Lemeshow Test: Step 5, significance: 0.309 (>0.05)

Factors associated with skilled birth attendance, 2011

Logistics regression analysis of the 2011 DHS showed that place of residence (urban/rural), their level of education, household income, and involvement in decisions on health care were predictors on use of skilled birth attendance service ($p<0.05$). The regression model was a good fit based on Hosmer and Lemeshow Test (significance > 0.05). Based on the summary outcome (Nagelkerke R Square of 0.490), the model could explain about 49% of the variation on skilled birth attendance.

The model also showed that, controlling for all other factors included in the analysis, women residing in urban areas were 5.3 times more likely to use skilled birth attendance services than women in rural areas; women with higher education were 9.2 times more likely to use the service than women with no education; women in the richest income category were 5.8 times more likely to use the service than women in the poorest income category; and women who could decide or were involved in decision making on health care were 1.6 times more likely to use the service than those who were not involved in such decisions ($p<0.05$).

Factors associated with skilled birth attendance, 2005

Logistics regression analysis of the 2005 DHS showed that factors associated with use of skilled attendance services included place of residence, level of education and household income ($p<0.05$). The regression model, based on Hosmer and Lemeshow Test (significance > 0.05), was a good fit. Based on the summary outcomes (Nagelkerke R Square of 0.432), the model could explain 43% of the variations on skilled birth attendance. Controlling for all other factors included in the analysis, women residing in urban areas were 4.2 times more likely to use the service than women in rural areas; women with higher education were 13.5 times more likely

to use the service than women with no education; and women in the richest income category were 10.6 times more likely to use the service than women in the poorest income category ($p<0.05$).

Factors associated with skilled birth attendance, 2000

Logistics regression analysis of the 2000 DHS showed place of residence, level of education, household income, out-of-pocket payment for services and involvement in decision making on contraception were factors associated with use of skilled birth attendance services ($p<0.05$). The regression model fitted was a good fit, based on Hosmer and Lemeshow Test (significance > 0.05). Based on the summary outcomes (Nagelkerke R Square of 0.419), the model could explain about 42% of the variations on the dependent variable (skilled birth attendance). Controlling for all other factors included in the analysis, women residing in urban areas were 3.9 times more likely to use the service than women in rural areas; women with higher education were 13.6 times more likely to use the service than women with no education; women in the richest income category were 7.1 times more likely to use the service than women in the poorest income category, women involved in decisions on contraception were 4.8 times more likely to use the services than those who were not involved, and women with no big problem for payment of health services were 2.2 times more likely to use the service than women without such a problem for payment of services ($p<0.05$).

In summary, at the national level, in all three data points (2000, 2005, and 2011), residence, level of education, and household income were identified as key factors explaining use of skilled birth attendance services ($p<0.05$). The region specific analysis revealed that in five regions (Tigray, Amhara, Oromiya, SNNP and Addis Ababa), women's education was identified in at least two of the three DHS

surveys as an important explanatory factor on skilled birth attendance ($p<0.05$). In six regions (Tigray, Amhara, Oromiya, Benishangul-Gumuz, Harari and Dire Dawa), women's residence (urban/rural) was identified in at least two of the three DHS surveys as an important explanatory factor ($p<0.05$). In Oromiya region, which accounted about 37% of the Ethiopian population (Population Census Commission, 2008), women's residence, education and household income were identified in all three surveys as explanatory factors on use of skilled birth attendance services ($p<0.05$).

Table 12

Region Specific Factors Associated with Use of Skilled Birth Attendance Services - Outcomes from Logistics Regression Analysis

National Or Region	DHS	Residence (urban/rural) (X1)	Women's level of education (X2)	Income (X3)	Distance to a health facility (X4)	Out-of-pocket payment for services (X5)	Women's decision making power, contraception (X6)	Women's decision making power, spending (X7)	Women's decision making power, health care (X8)	Terminated pregnancy (X9)
National	2000	$P<0.05$	$P<0.05$	$P<0.05$		$P<0.05$	$P<0.05$			
	2005	$P<0.05$	$P<0.05$	$P<0.05$						
	2011	$P<0.05$	$P<0.05$	$P<0.05$					$P<0.05$	
Tigray	2000	$P<0.05$	$P<0.05$							$P<0.05$
	2005		$P<0.05$	$P<0.05$				$P<0.05$		
	2011	$P<0.05$	$P<0.05$		$P<0.05$					
Affar	2000		$P<0.05$							
	2005		$P<0.05$							
	2011	$P<0.05$								
Amhara	2000	$P<0.05$	$P<0.05$					$P<0.05$		
	2005	$P<0.05$	$P<0.05$		$P<0.05$				$P<0.05$	
	2011		$P<0.05$	$P<0.05$						
Oromiya	2000	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$				
	2005	$P<0.05$	$P<0.05$	$P<0.05$						
	2011	$P<0.05$	$P<0.05$	$P<0.05$						
Somali	2000		$P<0.05$							
	2005			$P<0.05$						$P<0.05$
	2011	$P<0.05$					$P<0.05$			
Ben-Gumuz	2000	$P<0.05$								
	2005	$P<0.05$								
	2011	$P<0.05$								
SNNP	2000		$P<0.05$	$P<0.05$						
	2005		$P<0.05$	$P<0.05$						
	2011	$P<0.05$	$P<0.05$	$P<0.05$		$P<0.05$	$P<0.05$		$P<0.05$	
Gambela	2000									
	2005									
	2011	$P<0.05$								
Harari	2000	$P<0.05$								
	2005	$P<0.05$								
	2011	$P<0.05$								
Addis Ababa	2000		$P<0.05$							
	2005		$P<0.05$							
	2011		$P<0.05$			$P<0.05$				
Dire Dawa	2000									
	2005	$P<0.05$								
	2011	$P<0.05$								

Note. P<0.05 shows that variable is significantly associated with skilled birth attendance

Maternal Health Risks and Use of Maternal Health Services

The third Research Question (RQ3) referred to "are inequities in maternal health service use associated with differences in maternal health risks such as miscarriage, abortion and stillbirth?" The corresponding hypothesis tested was the following:

- Ho3: Inequities in maternal health service use are not associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

- Ha3: Inequities in maternal health service use are associated with differences in maternal health risks such as miscarriage, abortion and stillbirth.

For the years for which DHS data were collected (2000, 2005, and 2011), the hypothesis referred to whether inequity in use of maternal health services (antenatal care and attended delivery) showed similar trend as maternal health risks (miscarriage, abortion and stillbirth). Using chi-square test and odds ratio measures, results of the first research question (RQ1) attempted to answer to inequity levels and trends in the use of maternal health services at the three data points and compared women in four categories: by residence, level of education, household income category, and administrative region. Answering to RQ3 also used odds ration chi-square test and compared inequity results on maternal health risks with inequity results in use of ANC and skilled birth attendance services.

From the data recode manuals for DHS 2000, 2005, and 2011, maternal health risks (miscarriage, abortion and stillbirth) were measured through one variable ("pregnancy terminated") and the measurement referred to whether the respondent ever had a pregnancy that terminated in a miscarriage, abortion, or still birth. Therefore, differences on maternal health risk by the four women groups was

analyzed using this "pregnancy terminated" variable; and the results were compared with inequity measures on use of maternal health services. The analysis compared if there were patterns between inequity in use of maternal health services and inequity in maternal health risks. Pearson correlation was also used to determine if there was a pattern or association between inequity levels on maternal health risks and use of maternal health services.

Similar to the approach for answering to RQ1, SPSS was first used to produce the counts and expected values on maternal health risk (i.e., 'terminated pregnancy') for each women category for which odds ratio chi-square test was needed. Then an online tool called Vassar Stats available at http://vassarstats.net/odds2x2.html was used to calculate odds ratios and do the chi-square test for each group. Outcomes of the analysis are presented in tables 13-14 and figures 9-12.

Maternal health risk by residence, level of education and income

Table 13 presents analysis results of the three DHS survey data on odds ratio of experiencing maternal health risk (i.e., terminated pregnancy) by residence, level of education and household income category.

Table 13

Odds Ratio of Maternal Health Risk by Residence, Level of Education and Income

		OR	95% CI LL	95% CI UL	P-value	OR	95% CI LL	95% CI UL	P-value
Residence (Urban/Rural)									
			Reference: Urban				*Reference: National*		
2011	Urban	1.00	--	--	--	0.66	0.53	0.82	0.00
	Rural	1.67	1.34	2.08	<.0001	1.11	0.98	1.25	0.10
	National	1.51	1.22	1.87	0.00	1.00	--	--	--
2005	Urban	1.00	--	--	--	0.59	0.44	0.79	0.00
	Rural	1.86	1.38	2.50	<.0001	1.09	0.95	1.25	0.22
	National	1.70	1.26	2.29	0.00	1.00	--	--	--
2000	Urban	1.00	--	--	--	0.55	0.46	0.66	<.0001
	Rural	2.00	1.66	2.41	<.0001	1.10	1.02	1.20	0.02
	National	1.81	1.51	2.18	<.0001	1.00	--	--	--
Women's Level of Education									
			Reference: Higher Education				*Reference: National*		
2011	No education	2.87	1.64	5.01	0.00	1.36	1.20	1.55	<.0001
	Primary	1.43	0.81	2.53	0.27	0.68	0.57	0.81	<.0001
	Secondary	1.05	0.52	2.12	1.00	0.50	0.32	0.78	0.00
	Higher	1.00	--	--	--	0.47	0.27	0.83	0.01
	National	2.11	1.21	3.67	0.01	1.00	--	--	--
2005	No education	4.10	1.02	16.59	0.05	1.25	1.09	1.44	0.00
	Primary	1.66	0.40	6.85	>0.05	0.51	0.38	0.67	<.0001
	Secondary	1.92	0.45	8.10	>0.05	0.59	0.40	0.86	0.01
	Higher	1.00	--	--	--	0.31	0.08	1.23	0.12
	National	3.27	0.81	13.23	0.12	1.00	--	--	--
2000	No education	2.19	0.80	5.99	0.17	1.18	1.09	1.29	<.0001
	Primary	0.98	0.35	2.71	>0.05	0.53	0.43	0.64	<.0001
	Secondary	0.69	0.24	1.97	>0.05	0.37	0.27	0.51	<.0001
	Higher	1.00	--	--	--	0.54	0.20	1.48	0.31
	National	1.85	0.68	5.06	0.31	1.00	--	--	--
Household Income Category									
			Reference: Richest				*Reference: National*		
2011	Poorest	1.64	1.28	2.11	0.00	1.22	1.01	1.48	0.04
	Poorer	1.35	1.04	1.75	0.03	1.00	0.82	1.23	1.00
	Middle	1.60	1.25	2.06	0.00	1.19	0.99	1.45	0.08
	Richer	1.27	0.98	1.66	0.08	0.95	0.77	1.16	0.65
	Richest	1.00	--	--	--	0.74	0.61	0.91	0.00
	National	1.34	1.10	1.64	0.00	1.00	--	--	--
2005	Poorest	1.27	0.92	1.75	0.18	0.87	0.68	1.13	0.32
	Poorer	1.83	1.37	2.45	<.0001	1.26	1.02	1.56	0.04
	Middle	1.65	1.23	2.22	0.00	1.14	0.92	1.42	0.27
	Richer	1.66	1.23	2.23	0.00	1.14	0.92	1.42	0.26
	Richest	1.00	--	--	--	0.69	0.54	0.87	0.00
	National	1.45	1.15	1.84	0.00	1.00	--	--	--
2000	Poorest	2.00	1.64	2.46	<.0001	1.27	1.10	1.46	0.00
	Poorer	1.80	1.47	2.20	<.0001	1.14	0.99	1.31	0.08
	Middle	1.46	1.19	1.80	0.00	0.92	0.80	1.07	0.31
	Richer	1.78	1.45	2.18	<.0001	1.12	0.97	1.30	0.12
	Richest	1.00	--	--	--	0.63	0.53	0.75	<.0001
	National	1.58	1.34	1.87	<.0001	1.00	--	--	--

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper Limit. CI = Confidence Interval

Maternal health risk by women's residence

The analysis showed that, in all three surveys, as compared women in urban areas, women living in rural were at greater maternal health risk (*p*<0.05) (Table 13). Women in rural areas were 1.7 to 2 times more likely to have experienced pregnancy

termination as compared to women in urban areas (*p*<0.0001). (Table 13). These risk

levels were consistent with inequities observed on the use of ANC and skilled birth

attendance by residence. However, the overlapping 95% confidence intervals to odds

ratio on maternal health risk for the three data points (2000, 2005, and 2011) showed

there were no statistically significant differences over the years on the magnitude of

inequity on maternal health risk (Figure 9). Similarly, there were no statistically

significant differences over the three years on magnitude of inequity associated with

residence on use of maternal health services (Figure 9).

   In terms of pattern, increases or decreases in odds ratios of not using ANC

services by rural women showed similar trend as maternal health risk. As odds ratios

of not using ANC services by rural women declined from 7.4 in 2000 to 5.6 in 2011;

odds ratio of terminated pregnancy also showed a decline from 2.0 in 2000 to 1.7 in

2011 (Figure 9). On the other hand, as odds ratios of not using skilled birth attendance

services by rural women increased from 25 in 2000 to 27 in 2011, odds ratio of

terminated pregnancy by same group (rural women) showed a declining trend from

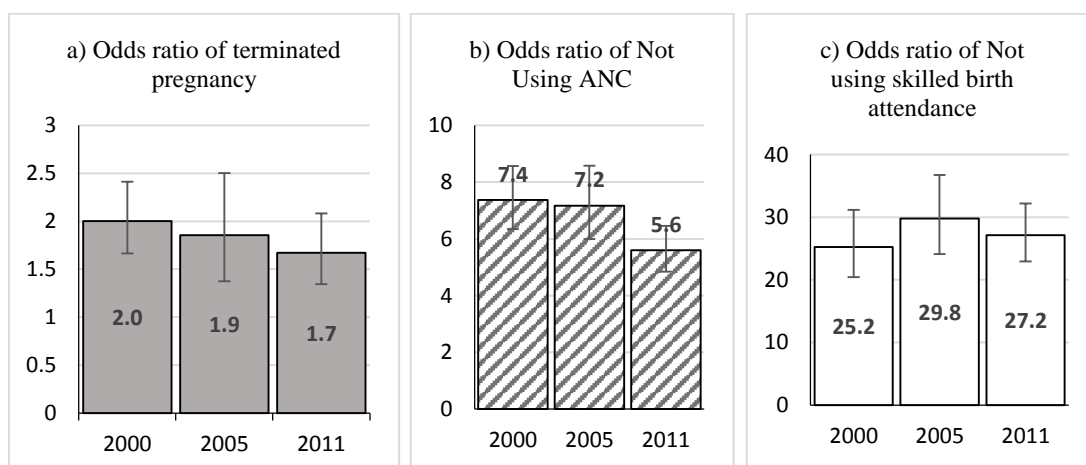2.0 in 2000 to 1.7 in 2011 (Figure 9).

Figure 9. Odds ratio of maternal health risks and use of maternal health services with 95% CIs: rural women as compared to urban women.

Maternal health risk by women's level of education

In all three surveys, as compared to women with higher education, women with no education, which account 50% to 75% of women population in Ethiopia in the three data points, were at greater maternal health risk ($p<0.05$) (Table 13). Women with no education were 2.2 to 4.1 times more likely to have experienced pregnancy termination as compared to women with higher education ($p<0.05$). These inequities in maternal health risk levels were consistent with inequities observed on the use of ANC and skilled birth attendance by level of education. Women with no education were more likely not to use maternal health services as compared to women in higher education ($p<0.05$) (Tables 4 & 6).

The 95% confidence intervals of odds ratios on inequity of maternal health risk between women with no education and those with higher education do overlap; and hence showing that there were no statistically significant differences between the three years on magnitude of inequity on maternal health risk (Figure 10). The same analysis also showed that here were no statistically significant differences over the three years on magnitude of inequity on use of maternal health services (ANC and skilled birth attendance) associated with women's education (Figure 10).

Inequity patterns on use of maternal health services and maternal risks by level of education indicated mixed results. As odds ratios of not using ANC services by women with no education increased from 14 in 2000 to 29 in 2011, odds ratio of terminated pregnancy also increased from 2.2 in 2000 to 2.9 in 2011 (Figure 10). However, as odds ratios of not using skilled birth attendance services by women with no education declined from 121 in 2000 to 64 in 2011, odds ratio of terminated pregnancy by same group increased from 2.2 in 2000 to 2.9 in 2011 (Figure 10).
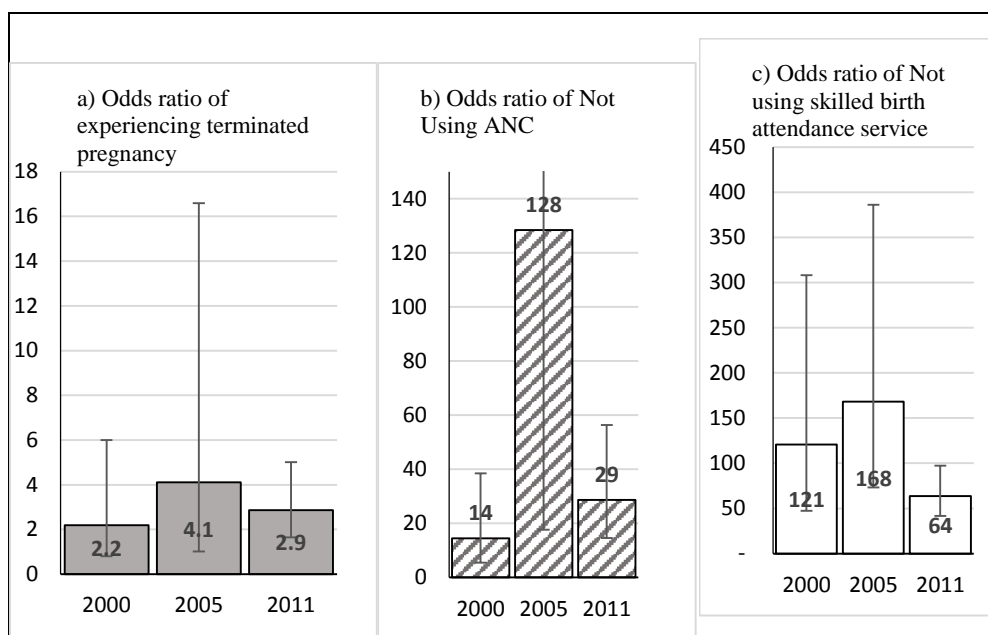
Figure 10. Odds ratio of maternal health risks and use of maternal health services with 95% CI: Women with no education compared with women with higher education.

Maternal health risk by household income category

Except in 2005, analysis of 2000 and 2011 DHS survey data showed that, as compared to women in the richest income category, women in the poorest income group were at greater maternal health risk ($p<0.05$) (Table 13). In 2000 and 2011, women in the poorest income category were, in their respect, 2.0 and 1.6 times more likely to have experienced terminated pregnancy as compared to women in the richest income category ($p<0.05$). These risk levels are consistent with inequities observed in ANC use and skilled birth attendance by income category. In 2000 and 2011, women in the poorest income category were more likely not to use maternal health services as compared to women in highest income group ($p<0.05$) (Tables 4 and 6).

While inequities by income category on maternal health risks as well as use of maternal health services were statistically significant in 2000 and 2011, the overlapping 95% confidence interval for odds ratios showed no significant variation on the magnitude of inequity from one year to the other (Table 13 and Figure 11). Similarly, while inequities on use of maternal health services associated with income

did exist, the trend analysis did not show variation on the magnitude of such inequity over the three years (Table 13 and Figure 11).

Inequity patterns on use of maternal health services and maternal risks by household income revealed mixed results. As odds ratios of not using ANC services by women in the poorest income category increased from 8.8 in 2000 to 9.7 in 2011, odds ratio of terminated pregnancy also showed a decline from 2.0 in 2000 to 1.6 in 2011 (Figure 11). On the other hand, as odds ratios of not using skilled birth attendance services by women in the poorest income category increased from 44 in 2000 to 51 in 2011, odds ratio of terminated pregnancy by same group showed a decline from 2.0 in 2000 to 1.6 in 2011 (Figure 11).
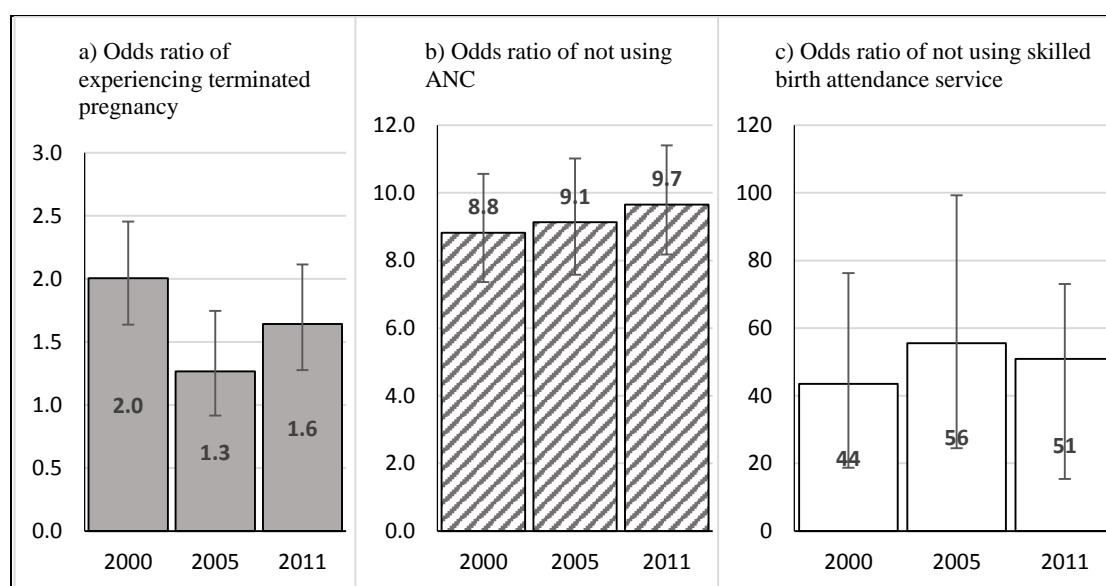

Figure 11. Odds ratio of maternal health risks and use of maternal health services with 95%CI: women in the poorest income category as compared to women in the richest income category.

Maternal health risk by administrative region

Table 14 presents analysis results of the three DHS survey data on odds ratio of experiencing maternal health risk by administrative region where women lived in at the time of the surveys.

Table 14

Odds Ratio of Maternal Health Risk by Administrative Region

DHS	Region	*Reference: Region*				*Reference: National*			
		OR	95% CI		P-value	OR	95% CI		P-value
			LL	UL			LL	UL	
		Reference Region: Amhara				*Reference: National*			
2011	Tigray	1.41	0.98	2.03	0.08	1.01	0.73	1.39	1.00
	Affar	1.32	0.53	3.27	>0.05	0.94	0.38	2.30	0.92
	Amhara	1.00	--	--	--	0.71	0.58	0.87	0.00
	Oromiya	1.61	1.29	2.01	<.0001	1.15	0.99	1.33	0.08
	Somali	3.01	1.92	4.70	<.0001	2.14	1.41	3.25	0.00
	Benishangul-Gumuz	1.31	0.57	3.01	>0.05	0.93	0.41	2.11	1.00
	SNNP	1.50	1.16	1.93	0.00	1.07	0.88	1.30	0.55
	Gambela	1.50	1.16	1.93	0.00	0.78	0.19	3.18	>0.05
	Harari	1.09	0.26	4.51	>0.05	1.11	0.27	4.58	>0.05
	Addis Ababa	1.18	0.78	1.80	0.50	0.84	0.57	1.24	0.43
	Dire Dawa	1.66	0.52	5.36	>0.05	1.18	0.37	3.78	0.05
	National	1.40	1.15	1.71	0.00	1.00	--	--	--
		Reference Region: Dire Dawa				Reference: National			
2005	Tigray	1.90	0.25	14.26	0.72	0.82	0.55	1.24	0.40
	Affar	1.43	0.15	13.97	1.00	0.62	0.20	1.94	>0.05
	Amhara	2.66	0.37	19.29	>0.05	1.15	0.94	1.40	0.19
	Oromiya	2.24	0.31	16.26	>0.05	0.97	0.81	1.16	0.78
	Somali	1.43	0.18	11.34	1.00	0.62	0.33	1.16	0.17
	Benishangul-Gumuz	1.69	0.17	16.53	1.00	0.73	0.23	2.30	0.05
	SNNP	2.62	0.36	19.02	>0.05	1.13	0.92	1.40	0.28
	Gambela	2.62	0.36	19.02	>0.05	0.68	0.09	4.97	0.05
	Harari	1.58	0.10	25.95	1.00	0.79	0.11	5.80	0.05
	Addis Ababa	1.56	0.21	11.94	1.00	0.68	0.41	1.10	0.14
	Dire Dawa	1.00	--	--	--	0.43	0.06	3.12	0.05
	National	2.31	0.32	16.70	>	1.00	--	--	--
		Reference Region: Addis Ababa				Reference: National			
2000	Tigray	2.45	1.61	3.74	<.0001	1.26	1.01	1.56	0.04
	Affar	4.07	2.36	7.02	<.0001	2.09	1.39	3.14	0.00
	Amhara	2.01	1.37	2.94	0.00	1.03	0.91	1.17	0.67
	Oromiya	1.87	1.28	2.72	0.00	0.96	0.86	1.07	0.47
	Somali	1.75	0.89	3.43	0.15	0.90	0.51	1.59	0.82
	Benishangul-Gumuz	2.76	1.50	5.10	0.00	1.42	0.87	2.33	0.21
	SNNP	1.97	1.34	2.90	0.00	1.01	0.88	1.16	0.92
	Gambela	1.15	0.26	4.98	1.00	0.59	0.14	2.45	>0.05
	Harari	1.15	0.26	4.98	1.00	0.59	0.14	2.45	>0.05
	Addis Ababa	1.00	--	--	--	0.51	0.35	0.74	0.00
	Dire Dawa	2.12	0.90	5.00	0.09	1.09	0.50	2.37	1.00
	National	1.95	1.34	2.82	0.00	1.00	--	--	--

Note. OR = Odds Ratio. LL=Lower limit. UL = Upper limit. CI = Confidence Interval

As compared with regions with relatively lower proportion of terminated pregnancies, statistically significant inequities ($<p<0.05$) were observed in six regions in 2000 (Tigray, Affar, Amhara, Oromiya, Benishangul-Gumuz and SNNP); no inequities in 2005; and inequities observed in four regions in 2011 (Oromiya, Somalia, SNNP and Gambela) (Table 14). As compared with national average, Tigray and Afar regions had higher percentage of terminated pregnancies in 2000 ($p<0.05$). In 2005, there were no statistically significant differences between regions; and in 2011, only Somalia region had significantly higher proportion of terminated pregnancy as compared to the national average ($p<0.05$) (Tables 14 and table 15). As compared to national average, for all regions except Amhara, there was no statistically significant difference on magnitude of inequity on maternal health risk between the three data points – 2000, 2005, and 2011 (Figure 12). In Amhara region, the risk of terminated pregnancy in 2011 had declined from the levels in 2000 and 2005 ($p<0.05$) (Table 14 and Figure 12).

Inequities on maternal health risk and use of maternal health services did not show consistent pattern (Table 15). Tigray region had a relatively better use of ANC services in 2000 ($p<0.05$), while terminated pregnancy in the same year and region was high as compared tonational average ($p<0.05$). On the other hand, Tigray region had relatively better use of ANC services in 2005 and 2011 as compared to national average ($p<0.05$). However, maternal health risk in 2005 and 2011 in the region did not differ statistically from national average ($p<0.05$) (Table 15).

Similarly, in Oromiya region (the region with the highest population in Ethiopia), ANC use in 2005 and 2011 was lower as compared to the national average ($p<0.05$). However, maternal health risk in 2005 and 2011 in the region did not differ from the national average ($p>0.05$) (Table 15). Addis Ababa is the region where ANC use and

skilled birth attendance was much better in all three data points as compared to the

national average ($p<0.05$). However, except in 2000, maternal health risk in Addis

Ababa did not differ significantly from the national average ($p>0.05$) (Table 15).

Pearson correlation analysis also supported that pattern on magnitude of

inequity on maternal health risk and use of maternal health services was not very

strong. In this regard, analysis of 2000 to 2011 data sets on association inequity levels

(as measured by odds ratios) between maternal health risk and use of ANC services

showed weak association (Pearson correlation: 0.14). Association between inequity

levels (as measured by odds ratios) between maternal health risk and use of skilled

birth attendance services showed moderate association (Pearson correlation: 0.57).

For each data point (2000, 2005, and 2011), Table 15 below summarized

statistical significance of inequity by residence, education, income, and, region on

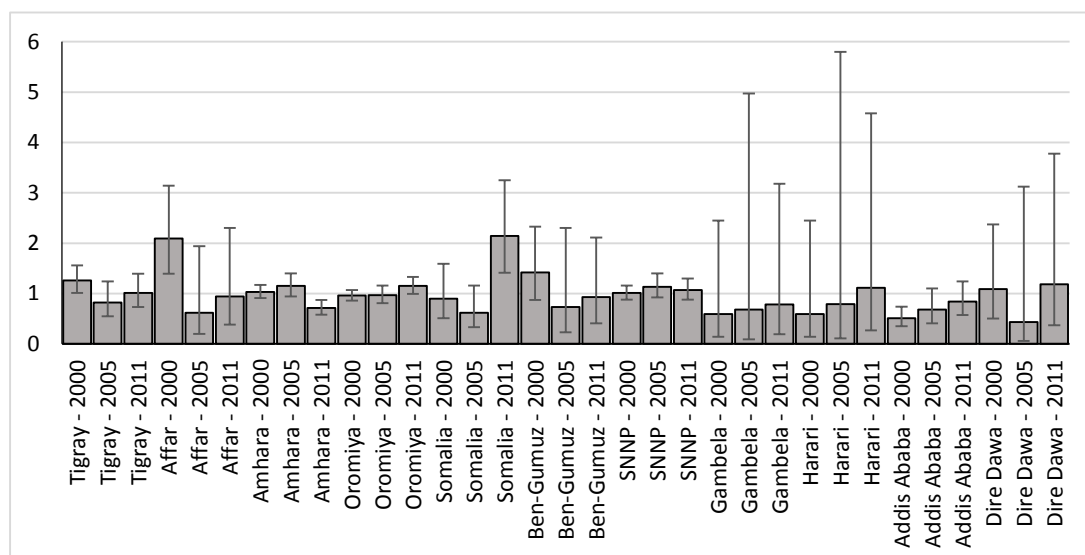maternal health risk, use of ANC services and skilled birth attendance.

Figure 12. Odds ratio of maternal health risks with 95% CI: risk level in each region as compared to national average.

Table 15

Summary of Inequity Patterns on Maternal Health Risk and Use of Maternal Health Services

| Comparison groups | Are there statistically significant associations (as measured by Odds Ratios) on use of maternal health services and maternal health risks? (Yes (↑), Yes(↓) or /No)* | | | | | | | | |
| | ANC use | | | Skilled birth attendance | | | Maternal health risk | | |
	2000	2005	2011	2000	2005	2011	2000	2005	2011
Residence (Rural compared with urban)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)
Education (No education compared with higher education)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	No	Yes(↓)	Yes(↓)
Household income (poorest compared with richest)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	Yes(↓)	No	Yes(↓)
Administrative regions (compared with National average)									
Tigray	Yes (↑)	Yes (↑)	Yes (↑)	No	No	No	Yes(↓)	No	No
Affar	No	Yes(↓)	No	No	No	No	Yes(↓)	No	No
Amhara	Yes(↓)	No	No	Yes(↓)	Yes(↓)	No	No	No	Yes (↑)
Oromiya	No	Yes(↓)	Yes(↓)	Yes(↓)	No	Yes(↓)	No	No	No
Somali	Yes(↓)	Yes(↓)	Yes(↓)	No	No	No	No	No	Yes(↓)
Benishangul-Gumuz	No	No	No	No	No	No	No	No	No
SNNP	No	Yes (↑)	No	No	Yes(↓)	Yes(↓)	No	No	No
Gambela	Yes (↑)	No	No	Yes (↑)	No	Yes (↑)	No	No	No
Harari	No	Yes (↑)	No	Yes (↑)	Yes (↑)	Yes (↑)	No	No	No
Addis Ababa	Yes (↑)	Yes (↑)	Yes (↑)	Yes (↑)	Yes (↑)	Yes (↑)	Yes (↑)	No	No
Dire Dawa	Yes (↑)	Yes (↑)	No	Yes (↑)	Yes (↑)	Yes (↑)	No	No	No

Note.

Yes (↑)   Refers there is statistically significant association, and the comparison group is better off (i.e, has better use of maternal health services or lower maternal health risk) as compared to the reference group

Yes(↓)   Refers there is statistically significant association, and the comparison group is worse off (i.e., has lower use of maternal health services or higher maternal health risk) as compared to the reference group

No   Refers there is No statistically significant difference between the comparison and reference groups (on use of maternal health services or maternal health risk)

Summary and Transition

Chapter 4 presented the findings to the three research questions:

1. Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education or wealth status?

2. Are socio-demographic characteristics (including income, educational level of women, residence - urban/rural, distance to a health facility, out-of-pocket payment for services, and women's decision making power) significantly associated with use of maternal health services by Ethiopian women?

3. Are inequities in maternal health service use associated with differences in maternal health risks such as miscarriage, abortion and stillbirth?

Answers to RQ1: Inequity in Use of Maternal Health Services

Analysis of the 2000, 2005, and 2011 DHS survey data supported statistically significant inequities in the use of maternal health services associated with residence, level of education, household income and administrative region. However, there were no statistically significant variations over the three years on the magnitude inequity in use of the services. Between 2000 and 2011, women in rural areas were 5.6 to 7.4 times more likely not to use ANC services as compared to women in urban areas ($p<0.0001$) (Table 4). Women with no education were 14 to 128 times more likely not to use ANC services as compared to women with higher education ($p<0.0001$) (Table 4). Women in the poorest income category were 8.8 to 9.7 times more likely not to use ANC services as compared to women in the richest income category ($p<0.0001$) (Table 4). In 2000, as compared to a rural type comparable region with relatively better ANC coverage, inequity was observed in three regions (Amhara, Oromiya and Somalia) (Table 5). In 2011, the inequity in the use of ANC services

increased to six regions (Afar, Amhara, Oromiya, Somalia, Benishangul-Gumuz and SNNP) (Figure 4).

Analysis of inequity on skilled birth attendance also showed similar conclusion that inequities existed in Ethiopia. As compared to inequity levels in ANC use, the magnitude of inequity on skilled birth attendance was quite alarming. In this regard, between 2000 and 2011, women in rural areas were 25 to 30 times more likely not to use skilled birth attendance services as compared to women in urban areas ($p<0.0001$) (Table 6). Women with no education were 64 to 168 times more likely not to use skilled birth attendance services as compared to women with higher education ($p<0.0001$) (Table 6). Women in the poorest income category were 44 to 56 times more likely not to use skilled birth attendance services as compared to women in the richest income category ($p<0.0001$) (Table 6). In 2000, as compared to a rural type region with a relatively higher service uses, inequity in use of skilled birth attendance services was observed in five regions (Tigray, Afar, Amhara, Oromiya and SNNP). In 2011, the inequity expanded to seven regions (Tigray, Afar, Amhara, Oromiya, Somalia, Benishangul-Gumuz and SNNP) (Table 7).

Answers to RQ2: Factors Associated with Use of Maternal Health Services

The logistics regression analysis showed that, in at least one of the three DHS surveys, factors associated with use of maternal health services (ANC services and skilled birth attendance) included residence, level of education, household income, distance to a health facility, out-of-pocket payment for health services, involvement in decision making (on contraception, health care and spending), and past experience of terminated pregnancy. In at least two of the three DHS surveys, residence, level of education, household income, distance to a health facility, and, involvement in decision making on spending were identified as statistically significant factors

(*p*<0.05) in ANC use. In all three data points (2000, 2005, and 2011), residence, level of education, and, household income were identified as key factors explaining use of skilled birth attendance services (*p*<0.05).

Factors associated with use of maternal health services were also analyzed for each region. In the three regions (Amhara, Oromiya and SNNP), which account about 80% of the total population in Ethiopia (Ethiopia Population Census Commission, 2008), women's education and household income were identified as explanatory variables on ANC use in all three DHS surveys (*p*<0.05). The region specific analysis also reveal that, in six regions (Tigray, Amhara, Oromiya, SNNP and Addis Ababa), level of education was identified in at least two of the three DHS surveys as an important explanatory factor for skilled birth attendance (*p*<0.05). Similarly, in six regions (Tigray, Amhara, Oromiya, Benishangul-Gumuz, Harari and Dire Dawa), residence was identified in at least two of the three DHS surveys as an important explanatory factor (*p*<0.05) for skilled birth attendance.

Answers to RQ3: Maternal Health Risks and Use of Services

Analysis using chi-square test and Pearson correlation showed inequities on maternal health risk associated with residence, education, household income, and administrative region. However, the magnitude of inequity by residence, education and income in all three areas (risk of maternal health, skilled birth attendance and use of ANC services) did not show statistically significant differences over the three data points – 2000, 2005, and 2011 (*p*<0.05) (Table 13 and Figure 9). In the three data points, women in rural areas were at greater risk of maternal health, and limited use of skilled birth attendance and ANC services as compared to women in urban areas (*p*<0.05) (Table 13 and Figure 9). Except in 2000, women with no education were at greater risk of maternal health and limited use of maternal health services as

compared to women with higher education (*p*<0.05). With the exception of 2005,

women in the poorest income category were at greater risk of maternal health and

limited use of maternal health services as compared to women in urban areas (*p*<0.05

(Table 13 and Figure 9).

Association of inequities on maternal health risk with inequities on maternal

health services revealed mixed results. In this regard, increases or decreases in odds

ratios of not using ANC services by rural women and women with no education

showed similar trend as maternal health risk. However, inequity on ANC use by

household income did not show similar pattern as inequity in maternal health risk.

Similarly, inequity trends on skilled birth attendance by residence, education and

income did not show similar patterns as inequities on maternal health risk (Figure 9).

As compared with regions with relatively lower proportion of terminated

pregnancy, statistically significant inequities were observed in six regions in 2000; no

inequities in 2005; and inequities observed in four regions in 2011 (Table 14).

Inequities by administrative region on maternal health risk and use of maternal health

services did not show consistent pattern (Table 15). Pearson correlation analysis also

showed that association between inequity levels on maternal health risk and use of

maternal health services was not very strong.

Chapter 5 discussed the results from the DHS analysis, synthesizing the

finding and comparing them with findings in other studies/literature.

Chapter 5: Discussion, Recommendations, and Conclusion

The purpose of the study was to identify factors associated with use of maternal health services and maternal health risks, to analyze inequity patterns between use of maternal health services and maternal health risks; and to measure the magnitude and trends in inequity. The study aimed to answer three research questions:

1. Are there trends of inequity in maternal health service use among Ethiopian women by region, geography, education or wealth status?

2. Are socio-demographic characteristics (including income, educational level of women, residence - urban/rural, distance to a health facility, out-of-pocket payment for services, and women's decision making power) significantly associated with use of maternal health services by Ethiopian women?

3. Are inequities in maternal health service use associated with differences in maternal health risks such as miscarriage, abortion and stillbirth?

Inequity in Use of Maternal Health Services

On the first research question, analysis of the three DHS survey data showed statistically significant inequities in the use of maternal health services (ANC use as well as skilled birth attendance) associated with women's residence (urban/rural), level of education, household income, and administrative region. Between 2000 and 2011, women in rural areas were 5.6 to 7.4 times more likely not to use ANC services as compared to women in urban areas ($p < 0.0001$) (Table 4). During the same period, women with no education were 14 to 128 times more likely not to use ANC services as compared to women with higher education ($p < 0.0001$) (Table 4). Women in the poorest income category were 8.8 to 9.7 times more likely not to use ANC services as compared to women in the richest income category ($p < 0.0001$) (Table 4).

The magnitude of inequity on skilled birth attendance was wider than on ANC use. Women in rural areas were 25-30 times more likely not to use skilled birth attendance services as compared to women in urban areas ($p < 0.0001$) (Table 6). Women with no education were 64-168 times more likely not to use skilled birth attendance services as compared to women with higher education ($p < 0.0001$) (Table 6). Women in the poorest income category were 44-56 times more likely not to use skilled birth attendance services as compared to women in the richest income category ($p < 0.0001$) (Table 6).

Comparison of the magnitude of inequities between the three data points (2000, 2005, and 2011) using the 95% confidence intervals of odds ratios on maternal health service utilization revealed that there was no statistically significant variation in the magnitude of inequity on ANC utilization as well as skilled birth attendance associated with residence, educational level, and household income.

Inequity analysis by administrative region showed, as compared to regions where ANC service use was relatively better, the magnitude of inequity in using the ANC service ranged from 2.6 to 5.1 in 2000 and from 2.7 to 5.4 in 2011 ($p < 0.05$) (Table 5). Inequity analysis on skilled birth attendance showed, as compared to regions where service use is relatively better, the magnitude of inequities ranged from 4.1 to 8.3 in 2000 and from 2.7 to 4.9 in 2011 ($p < 0.05$) (Table 7).

Inequity analysis of ANC use by administrative region showed that, as compared to a comparable rural region with relatively better use of ANC, three regions (Tigray, Amhara, Oromiya) had inequity issues in 2000; this expanded to six regions (Afar, Amhara, Oromiya, Somalia, Benishangul-Gumuz, and SNNP) in 2011 (Table 5 and Figure 4). However, as compared to the national average on ANC use, the number of regions with inequity issues were only two (Amhara and Somalia) in

2000 and two (Oromiya and Somalia) in 2011. As compared to the national average, the magnitude of inequity in using ANC services significantly declined ($p < 0.05$) in four regions (Tigray, Amhara, Somalia, and SNNP) in 2011 as compared to the levels in 2000 or 2005 (Table 5 and Figure 4).

Inequity analysis of skilled birth attendance by administrative region showed that, as compared to a comparable rural region with relatively better use of the service, the inequity issue expanded from five regions in 2000 (Tigray, Afar, Amhara, Oromiya, and SNNP) to seven regions (Tigray, Afar, Amhara, Oromiya, SNNP, Somalia, and Benishangul-Gumuz) in 2011 (Table 7). However, as compared to the national average, inequity issues were observed in two regions in 2000 (Amhara and Oromiya) and two in 2011 (Oromiya and SNNP) (Table 7). Oromiya, the region with the largest population in the country (Ethiopia Population Census Commission, 2008), remained inequitable in both 2000 and 2011. In terms of magnitude of inequity on skilled birth attendance, the magnitude of inequity as compared to the national average did not show significant differences during 2000, 2005, and 2011 except in one region (Amhara) (Figure 8). In Amhara region, the magnitude of inequity on skilled birth attendance (as compared to the national averages) declined by 36% in 2011 from the 2000 level ($p < 0.05$) (Figure 8).

Factors Associated With Use of Maternal Health Services

On the second research question, logistic regression analysis indicated factors significantly associated with use of maternal health services (ANC and skilled birth attendance). The factors identified in at least one of the three DHS surveys as having significant association with use of maternal health services included women's residence (urban/rural); educational level; household income; distance to a health facility; out-of-pocket payment for health services; involvement in decision making

on contraception, health care, or spending; and past experience of terminated pregnancy (Tables 9-12).

In all three surveys (2000, 2005, and 2011), women's level of education and household income were identified as key factors explaining use of ANC ($p < 0.05$) (Tables 9-18). On the other hand, in all three surveys residence (urban/rural), level of education, and household income were identified as key factors explaining use of skilled birth attendance services ($p < 0.05$) (Tables 11-12). Through a similar analysis, region-specific factors were also identified. For example, in the regions of Amhara, Oromiya and SNNP, which account for 80% of the total population in Ethiopia (Ethiopia Population Census Commission, 2008), women's education and household income were identified as explanatory variables on ANC use in all three DHS surveys ($p < 0.05$).

Maternal Health Risks and Patterns With Use of Maternal Health Services

On maternal health risks measured through women's experience of having terminated pregnancy in the past, statistically significant inequities were observed that were associated with residence, education level, and household income ($p < 0.05$) (Table 13). However, the 2000 and 2005 data sets did not support existence of inequities between maternal health risk and women's educational level and household income. In all other data points, statistically significant inequities were observed on maternal health risk and use of services (ANC and skilled birth attendance) that were associated with residence, education, and income (Tables 4, 6, and 13).

However, there were no statistically significant differences during 2000, 2005, and 2011 on the magnitude of inequity on maternal health risks that were associated with residence, education level, and household income category ($p > 0.05$) (Table13). These results were similar to results on inequity trends on use of maternal health

services, i.e., no statistically significant difference during 2000, 2005, and 2011 on the magnitude of inequity in use of ANC services and skilled birth attendance that were associated with residence, education level, and household income category ($p>0.05$) (Tables 4 and 6).

Regarding patterns of use of maternal health services and maternal health risk, there were mixed results. As inequity by residence on use of ANC declined from 7.4 in 2000 to 5.6 in 2011, maternal health risk also declined from 2.0 in 2011 to 1.7 in 2011 (Figure 9). Similarly, as inequity in use of ANC by women's education increased from 14 in 2000 to 29 in 2011, maternal health risk also increased from 2.2 in 2000 to 2.9 in 2011 (Figure 10). However, there were no patterns on inequity on ANC use and maternal health risk that were associated with household income (Figure 10). Similarly, trends of inequity on skilled birth attendance associated with women's residence, education, and household income did not follow the same pattern as inequity trends on maternal health risk (Figures 9, 10, & 11). For example, as odds ratio of not using skilled birth attendance by rural women increased from 25 in 2000 to 27 in 2011, odds of experiencing a terminated pregnancy in the same group (rural women) decreased from 2.0 in 2000 to 1.7 in 2011 (Figure 9).

As compared with regions with a relatively lower terminated pregnancies, regions with statistically significant inequities on maternal health risk decreased from six regions in 2000 (Tigray, Affar, Amhara, Oromiya, Benishangul-Gumuz, and SNNP) to four regions in 2011 (Oromiya, Somalia, SNNP, and Gambela). As compared with the national average, two regions in (Tigray and Afar) in 2000 and only one region (Somalia) in 2011 had inequity issues on maternal health risks ($p < 0.05$) (Tables 14 and 15).

Regarding inequity patterns by region, trends on magnitude of inequity in use of maternal health services by administrative region did not show similar patterns as inequity trends on maternal health risk (Table 15). For example, as compared to the national averages, the regions with significant inequity issues in 2000 were Tigray and Afar, while on ANC use the regions with inequity issues were Amhara and Somalia. The regions with inequity issues on skilled birth attendance during the same year (2000) were Amhara and Oromiya. Similarly, in 2011 and as compared to the national averages, Somalia was the only region with maternal health risk inequity while Oromiya and Somalia on ANC and Oromiya and SNNP on skilled birth attendance were identified as regions with inequity concerns in 2011 (Tables 5, 7, and 14). This lack of pattern on magnitude of inequity on maternal health risk and service utilization was also supported by a measure of association. Measure of association (using Pearson correlation) on inequity levels (as measured by odds ratios) between maternal health risk and use of ANC services showed weak association (Pearson correlation: 0.14); measure of association between maternal health risk and use of skilled birth attendance inequities showed no strong association (Pearson correlation: 0.57).

In summary, the analysis on maternal health risks revealed statistically significant associations linked to women's residence, education, and household income. Similar to these findings, statistically significant inequities on use of maternal health services (ANC use and skilled birth attendance) associated with residence, education, household income, and administrative regions were observed. In addition, some regions showed significantly higher levels of maternal health risk than others or as compared to the national average. However, the analysis of inequities on maternal health risks with inequity trends on maternal health services revealed no conclusive

pattern showing whether an increase or decrease in the magnitude of inequity in the use of maternal health services (ANC or skilled birth attendance) leads to a similar pattern on maternal health risks).

Interpretation of the Findings

The significant inequity levels on use of maternal health services and maternal health risk, revealed through analysis of the three DHS surveys in Ethiopia, confirmed the global concern on health inequity issues within and between countries and the need to close such gaps in order to improve overall health and development (Bishaw, 2012; Thomas et al., 2014; WHO, 2013). The analysis of factors associated with use of maternal health services also conformed with Graham's (2014) argument that to address socioeconomic inequalities in health, it is vital to identify and plan for addressing the underlying factors leading to such inequalities. The findings answering each of the three research questions are interpreted below.

Use of Maternal Health Services and Inequities by Residence, Education, and Income

The analysis shows that use of maternal health services has increased between 2000 and 2011; specifically, ANC use (at least one visit) has increased from 27% in 2000 to 43% in 2011 (Table 2); deliveries attended by skilled health personnel have increased from 6% in 2000 to 12% in 2011 (Table 3). These increases in services coverage could be related to the expansion of health service coverage in the country. However, the service use (ANC and skilled birth attendance) did not increase at the same rate as the service expansion. In this regard, Haile Mariam (2011) documented similar concerns that while health service coverage in Ethiopia has increased from 49% in 2001 to 90% in 2009, utilization of health services in general has remained very low at 0.3%.

The WHO Global Health Observatory shows that, for low-income countries, ANC use (at least one visit) and skilled birth attendance average 75% and 51%, respectively (WHO, 2015a). Analysis of DHS survey data shows that the service use in Ethiopia (43% for ANC and 12% on skilled birth attendance in 2011) is very low even when compared with other low-income countries. Average use of skilled birth attendance in sub-Saharan Africa (40%) (Adjiwanou & LeGrand, 2014) is nearly four times higher than that of Ethiopia (12%) as measured from the 2011 DHS survey data. These comparisons seem to potentially explain the high rate of maternal mortality in Ethiopia, which is very high even as compared to peer countries. In this regard, Thomas et al. (2014) and WHO (2014a) documented that MMR in Ethiopia is twice the average in other developing countries.

The magnitude and not declining inequity trend on use of maternal health services (both on ANC and skilled birth attendance) by residence, education, income, and administrative region appears to support the evidence by Barros et al. (2012) that Ethiopia is the most inequitable country associated with income on skilled birth attendance among 54 developing countries included for analysis. The Ethiopian population characteristics, specifically by residence and level of education, combined with the magnitude of inequity by these characteristics are potential factors for the very low level of maternal health service use (both on ANC and skilled birth attendance).

According to all three DHS surveys, a large majority (between 68% and 77%) of Ethiopian women are residing in rural areas (Tables 2 and 3). Based on the inequity analysis, women residing in rural areas are 5.6 to 7.4 times more likely not to use ANC services as compared to women in urban areas (Table 4). Similarly, women residing in rural areas are 25-30 times more likely not to use skilled birth attendance

services as compared to women with higher education (Table 6). Therefore, the very limited use of ANC and skilled birth attendance services by women residing in rural areas will significantly lower the overall use of the services at the national level.

Similarly, from all three DHS surveys, a large majority (75% in 2000 to 50% in 2011) of Ethiopian women do not have any education (Table 1). Based on DHS data analysis, women with no education are 14 to 128 times more likely not to use ANC services as compared to women with higher education (Table 4). Similarly, women with no education are 64 to 168 times more likely not to use skilled birth attendance services as compared to women with higher education (Table 6). Therefore, the very limited use of ANC and skilled birth attendance services by women with no education combined with the large percentage (50% to 75%) of the no-education group is a significant factor leading to overall very low use of maternal health services. According to the 2011 DHS survey data, ANC use (at least one visit) was measured at 43% as compared to the 75% average for low-income countries (WHO, 2015a). Similarly, analysis of the 2011 DHS data revealed that skilled birth attendance in Ethiopia is 12% as compared to the 51% average for low-income countries (WHO, 2015a).

The odds ratios show that the magnitude of inequities on use of skilled birth attendance by residence and education are much wider than the magnitude of inequities on ANC use; and hence potentially contributing to the very low level of skilled birth attendance at the national level (12%) as compared to ANC use (43%) in 2011.

Use of Maternal Health Services and Inequities by Administrative Region

According to the World Reference Bureau (2015), the Ethiopian population in mid-2014 was estimated at 95.9 million, and this is projected to reach 165 million by

2050, making the county one of the top-10 most populous countries in the World. The last population census was conducted in 2007, in which the population size was estimated at 73.4 million (Ethiopia Population Census Commission, 2008). The population distribution by administrative region in 2013 ranges from 220,000 in Harari Region to 31.9 million in Oromiya region. The three most population regions in the country are Oromiya, Amhara and SNNP, which account slightly over 80% of the Ethiopian population. Oromiya, Amhara, SNNP, and Tigray account slightly over 86% of the Ethiopian population. Inequities observed in the most populous regions will have greater impact on the national level maternal health service utilization rate.

The analysis has shown that Oromiya, the most populous region accounting 37% of population in the Country, had inequity issues on use of maternal health services (ANC and skilled birth attendance) in all three data points. As compared to regions with relatively better use of ANC services, women in Oromiya region were 1.9 to 2.8 times less likely to use the services between 2000 and 20011 (Table 5). Similarly, women in Oromiya Region were 3.3 to 6.5 times less likely to be attended by skilled health personnel at the time of delivery as compared to regions with relatively better use of the service (Table 7). In 2011, women in Amhara and SNNP Regions were, in their respect, 2.8 and 2.7 times less likely to use ANC services as compared to a reference region with better service utilization (Table 5). In 2011, women in Amhara, SNNP and Tigray Regions were, in their respect, 3.4, 4.9 and 2.7 times less likely to use skilled birth attendance services as compared to a reference region (Table 7). The inequity level in the three regions on use of skilled birth attendance is also much wider than inequities on ANC use in same regions; and hence the overall skilled birth attendance use at the national level (12%) is much lower than ANC use (43%) in 2011.

The magnitude of inequities (on both ANC use and skilled birth attendance) within each region did not show statistically significant variation over the three data points (2000, 2005, and 2011) (Tables 5 & 7 and Figures 4 & 8). However, inequity has reached more regions in 2011 than in 2000 and this could contribute to the very low level of service utilization in the country (WHO, 2015a). As compared to a region with relatively better use of ANC services, inequity has reached six regions in 2011 as compared to three in 2000 (Table 5). Similarly, as compared to a reference region, inequity on skilled birth attendance has reached seven regions in 2011 as compared to five in 2000 (Table 7)

Factors Associated With Use of Maternal Health Services

Logistic regression analysis of the three DHS survey data has shown that factors significantly associated with use of maternal health services (ANC and skilled birth attendance) include: residence (urban/rural), level of education, household income, distance to a health facility, out-of-pocket payment for health services, involvement in decision making (on contraception, health care and spending), and past experience of terminated pregnancy. When controlling for other factors included in the analysis, the magnitude of inequity in use maternal health services is lower than when other variables are not controlled. For example, logistics regression has shown that ANC use by women in urban areas as compared to women in rural areas ranges from 1.6 to 2.0; while a chi-square test has shown that women residing in urban areas were 5.6 to 7.4 times more likely to use ANC services as compared to women in urban areas.

Logistics regression analysis has shown that skilled birth attendance by women in urban areas was from 3.9 to 5.3 times more than women in rural areas; and a chi-square test has indicated skilled birth attendance by women residing in urban

areas was 25 to 30 times more than for women in rural areas. Similar variations in the magnitude of inequity is observed by level of education, income and administrative region. Logistics regression analysis has revealed similar results as chi-square test showing existence of statistically significant inequities that are associated with residence, level of education, household income category and administrative region. The logistics regression has also shown inequities associated with distance to a health facility, out-of-pocket payment for health services, involvement in decision making (on contraception, health care and spending), and past experience of terminated pregnancy.

The association found between use of maternal health service (ANC and skilled birth attendance) and residence, level of education and household income is consistent with evidence documented by the World Health Organization (WHO, 2014b). Barros et al (2012) also documented strong association between skilled birth attendance and household income in Ethiopia. Aliy and Haile Mariam (2012) also found place of residence, income level, distance to a health facility are all significantly associated with use of antenatal care services; and Akalu et al (2012) discovered that out-of-pocket expenditures impact use of maternal health services by poor women. Adjiwanou and LeGrand (2014) studied women's decision-making power as an important factor for ANC use and skilled birth attendance.

The analysis has also revealed region specific factors that are associated with use of maternal health services. In most of the regions, residence (urban/rural), education, household income and women's decision making power were identified as important explanatory variables on use of maternal health services. However, some factors were not common to many regions. Out of pocket payment for medical services was identified as a factor in at least one DHS survey in Tigray, Amhara,

Oromiya, SNNP and Addis Ababa regions. Past incidence of terminated pregnancy is associated with ANC use in Oromiya Region and with skilled birth attendance in Tigray and Somalia Regions.

In the three most populous regions (Amhara, Oromiya and SNPP) that account about 80% of the Ethiopian population (Ethiopia Population Census Commission, 2008), education and household income were associated with use of ANC services and education associated with skilled birth attendance in all three data points. In Tigray region, education was associated with skilled birth attendance services. Given that the four regions (Amhara, Oromiya, SNNP and Tigray) account about 86% of the Ethiopian population (Ethiopia Population Census Commission, 2008), addressing the factors constraining use of maternal health services could help address inequity issues in the regions and improve maternal service coverage nationally.

Maternal Health Risks and Patterns With Use of Maternal Health Services

From previous studies, it has been learned that maternal health risks including miscarriage, abortion, and still birth impact on maternal mortality and morbidity. For example, 14% of maternal deaths are accounted by abortion in Sub-Saharan Africa; and one in 27 Ethiopian women die from complications of pregnancy or childbirth (Gebrehiwot & Liabsuetrakul, 2009; Gebreselassie et al., 2010). However, most of the studies reviewed attempted to explain factors associated with the maternal risks from a clinical perspective and not from a social and behavioral angle. This research gap necessitated including the third research question to this study; which aimed to analyze whether inequities in the use of maternal health service are associated with differences in maternal health risks.

Analyses of the three DHS surveys have shown that inequities on maternal health risk do exist that are associated with residence (urban/rural), education,

household income, and administrative region. In all three surveys, rural women as compared to urban women; women with no education as compared to women with higher education and women in the poorest wealth quintile as compared to those in the richest income category are at greater maternal health risk ($p < 0.05$) (Table13). Similarly, statistically significant regional variations are observed in the magnitude of maternal health risks (Table 14). In general, there are similarities on the factors that are associated with maternal health risks and use of maternal health services (ANC use and skilled birth attendance); and the factors include women's residence, level of education, household income and administrative region.

However, the magnitude and trends of inequity on maternal health risks and use of maternal health services vary and do not always show similar pattern, i.e., an increase or decrease in the magnitude of inequity in use of maternal health services may not imply an increase or decrease in inequity levels on maternal health risks. Pearson correlation co-efficient also evidenced that DHS data do not support existence of association between inequities on maternal health risk and inequities on use of maternal health services. There are no many studies found on this area and this could be a potential area for further research.

Findings in the Context of the Theoretical Framework for the Study

Behavioral-cultural and structural theories of health inequality (McCartney, Collins & Mackenzie, 2013) form the basis of this study. Out of the four theories (artefact, selection, behavioral-cultural and structural) developed by the Black Report in the 1980s to explain social inequalities in health in Britain, the Working Group of the Report accepted the soft version of the behavioral-cultural and hard and soft versions of the structural theory (Macintyre, 1997), which form the basis of this study. The soft version of the behavioral-cultural theory refers that selection of a risky

behavior to health has a social gradient and this contributes to social inequalities to health (Macintyre, 1997). On the other hand, the hard version of the structural theory refers that differences in material and physical condition fully explain social inequalities in health; while the soft version refers that differences in material and physical conditions contribute to social inequalities in health.

Analysis of the three DHS survey data showed that use of ANC or skilled birth attendance services are explained by women's residence (urban/rural), level of education, household income, distance to a health facility, out-of-pocket payment for health services, involvement in decision making (on contraception, health care and spending), and past experience of terminated pregnancy. The findings support the behavioral-cultural theory that risky practice of women not using maternal health services (ANC and skilled birth attendance) are associated with other factors/ingredients (such as place of residence and educational level); and hence the risky practice of not using the services is not a choice by women themselves. Differences in material and physical condition of women – such as residing in an urban or rural area, level of education, household income – were identified in all three DHS surveys as important factors that determine the level of use of ANC and skilled birth attendance services. These results, therefore, conform with the structural theory that explains differences in the socioeconomic circumstances of social groups (including differences in income, wealth, power, environment and access) at all stages of the life-course, cause differences in health outcomes.

Limitations of the Study

The study is based on secondary data analysis, i.e., three national level surveys conducted in 2000, 2005, and 2011. Therefore, all analysis are limited to variables and data captured in the three DHS surveys. Therefore, other factors that may have implications on use of maternal health services were not identified through this analysis. It is possible that other factors, such as Government budget allocation to regions had implications on the use of maternal health services and hence contribute to inequity. However, these type of data were not gathered through the DHS surveys and hence not included in the analysis.

On the other hand, the DHS reports documented some limitations in the sampling process in two regions – Afar and Somalia. The 2000 and 2005 DHS did not include some geographic areas (specifically nomadic areas) into the sampling frame (CSA, 2000, 2005). Similarly, in the 2011 DHS, some geographic areas in Somalia region were not included in the study for security reasons (CSA, 2011). Therefore, the generalizability of the estimates on service coverages and inequity measures in these two regions (Afar and Somalia) would need to be interpreted with caution.

Some regions (including Benishangul-Gumuz, Gambela, Harari and Dire-Dawa) each account less than 0.5% of the Ethiopian population. In this regard, the DHS sampling which takes into accounts population size of each region resulted in having relatively smaller sample size in these regions, ranging from 40 in Gambela to 160 in Benishangul-Gumuz. The small sample size in these regions limited analysis, specifically logistics regression for the regions. Similarly, chi-square tests and odds ratio computations in these regions resulted in producing wide confidence intervals. Therefore, interpretation of inequity measures and associated factors on service utilization for these regions need to consider these limitations.

Recommendations

Reaching Rural Women With Maternal Health Services

Over two-third of women in Ethiopia reside in rural areas, where odd ratios of not using ANC services are 5.6 to 7.4 times higher than in urban areas. Women residing in rural areas are 25 to 30 times more likely not to use skilled birth attendance services as compared to women in urban areas. Therefore, it is important that maternal health services are designed in such a way that women in rural areas are aware of availability of the services and know more about risks associated with not using the services. It is also necessary to understand better women's challenges for accessing and using the services. In this regards, more qualitative and region specific studies could help for more in-depth understanding of the bottlenecks for accessing and using the services.

Reaching Women With No Education

From the three national level DHS surveys, percentage of women in Ethiopia with no education ranged from 75% in 2000 to 50% in 2011. Women with no education are the least in using ANC and skilled birth attendance services. For example, in 2011, as compared to women with higher education, women with no education were 29 and 64 times less likely to use ANC and skilled attendance services, respectively. As women with no education will be unable to access information from published materials on availability of services, risk of not using the services is high. Therefore, intervention approaches that fill these gaps are necessary. Specifically, interventions using community health workers, which have been in place in the country since 2004, need to be continued. A continuous review of the community health workers service delivery system in reaching women with no education could help to understand and address the challenges in service delivery.

Reaching Women With Very Limited Economic Capacity

From analysis of the three DHS survey data, women in the poorest income category as compared to women in the richest income group were 9 to 10 times and 44 to 51 times less likely to use ANC and skilled attendance services, respectively. This is an areas that will require further research to understand what aspects of ANC and skilled birth attendance service delivery demand financial resources or payments from clients. Such research should help in developing service delivery strategies so that women with very limited financial capacity are able to access maternal health services.

Considering Locality-Specific Factors and Women's Conditions

The analysis has generated evidence on region specific factors that are associated with use of maternal health services and factors that explain maternal health risks. The magnitude of inequity and the number of times the factors have been identified as significant indicate the importance of the issues in each specific region. For example, Oromiya is the most populous region accounting 37% of the Ethiopian population. In each of the three DHS surveys, the analysis showed statistically significant inequity issues in the region both on ANC use and skilled birth attendance. In Oromiya region, residence, education level and household income were associated with use of skilled attendance services. Similarly, in two of the DHS surveys (2005 and 2011), level of education and household income were associated with use of ANC services. These evidence indicate that Oromiya region would require maternal health service programs that can address the identified barriers including level of education, household income and residence.

Need for Further Research

As described in the limitations section, the sample size in some regions including Benishangul-Gumuz, Gambela, Harari, and Dire-Dawa were not adequate enough for conducting some statistical analysis, such as region specific regression analysis. In this regard, further research with more adequate sample size in such regions would help to identify factors associated with use of maternal health services. In addition, this study is limited to variables collected through DHS; and only 20% to 49% of the variations on maternal health services can be explained by the regression models constructed (Tables 9 to 12). In this regard, further study that includes all potential variables that can further explain use of maternal health services could help in designing more comprehensive maternal health programs.

<div align="center">Implications</div>

The study has identified important findings on maternal health inequity issues; factors associated with use of maternal health services and maternal health risks; and patterns of maternal health risks against use of maternal health services. The study is unique in that it has been based on nationally representative sample, it looked at issues over three data points which span from 2000 to 2011, and analyzed issues both at national and sub-national level. Therefore, the study adds knowledge and contribute to policy design and for planning maternal health programs at national and sub-national levels.

Specifically, the study would add knowledge in terms of factors or bottlenecks that hinder women from accessing and using ANC and skilled birth attendance services. As studied, residence, level of education and income are key factors that are significantly associated with use of maternal health services. In this regards, policies and program on maternal health would need to consider approaches on how to reach

women in rural areas, women with no education and women with limited economic capacity. Improving the urban/rural setting, education and income levels are important but achievable through long-term development plans. Therefore, immediate actions and plans are needed to provide maternal health services to women who are currently residing in rural settings, have no education or have limited capacity in their income.

The analysis has revealed significant inequities in using maternal health services associated with residence, education, income and administrative region. Importantly, the level of inequity did not significantly change over the ten years-time of 2000 to 2011. More alarmingly, inequities have expanded to more administrative regions in 2011 as compared to 2000. These findings seem to explain the very low level of maternal service use in Ethiopia contributing to very high MMR in the country. In this regard, as compared to other low-income countries, ANC use (at least one visit) in Ethiopia is 43% as compared to 75% in other low-income countries; skilled birth attendance in Ethiopia is 12% as compared to 51% in other low-income countries and MMR in Ethiopia is twice higher than the average in other developing countries (WHO, 2015a, WHO (2014a, Thomas et al., 2014).

Therefore, policies and programs both at national and sub-national level that consider findings in this study and other similar evidence would potentially contribute in reaching the most disadvantaged women residing in rural areas, with no education and with low economic capacity. From the analysis, over three-quarters of women resided in rural areas and 50% did not have any education in 2011. Therefore, policies and programs aiming to reach this majority of women would significantly contribute to improve maternal health and enhance their great contributions to society that would lead to positive social change.

Conclusion

From analysis of the three DHS survey data in Ethiopia, maternal health service use inequity levels between rural and urban women, between women with no education and women with higher education, and between women in the poorest income category and those in the highest income group are unacceptably high and not showing declining trends. On the other hand, the factors associated with use of maternal health services are all "avoidable" if maternal health policies and programs are designed to reach women who are most disadvantaged in accessing and using the services. Women's education, residence and income are social contexts that may not change in a short time span. In this regards, improving access to and use of maternal health services should not wait until the long term development issues such as education, residence or income are realized. Rather, policies and programs need to be designed such that women in rural areas, with no education or with limited economic capacity can access and use the maternal health services. "Where systematic differences in health are judged to be avoidable by reasonable action they are, quite simply, unfair; and addressing health inequity, which is due primarily to social factors, is a matter of social justice and an ethical imperative" (WHO, 2013, p. 7).

Finally, it is worth mentioning the need for more studies addressing the limitations highlighted in this research. Regions with smaller population size and hence small sample size in the DHS surveys need further research with large sample size so that the findings for those regions are generalizable. In addition, studies on associations between use of maternal health services and maternal health risks are very limited in Ethiopia and need more research.

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