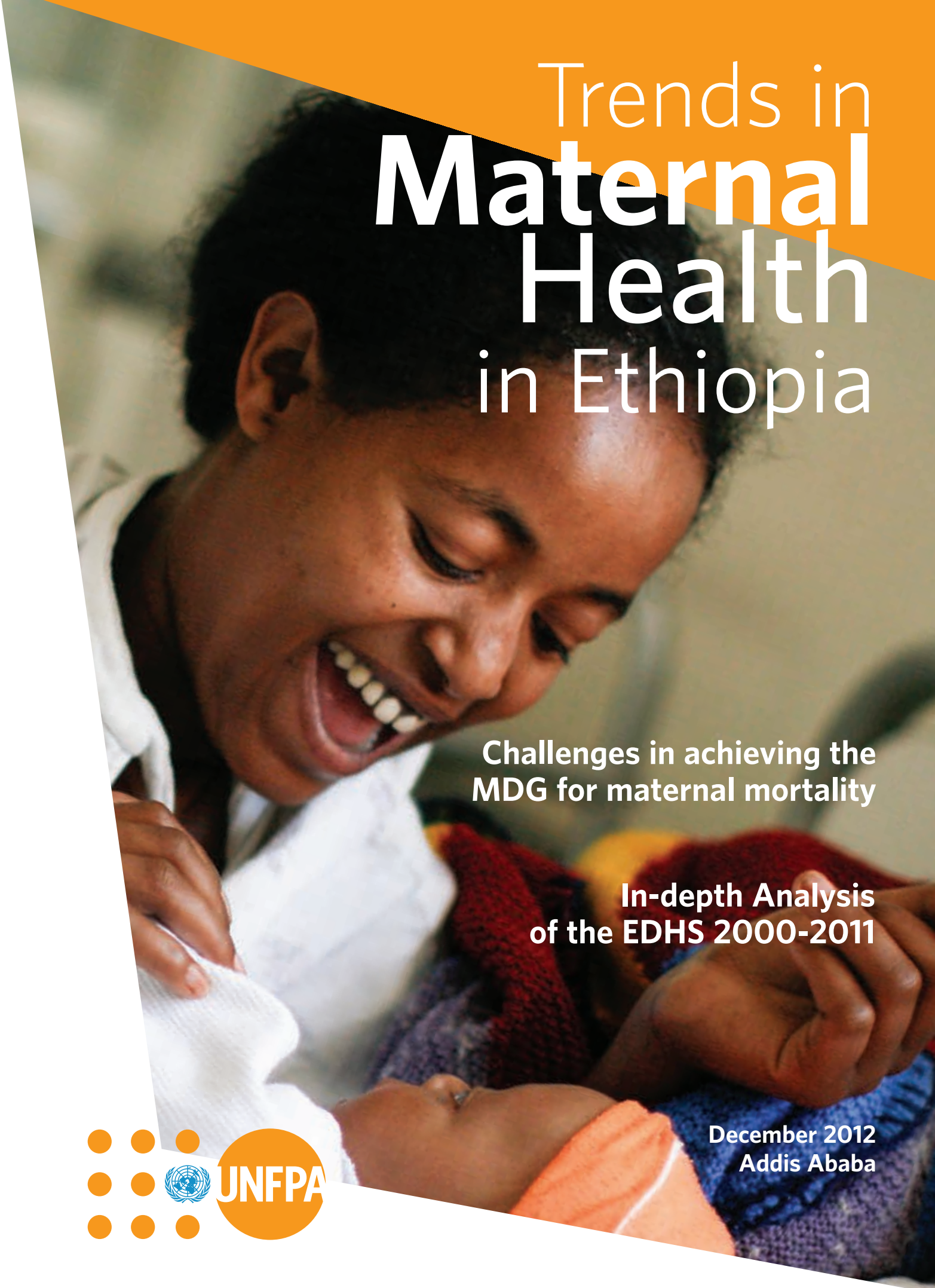
Trends in Maternal Health in Ethiopia



Challenges in achieving the MDG for maternal mortality

In-depth Analysis of the EDHS 2000-2011

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Note: The views expressed and arguments made in this document are those of the author and do not necessarily reflect the views of the UNFPA.

Table of Contents

Foreword

This report is one of the two reports commissioned by UNFPA, the United Nations Population Fund, that are based on the in-depth analysis of the three Ethiopian Demographic and Health Surveys (DHS 2000, 2005 & 2011). The wealth of data that the DHS provides is instrumental in monitoring and evaluating the performance of population and health programmes.

This analysis is aimed at providing a more in-depth look into the progresses and challenges in achieving the Millennium Development Goal of reducing maternal mortality (MDG5) in Ethiopia. Guided by a conceptual framework, the analysis predominantly focuses on several intermediate determinants that have direct or indirect influence on maternal mortality. Owing to data gap in maternal mortality, the researchers took the analysis one step further by developing a maternal mortality risk factors index based on several intermediate determinants in order to highlight regional and socio-economic variations in maternal mortality burden.

In sum, the study emphasized that a multifaceted and integrated approach is warranted in order to address the high maternal mortality in the country. It identified and highlighted several areas for intervention including prevention of fertility-related high-risk pregnancy, improving the health and nutritional status of women, improving women's access to quality maternal health care services, especially safe and clean delivery and postpartum care services. This study shows that the pervasive inequalities in maternal mortality burden by region, urban-rural residence and socio-economic status of the population further compounded the problem making efforts to improve maternal health and thereby reduce maternal mortality more challenging.

An independent research team, led by Dr. Yared Mekonnen , conducted the study. I would like to put on record my sincere appreciation for the research team and for those who provided valuable comments on an earlier version of the report. We hope that this report will be of value to policy makers and programmers, and provide insights that will contribute to the understanding of the challenges in achieving the MDGs for maternal mortality in Ethiopia. The programmatic areas highlighted in the report can also serve as useful input in any effort to address maternal health and thereby maternal mortality in the country.

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Executive Summary

Ethiopia is one of the countries in sub-Saharan Africa with markedly high maternal mortality ratio. The maternal mortality ratio (MMR) in the country has stagnated at 676 per 100,000 live births after declining from 871 per 100,000 live births in 2000 to 673 in 2005. Efforts to reduce maternal mortality should focus on reducing the likelihood that a woman will have a high risk pregnancy; reducing the likelihood that a pregnant woman will experience a serious complication of pregnancy or childbirth and improving the outcomes for women with complications. Ethiopia's Health Sector Development Program (HSDP) acknowledges the importance of increasing access to high quality antenatal and post-abortion care, strengthening reproductive health care and family planning, increasing access to skilled delivery care, and providing education about family planning are key areas of interest in order to bring down the high maternal mortality in the country.

Guided by a conceptual framework, this study examines several intermediate determinants of maternal mortality including high-risk pregnancy, maternal nutrition, anemia, HIV, the use of antenatal, postpartum and delivery care services in Ethiopia in order to provide up-to-date information and identify areas for improvement. The analysis was based on 21,971 women who had a live birth in the five-year preceding the 2000, 2005 and 2011 Ethiopia Demographic and Health surveys. Data analyses encompassed trend, descriptive and multivariate methods. Cognizant of the lack of disaggregated data on maternal mortality by region, we developed a maternal death risk factors index based on several intermediate determinants to highlight regional disparities in maternal mortality burden.

The salient findings are summarized below.

High risk pregnancy: High risk pregnancies, mainly due to high parity, older maternal age and closely spaced pregnancies and birth appear to characterize the fertility behavior of the vast majority of Ethiopian women. Among the women who had a birth in the five years preceding the 2011 DHS, 56.7% were exposed to one or more fertility-related high risk pregnancy and 20% to two or more risks. Furthermore, there have not been significant decline in the proportion falling in high risk pregnancy over the past decade. Significant variations in women's exposure to high-risk pregnancy by region and socio-demographics have also been apparent. Rural women, uneducated and those from poor households were excessively exposed to high-risk pregnancy. Unmet need for family planning among women who were exposed to one or more high-risk pregnancy (37.7%) was much higher than those without any fertility-related pregnancy risk (24.6%). Unmet need rose to 45% among women who were exposed to two or more fertility-related high risk pregnancy.

Maternal Malnutrition: Malnutrition can be considered widespread among Ethiopian women with a prevalence of underweight at 23.2% in 2011. It appears that malnutrition remained high over the last decade - 25.7% in 2000 and 23% in 2005. In a multivariate analysis, higher risk of underweight is significantly associated with rural residence, living in lowland, having low education, being poor, a lack of household toilet facility and being anemic.

Anemia: Data suggest that Ethiopia has a relatively mild prevalence of anemia compared to other developing countries. In 2011, the prevalence of Anemia in Ethiopia was found to be 13% among all women who had a live birth in the five years preceding the survey. There has been a significant decline in the prevalence of anemia from 20% to 13% between 2005 and 2011. Although the prevalence at the national level is considered to be mild, some regions in the lowlands exhibited extremely high prevalence of anemia. For instance, in Somali region nearly 50% of the women were anemic in 2011, in Afar 40.4% and Dire Dawa 33%. This is further compounded by the fact that unlike most regions of the country these three regions did not record significant decline in the prevalence of anemia during the period 2005-2011.

Anemia in pregnancy: The prevalence of anemia is notably high among pregnant women at 30% in 2011 vis-à-vis only 11% among non-pregnant women. Trend in the prevalence of anemia among pregnant women has remained high and unchanged in the second half of the last decade - 33% in 2005 and 30% in 2011.

HIV prevalence among women: The impact of HIV on maternal mortality has recently been well recognized and varies in accordance with, among others, the rate of HIV infection, fertility pattern, and availability of ART in the women population. Among women who had a live birth in the preceding five years, we found an HIV prevalence rate of 1.4%. This rate has remained nearly stable over the past five years. We can safely conclude that the maternal mortality impact of HIV is not as severe in Ethiopia as in the other sub-Saharan African countries. Nevertheless, its impact could be more vivid in the urban areas of the country as well as in some regions such as Addis Ababa, Gambela, and Harari with notably high HIV prevalence rates.

Antenatal care (ANC): Results for antenatal care are mixed. On the one hand the country has witnessed an encouraging improvement in the ANC coverage (at least one visit) in the last decade from 27% in 2000 to 42% in 2011. On the other hand, the receipt of adequate ANC by the women is a real challenge - only 11% of the women began attending ANC in the first trimester, and only 19% made the recommended number of four visits in 2011. Moreover, the trend is not fast enough to meet the target set in the HSDP-IV by 2015.

Determinants of ANC uptake: Disparities in ANC uptake between urban and rural areas, across regions, and by women socio-economic status and women's fertility behaviors have been documented. Our analysis also shed light to the importance of preceding birth interval and wontedness of pregnancy on ANC uptake. Women with shorter preceding birth interval were less likely to uptake ANC. Lower ANC use was also recorded among women whose pregnancy was unintended.

Missed opportunity for key elements of ANC: Services with proven benefit had a low coverage among ANC clients, representing substantial missed opportunity. Nearly 60% of the ANC clients did not have their urine tested, 46% did not have their blood tested, 44.2% were not given two doses of TTI and 28% did not have their blood pressure measured. Pregnant women are ill-equipped to make appropriate choices especially when they are in danger - 80% of the ANC clients were not told about pregnancy complications.

Skilled birth attendants: Skilled birth attendant is staggering low in the country. Only 13% of the women who had a live birth in preceding five years of the 2011 survey were assisted by a skilled health worker and 12% were delivered in health facilities although this represented an improvement from 6.2% in 2000. This rate is in the lowest bound by sub-Saharan Africa standard. We attempted to predict skilled attendance at delivery for the MDG target year of 2015. Skilled assistance at delivery estimated to increase at a low pace of 5.6% per annum and, with this pace, the proportion that will be attended by skilled workers predicted at 21% by 2015. Multivariate analysis suggests rural women, uneducated, and poor were less likely to deliver in health institutions.

Reasons for not delivering in health institutions: A closer look at the reasons for not delivering in the health institutions suggests that women in general were less likely to blame on service costs and accessibility among the major barriers to delivering in health institution although indirect costs can be a real barrier. Rather the vast majority of women with home deliveries saw institutional delivery as "unnecessary" and "not a customary practice". In Afar, Somail, Gambela and Benishangul Gumuz lack of easy physical access to health facilities was also reported on top of the attitudinal barriers.

Postpartum care: Ethiopia has the lowest postpartum care coverage of 13% compared to any sub-Saharan Africa country. Only less than 1% of the women who delivered at home received postpartum care within 42 days, as of the most recent DHS. This has declined from the 3.5% reported in the 2000 DHS. The socio-economic and demographic factors that are associated with delivery care are also relevant to the uptake of postpartum care.

The relationship between ANC, and delivery and postpartum care: Strong and positive correlations between the number of antenatal visits and the use of skilled birth attendants and postpartum care use were found. Women who receive antenatal care were more likely to receive skilled birth attendants for delivery as well as postpartum care.

Regional disparity in maternal mortality burden: Based on the maternal mortality risk factors index we developed, five out of the 11 regions estimated to have higher maternal mortality burden than the national average; the highest being in Somali and Afar. These were followed by SNNP, Amhara, and Oromia regions. Benshangul Gumuz, Tigray and Gambella regions have their maternal mortality burden a little bit lower than the national average. Harari and Dire Dawa estimated to have their maternal mortality burden significantly lower than the national average. Addis Ababa estimated to carry the lowest maternal mortality burden.

Conclusion: The findings suggest that there are a number of challenges to address in order to achieve the MDG target for maternal mortality in Ethiopia. Women's high-risk fertility behaviors, their health and nutrition status and the use of essential maternal health care services have yet to improve significantly to result in a reduction in maternal mortality in the country. The pervasive inequalities in maternal mortality burden by region, urban-rural residence and socio-economic status of the population further compounded the problem; making efforts to improve maternal health and thereby reduce maternal mortality more challenging. Yet, there are ample opportunities to alleviate the situation. Strategies to address maternal mortality in the country requires a multifaceted and integrated approaches that encompass several preventive and treatment interventions such as preventing high risk pregnancy, improving the health and nutritional status of women, and improving women's access to quality maternal health care services, especially safe and clean delivery and postpartum cares services. Although this analysis has not contributed to the current status and trend of emergency obstetrics care services in the country due to paucity of data, this remains the most recognized treatment intervention that can result in significant reduction in maternal mortality.

I. Introduction

Over half a million women die from pregnancy-related causes annually and the vast majority of these deaths occur in developing nations [1]. Maternal survival has been on the centre of attention since the last few decades and improving maternal health is one of the eight Millennium Development Goals (MDGs) adopted at the 2000 Millennium Summit. The two targets for assessing progress in improving maternal health (MDG 5) are reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015, and achieving universal access to reproductive health by 2015 [2].

With a population of nearly 83 million in 2010 [3], Ethiopia is the second most populous country in Africa next to Nigeria. The population grows at a rate of 2.6 percent per annum. The vast majority of the people (84 percent) resides in rural areas, agriculture being the major source of livelihood [4].

The maternal mortality ratio in Ethiopia is strikingly high and has stagnated at 676 per 100,000 live births after declining from 871 per 100,000 live births in 2000 to 673 in 2005 ratio of 676 deaths per 100,000 live births [5]. The MDG goal on maternal health aims to reduce MMR by two-thirds to 267 per 100,000 live births. As part of the strategies for reducing maternal mortality, Ethiopia plans to raise the number of deliveries attended by skilled health personnel from 16 percent in 2006 to 60 percent by 2015 [2]. At the current pace, there is little optimism that Ethiopia will be able to meet the MDG 5 target [6].

There are well recognized determinants of maternal mortality in developing countries that encompass a range of factors related to pregnancy complications and the management of pregnancy complications during labor, delivery and postpartum period; access and use of maternal health care services; women's reproductive and health behaviors as well as women's health and nutrition status[7]. Closer examination of the levels and trends of these determinants is needed to inform programs and guide advocacy efforts and researches. There is however a dearth of national level study on the determinants of maternal mortality in Ethiopia. The three nationally-representatives Ethiopia Demographic and Health surveys that were conducted in the past 10 years present unique opportunity to examine the trends and track progress in the determinants of maternal mortality at the national and regional levels. This study seeks to contribute to the understanding of the trends and determinants of maternal health in the country using data from the 2000, 2005 and 2011 Demographic and health surveys. The study in particular aims to examine trends in women's reproductive status, health status and the use of maternal health services in order provide up-to-date information and suggest programmatic areas to help lessen maternal mortality in the country.

The subsequent sections of this report are organized as follows: section two presents the conceptual framework that delineates the various determinants of maternal mortality and guides data analyses. This is followed by section three that presents the method and data analyses approaches in detail. Section four presents the main results from the data analyses; with emphasis on the trends and determinants of the intermediate determinants of maternal mortality including reproductive status, health status, maternal health care service use. This section also presents a promising analytical approach and analyses to unknot disparities in maternal mortality burden by region, urban-rural residence and socio-economics. Section five discuses the key findings emerging from the analyses. Last but not least, section six presents conclusion and policy implications of the key findings to accelerate progress towards MDG 5 target for maternal mortality.

II. Conceptual Framework

The study is guided by a framework for the determinants of maternal mortality original proposed by McCarthy and Maine (1992). Figure 1 presents the details components of a reduced form of the original framework that employed in this paper. The framework divides the various determinants of maternal mortality into distal and intermediate determinants. Outcomes include pregnancy, complications, death and disability. As a result the framework can be equally applied to the study of different outcomes including maternal mortality, pregnancy complication, and disability.

Closest to the event of a maternal death are a sequence of situations or outcomes that culminates in either disability or death; these outcomes are pregnancy and pregnancy-related complications. A woman must be pregnant and experience some complication of pregnancy or childbirth, or have a preexisting health problem that is aggravated by pregnancy, before her death can be defined as a maternal death. This sequence of outcomes is most directly influenced by intermediate determinants including the health status of the woman; her reproductive status; her access to and use of health services; as well as some unknown factors. Finally, a set of socioeconomic and cultural background factors is at the greatest distance from a maternal death[8]. However, they can have an influence on maternal mortality through the intermediate determinants. The distal determinants broadly encompass women's, family's and community's status. In particular women's socio-economic status such as education, income, and access to resources play important roles in helping women to adopt behaviors and services that can reduce the likelihood of maternal mortality.

Paucity of data limits our application of the full framework. However, we examined in this study several determinants that fall under the intermediate determinants - i.e. reproductive status, health status, and use of health services. Fertility-related high risk pregnancy and birth are the main focus of our analysis under the reproductive status.

Within the health status, we examined maternal nutritional status, anemia and HIV infection. Use of antenatal care, family planning, delivery care and postpartum care services constitute women's health services status. Distal determinants such as maternal education, partners' education, household wealth, marital status, place of residence and regions were examined along with the intermediate determinants.

Pregnancy and child bearing patterns of women, which are related to women's age, birth spacing, and parity are studied to reflect the reproductive status of women that are relevant to the risk of maternal mortality. Studies have shown that among the factors that contribute to maternal death are pregnancies that are too early, too close, too late and/or too many [9, 10] . When a woman becomes pregnant before age 18 she is more likely than an older woman to develop hypertension, anemia and prolonged or obstructed labor [11] and to die as a result of pregnancy[12]. For pregnancies among women in their 40s, the risk of death can be as much as seven times higher than among women in their 20s. When pregnancy occurs less than six months from the last birth, a woman is more than twice as likely to die in childbirth than a woman who becomes pregnant between 18 to 23 months later [13]. Five or more pregnancies significantly increase the risk of dying of pregnancy-related causes [14, 15]. The role of family planning in the reduction of maternal

mortality by preventing high-risk and unwanted pregnancy as well as unsafe abortion and by promoting healthy pregnancies has been well recognized[16]. Enabling couples to determine whether, when, and how often to have children is crucial to safe motherhood and healthy families [17]. It has been suggested that about 35 percent of maternal deaths could be eliminated if all women and men had access to contraception to prevent unwanted pregnancies [18]. This study looked into the characteristics of women who are exposed to high-risk pregnancy due to their age, parity and birth spacing.

Malnutrition and micronutrient deficiency in women increase the risk of maternal mortality. Maternal short stature and iron deficiency anemia increase the risk of death of the mother at delivery, accounting for at least 20 percent of maternal mortality [19]. The nutritional status of a woman before and during pregnancy is important for a healthy pregnancy outcome [20]. Studies have consistently shown that maternal short stature and low body-mass index have independent adverse effects on pregnancy outcomes [19]. Severe anemia (Hb<7 g/dL) in pregnancy is associated with increased risk of maternal mortality. It has been estimated that the increased risk of death for pregnant women with Hb <7 g/dL is 1.35, and that those with Hb <5g/dL have a 3.5 times greater risk of dying from obstetric complications compared with non-anemic women [21]. Thus improving maternal nutrition and correcting anemia of any severity reduced the risk of death during pregnancy and childbirth.

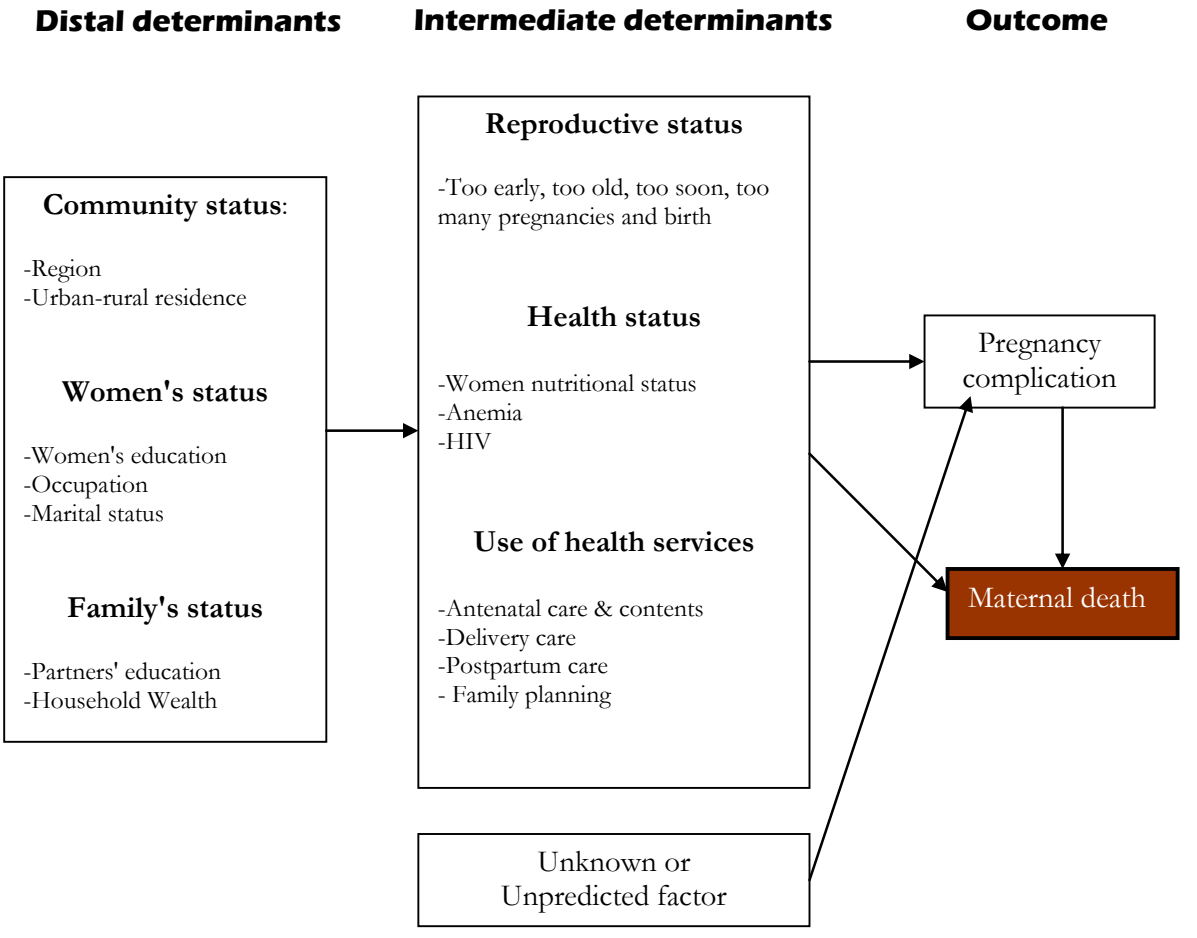
The HIV epidemic has further complicated efforts to prevent maternal mortality in most sub-Saharan African countries. According to Hogan MC et al. (2010) [22] maternal deaths worldwide could be reduced by 60,000 per year if women received appropriate HIV diagnosis and treatment. In sub-Saharan Africa, maternal mortality rates increased by at least 1 percent per year in South Africa, Namibia, Mozambique, Lesotho, Swaziland, Botswana and Zimbabwe, driven largely by HIV-related deaths. Therefore, as part of health status determinants, we examined maternal nutritional status, anemia and HIV prevalence in women. The DHS collected anthropometric data on adults and blood samples to measure blood hemoglobin level and HIV in 2005 and 2011. Body mass index (BMI) will be used to assess the nutritional status of women, which is available since the 2000 DHS. The HIV test results of individual respondents are available linked to other survey data for each individual.

There is sufficient evidence to suggest that high maternal mortality is associated with inadequate and poor-quality maternal health care, including antenatal care, skilled attendance at birth and postpartum care. Antenatal care has been considered as a key maternal service in improving a wide range of health outcomes for women and children [23, 24]. Antenatal care service also presents good opportunity to deliver interventions for improving maternal nutrition, providing health education, and encouraging skilled attendance at birth and use of facilities for emergency obstetric care. The World Health Organization recommends a minimum of four antenatal care visits, based on reviewing the effectiveness of different models of service delivery. A standard antenatal care should contain blood pressure measurement, urine testing, and blood testing to detect syphilis and severe anemia. Some other services, including giving tetanus immunization, providing iron tablets and teaching women about danger signs of pregnancy complications, are also important to improve both maternal and newborn health [25].Most maternal deaths occur during labor, delivery, or the first 24h what???? h postpartum, and most complications cannot be predicted or prevented. The location of women when they deliver, who is attending them, and how quickly they can be transported to referral-level care are thus crucial factors in determining

interventions that are needed and feasible [26].

We analyzed an array of maternal health service indicators from the three surveys to track trends and examine determinants of service uptake. Indeed, the Ethiopia DHS collected fairly wealthy data on maternal health care services including antenatal care use, the number of visits, gestational age at first visit; and services and information provided during the antenatal visit including the places and the persons provided the care. Delivery related information including place and assistance during delivery and reasons for not delivering in health facility among other are available in the DHS. Postpartum care data available in the DHS include the timing of care, place and type of service provider.

Figure 1. Framework for analyzing the determinants of maternal mortality [Modified from McCarthy J and Maine



III. Data and Method

3.1. Data source

The first ever DHS was conducted in Ethiopia in 2000. This was followed by the 2005 and 2011 DHS. The surveys were based on nationally representative probability sample that covered the entire country. Women age 15-49 years and adult men 15-54 years were interviewed using standard questionnaires. The three surveys collected several data from mothers or caretaker of live-born infants in the five-year preceding the date of interview. Socio-economic and demographic information was also collected from women and household. The data from the three surveys were pooled into one data file system for analysis. Details about the Ethiopia DHS procedure and methodology can be consulted from the national reports [5, 27, 28] . This analysis is based on 21,971 women who had a live-born infants in the five-year preceding the date of interview i.e. 7437 in 2000, 6678 in 2005 and 7856 in 2011. We obtained the full datasets for the three surveys on a CD-ROM from the Central Statistical Agency of Ethiopia. The DHS data used for this study is openly available and can be downloaded at http://www.measuredhs.com.

3.2. Study variables

The inclusion of variables in this study was guided by the conceptual framework for the determinants of maternal mortality discussed in the previous section. We broadly categorized the determinants of maternal mortality as intermediate and distal determinants. Intermediate determinants are further categorized into three broader groups as reproductive status, health status, and the use of maternal health services. The distal determinants encompass community, family and women status.

Reproductive status:

Reproductive status of the women is measured through women's fertility pattern based on their age, parity and birth spacing. We define fertility related high-risk pregnancy if one or more of the following conditions present:

- *a woman is below 18 years of age at the time of pregnancy with her most recent birth (too young)*
- *a woman is more than 34 years of age at the time of pregnancy with her most recent birth (too old)*
- *a woman already had three or more live births at the time of pregnancy with her most recent birth (too many)*
- *a woman gave birth to her most recent child within 24 months of a previous live birth (too soon)*

If a woman is exposed to at least one of these fertility conditions, then she will be considered as having high-risk pregnancy. Likewise, a woman is defined as being exposed to two or more fertility related high-risk birth if she fulfilled two or more of the above conditions at the time of pregnancy.

Health status:

Women's health status that potentially put them to the risk of maternal deaths is gauged by the presence of under-nutrition, anemia and HIV infection. Due to paucity of data we couldn't investigate other health conditions that have detrimental effect on maternal health. Women' nutritional status was assessed using Body Mass Index (BMI). It is an estimate of body composition that correlates an individual's weight and height to lean body mass. High values can indicate excessive fat stores, while low values can indicate reduced fat stores. The BMI is a useful tool in both clinical and public health practice for assessing the nutritional status of women. BMI was calculated by dividing weight in kilograms by height in meters squared (m^2). Women with BMI less than 18.5 kg/m^2 were considered underweight/under-nourished [29].

Anemia is defined as a hemoglobin concentration lower than the established cut-off defined by the World Health Organization [30]. The cut-off figure is 120 g/L for non-pregnant women and 110 g/L for pregnant women. These cut-off values were used to define anemia in this study. Data on anemia is available only for the years 2005 and 2011.

HIV infection status of survey respondents was measured in the 2005 and 2011 DHS surveys. Blood sample was collected from survey respondents based on informed consent and voluntary participation. The response rates for the blood sample were 83% and 89%, respectively, in 2005 and 2011.

Maternal health service use:

Several variables were examined in relation to the maternal health service use. These include antenatal care (ANC) and its elements, place of delivery, assistance during delivery, reasons for not delivering in the health intuitions, caesarean section delivery (an indicator of population access to obstetric care services), postpartum care (PPC), family planning use and unmet need for family planning. Women who reported visited by health worker within six weeks (0-42 days) after delivery are considered receiving Postpartum Care (PPC).

Distal determinants:

Distal determinants included in this analysis are the urban-rural residence, region, maternal education, partner's education, household wealth and marital status. Women's educational status was categorized into three: no education, elementary education (1-6 years of schooling) and secondary or higher education (7 plus years of schooling). The DHS raw data were provided along with wealth index variables that were constructed to rank households using principal component analysis. The wealth quintiles were trichotomized into low, medium and high wealth scores for the present analyses. Marital status was dichotomized as currently married and not currently married.

Maternal Death Risk Factor Index (MDRFI)

Principal components analysis (PCA) was used to assign the weights for a total of 11 maternal mortality intermediate determinants to generate an index of maternal death risk factor. The intermediate determinants encompass indicators of high-risk pregnancy, prevalence of underweight, anemia, HIV infection, four or more antenatal care visits, two or more Tetanus Toxoid Injections, Iron tablets during pregnancy, skilled birth attendants, cesarean section delivery, postpartum care and family planning. Details about the method can be found in Annex 1 of this report.

3.3. Method of analysis

Analyses encompassed univariate, trend and multivariate. The multivariate analysis for the different outcome indicators was performed using Multivariate Logistics Regression model. The mean MDRFI values were used to predict maternal mortality for each region and also to rank maternal mortality burden by region, urban-rural residence, women's educational status, and household wealth (See Annex 1 for details).

STATA 10 (Stata Corporation, College Station, TX, USA) was employed for data management and analyses. The Survey command in STATA was used to declare the strata and primary sampling unit. Proportions, rates and odds ratios presented in this paper were all weighted for the sampling probabilities.

3.4. Study Limitations

Due to limitations of the DHS data we did not examine the full array of determinants of maternal mortality. Women's health status that could predispose them to maternal death can be numerous including Diabetes, Preeclampsia, premature labor, among others. These and others were not available in the DHS. Obstetric care related information is also unavailable in the DHS.

The maternal death risk factors index we propose in this study is limited by paucity of data including access and use of emergency obstetric care services. The method can be refined by including more data in future surveys.

IV. Analysis and Presentation of Results

4.1. Characteristics of the study population

The data for this analysis came from the three Ethiopia Demographic and Health Surveys. It was based on 21, 971 interviewed women who had a live birth in the five years preceding the surveys. As shown in Table 1, the majority of the women in the three surveys (85-91%) were from rural household. The proportion of urban women interviewed increased slightly from 11.4% in 2000 to 15% in 2011. The DHS collected data from the 11 regions of the country with the majority (over 85%) in the three big regions, namely, Oromiya, Amhara and SNNP.

There has been improvement in the economic status of households during the period 2000-2011, as measured by household wealth index. The proportion of households that resided in households with low wealth index value decreased from 70.5% in 2000 to 42.1% in 2011. Conversely, women in households that had high wealth index value increased from 12% to 28% during the same period.

In 2000, the vast majority (82.3%) of the women did not have formal education. There has been significant improvement in participation of women in primary education over the past decade. Women with elementary education increased from 12.4% in 2000 to 16.5% and 28.7%, respectively, in 2005 and 2011. On the other hand there was no temporal trend in the proportion of women that achieved secondary or higher level of schooling.

Out of wedlock child birth can be considered quite low in the country. Over 90% of the women who had a live birth in the preceding five years were married and living with a partner. Of all women who gave birth in the preceding five year, the majority (between 44%-49%) happened to women aged 25-34 years. This was followed by older women age 35-49 years. The proportion of youth (age 15-24 years) that had a live birth were 27.5% in 2000 and 25.4% in 2011. Child birth among adolescents age 15-19 years constituted between 5.1% and 6.1% during the survey period.

High fertility is typical of most of the women studied. The mean number of children ever born remained nearly unchanged over the past decade - 4.3 and 4.1, respectively, in 2000 and 2011. The proportion of women with five or higher parity was 42.3% in 2000 and 2005. This decreased, though slightly, to 38.6% in 2011. Among women who had a live birth in the preceding five years, 42.6%, 43% and 41.8%, respectively, in 2000, 2005 and 2011 gave birth to two or more live births in the past five years.

Table 1. Percentage (weighted) distribution of selected characteristics of women who had a live birth in the five years preceding the survey- 2000, 2005 and 2011 Ethiopia DHS

	2000 n=7438	2005 N=6678	2011 N=7855
Residence			
Urban	11.4	8.7	15.0
Rural	88.6	91.3	85.0
Region			
Tigray	6.8	6.6	6.7
Affar	1.0	0.9	1.0
Amhara	28.0	25.4	25.3
Oromiya	38.1	37.3	39.4
Somali	1.1	3.9	2.5
Benishangul Gumz	1.0	0.9	1.2
SNNP	21.4	22.4	20.6
Gambela	0.3	0.3	0.4
Harari	0.2	0.2	0.2
Addis Ababa	1.8	1.8	2.4
Dire Dawa	0.3	0.3	0.3
Wealth Score			
Low	70.5	56.3	42.1
Medium	17.5	25.9	29.9
High	12.0	17.8	28.0
Women's education			
No education	82.3	78.4	66.6
Elementary	12.4	16.5	28.7
Secondary or higher	5.3	5.2	4.7
Marital status			
Currently married	90.1	92.7	90.9
No currently married	9.9	7.3	9.1
Age of women			
15-19	5.9	6.1	5.1
20-24	21.6	20.1	20.3
25-34	44.0	46.4	48.9
35-49	28.5	27.4	25.7
Number of children ever born (CEB)			
1-2	33.1	31.2	34.9
3-4	24.6	26.5	26.7
5+	42.3	42.3	38.6
Mean CEB (95% CI)	4.3(4.2-4.4)	4.3(4.2-4.5)	4.1 (4.0-4.2)
Number of live births in the previous five years			
1	57.4	57.0	58.2
2+	42.6	43.0	41.8

Percentage weighted

4.2. Reproductive status

Studies have shown that among the factors that contribute to maternal death are pregnancies that are too early, too close, too late and/or too many [9, 10]. These conditions pose risks to the health of mothers and their babies. This section presents the level, trend and determinants of high-risk pregnancy as well as their family planning use behaviours and unmet need for family planning.

4.2.1. Fertility-related high risk pregnancy: levels and trends

The analysis is restricted to women who had a live birth in the five years preceding the survey. Table 2 presents the distribution of women according to their exposure to high-risk pregnancy. Over half of the women (56.7%) can be categorized as being exposed to at least one type of fertility-related high risk pregnancy in the previous five years of the 2011 survey. Exposure to two or more high risk related pregnancies was recorded among a fifth of the women. The proportion of women who were exposed to at least one high risk pregnancy remained high and unchanged over the past decade - 56.4 in 2000, 60.7% in 2005 and 56.7% in 2011.

The most recent DHS shows that the women in high-risk were predominantly exposed to high parity (44.2%), followed by older age at pregnancy (16.9%) and closely spaced pregnancies (12.9%). There appears a slight but significant increasing trend in the proportion who have had three or more children over the past decade. It is important to note that 90% of the women included in this analysis were married, which signals the fact that marital fertility is notably high in the country. Pregnancy and child birth among women age 35 year or older also reported to be common although it has shown some declining trend over the past decade - from 21.1% in 2000 to 16.9% in 2011. Younger maternal age (less than 18 years) at pregnancy was reported by 4.6% of the women, which remained almost stable over the past decade. The prevalence of closely spaced pregnancy was reported by 13.5% in 2000, and remained at almost same rate in 2005 (14.8%) and 2011 (12.9%).

Table 2. Percentage (weighted) distribution of women who had a live birth in the five years preceding the survey according to high risk pregnancy and birth- 2000, 2005 and 2011 Ethiopia DHS

	2000 n=7438	2005 n=6678	2011 N=7855	P-value (Test for trend)
Single risk categories at time of birth				
Too young (age < 18 years)	4.6	4.5	4.6	0.921
Too old (age>34 years)	21.1	20.2	16.9	0.000
Too many (3 or more births)	42.3	47.4	44.2	0.000
Too soon (<2 years birth interval)	13.5	14.8	12.9	0.929
Combination of risk categories				
Too young & Too soon	0.2	0.4	0.3	0.176
Too old & Too soon	2.4	2.2	1.8	0.134
Too old & Too many	18.9	18.3	15.2	0.000
Too soon & Too many	5.7	7.3	6.2	0.027
Too old, Too soon & Too many	2.2	2.0	1.6	0.181
High risk summary				
No risk	43.6	39.3	43.3	N/A
One or more risks	56.4	60.7	56.7	0.110
Two or more risks	22.9	24.2	20.1	0.060

N/A=not applicable; percentage weighted

Women's exposure to high risk pregnancy appeared to vary in accordance with their place of residence and region. Table 3 presents the proportion of women who were exposed to two or more fertility-related high risk pregnancy by residence and region. Exposure to two or more fertility-related high risk pregnancy was significantly higher in rural area than in the urban; and the difference has persisted over the years. Trend data show that the proportion of women who were exposed to two or more fertility-related high risk pregnancy declined slightly from 15.3% in 2000 to 11.3% in 2011. In the rural area the trend has been stagnated over the past decade - 23.8% in 2000 and 21.7% in 2011.

Women in some regions of the country were more likely than others to have been exposed to high risk pregnancy than others. The 2011 data revealed that women in Somali region were the most exposed to high risk pregnancy (two or more risks at 34.4%), followed by those in SNNP, Afar, Tigray and Amhara regions. In seven out of the 11 regions there was no significant trend in the proportion that were exposed to two or more fertility-related high risk pregnancy during the period 2005-2011. Significant declining trend can be noted in Addis Ababa (from 13.1% in 2000 to 3.7% in 2011) and Oromiya (from 22.7% in 2000 to 18.9%). On the other hand, reversal trend was also noted in Somali (from 26.8% in 2000 to 34.4% in 2011) and Gambela (from 10.5% to 14.9%) regions.

Table 3. Among women who had a live birth in the five years preceding the survey, the percentages having two or more risks according residence and region- 2000, 2005 and 2011 Ethiopia DHS

	2000		2005		2011		P-value (Test for trend)
	% two or more risks	N	% two or more risks	N	% two or more risks	N	
Residence							
Urban	15.3	1,315	15.3	1,069	11.3	1,533	0.005
Rural	23.8	6,123	25.0	5,609	21.7	6,322	0.548
Region							
Tigray	21.3	776	23.5	679	21.0	852	0.863
Affar	19.3	427	26.7	383	22.2	723	0.726
Amhara	22.1	1,165	22.2	1,047	19.2	983	0.196
Oromiya	22.7	1,368	25.7	1,233	18.9	1,111	0.009
Somali	26.8	430	32.7	399	34.4	565	0.029
Benishangul Gumuz	21.6	552	18.6	465	19.6	683	0.221
SNNP	25.8	1,070	24.1	1,145	23.9	1,064	0.333
Gambela	10.5	479	13.8	390	14.9	614	0.013
Harari	18.6	379	14.7	343	14.9	446	0.270
Addis Ababa	13.1	419	9.5	318	3.7	351	0.000
Dire Dawa	16.3	372	17.1	277	14.3	463	0.751

percentage weighted

4.2.2. Factors influencing exposure to high risk pregnancy

Multivariate Logistic Regression analysis was used to examine the factors that could influence women's exposure to fertility-related high risk pregnancy. The outcome variable of interest was the odds of having two or more fertility-related high risk pregnancy and birth. As shown in Table 4, contextual, social and reproductive goals significantly shape women's exposure to high risk pregnancy.

The odds of being exposed to high-risk pregnancy estimated to be higher among women in Somali and SNNP regions compared to those in Addis Ababa. Women in Somali were 37% more likely than those in Addis Ababa to have had high risk pregnancy; this was nearly 50% higher in SNNP. Women in other regions did not carry significantly higher odds of being exposed to high risk pregnancy than those in Addis Ababa. Of note, women in Addis Ababa had the lowest exposure to high risk pregnancy.

Both women's and partners' education emerged amongst the most important predictors of women's exposure to high risk pregnancy. Higher education is associated with lower odds of being exposed to high risk pregnancy. Conversely, women with no education were 2.8 times more likely than those with secondary or higher education to have had high risk pregnancy. Compared to women with secondary or higher education, women having had elementary education also carried 63% higher odds of exposure to high risk pregnancy. Similar protection effect of husband's education is also apparent.

Women's reproductive goal as measured by their ideal family size and husband-wife concordance on the number of children were examined. The result shows that higher ideal family size was associated with an increased likelihood of being exposed to high risk pregnancy. Women who stated an ideal family size of five or more children had 65% excess odds of being exposed to high risk pregnancy compared to those with an ideal family size of 4 children or less. Similarly, those women who failed to state their ideal family size - said "up to god" or "do not know" - were nearly 90% more likely than those with an ideal family size of 4 or less to be exposed to high risk pregnancy. The role of men in driving couple's fertility is also apparent from our analysis in that exposure to high risk pregnancy is relatively lower in couples who agree on the number of children they would like to have. Conversely, when the husband wants more children than the wife there is a 15% increased odds of being exposed to high risk pregnancy. Contrary to our expectation, we didn't find significant difference in exposure to high risk pregnancy between women who ever and never used family planning. It may well be that family planning program in the country is not geared towards addressing high-risk pregnancy and that most women who are using family planning began adopting contraception after meeting their ideal family size that is often more than 4 children.

Table 4. Multivariate logistic regression in the estimation of exposure to two or more fertility-related high risk pregnancy according to selected variables- 2000, 2005 and 2011 Ethiopia DHS

	Adjusted OR	95% CI	
		Lower	Higher
Year (*1995-2000*)			
2001-2005	1.094	1.002	1.195
2006-2011	1.033	0.944	1.131
Residence (*Urban*)			
Rural	1.114	0.954	1.301
Region (*Addis Ababa*)			
Tigray	1.142	0.863	1.513
Affar	0.901	0.672	1.207
Amhara	1.036	0.786	1.366
Oromiya	1.216	0.925	1.598
Somali	1.369	1.026	1.825
Benishangul Gumuz	0.971	0.727	1.298
SNNP	1.499	1.138	1.974
Gambela	0.852	0.629	1.154
Harari	0.787	0.581	1.065
Dire Dawa	0.847	0.628	1.143
Woman's education (*Secondary +*)			
No education	2.822	2.156	3.693
Elementary	1.627	1.243	2.130
Husband's education (*Secondary +*)			
No education	2.281	1.927	2.701
Elementary	1.253	1.057	1.485
Household wealth score (*Low*)			
Medium	1.08	0.981	1.189
High	1.12	0.945	1.769
Ideal family size (*4 or less*)			
5 or more	1.648	1.505	1.806
Non-numeric	1.896	1.702	2.112
Husband-wife concordance on number of children (*Both want same*)			
Husband wants more	1.150	1.048	1.261
Husband wants fewer	0.965	0.823	1.133
Do not know	1.014	0.929	1.106
Ever use of family planning (*No*)			
Yes	1.007	0.916	1.107

Reference category in parenthesis

4.2.3. Contraceptive use, unmet need and high risk pregnancy

One of the strategies to reduce maternal morbidity and mortality is to avert high risk pregnancies through the use of effective and appropriate family planning methods. It has been suggested that about 35 percent of maternal deaths could be eliminated if all women and men had access to contraception to prevent unwanted pregnancies [18]. Figure 2 shows current contraceptive use (contraceptive prevalence rate) by women's exposure to high risk pregnancy.

Lower contraceptive use was reported among women who were exposed to high risk pregnancy compared to women without fertility-related risk. Contraceptive prevalence was 26.1% for women who fall in one or more fertility-related high risk pregnancy in 2011, and this was even lower at 23.3% for those who were exposed to two or more risks during the same period. In contrast, about 38% of the women without fertility-related risk were using some form of family planning in 2011. Similar variation in contraceptive use by exposure to fertility related risk can also be noted in 2005. Our analysis also showed differential in the pace of increase of contraceptive use by exposure to fertility-related high risk pregnancy.

Not only contraceptive prevalence rate was lower among women in high-risk pregnancy but also has it shown a slower trend over the past decade compared to the trend for women without any risk. Among women without any risk, the contraceptive prevalence rate increased by more than three fold between 2000 and 2011 - from 10.1% to 37.7%. By contrast, this has increased from 10.2% to 23.3%, which is a two-fold increase, in those who were exposed to two or more high risk pregnancies.

Figure 2. Current use of family planning according to women's exposure to high risk birth by year survey, 2000, 2005 and 2011 Ethiopia DHS

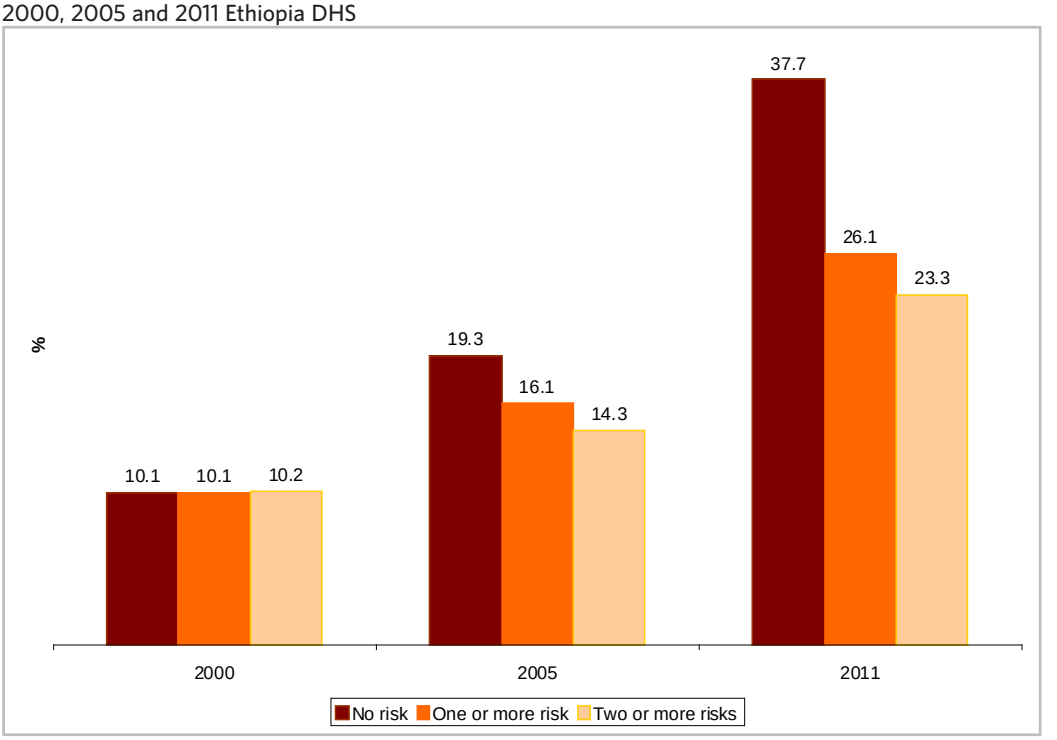


Table 5. Unmet need for family planning according to exposure to high risk birth by year of survey, 2000, 2005 and 2011 Ethiopia DHS

	2000 N =6472	2005 N=5921	2011 N=6905	P-value (Test for trend)
Unmet need for spacing				
No risk	29.2	26.9	21.1	0.000
One or more risk	24.5	23.1	20.4	0.033
Two or more risks	16.5	17.8	16.5	0.775
Unmet need for limiting				
No risk	7.9	7.8	3.5	0.000
One or more risk	24.2	22.3	17.3	0.000
Two or more risks	36.2	32.3	28.6	0.011
Total unmet need				
No risk	37.2	34.7	24.6	0.000
One or more risk	48.7	46.1	37.7	0.000
Two or more risks	52.7	50.1	45.1	0.023

percentage weighted

Whether those women with high risk pregnancy have unmet need for family planning has programmatic implication. In general, there is a substantially higher unmet need for family planning among women with high risk pregnancy compared to women without fertility-related risk. The total unmet need for family planning in 2011 was 37.7% and 45.1%, respectively, among women who were exposed to at least one fertility-related high risk pregnancy and birth. The corresponding unmet need for family planning was much lower at 24.6% for women without any fertility-related risk. Unmet need for limiting is higher than that for spacing among women who were exposed to two or more fertility-related risk. For women who were exposed to two or more fertility-related high risk pregnancy, the unmet need for family planning was 28.6% in 2011, which declined significantly from 36.2% in 2000. The unmet need for spacing remained nearly unchanged at 16.5% during the same period (Table 5).

4.3. Women's Health status

Malnutrition, micronutrient deficiency and anemia in women increase the risk of maternal mortality [19]. There is evidence of the association between HIV infection and heightened risk of maternal mortality. It was suggested that the HIV epidemic has further complicated efforts to prevent maternal mortality in most sub-Saharan African countries[22]. This section presents trends and determinants of women's nutritional status, the prevalence of anemia and HIV infection using available data from the Ethiopia DHS.

4.3.1. Levels and trends of underweight in women

Body mass index (BMI) is an estimate of body composition that correlates an individual's weight and height to lean body mass. Low values indicate reduced fat stores. The BMI is a useful tool in both clinical and public health practice for assessing the nutritional status. Underweight mothers are at increased risk of maternal morbidity and mortality. We used BMI to assess the malnutrition status

of women. It is calculated by dividing weight in kilograms by height in meters squared (m^2). Three categories were created to estimate the degree/ severity of malnutrition in women (a) underweight (BMI: <18.5 kg/m^2), (b) Normal (BMI: 18.5-24.9 kg/m^2) and (c) overweight (BMI: >24.9 kg/m^2).

As shown in Table 6, the proportion women who gave birth in the previous five years and categorized as underweight is notably high ranged between 25% in 2000 and 23.2% in 2011. The mean BMI estimated at around 20 kg/m^2over the last decade. In general, the prevalence of underweight not only has remained high but also unchanged over the past decade. Few women (less than 5%) were categorized as overweight and the data show a significant increase in the proportion of underweight from 2.3% in 2000 to 3.4% and 4.5%, respectively, in 2005 and 2011.

In the rural areas, the prevalence of underweight has declined slightly but significantly from 26.2% in 2000 to 24.2% in 2011 (Table 7). There was no significant trend in the urban area - 22% in 2000 and 19.3% in 2011. In 2011, the highest prevalence of underweight was documented in Afar (42.9%), followed by Gambella (41.6%), Tigray (34.1%) and Somali (33%) regions. The lowest was in Addis Ababa at 9.4%. Underweight prevalence remained nearly stable in seven out of the 11 regions. Significantly increasing trend can be noted in Tigray from 28.9% to 34.1% during the period 2000 to 2011. On the other hand, significant declining trend has shown in Somali (from 45% to 33%), SNNP (from 25% to 18.6%) and Addis Ababa (from 15.8% to 9.4%).

Table 6. Distribution of women according to their nutritional status by year of survey, 2000, 2005 and 2011 Ethiopia DHS

	2000	2005	2011	P-value (Test for trend)
	N=6420	N=2870	n=6749	
Underweight (BMI: <18.5)	25.7	23.0	23.2	0.284
Normal (BMI: 18.5-24.9)	72.0	73.6	72.4	0.579
Overweight (BMI: >=25)	2.3	3.4	4.5	0.000
Mean BMI (95 % CI)	19.9 (19.8-20.0)	20.2(20.1-20.3)	20.3(20.2-20.4)	

percentage weighted

Table 7: Trend in the prevalence of underweight in women (BMI<18) by residence and region, 2000, 2005 and 2011 Ethiopia DHS

	2000		2005		2011		P-value (Test for trend)
	% underweight	N	% underweight	N	% underweight	N	
Residence							
Urban	21.9	1185	18.3	491	19.3	1377	0.066
Rural	26.2	5235	23.5	2379	24.2	5412	0.036
Region							
Tigray	28.9	677	34.4	276	34.1	754	0.044
Affar	41.5	365	34.5	181	42.9	598	0.635
Amhara	24.2	1,021	19.6	427	21.3	891	0.246
Oromiya	26.0	1,160	20.7	506	24.4	967	0.191
Somali	45.0	349	33.5	171	33.0	453	0.013
Benishangul Gumuz	31.3	474	27.6	212	26.9	561	0.743
SNNP	25.0	905	24.8	505	18.6	900	0.010
Gambela	38.0	431	43.1	174	41.6	552	0.286
Harari	24.3	326	22.9	150	23.1	378	0.297
Addis Ababa	15.8	389	14.6	144	9.4	314	0.035
Dire Dawa	23.0	323	24.8	124	23.8	381	0.807

percentage weighted

4.3.2. Factors influencing underweight in women

We restricted the analysis on the factors affecting underweight in women to the 2005 and 2011 DHS data in order to include anemia and HIV as potential predictors, which are not collected in the 2000 DHS. Table 8 presents adjusted odds ratio (AOR) and 95% confidence interval (CI) of a multivariate Logistic regression model. Several predictors of underweight have been identified in this analysis including region, woman's and husband's/partner's education, household wealth, cluster altitude, availability of toilet in the household, and anemia status. Compared to women in Addis Ababa, women in most regions had significant excess risk of underweight. The odds of low BMI was 3.1 times higher in Gambela compared to Addis Ababa. Similarly, women in Tigray and Afar carried over 2 times higher odds of low BMI compared to those in Addis Ababa. The adjusted excess odds of low BMI was in the range of 1.7 and 1.9 in Somali, Harari and Dire Dawa.

Lower education of the women and their partners both were associated significantly with a higher risk of underweight. Women who had no education and those with elementary education were 37% more likely than those who achieved secondary or higher education to be underweight. Similarly, the risk of being underweight increased by 36% and 25%, respectively, for those whose partners had no education and those whose partners had elementary education, compared to those women whose partners had secondary or high education.

Household wealth emerged among the significant predictors of underweight. Women who resided in households that scored low in the wealth index had a 32% increased risk of being underweight compared to those from households with high wealth score. Medium household wealth score carried a 25% excess risk of underweight.

After adjustment for several factors, this study found significant association between altitude and the risk of underweight in women. Data show women residing in lowlands (altitude area <1000 meters) were 56% more likely than those in highland (2500 + meters) to be underweight.

Health related factors that were found to be significantly associated with underweight were the presence of toilet facility in the household and women's anemia status. A high risk of underweight was associated with the lack of toilet facility in a household. Women in households that had toilet facilities were 15% less likely than those in households without toilet facilities to be underweight. When women are anemic they were more likely to have low BMI and the excess odds of being underweight among anemic women compared to the non-anemic was 16%.

Table 8. Multivariate logistic regression OR in the estimation of the risk of under weight (BMI<18) in women according to selected characteristics, 2005 and 2011 Ethiopia DHS

	Adjusted OR	95% CI	
		Lower	Higher
Year (*2000-2005*)			
2006-2011	1.075	0.960	1.204
Residence (*Urban)*			
Rural	1.185	0.976	1.438
Region (*Addis Ababa*)			
Tigray	2.337	1.606	3.402
Affar	2.149	1.420	3.251
Amhara	1.108	0.758	1.620
Oromiya	1.371	0.943	1.992
Somali	1.725	1.146	2.597
Benishangul Gumuz	1.553	1.038	2.323
SNNP	1.208	0.826	1.767
Gambela	3.108	2.054	4.703
Harari	1.810	1.209	2.708
Dire dawa	1.875	1.248	2.817
Woman's education (*Secondary +*)			
No education	1.377	1.030	1.840
Elementary	1.371	1.035	1.816
Husband's education (*Secondary +*)			
No education	1.357	1.108	1.661
Elementary	1.253	1.032	1.520
Household wealth score (*High*)			
Low	1.318	1.125	1.544
Medium	1.241	1.055	1.460
Age (*35-49 years*)			
15-19 years	1.118	0.850	1.471
20-24 years	0.924	0.763	1.120
25-34 years	0.975	0.854	1.113
Children ever born (*3-4*)			
1-2	1.132	0.968	1.324
5+	0.976	0.850	1.120
Preceding birth interval (*First born*)			
<2 years	1.077	0.873	1.329
2+ years	1.107	0.925	1.325
Cluster Altitude (*2500 + mts*)			
<1000 mts	1.562	1.210	2.016
1000-1499 mts	0.856	0.684	1.069
1500-2499mts	0.972	0.812	1.163

Table 8 (continued)

Preceding birth interval (*First born*)			
<2 years	1.077	0.873	1.329
2+ years	1.107	0.925	1.325
Cluster Altitude (*2500 + mts*)			
<1000 mts	1.562	1.210	2.016
1000-1499 mts	0.856	0.684	1.069
1500-2499mts	0.972	0.812	1.163
Improved water source(*No*)			
Yes	0.904	0.803	1.018
Toilet in the household (*No*)			
Yes	0.851	0.759	0.955
Anemia (*No*)			
Yes	1.162	1.025	1.317
HIV (*Negative*)			
Positive	1.357	0.932	1.975

Reference category in parenthesis

4.3.3. Prevalence and trend of Anemia

Anemia is defined as a hemoglobin concentration lower than 120 g/L for non-pregnant women and 110 g/L for pregnant women as defined by the World Health Organization [30]. Data on anemia is available for the years 2005 and 2011. Table 9 presents the prevalence and trend of anemia.

The prevalence of anemia among women who had a live birth in the five years preceding the surveys decreased significantly from 20% in 2005 to 13% in 2011. Rural women had a significantly higher prevalence of anemia compared to their urban counterparts. The rural-urban gap was much higher in 2005 at 20.9% vs. 9.4%. This difference has persisted in 2011 though significantly narrowed with the rural prevalence being 13.6% vis-à-vis an urban prevalence of 9.2%. There has been significant declining trend in the prevalence of anemia in rural area between 2005 and 2011 from 20.9% to 13.6%. On the other hand, it has remained nearly stable in urban area during the period.

Extremely high prevalence of anemia was documented in Somali (49.9%) and Afar (40.4%) regions in 2011. Prevalence rates were also notably high in Dire Dawa (33.2%), Bensihsangul Gumuz (21.5%), Gambela (21.1%), and Harari (18.8%). Most regions saw a decline in the prevalence of anemia in the past 5 years. Exceptions to this trend are Somali, Afar, Harari and Dire Dawa.

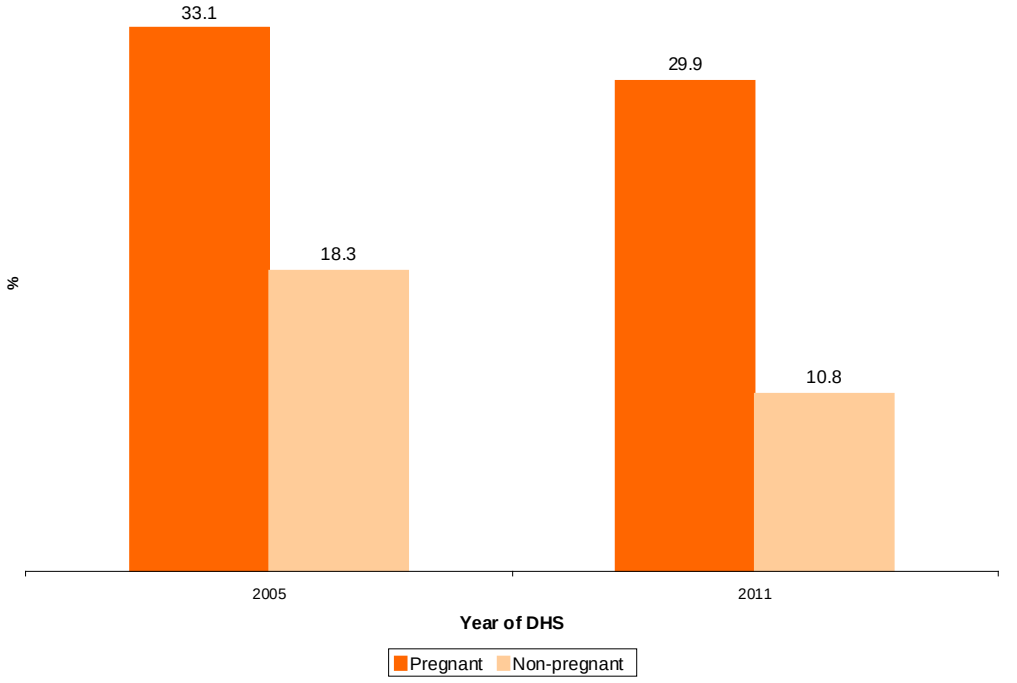
Table 9. Prevalence and trend of Anemia by residence and region, 2005 and 2011 Ethiopia DHS

	2005		2011		P-value (Test for trend)
	% Anemic	N	% Anemic	N	
Residence					
Urban	9.4	425	9.2	1,406	0.912
Rural	20.9	2,583	13.6	6,154	0.000
Region					
Tigray	21.0	318	10.5	834	0.000
Affar	42.2	165	40.4	712	0.786
Amhara	18.7	434	9.6	948	0.000
Oromiya	20.0	561	14.8	1,083	0.065
Somali	42.7	163	49.9	512	0.234
Benishangul Gumuz	32.3	242	21.5	665	0.013
SNNP	16.9	563	9.0	1,039	0.001
Gambela	42.0	176	21.1	600	0.000
Harari	20.5	144	18.8	405	0.643
Addis Ababa	6.2	130	2.6	320	0.088
Dire Dawa	28.0	112	33.2	442	0.418
Total	**20.0**	**3008**	**13.0**	**7560**	**0.000**

percentage weighted

We compared the prevalence of anemia between currently pregnant and non-pregnant women. Among the women who had a live birth in the previous five years of the 2011 survey, 12% were pregnant at the time of interview. The same rate of pregnancy was documented in 2000 and 2005. As shown in Figure 3, the prevalence of anemia was much higher among pregnant women than non-regnant women. In 2005, among those women who had a live birth in the preceding five years were pregnant at the time of interview, 33.1% were anemic. This was lower at 18.3% for the non-pregnant women. There was a slight but insignificant decline in the prevalence of anemia among pregnant women between 2005 (33.1%) and 2011 (29.9%). The data for 2011 revealed a much wider gap in the prevalence of anemia between pregnant (29.9%) and non-regnant women (10.8%).

Figure 3. Prevalence of anemia according to pregnancy status, 2005 and 2011 Ethiopia DHS



4.3.4. Factors influencing the presence of anemia in women

Several factors were examined as determinants of anemia (Table 10). Amongst the factors included in the model, region, women's education, current pregnancy status were significantly and independently associated with the risk of anemia.

In the multivariate analysis, most regions carried significantly higher risk of anemia compared to Addis Ababa. Whereas there was no significant difference in the risk of anemia among women in Tigray, Amhara, SNNP and Benshangul Gumuz regions compared to those in Addis Ababa. The gross association between rural residence and heightened risk of anemia waned in the multivariate analysis after adjusting for several factors. Women's risk of anemia increased by nearly 81% for those who did not have any education when compared with the women with secondary/ higher education. Pregnancy emerged as the major predictor of anemia in this study population. The risk of being anemic is nearly 3 times higher among pregnant women compared to non-pregnant women. Other factors including age, the number of children ever born and HIV were not retained in the multivariate analysis. Studies have shown that HIV is the major risk factor of anemia; the lack of association in this study may be due to low prevalence of HIV in this population.

Table 10. Multivariate logistic regression adjusted OR in the estimation of risk factors for anemia, according to selected variables, 2005 and 2011 Ethiopia DHS

	Adjusted OR	95% CI	
		Lower	Higher
Year (*2000-2005*)			
2006-2011	0.677	0.532	0.861
Residence (*Urban*)			
Rural	1.308	0.901	1.897
Region (*Addis Ababa*)			
Tigray	2.066	1.083	3.938
Affar	9.065	4.729	17.378
Amhara	1.913	1.001	3.657
Oromiya	2.659	1.430	4.944
Somali	11.860	6.261	22.465
Benishangul Gumuz	4.335	2.286	8.221
SNNP	1.818	0.949	3.484
Gambela	5.739	2.958	11.134
Harari	4.110	2.172	7.775
Dire dawa	8.164	4.421	15.074
Woman's education (*Secondary +*)			
No education	1.805	1.037	3.143
Elementary	1.379	0.799	2.380
Household wealth score (*High*)			
Low	1.173	0.910	1.511
Medium	1.176	0.904	1.529
Age (*35-49 years*)			
15-19 years	1.218	0.798	1.860
20-24 years	0.809	0.593	1.104
25-34 years	0.885	0.720	1.088
Children ever born (*3-4*)			
1-2	1.087	0.866	1.365
5+	0.921	0.734	1.155
Improved water source (*No*)			
Yes	1.198	0.984	1.459
Toilet in the household (*No*)			
Yes	0.837	0.681	1.028
Pregnancy status (*Not pregnant*)			
Currently pregnant	2.971	2.404	3.673
HIV (*Negative*)			
Positive	1.149	0.586	2.251

Reference category in parenthesis

4.3.5. HIV prevalence and trend

Overall HIV prevalence is low (1.4%) and remained nearly stable during the previous five years (Table 11). The DHS data confirms previous studies in that prevalence is much higher among urban women than their rural counterparts. In 2005, the proportion of urban women who had a live birth in the preceding five years and were positive for HIV were 9.6%, which was significantly higher than the 0.7% reported among rural women for the same year. There has been a decline in HIV prevalence in the urban area from 9.6% in 2005 to 5.7% in 2011 though not statistically significant. The notably low HIV prevalence in the rural area has remained stable over the past five years. Regional variation in HIV prevalence was apparent. Among women who had a live birth in the preceding five years, the highest HIV prevalence was documented in Addis Ababa at 6.1% followed by Gambela (4.4%), Harari (2.7%), Tigray (2.4%) and Afar (2.1%). Based on the 2011 data, the HIV epidemic in women can be considered notably low in SNNP (0.8%) and Oromiya (0.9%).

Figure 4 presents HIV prevalence by pregnancy status. In 2005, there was no difference in HIV prevalence between pregnant and non-pregnant women. The most recent DHS, on the other hand, come up with a much lower prevalence among pregnant women at 0.2% compared to non-pregnant women (1.5%). This finding is difficult to comprehend as it may be subject to selection bias. It may well be that the widespread HIV testing and counseling in the general population may result in avoiding pregnancy among women who knew their HIV status from previous testing.

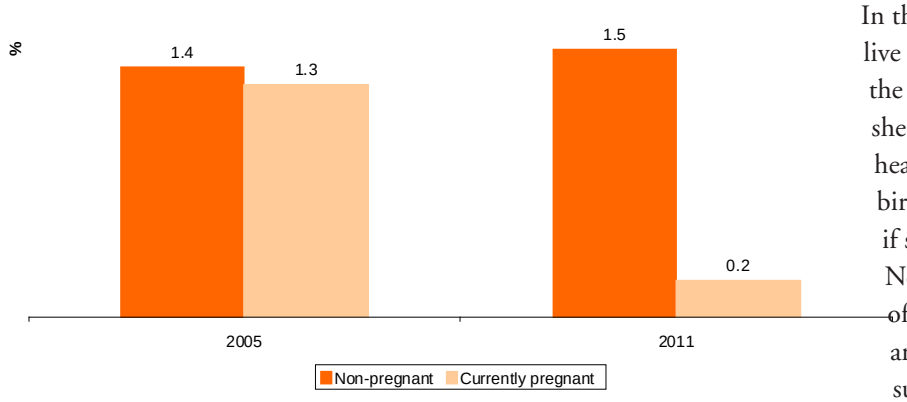
Due to the low HIV prevalence in the country as well as the known limitations of the DHS data for proper investigation of sexual behaviors and other potential risk factors of HIV, we decided to present an analysis of the determinants of HIV infection.

Table 11. HIV prevalence and trend among women who had a live birth in preceding five years by region and residence, 2005 and 2011 DHS - Ethiopia

	2005		2011		P-value (Test for trend)
	% HIV	N	% HIV	N	
Residence					
Urban	9.63	532	5.67	1383	0.135
Rural	0.67	2864	0.70	6122	0.911
Region					
Tigray	1.98	343	2.40	834	0.776
Affar	2.02	208	2.05	705	0.982
Amhara	1.66	492	1.90	937	0.791
Oromiya	1.78	623	0.86	1,080	0.185
Somali	0.61	209	1.43	507	0.419
Benishangul Gumuz	0.64	255	0.78	664	0.821
SNNP	0.00	587	0.96	1,033	0.076
Gambela	2.58	198	4.39	597	0.431
Harari	3.94	185	2.65	397	0.422
Addis Ababa	9.47	159	6.09	316	0.222
Dire Dawa	1.83	137	1.74	435	0.952
Total	**1.40**	**3396**	**1.41**	**7505**	**0.911**

percentage weighted

Figure 4. HIV prevalence by pregnancy status, 2005 and 2011- Ethiopia



4.4. Maternal Health service use

There is sufficient evidence to suggest that high maternal mortality is associated with inadequate and poor-quality maternal health care, as discussed elsewhere in this report. This section presents detailed analyses of the levels, trends and determinants of the three key maternal health service indicators, namely antenatal, delivery and postpartum care services. The analyses also encompassed the contents of antenatal care, missed opportunity for the essential elements of antenatal care, place and assistant during delivery, model of delivery and reasons for not delivering in health facilities. It also presents an analysis of the relationship between antenatal care uptake and usage of intuitional delivery and postpartum care services.

4.4.1. Levels and trends of antenatal care (ANC)

In the DHS each woman who had a live birth during the five years prior to the survey was initially asked whether she had gone for ANC check-up to a health institution for the most recent birth during the reference period and, if so, who she saw for the check-up. Next she was asked at which month of pregnancy she first went for an antenatal check-up and how many such visits she made.

Table 12 shows a significant increase in the proportion of women who had at least one ANC - from 27.2% in 2000 to 28.3% in 2005 and 42.5% in 2011. The increase has been substantial during the period 2005-2011. Despite this notable improvement, women are not receiving adequate number of ANC visits as revealed by the notably low proportion of women who had four or more number of ANC visits. WHO recommends that a woman initiate the first ANC visit in the first trimester of pregnancy and receive at least four ANC visit during the course of pregnancy. In 2011, only 19% had attended four or more number of ANC although this has increased significantly from an even lower coverage of 10.6% in 2000.

A key objective of maternal health care programs has been to ensure that women present for antenatal care early in pregnancy in order to allow enough time for essential diagnosis and treatment. The data suggest that this objective has not been adequately met. Although 42% had at least one ANC in 2011, only 11.1% had started their first visit during the first trimester of pregnancy, 24.4% in the second and the remaining 7% in the third. This has slightly but significantly increased from the 6.2% reported in 2000 (Table 12).

Table 12. Antenatal care (ANC) use for the most recent live birth by year of survey, DHS 2000, 2005 and 2011 - Ethiopia

	2000	2005	2011	P-value
	N=7438	N=6678	N=7855	(Test for trend)
Any ANC visit	27.2	28.3	42.5	0.000
Number of ANC Visits				
No ANC	73.1	71.9	57.7	
1	5.9	4.6	4.4	
2	4.8	4.8	6.5	
3	5.6	6.6	12.4	
4+	10.6	12.1	19.0	0.000
Timing of first ANC				
No ANC	72.8	71.7	57.5	
1st trimester	6.2	6.3	11.1	0.000
2nd trimester	14.7	15.3	24.4	
3rd trimester	6.2	6.7	7.0	

percentage weighted

Using simple linear regression analysis, we looked at yearly (by year of pregnancy) trend in the proportion of women who reported at least four ANC visits during the period 1994-2010. Since the DHS collected birth history questions for all live births in the five years preceding the date of the survey this allows to stretch our analysis date back to 1994. The DHS surveys collected birth history information in the five years preceding the survey, allowing trend analysis during the period 1994-2010. Since the surveys did not specify the type of provider seen at each ANC visit, but sum up all the providers seen throughout the pregnancy, we were able to assess only the total number.

Figure 5a and 5b present trends in the receipt of one or more and four or more ANC visits by year of pregnancy. On average, the proportion that received at least one ANC increases by 3.4% per annum. At the current pace, the proportion that will receive at least one ANC visit by 2015 (MDG deadline) is predicted to reach 47%. The trend analysis also revealed that the receipt of four or more ANC by women increased even at slower pace of 2.6% per annum for the entire country. Trend was much faster in the rural area at 5.4% per annum while the pace of increase was slower at 1.3% per annum in the urban. At the current pace, the coverage of four or more ANC visits for 2015 is predicted at 26.8% for the entire country - 18.3% for the rural and 49.6% for the urban

Table 13 presents trend in the uptake of four or more ANC by urban-rural residence and region. Four out of the 11 regions exhibited significant increasing trend in ANC use in the last decade. The proportion that received four or more ANC increased significantly in Tigray (from 15.9% in 2000 to 30.9% in 2011), in Amhara (from 4.6% to 12.4%), Oromiya (from 10.8% to 18.5%) and Addis Ababa (from 72.1% to 86.6%). Other regions did not exhibit significant trend over the years. Regional variation in the receipt of four ANC is also quite apparent from the 2011 data, ranging from a low of 6.9% in Somali to 86.6% in Addis Ababa. In six of the 11 regions the proportions that received four or more ANC visits were less that 20%.

Figure 5a. Trend in the receipt of one or more ANC visit-1994-2010, Ethiopia

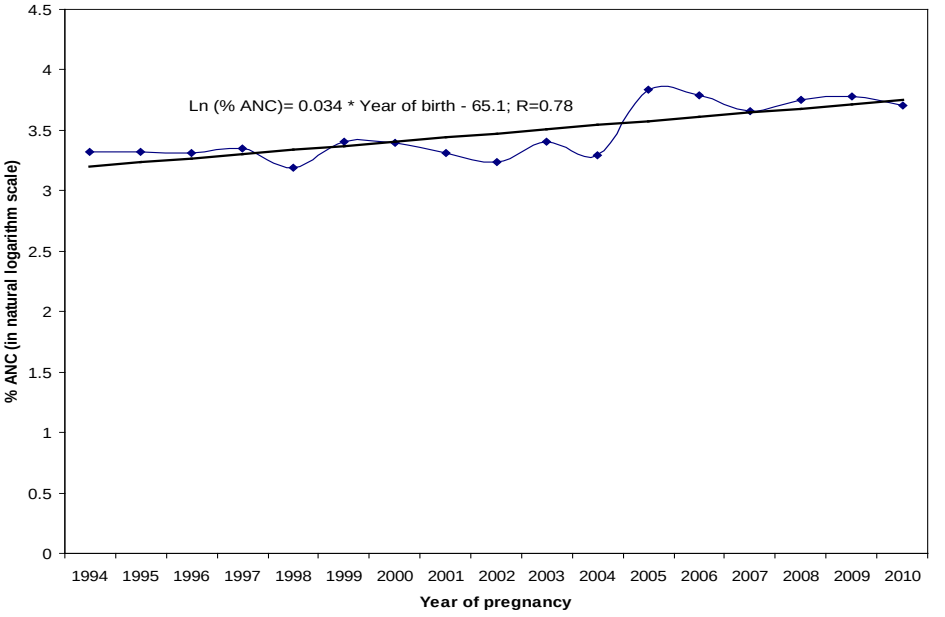


Figure 5b. Trends in the receipt of four or more ANC visit-1994-2010, Ethiopia

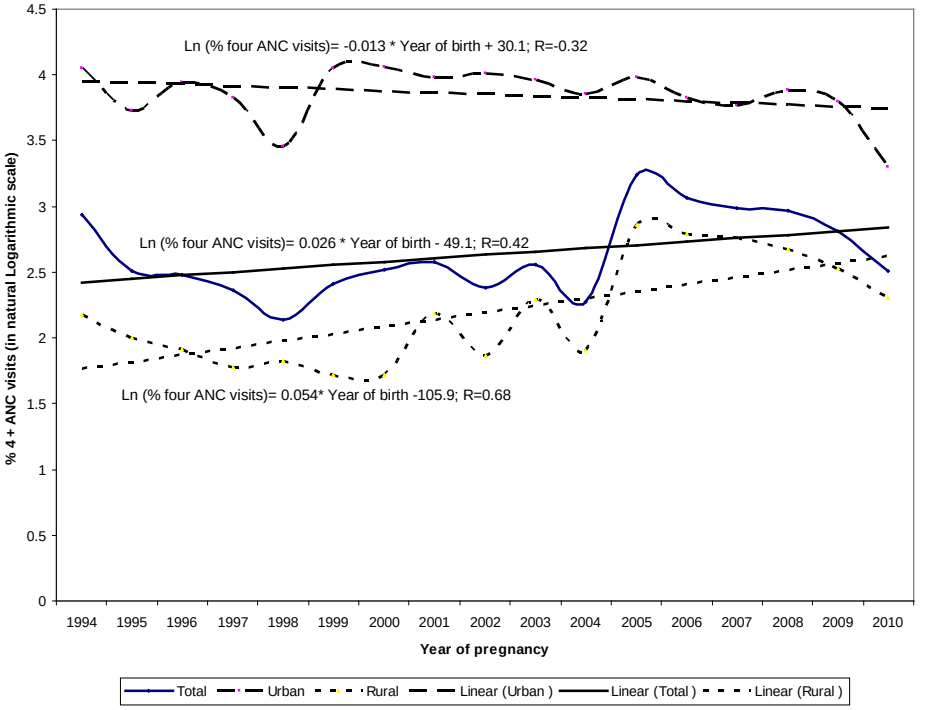


Table 13. Four or more ANC visits for the most recent live birth in the five years preceding the survey by residence and region, DHS 2000, 2005 and 2011 - Ethiopia

	2000		2005		2011		P-value (Test for trend)
	% 4 or more ANC	N	% 4 or more ANC	N	% 4 or more ANC	N	
Residence							
Urban	44.3	1,315	54.7	1,069	45.6	1,533	0.160
Rural	6.2	6,123	8.0	5,609	14.3	6,322	0.000
Region							
Tigray	15.9	776	18.2	679	30.9	852	0.004
Affar	7.2	427	8.4	383	11.4	723	0.484
Amhara	4.6	1,165	7.3	1,047	12.4	983	0.001
Oromiya	10.8	1,368	10.1	1,233	18.5	1,111	0.002
Somali	3.3	430	4.4	399	6.9	565	0.582
Benishangul Gumuz	10.2	552	10.0	465	14.5	683	0.276
SNNP	10.9	1,070	14.7	1,145	17.6	1,064	0.066
Gambela	33.7	479	26.3	390	30.6	614	0.561
Harari	26.0	379	25.6	343	34.8	446	0.262
Addis Ababa	72.1	419	80.9	318	86.6	351	0.000
Dire Dawa	34.3	372	34.0	277	39.4	463	0.731

percentage weighted

4.4.2. Contents of ANC and missed opportunity

Antenatal care provides an opportunity to assess women's health and also provide some essential services such as Tetanus Toxoid Injections (TTI), iron folate, malaria, STI and other treatments. It also serves as a gateway to inform and educate pregnant women on a variety of issues related to pregnancy complications, where to seek care if complication arises, and birth preparedness.

The Ethiopia DHS have asked questions about common elements of antenatal care including taking of weight and height, measurement of blood pressure, taking blood or urine samples. Of note the 2011 DHS did not collect information in the taking of weight and height measurements of pregnant women during ANC visits. Women were also asked whether they received information about danger signs for pregnancy complications. Figures 6 A-F show that among women who received at least one ANC, the proportion that receive the different elements of ANC. The most common elements of ANC that were received by most clients were blood pressure measurement, followed by the provision of TTI, taking of blood sample, and urine testing. Information on the different danger signs of pregnancy complications was rarely provided to women attending ANC.

The proportion of ANC clients that had their blood pressure measured remained nearly unchanged over the years. In 2000, 70.2% of the ANC clients had their weight measured but this declined to 61.9% in 2005. By 2011, this was reported at 71.8%. There have been significant increase in the testing of both blood and urine sample during the period. The proportion of ANC clients who reported giving blood sample increased significantly from 25% in 2000 to 54.1% in 2011.

Likewise, urine testing also increased significantly from 21.4% to 41.5%. The receipt of two doses of TTI also increased notably from 44.6% to 55.8% during the period.

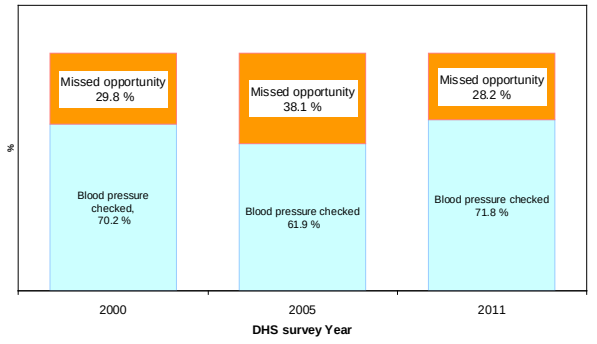
Missed opportunity represents the proportion of women who received ANC but not given the different elements of ANC. This is a useful indicator of the quality of ANC provided to the women. Missed opportunity is the highest for the provision of information about danger signs of pregnancy complication, followed by the testing of urine and blood samples and TTI. The lowest missed opportunity among the ANC elements assessed here was blood pressure testing. Based on the 2011 data, missed opportunity estimated at nearly 80% for information about pregnancy complication, 58.5% for urine testing, 45.9% for blood testing, 44.2% for two doses of TTI and 28.2% for blood pressure testing.

Compared to other elements of ANC, relatively fewer pregnant women were provided with information about the danger signs of pregnancy complication. There has also been a reversal in trend in the provision of such information from 26.9% in 2000, 31.3% in 2005 and 20.3% in 2011. Women were further asked whether they were told about the different signs of pregnancy complication including vaginal bleeding, vaginal gush fluid, severe bleeding, fever and abdominal pain. Although certain obstetric emergencies cannot be predicted through antenatal screening, women can be educated to recognize and act on symptoms that potentially lead to serious conditions [31]. Therefore, the continuity of care starting from raising awareness about danger signs at first level facilities to recognition of such signs at household level to access and receipt of the appropriate care for such complications at referral health facilities is crucial in reducing maternal deaths [32]. Unfortunately, Figure 5F shows this goal of ANC has not been met. In the whole, the vast majority of Ethiopian women were not given adequate information about pregnancy complications and danger signs during the ANC visit. In 2011, only about a tenth were told about abdominal pain and 7.2% about severe headache amongst the danger signs. Other important signs of pregnancy complications such as vaginal bleeding (5.2%), vaginal gush fluid (4.6%), and fever (2.8%) were rarely communicated to pregnant women. There is small variation by residence with the urban women slightly more informed about the different danger signs than their rural counterparts.

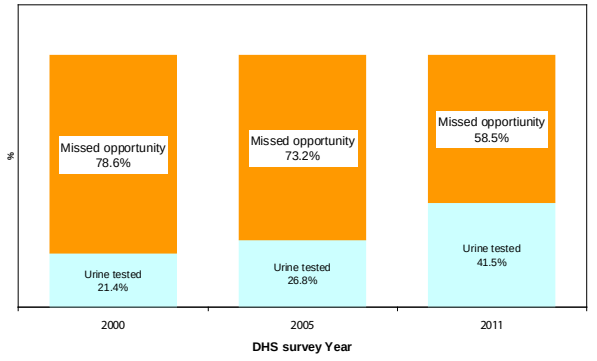
Among ANC clients, 24.1% and 31.3%, respectively, in 2005 and 2011 were given Iron tablets. The temporal trend was not statistically significant. Comparable coverage of Iron tablets during ANC was reported better in the urban and rural areas (Figure 6G).

Figure 6 A-G. Elements of ANC and Missed opportunity for the different services among women who had a least on ANC visit, DHS 2000, 2005 and 2011 - Ethiopia

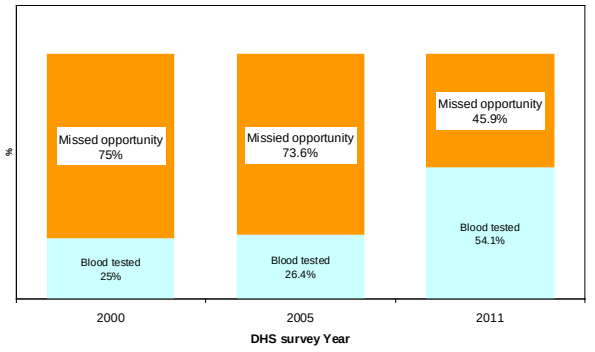
A. Missed opportunity for blood pressure checking during pregnancy



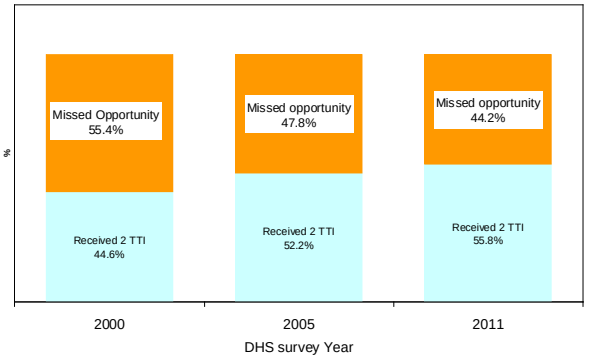
B. Missed opportunity for urine testing during pregnancy



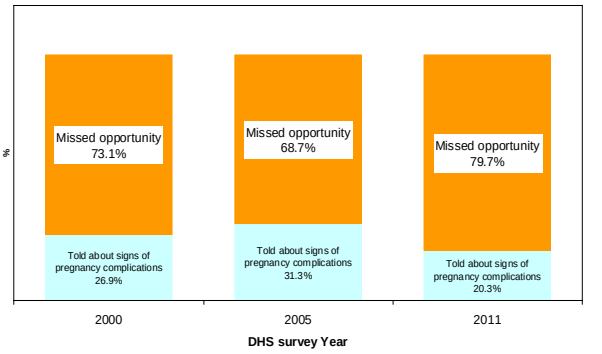
C. Missed opportunity for blood testing during pregnancy



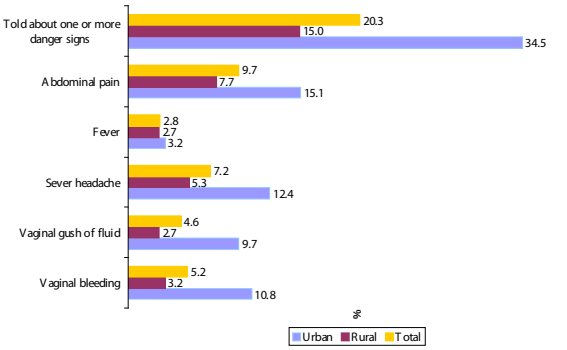
D. Missed opportunity for TTI during pregnancy



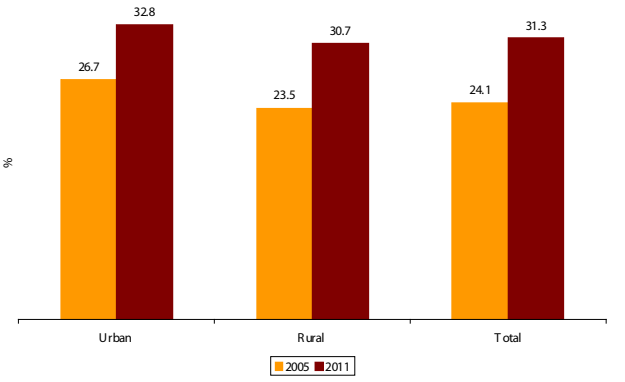
E. Missed opportunity for the receipt of infromation and connseling about signs and symptoms of pregnancy complications



F. Type of information on pregnancy complications given to ANC clients (2011 DHS)



G. Among ANC clients, the proportion who were given Iron Tablets



4.4.3. Levels and trends in delivery care

Evidence suggests that skilled attendance at birth and access to emergency obstetric care are key factors in reducing the risk of maternal death, in both industrialized and developing countries [33]. WHO has defined a skilled attendant as an accredited health professional – such as a midwife, doctor or nurse – who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns [34].

Skilled birth attendant has been identified as a key indicator to track progress towards the MDG 5 target for the reduction of maternal mortality.

On the whole, institutional delivery is notably low in the country despite recent improvements. In 2011, 12.1% of the women who had a live birth in preceding five years delivered in health facility. This represented a two fold increase from the 5.5% reported for the same in 2000 (Table 14). Assistance at delivery by health worker was also quite low at 13.2% in 2011 although this has increased significantly from a low of 6.2% in 2000. The data also indicate that 99% of the home deliveries were not assisted by health workers.

Figure 6 shows trends in the proportion of women assisted by health worker during the period 1995-2011 by year of birth. In general, the country saw an increasing trend in the professionally assisted delivery although the actual level is extremely low. The proportion of women who were assisted by health workers were estimated to increase by 5.6% per annum in the total sample. The trend for the rural area is a bit faster at 6.6% per annum while it was 3.6% per annum for the urban. The coverage of skilled birth attendant was predicted using a simple linear regression equation, separately for the urban and rural areas. At the current pace, the proportion of women who will be assisted by skilled workers will be 20.9% by 2015. This was predicted at 6% in the rural and 54.5% in the urban (Figure 6).

Traditional birth attendants (TBAs) role in assisting women during delivery has dwindled over the last decade, especially since 2005. In 2000, 30.4% of the women were assisted by traditional birth attendants and this has slightly declined to 26.9% in 2005. By 2011 only 7.8% were assisted by TBAs. On the other hand, the proportion assisted by families, friends or neighbors increased from 63.4% to 79% during the period.

Table 14. Percentage distribution of women who delivered in the preceding five years according to place of delivery and assistance during delivery DHS 2000, 2005 and 2011 - Ethiopia

	2000	2005	2011	P-value
	N=7438	n=6678	n=7855	Test for trend
Place of delivery				
Home delivery	94.5	93.1	87.9	
Institutional delivery	5.5	6.9	12.1	0.000
Assistance during delivery				
Health worker	6.2	7.5	13.2	0.000
Traditional Birth attendant	30.4	26.9	7.8	0.000
Families/relatives/friends	63.4	65.6	79.0	
Mode of delivery				
Vaginal	99.3	98.8	98.2	
C-section	0.7	1.2	1.8	0.001

percentage weighted

Figure 7. Trend in institutional delivery by residence, 1995-2011 - Ethiopia

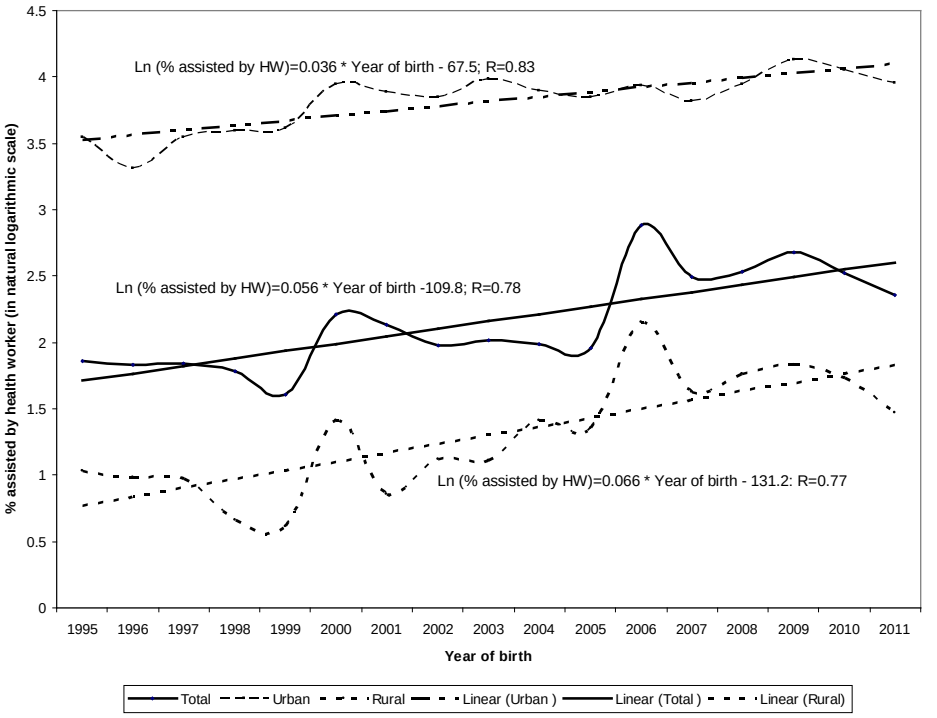


Table 15. Percentage distribution of skilled birth attendants by residence and region, DHS 2000, 2005 and 2011 - Ethiopia

	2000		2005		2011		P-value (Test for trend)
	% assisted by Health worker	N	% assisted by Health worker	N	% assisted by Health worker	N	
Residence							
Urban	37.1	1,315	49.0	1,069	54.4	1,533	0.003
Rural	2.2	6,123	3.0	5,609	5.3	6,322	0.000
Region							
Tigray	6.8	776	8.1	679	15.7	852	0.033
Affar	7.4	427	6.9	383	8.9	723	0.728
Amhara	3.9	1,165	4.8	1,047	11.5	983	0.000
Oromiya	4.7	1,368	6.5	1,233	11.0	1,111	0.008
Somali	8.1	430	6.7	399	11.1	565	0.650
Benishangul Gumuz	11.5	552	20.6	465	19.8	683	0.327
SNNP	5.2	1,070	5.2	1,145	9.4	1,064	0.076
Gambela	25.2	479	20.4	390	31.4	614	0.112
Harari	31.3	379	38.0	343	39.2	446	0.557
Addis Ababa	70.4	419	81.5	318	83.4	351	0.013
Dire Dawa	36.3	372	32.7	277	49.9	463	0.146

percentage weighted

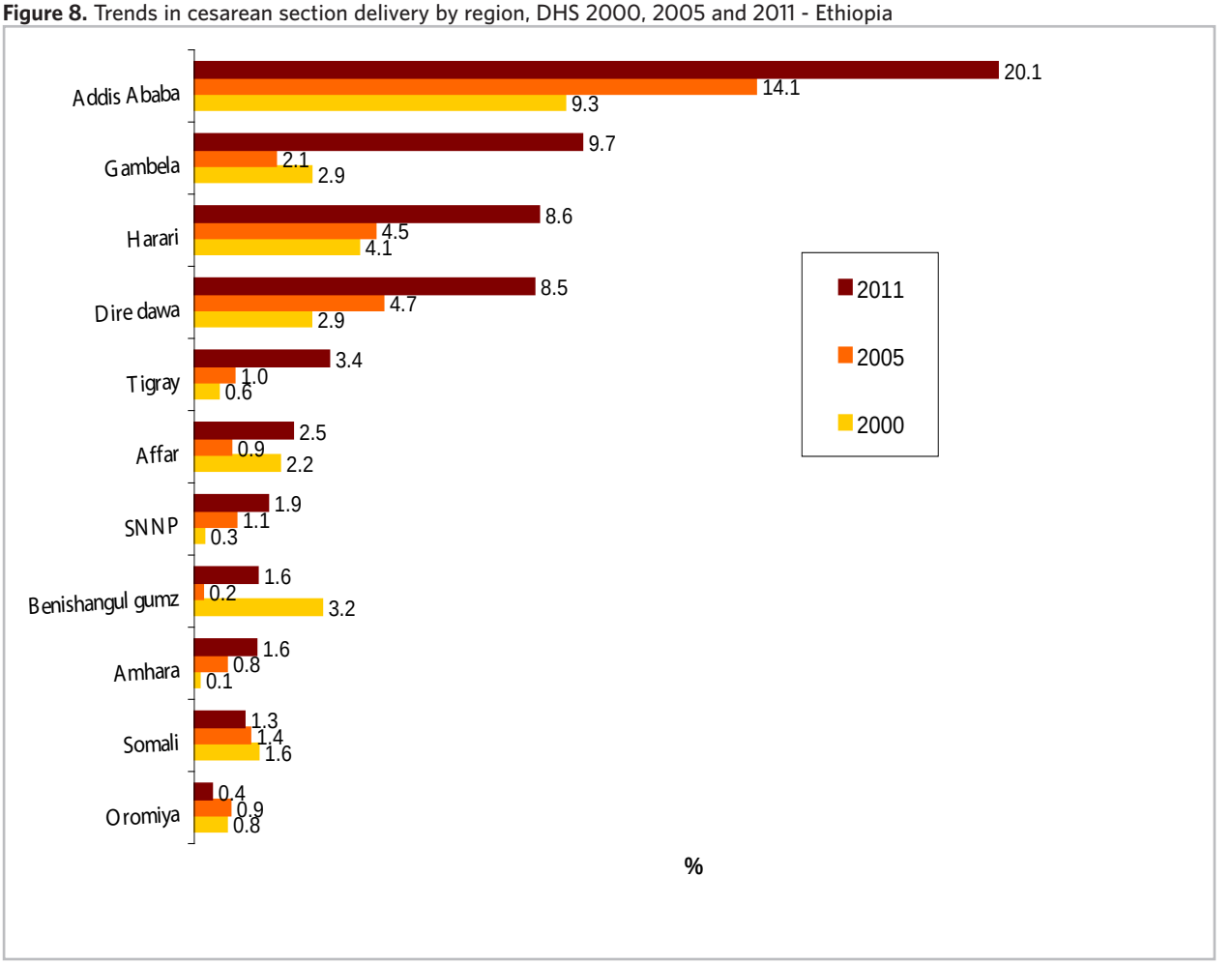
Regional variation in the proportion assisted by health workers can be apparent from Table 15. Coverage was the highest in Addis Ababa at 83.4% in 2011. This was followed by Dire Dawa 949.9%), Harari (39.2%), and Gambella (31.4%). Coverage were below 20% for the rest of the regions and it was below 15% for five regions. Of note, the most populous regions of Oromiya (11%) and Amhara (11.5%) were among the lowest coverage regions.

Four out of the 11 regions saw significant increasing trend in the proportion assisted by health institutions during the period 2000 to 2011 - Tigray from 6.8% to 15.7%, Amhara from 3.9% to 11.5%, Oromiya from 4.7% to 11%, and Addis Ababa 70.4% to 83.4%.

4.4.4. Caesarean section delivery

A higher caesarean section percentage suggests the availability of obstetric care, which is offered primarily in institutional facilities. It is well recognized that very low and or very high levels of caesarean section are dangerous. WHO has proposed that in a country a rate of 5-15 percent of births undergoing a caesarean section is optimal, and a rate above 15 percent in a country is not recommended [35]. On the whole, caesarean delivery is extremely low with a coverage rate as low as 1.8% according to the 2011 DHS (Table 14). In seven out of the 11 regions the rate of caesarian section was below 2%. Rates were in the range of 8-10% in Gambella, Harai and Dire Dawa. The highest rate of caesarean section delivery was reported in Addis Ababa at 20% according to the 2011 DHS. This may well indicate the variation in the availability of obstetric care services by region, the region with the highest rate of caesarian section having higher obstetric care services. There was also a significant increasing trend in the rate of caesarian section delivery in Addis Ababa (from 9% in 2000 to 20% in 2011), in Dire Dawa (from 3% to 8.5%), Harari (from 4.1% to 8.6%), Gambella (3% to 9.7%) and Tigray (0.6% to 3.4%) regions (Figure 8).

Figure 8. Trends in cesarean section delivery by region, DHS 2000, 2005 and 2011 - Ethiopia



4.4.5. Reason for not delivering in health institution

Women who did not deliver in health facilities were asked the reasons for not doing so. The 2011 data revealed that the two outstanding reasons were "not necessary" and "not customary", as reported by 61.4% and 29.6%, respectively (Figure 9A). These were followed by place too far/lack of transportation (14.4%). Other reasons were reported by a tiny portion of the women. Only very few (2.1%) blamed service cost as a reason for not delivering in health facilities. Notably, the reporting of these reasons follow similar pattern both in the urban and rural areas. Strikingly, about two-third of the urban women who did not deliver in health facilities said it was not necessary and 17% said it was not customary.

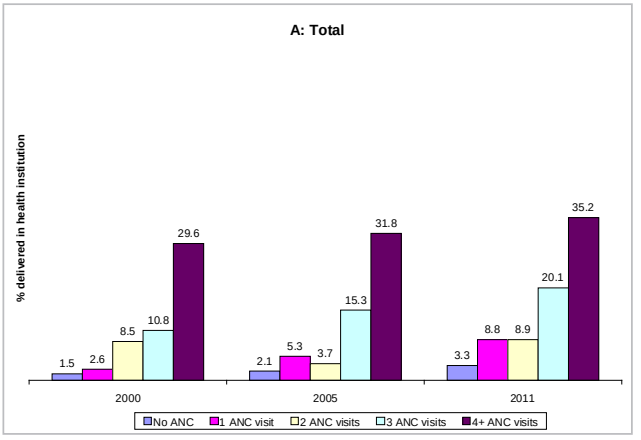
We also looked at the distribution of the three leading reasons by region (Figure 9B). Likewise the vast majority of the women who did not deliver in the health facilities saw delivery in the health institution as unnecessary across all the regions, ranging from 33% in Benishangul Gumuz to 83% in Gambela. The reporting of "not customary" was the highest in Afar (41%), Benishangult Gumuz, Somali and Amhara. In the emerging regions i.e. Afar, Somail, Gambela and Benishangul Gumuz physical access was reported among the barriers to up taking institutional delivery on top of the other reasons.

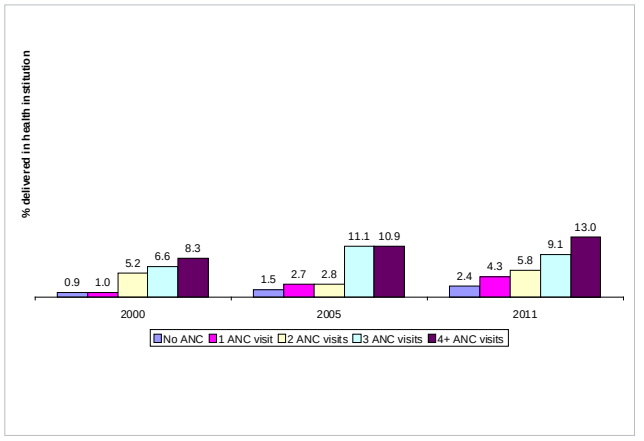
4.4.6. The relationship between ANC and institutional delivery

There appears a dose response relationship between use of antenatal care and delivery assisted by a health professional both in the urban and rural areas. According to the 2011 data, the proportion of women that delivered in health institution increased from a low of 3.3% among those who did not have any ANC, to 8.8%, 8.9%, 20.1% and 35.2%, respectively, among those who had one, two, three and four or more ANC visits (Figure 10a). The same dose-response relationship can also be noted for the 2000 and 2005 surveys data (Figures 10b and 10c).

Notably, despite the low coverage of institutional delivery in the rural area, those women who received four or more ANC were the most likely to deliver in the health institutions. For instance, the 2011 data shows that only 2.4% of those who did not attend any ANC were delivered in the health institutions. This has increased significantly to 13% for women with four or more ANC visits. Though the dose-response relations is less apparent in the urban than in the rural, having had four or more ANC visits is consistently shown to be associated with the highest use of instructional delivery in the urban area (Figure 9c).

Figure 10 A-C. Proportion who had institutional delivery according to their ANC uptake, DHS 2000, 2005 AND 2011- Ethiopia





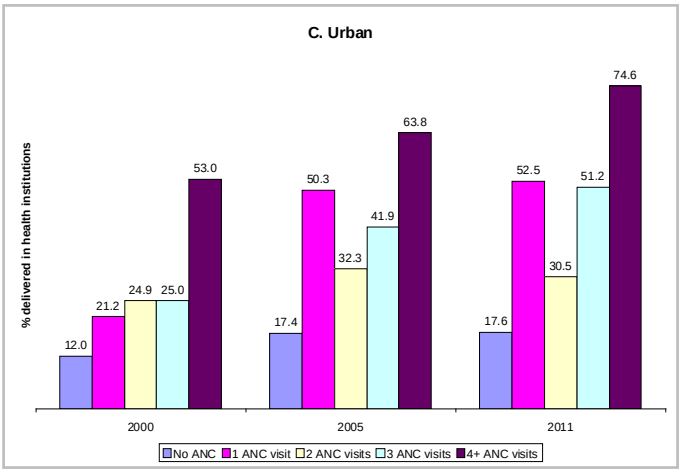
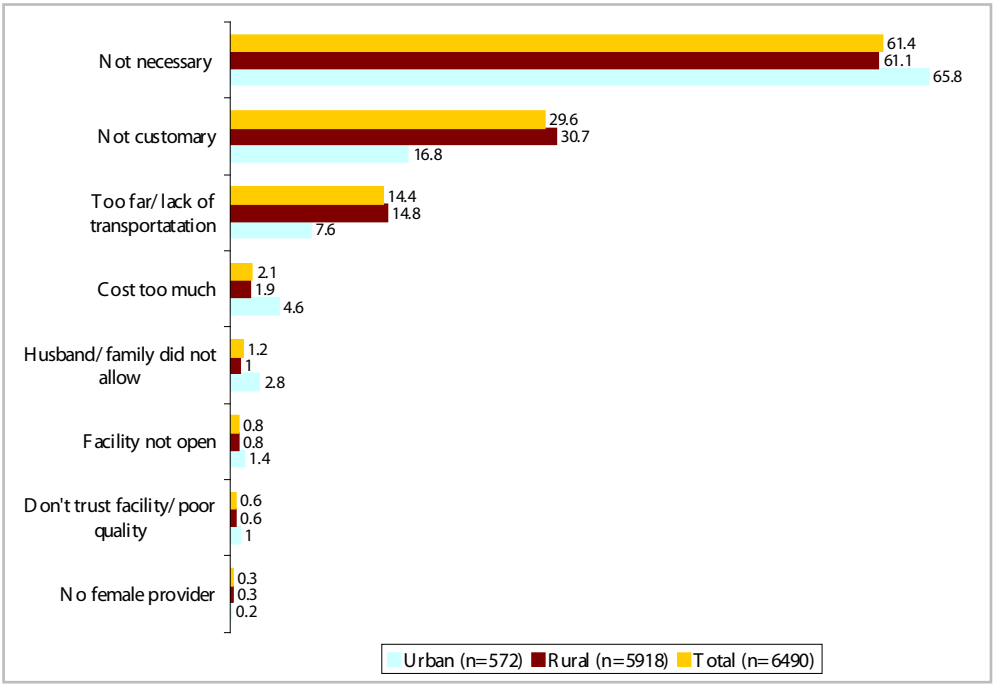
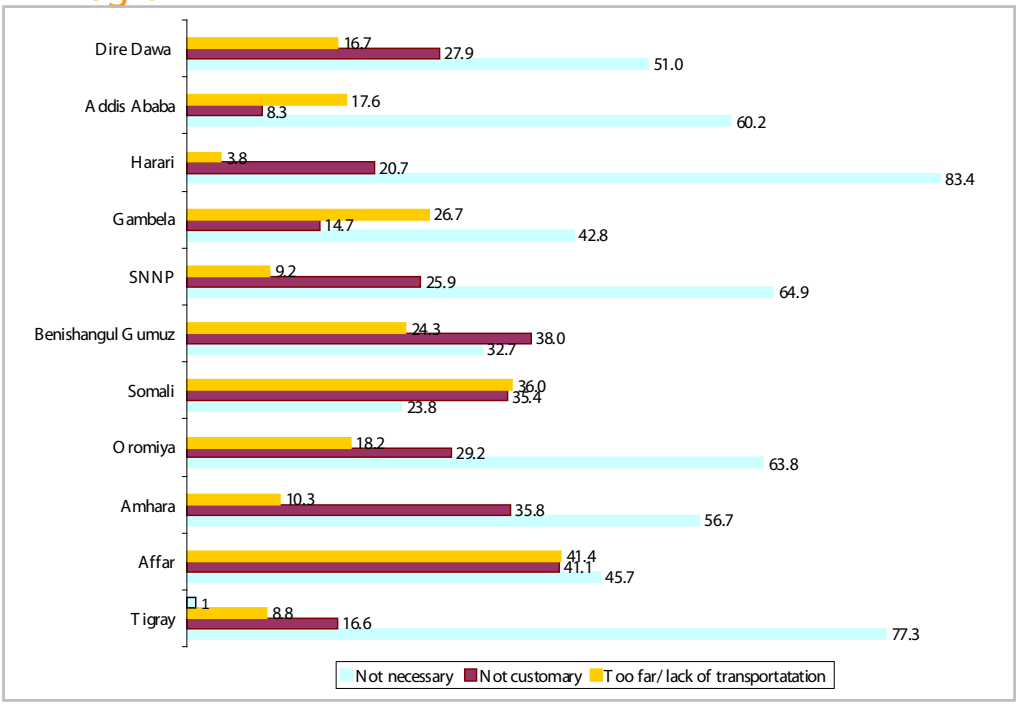


Figure 9. Reasons for NOT delivering in health institution, DHS 2011-Ethiopia (A: by residence, B: by region)

A: Residence



B: Region



4.4.7. Postpartum care

The postpartum period, or puerperium, starts about an hour after the delivery of the placenta and includes the following six weeks. Postpartum care should respond to the special needs of the mother and baby during this special phase and should include: the prevention and early detection and treatment of complications and disease, and the provision of advice and services [36].

Women who reported visited by health worker within six weeks (0-42 days) after delivery are considered receiving Postpartum Care (PPC). In addition, women who delivered in health institutions are considered as receiving postpartum care. Accordingly, 12.8% of the women who had a live birth in the five years preceding the 2011 survey reported to have had PPC. There has been significant positive trend since 2000. In general, few mothers received PPC in the rural area although it slightly increased from 3.4% in 2000 to 5.6% in 2011, which was mainly due to the increase in institutional delivery. As expected, the PPC rate was much higher in the urban than that in the rural. It also increased significantly from 41% in 2000 to 53.7% in 2011.

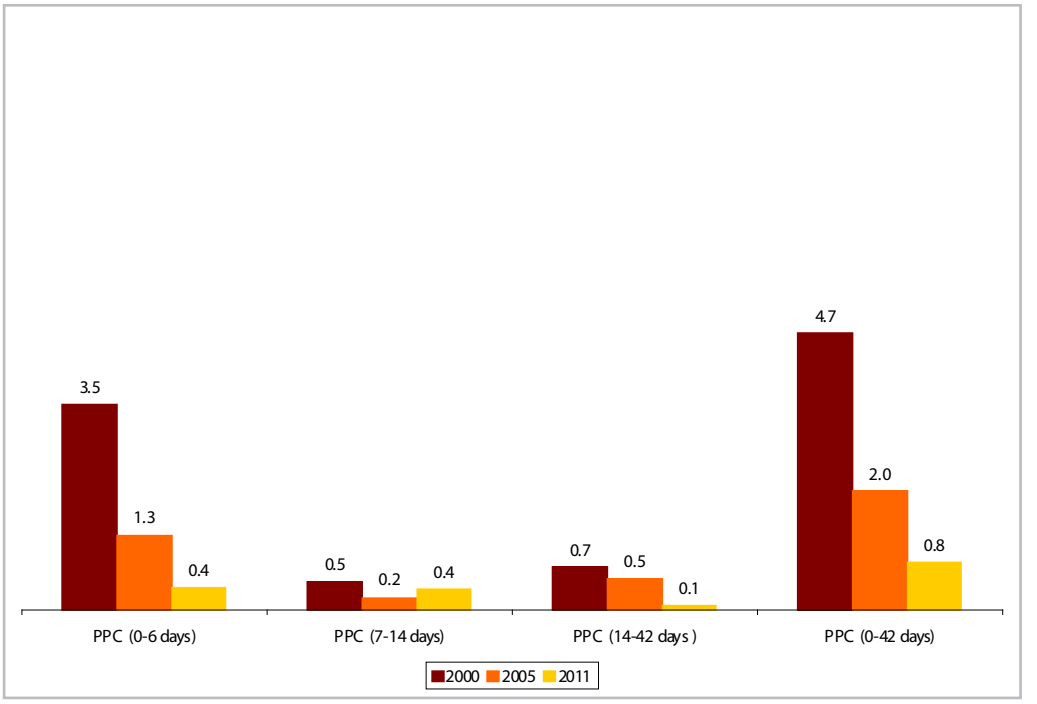
In eight of the 11 regions, the proportion of women who received PPC has not changed significantly over the past decade. Trends were significant in Amhara (from 5.3% in 2000 to 11.4% in 2011), Oromiya (from 5.9% to 10.6%), and Addis Ababa (72.9% to 83.1%).

Table 16. Distribution of women according to postpartum care by residence and regions, DHS 2000, 2005 AND 2011- Ethiopia

	2000		2005		2011		P-value (Test for trend)
	%PPC by health professional	N	% PPC by health professional	N	% PPC by health professional	N	
Residence							
Urban	41.0	1,315	52.4	1,069	53.7	1,533	0.032
Rural	3.4	6,123	4.0	5,609	5.6	6,322	0.004
Region							
Tigray	8.9	776	9.7	679	15.8	852	0.115
Affar	8.4	427	7.0	383	9.2	723	0.836
Amhara	5.3	1,165	5.4	1,047	11.4	983	0.003
Oromiya	5.9	1,368	7.1	1,233	10.6	1,111	0.044
Somali	10.0	430	7.1	399	9.3	565	0.800
Benishangul Gumuz	11.9	552	20.7	465	19.1	683	0.228
SNNP	6.7	1,070	6.0	1,145	8.4	1,064	0.532
Gambela	32.4	479	23.0	390	34.4	614	0.228
Harari	34.2	379	38.5	343	39.4	446	0.757
Addis Ababa	72.9	419	83.0	318	83.1	351	0.036
Dire Dawa	39.2	372	32.9	277	48.7	463	0.255
Total	**7.7**	**7437**	**8.3**	**6679**	**12.8**	**7855**	**0.000**

percentage weighted

Figure 11. Among women who delivered at home, the proportion who received PPC, DHS 2000, 2005 AND 2011- Ethiopia



It is of interest to know the proportion of women who delivered in the homes and received PPC. In general PPC among home deliveries can be considered virtually non-existence. As shown in Figure 11 among women who delivered in the homes, a tiny portion (0.8%) reported to have received PPC as per the most recent DHS. Of note, there was a significant declining trend in the receipt of PPC from 4.7% in 2000 to 2% and 0.8%, respectively, in 2005 and 2011. The proportion that received PPC in the first week also declined significantly from 3.5% in 2000 to 0.4 in 2011.

4.4.8. Determinants of maternal health care use

Three models were estimated: (1) the first assesses the factors that shaped ANC use (model 1), (2) the second assesses factors influencing delivery in health institutions (model 2) and (3) the third model assesses postpartum use among women who delivered in the home (model 3)- Table 17. The multivariate models are based on binary Logistic Regression analyses. The outcome variable for model 1 was defined as "having attended at least four ANC visits". We intentionally did not use the indicator "having attended at least one ANC visit" as an outcome since this would have been inappropriate to adequately inform policy makers interested in increasing steady, rather than sporadic ANC utilization. Furthermore, adequate ANC requires at least four visits. The outcome variable for model 2 was defined as "having delivered in a health facility" and for model 3 "having received postpartum care by health worker in the first 42 days after delivery (among those who delivered at home)". The independent variables included in the analysis are mostly self explanatory.

The factors that significantly shape the use of four or more ANC visits are broadly categorized as contextual, socio-economic and fertility behaviors. Among the contextual factors studied, both urban-rural residence and region retained in the multivariate analysis after adjustment for several confounders. The gross association between residence and four or more ANC use has retained in the multivariate analysis. The likelihood of

having four or more ANC visit was 3.6 times higher in the urban than in the rural. Compared to Addis Ababa, the likelihood of having four or more ANC visit was significantly lower in any of the other regions.

Socio-economic factors that significantly influence four or more ANC visits include women's and partner's education, household wealth and marital status. The odds of having four or more ANC increased by 1.6 and 3.2 times, respectively, among women with elementary and secondary or higher education compared to women with no education. Similar association can also be noted with partners' education. The influence of household economy status, as measure by household wealth score, on the probability of having four or more ANC visits has also been demonstrated in the model. Women in households scoring medium and high in the wealth index were 1.4 times and 2.2 times, respectively, more likely than those in households with low wealth index to seek four or more ANC visits. Married women were 26% more likely than unmarried women to seek four of more ANC.

Women's fertility behavior as measured by age at pregnancy, preceding birth interval and wontedness status of the pregnancy were significantly and independently associated with the likelihood of up taking four or more ANC. Younger age at pregnancy (<18 years) carried a 22% lower odds of seeking four or more ANC visits compared to women age 18-34 years at the time of pregnancy. Older women age 35-49 years are not significantly different from those age 18-34 years in their likelihood of up taking four or more ANC visits. Compared to women whose preceding birth interval was two or longer years, those who became pregnant within less than two years of the previous delivery were 17% less likely to have had four or more ANC visits. Higher birth order is inversely associated with the likelihood of having four or more ANC visits. The odds of receiving four or more ANC visits declined significantly by 24% and 20%, respectively, among women with 3rd or 4th order pregnancy and those with 5th or higher compared to those with a birth order of 2 or less. Women's fertility preference as measured by wantedness of pregnancy appeared to influence ANC uptake in our analysis. The odds of receiving four or more ANC visits was 12% higher for women whose pregnancy was intended compared to those having unintended pregnancy.

The factors that significantly influence institutional delivery also revolve around contextual, socio-economic, and fertility behavior. On top of these, we also found the role of ANC use and the receipt of information about pregnancy complication during pregnancy in shaping women's likelihood of delivering in health institution.

As clearly demonstrated in the univariate analysis elsewhere above, urban women were significantly more likely than their rural counterparts to deliver in health institution (Adjusted OR=6.5). After adjustment of several factors, women in most regions of the country with the exception of Dire Dawa, Harari and Benishangul Gumuz, were significantly less likely than those in Addis Ababa

to deliver in health institutions. Both women and partner education were significantly associated with instructional delivery. Secondary or higher education in women carried a 2.4 times higher odds of delivering in health institution. Even elementary education appeared to be associated with higher likelihood of delivering in the health institution (OR=1.4). Similar findings can be noted for the role of partner's education on institutional delivery.

Whereas there was no increased likelihood of delivering in health institution associated with women in households with medium wealth score, those in households with high wealth score were found to have a 1.54 times increased odds of delivering in the health institution. Of note, medium wealth score was associated positively with the likelihood of up taking four or more ANC visits.

Women who have just initiated child bearing were significantly more likely than others to deliver in health institution. By contrast, those women with higher order pregnancy (5 or more children) were less likely to deliver in health institution. For high gravid women i.e. pregnant with their 5th or higher babies the likelihood of delivering in health institution significantly decreased by 20% compared to those with their 2nd or 1st pregnancy.

The multivariate analysis further confirms the link between ANC use and institutional delivery. The dose-response relationship described elsewhere above in this paper is also apparent in the multivariate analysis. Higher number of ANC visits is associated with an increased likelihood of delivering in the health institution. The odds of delivering in health intuition was 1.8, 2.7 and 4 times higher, respectively, for women who have had only 2, 3 and 4 or more ANC visits during pregnancy compared to women who did not have a single ANC visit. Of note, one ANC visit is not significantly associated with a higher likelihood of delivering in health institution. Another interesting finding in relation to ANC visit is the positive influence of receiving information about the danger signs of pregnancy complication on women's subsequent decision to deliver in health intuition. There appears a 45% excess odds of delivering in health institution if women were told about the danger signs of pregnancy complication during ANC visits. This association can be bi-directional if health workers selectively inform about pregnancy danger signs to those women with some pregnancy complications who in turn are more likely to deliver in health intuition.

Since the vast majority of the women were delivered in the homes, postpartum care is of paramount importance. In model 3 we presented multivariate results of the factors influencing postpartum uptake among women who delivered in the homes. Variation by residence is apparent with urban women were found 2.5 times more likely than their rural counterparts to receive PPC. Regional variation in the uptake of PPC among women who delivered in the homes was virtually non-existence with the exception Gambela women who happened to have a nearly 2.5 times higher likelihood of receiving PPC compared to women in Addis Ababa.

The role of maternal and partner's education also emerged. Secondary or higher education in women was associated with a 1.9 times increased use of PPC compared to women with no education. But elementary education did not carry any significant higher likelihood of having PPC. On the other hand, both elementary and secondary schooling of partners significantly associated with increased utilization of PPC.

A dose-response relationship emerged between ANC uptake and PPC. The likelihood of having PPC increased significantly by over fourfold among women who have had 3 or more ANC visits compared to women who did not have any ANC. Even a single ANC visit was associated with a twofold increased uptake of PPC.

Table 17. Multivariate Logistic regression adjusted odds ratios in the estimation of the uptake of four or more ANC, institutional delivery, and PPC (among home deliveries), according to selected characteristics, DHS 2000, 2005 AND 2011- Ethiopia

	Model 1 Four or more ANC Visits AOR (p-value)	Model 2 Institutional Delivery AOR (p-value)	Model 3 Postpartum care by health workers (among home deliveries) AOR (p-value)
DHS survey year (*2000*)			
2005	1.145	1.734***	0.518***
2011	1.626***	2.149***	0.237***
Residence (*Rural*)			
Urban	3.640***	6.532***	2.512***
Region (*Addis Ababa*)			
Tigray	0.411***	0.173***	0.946
Affar	0.085***	0.170***	1.357
Amhara	0.132***	0.265***	0.758
Oromiya	0.211***	0.224***	0.802
Somali	0.062***	0.250***	0.996
Benishangul Gumz	0.227***	1.057	1.003
SNNP	0.296***	0.161***	0.891
Gambela	0.420***	0.733*	2.475**
Harari	0.188***	0.775	0.684
Dire Dawa	0.297***	0.753	0.591
Woman's education *(No education)*			
Elementary	1.627***	1.364***	0.942
Secondary +	3.241***	2.409***	1.937**
Husband's education *(No education)*			
Elementary	1.393***	1.474***	1.385*
Secondary +	2.008***	2.362***	1.717*
Household wealth index (*Low*)			
Medium	1.389***	1.003	1.058
High	2.246***	1.539***	1.603
Marital status (*Not married*)			
Currently in union	1.263*	0.965	0.975
Age at pregnancy/birth *(18-34 years)*			
<18 years	0.780*	0.765	1.473
35-49 years	0.958	1.175	1.237
Preceding birth interval (*First born*)			
<2 years	0.838*	0.920	0.978
2+ years (ref)	1.000	1.000	1.000

*Reference category in parenthesis; *p<0.05, **p<0.001, ***p<0.0001*

Table 17 continued

	Model 1 Four or more ANC Visits AOR (p-value)	Model 2 Institutional Delivery AOR (p-value)	Model 3 Postpartum care by health workers (among home deliveries) AOR (p-value)
Birth order (*Two or less*)			
3-4	0.761**	0.852	0.881
5+	0.805**	0.797*	1.159
Pregnancy intended (*No*)			
Yes	1.119*	1.076	0.848
Number of ANC visits (*No ANC*)	N/A		
Only 1 visit		1.241	2.271**
2 visits		1.844***	3.529***
3 visits		2.718***	4.329***
4 or more visits		4.011***	4.392***
Told about signs of pregnancy complications during ANC (*No*)	N/A		
Yes		1.452***	1.811***

*Reference category in parenthesis; *p<0.05, **p<0.001, ***p<0.0001; NA=Not applicable*

4.5. Maternal Death Risk Factors Index

Overview of the method:

There is currently an unprecedented expressed need and demand for estimates of maternal mortality in developing countries, which has been stimulated in part by the creation of a Millennium Development Goal that will be judged partly on the basis of reductions in maternal mortality by 2015 [37]. The maternal mortality ratio is often costly and complicated to measure. Shortcomings in the maternal mortality data leave no alternative but to derive an estimate of the level of maternal mortality using a number of strong assumptions and to accept a high degree of uncertainty [38].

The Ethiopia DHS provides a single Maternal Mortality Ratio (MMR) estimate for the entire country. It is well recognized that DHS small sample size and methodological limitations are to blame for this. There is a clear regional data gap on maternal mortality in the country for evidence-based programming. This necessitates disaggregating data at least to the regions level in order to identify regions for priority intervention. Cognizant of this data gap, we propose a simple method for ranking regions according to their potential maternal death burden based primarily on several intermediate determinants of maternal mortality that are discussed elsewhere above in this report. With recognition of some uncertainties, the method we are proposing here can be extended to predict maternal mortality ratio for each region, urban-rural residence and socio-economic status. Detail description of the method is presented in Annex 1.

In brief, the method is developed based on 11 intermediate determinants of maternal mortality broadly categorized as reproductive status, health status and the use of maternal health services including cesarean section delivery (an indicator of

access to obstetric care services) that are discussed elsewhere above in this report (see Annex 2 for details about the intermediate determinants). Principal components analysis (PCA) was used to assign weights for each determinant. STATA Factor Analysis procedure was used to generate the factor loadings for each of the determinants. The weighted sum of the determinants yielded a continuous variable that is labeled here as a maternal death risk factor index (MDRFI). This variable ranges from 0 to higher integer value. Zero value indicates the absence of any of the 11 intermediate risk factors. Higher mean values imply the presence the risk factors in excess. By implication, higher MRDFI suggest high maternal mortality burden while lower MRDFI values suggest low maternal mortality burden.
To predict MMR for regions, a simple mathematical relationship was established between the MRDFI and MMR.

We acknowledge the fact that gauging maternal mortality burden via a risk approach, as we propose here, has obvious limitation because pregnancy complications and maternal death can arise both from predictable and unpredictable factors. Other than a lack of access to or use of health services, or poor health conditions prior to or during a pregnancy, or a woman's reproductive status, women who are from advantaged backgrounds, who have ample access to high-quality health services (including antenatal care), and who are in good health prior to pregnancy do experience serious obstetric complications for reasons that cannot be explained or predicted [8]. But our approach rests on the assumption that the unpredictable factors of maternal mortality and other factors that are not measured by the DHS (e.g. indicators of emergency obstetric services) are assumed to be either inversely correlated with the MDRFI or equally distributed across regions. This assumption appears fairly valid since it is unrealistic to anticipate a positive relationship between MDRFI and, for example, population access to emergence obstetric service. Such services are expected to be more apparent in urban areas and regions with better access to maternal health services, which in turn have lower MDRFI values. With stipulation of its limitations, the maternal death risk factor index (MDRFI) we are proposing here can be used as a potential indicator to rank regions and socio-economic classes according to their maternal mortality burden as well as to track progress in maternal health.

Maternal mortality burden by region, urban-rural residence and socio-economics:

Figures 12A-D; present the mean values of the MDRFI by region, urban-rural residence, education status, and household wealth. Regional mean MDRFI values show that the maternal mortality burden appeared by far the highest in Somali (mean=3.33) and Afar (mean=3.21) regions. For instance, compared to Addis Ababa, the maternal mortality burden is about 3 times higher in Somali and Afar regions. Next to Afar, notably high MDRFI mean values were found in SNNP (mean=3.11), Amhara (mean=3.09), and Oromiya (mean=3.08) regions. The three most populous reigns of the country, namely, SNNP, Oromiya and Amhara, constitute over 75% of the country's population and significantly influence the overall maternal mortality burden in the country. Benishangul Gumuz, Tigray and Gambela are next in the list with notably high MDRFI values. As expected, Addis Ababa has the lowest MDRFI (mean=1.04. Both Dire Dawa and Harari are in the lowest category but with substantially higher excess mortality burden than in Addis Ababa.

Urban-rural and socio-economic differentials in maternal mortality are apparent. The mean value of MDRFI for the urban area was significantly higher than in the rural (3.2 vs. 1.99, $p<0.0001$). Irrespective of their place of residence, educated, and wealthier women were found to have a relatively lower maternal mortality burden. Women

who have achieved secondary or higher education rated the lowest in the MDRFI index both in the urban and rural areas. Higher wealth is associated with lower MDRFI values both in the urban and rural areas.

The predicted maternal mortality ratios (MMRs) by region for the year 2011 are shown in Figure 13. According to the prediction (See Annex 1), maternal mortality ratio is higher than the national average (676/100,000 live births) in five out of the 11 regions; the highest being in Somali (747 per 100,000 live births) and Afar (717 per 100,000 live births). These were followed by SNNP, Amhara, and Oromiya regions, with predicted MMRs marginally higher than the national average. Benshangul Gumuz, Tigray and Gambella exhibited MMRs a little bit lower than the national average. The predicted ratios in Harari and Dire Dawa are significantly lower that the national average. Although Addis Ababa predicted to have the lowest maternal mortality ratio of any other region, the predicted MMR of 234 per 100,000 appears unacceptably high by any standard.

Figures 12A-E. Mean distribution of MDRFI values according to (A) region, (B) residence, (C) women's education, and (D) household wealth, Ethiopia DHS 2011

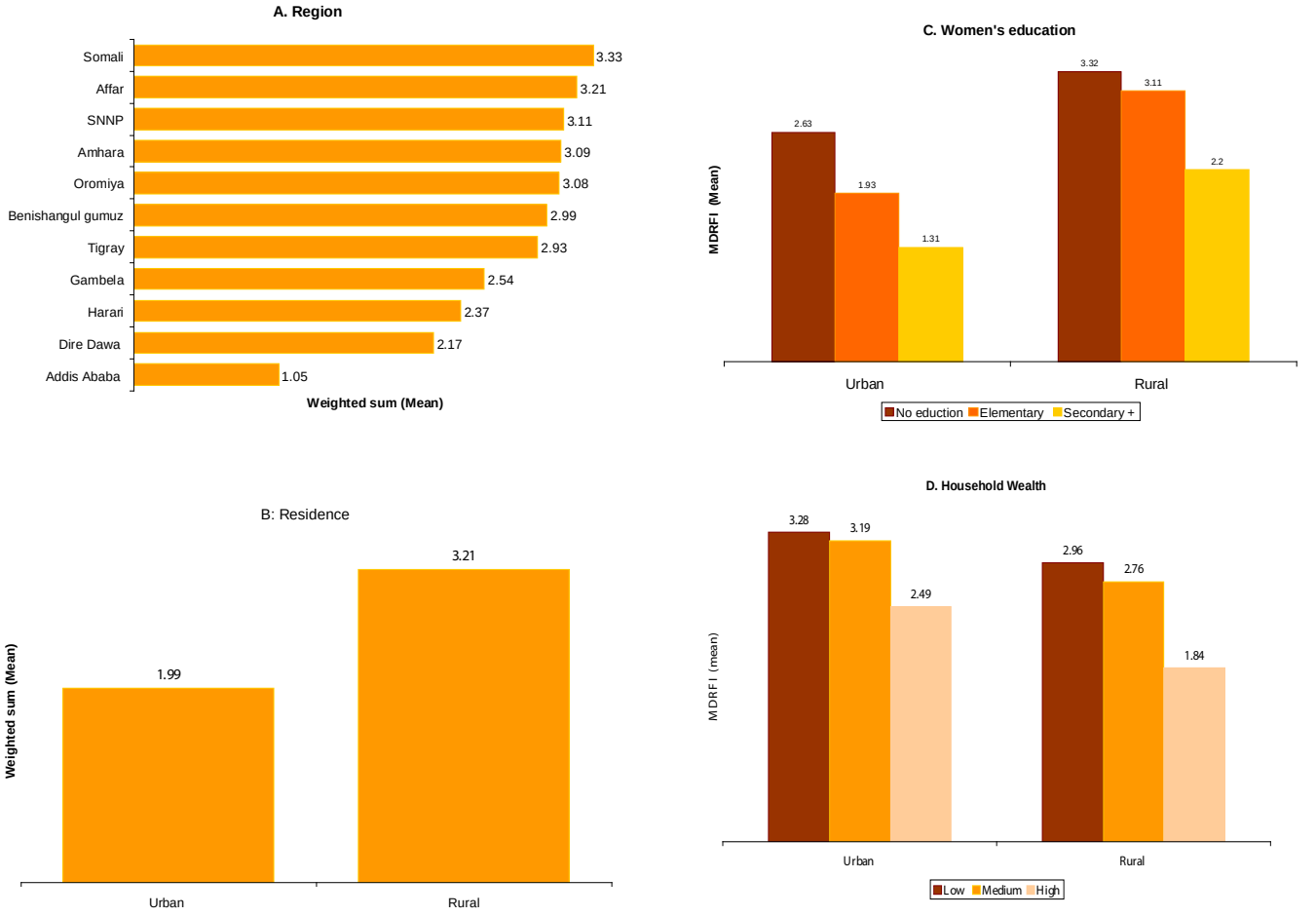
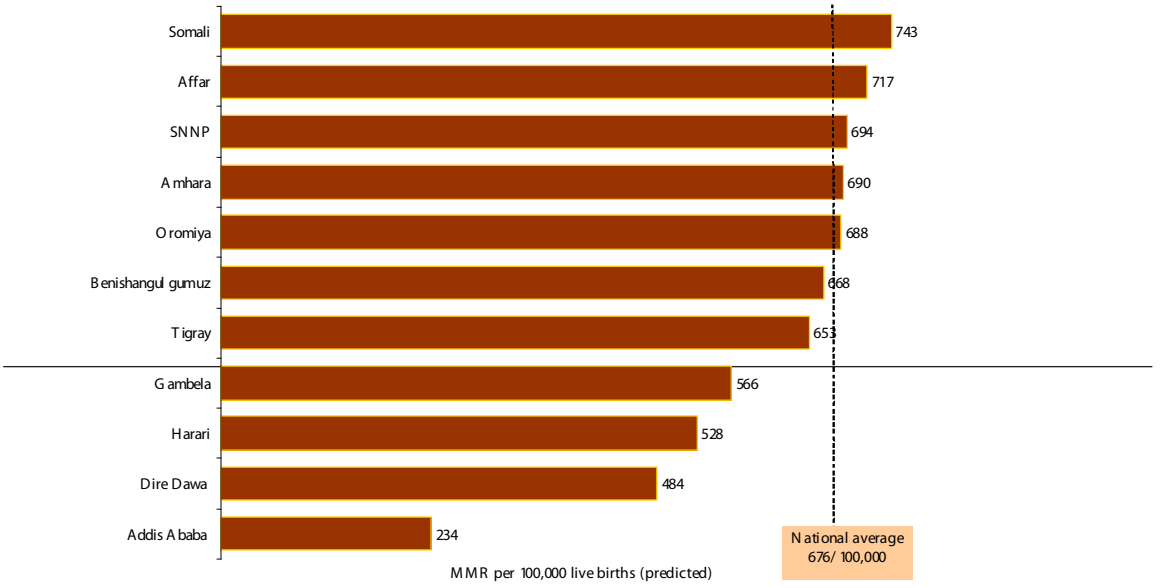


Figure 13. Predicted MMR by region for the year 2011- Ethiopia



V. Discussion

The maternal mortality ratio in Ethiopia is strikingly high and has stagnated at 676 per 100,000 live births after declining from 871 per 100,000 live births in 2000 to 673 in 2005. This study was set out to examine trends and determinants of maternal health in order to inform programs and suggest programmatic areas that would help lessen maternal mortality in the country. It was guided by a conceptual framework that delineates distal and intermediate determinants of maternal mortality. Several intermediate determinants of maternal mortality were included in this study although others were not examined due to paucity of data. This section discusses the main findings emerged from the analyses.

High-risk pregnancy, family planning use and unmet need:

High risk pregnancies, mainly due to high parity, older maternal age and closely spaced pregnancies and birth appear to characterize the fertility behavior of the vast majority of Ethiopian women. Our analyses revealed that among the women who had a birth in the five years preceding the 2011 DHS, 56.7% were exposed to one or more fertility-related high risk pregnancy and 20% to two or more risks. Furthermore, there have not been significant decline in the proportion falling in high risk pregnancy over the past decade despite the recent surge in family planning in the country. Preventing high risk and unintended pregnancies is an important strategy for reducing maternal mortality, as by preventing pregnancies, exposure to obstetric risk is also reduced. An estimated one fourth of maternal mortality could be prevented through preventing these pregnancies [39]. In spite of the fact that family planning is most needed by women in high risk, we found lower contraceptive prevalence rate (23.3%) among women in high risk compared to women without fertility-related pregnancy risk (38%). This partly explains the positive role of family planning in reducing high risk pregnancies. Focused family planning promotion among women in high risk has paramount importance for the reduction of maternal mortality and the finding of lower contraceptive use among high risk women in this study may well signal the failure to integrate family planning with maternal health services in the country. Whether those women in high risk pregnancy have unmet need for family planning has programmatic implication. In general, there is a substantially higher unmet need for family planning among women with high-risk pregnancy (37.7%) compared to women without fertility-related pregnancy risk (24.6%). Unmet need even rose to 45% for women exposed to two or more fertility-related high risk pregnancy. The notably high unmet need for family planning among women in high risk may well suggest the presence of a high level of unsatisfied demand for family planning in this group of women.

Significant variations in women's exposure to high-risk pregnancy by region and socio-demographics have also been apparent. Rural women, uneducated and those from poor households were excessively exposed to high-risk pregnancy. After adjustment

for several factors, women in Somali and SNNP regions were also found more exposed to high risk pregnancy than others. To influence women's fertility behaviors, these contextual and socio-economic factors may operate through the lack of women's knowledge, lack of access to information and services, high value for children, low contraceptive use, among other socio-cultural aspects. In addition, women's reproductive goal was also found to significantly shape their exposure to high risk pregnancy. When women have a higher ideal family size they are more likely to fall in the trap of high risk pregnancy. The role of men in driving couple's fertility is also apparent from our analysis. It appears that exposure to high risk pregnancy is significantly higher when the husband wants more children than the wife. These are all interesting findings with paramount programmatic implications, as discussed in subsequent sections.

Prevalence of under-nutrition, trends and determinants:

Malnutrition is widespread among Ethiopian women with a prevalence of underweight at 23.2% in 2011. It appears that malnutrition remained high with no sign of a decline over the last decade - 25.7% in 2000 and 23% in 2005. The few previous studies in Ethiopia also found a similarly high prevalence of low BMI in the range of 16%-32% [40-43] . In sub-Saharan African countries studies have shown that more than 20% of women are malnourished [44].Regional variation in the prevalence of under-nutrition among women has been apparent; in some regions such as Afar and Gambella rates exceeding 40% were recorded. In a multivariate analysis, higher risk of underweight is significantly associated with rural residence, living in lowland, having low education, being poor, a lack of household toilet facility and being anemic. Most of these factors have been identified as predictors of underweight in Ethiopia and elsewhere [43, 45, 46] . The low BMI among rural, uneducated and poor women is a reflection of the overall health inequalities that exist by residence and socio-economic status in the country. Lack of toilet facility can influence malnutrition in two ways: first, households with no toilet facility are highly prone to infections due to contaminations that subsequently lead to disease-induced malnutrition. Secondly, a lack of toilet facility in the household can serve as a proxy to poor economic status, limited access to food, which in turns linked to higher malnutrition.

Prevalence of Anemia, trend and determinants:

Data suggest that Ethiopia has a relatively mild prevalence of anemia compared to other developing countries. Studies from other African countries found higher prevalence estimates often exceeding 40% [47-50] , indicative of its being a sever public health problem. According to WHO anemia prevalence in the range of 5%-19% [51] is considered as having mild public health significance. In 2011, the prevalence of Anemia in Ethiopia was found to be 13% among all women who had a live birth in the five years preceding the survey. There has been a significant decline in the prevalence of anemia from 20% to 13% between 2005 and 2011. The few previous studies in Ethiopia among the rural and urban communities also recognized anemia, particularly iron deficiency anemia, as a mild public health problem in the country [52, 53]. It is suggested that because of exposure to high iron intake combined with hypoxia due to high altitude and infestations with intestinal parasites or other illness anemia due to malnutrition may not be as common in Ethiopia [54-56] . The DHS data does not allow us to make distinction between iron-deficiency and non-iron deficiency related anemia.

Although prevalence of anemia at the national level is considered to be mild, some regions in the lowlands exhibited extremely high prevalence of anemia. For instance, in Somali region nearly 50% of the women were anemic in 2011, in Afar 40.4% and Dire Dawa 33%. This is further compounded

by the fact that unlike most regions in the country these three regions did not see a significant decline in the prevalence of anemia in the previous five years. Therefore, in these lowland regions anemia can be considered a significant public health problem affecting the lives of women, contributing significant to maternal deaths.

As expected, pregnancy was associated with an excess risk of anemia in this study. In fact, anemia prevalence, as high as 30%, was documented among pregnant women in 2011 vis-à-vis 11% among non-pregnant women. The excessively high prevalence of anemia among pregnant women should be emphasized because this is more relevant as a risk factor for maternal mortality. Indeed, all pregnant women are at risk for becoming anemic because of they need more iron and folic acid than usual but the risk is higher in certain situations than others such as lack of iron-rich food, heavy menstrual bleeding before pregnancy, too much vomiting during pregnancy, among other factors [57].

HIV prevalence and trend:

HIV prevalence among Ethiopian women can be considered moderate and in the lower bound of the rates for the sub-Saharan African countries. Among women who had a live birth in the preceding five years, we found an HIV prevalence rate of 1.4%. This rate has remained nearly stable over the past five years. According to MEASURE DHS surveys, national HIV prevalence estimates are highest in southern Africa, with more than 14% of women age 15-49 infected with HIV. East Africa has more moderate rates of HIV infection, ranging from 1.4% in Ethiopia to 6.4% in Uganda. Most countries in West/Central Africa have HIV prevalence rates under 2% [58]. Our analyses also suggest that HIV epidemic in the country is heterogeneous - generalized in the urban (5.7%) area while low-level epidemic in the rural (0.7%) areas. The threshold to consider a HIV epidemic as generalized is when the prevalence rate in the general population exceeds 1%. In low-level epidemics, relatively little HIV is measured in any group [59].

The impact of HIV on maternal mortality has recently been well recognized and varies in accordance with, among others, the rate of HIV infection, fertility pattern and availability of ART in the women population. As a fraction of all maternal deaths, HIV-associated maternal deaths are reported to be highest in the sub-Saharan region, ranging between 9% and 32% according to different estimates [60]. The UN-affiliated Maternal Mortality Estimation Inter-Agency Group (MMEIG), developed estimates of indirect maternal deaths due to HIV. It is estimated that in Ethiopia 948 maternal deaths annually are due to HIV/AIDS. Nigeria is consistently ranked first, with the estimated number of maternal deaths associated with HIV per year 2,472. Six countries make the top ten - Kenya, Malawi, Mozambique, Nigeria, Tanzania, and Uganda. While Ethiopia ranks tenth [61]. Therefore, we can safely conclude that the maternal mortality impact of HIV is not as severe in Ethiopia as in the other sub-Saharan African countries. Nevertheless, its impact could be more vivid in the urban areas of the country as well as in some regions such as Addis Ababa, Gambela, and Harari with notably high HIV prevalence rates. In settings with a high HIV burden and continuing high maternal mortality ratios, scaling up comprehensive and integrated programs that include both improved HIV treatment and care and improved reproductive health services is highly suggested [62].

Antenatal care: levels, trends and determinants:

Results for antenatal care are mixed. On the one hand the country has witnessed an encouraging improvement in the ANC coverage in the last decade from 27% in 2000 to 42% in 2011. On the other the trend is not fast enough to meet the ANC target set in the MDG by 2015. The trend analysis

revealed that the receipt of at least one ANC is showing an annual increasing trend of 3.4% per annum; and, at the current pace, the proportion who will be receiving one or more ANC by 2015 will reach at 47%. This prediction, though quite simplistic, is in stark contrast to the 90% target for the same in the MDG [2].

In the overall, Ethiopia stands among the few countries in sub-Saharan Africa with the lowest ANC coverage. An analysis of the Antenatal care coverage in sub-Saharan Africa revealed that the ANC coverage ranges from 55 percent to 87 percent in most sub-Saharan African countries, as of the most recent surveys [63].

Another challenges of the ANC service of the country is its lack of adequacy and quality when gauged from the perspective of standard ANC service [25, 64]. Only 11% of the women began attending ANC in the first trimester, and 19% made the recommended number of four visits. Services with proven benefit had a low coverage among ANC clients, representing substantial missed opportunity. Nearly 60% of the ANC clients did not have their urine tested, 46% did not have their blood tested, 44.2% were not given two doses of TTI and 28% did not have their blood pressure measured. Pregnant women are ill-equipped to make appropriate choices especially when they are in danger - four out of five ANC clients were not told about pregnancy complication.

Disparities in ANC uptake between urban and rural areas, across regions, and by women socio-economic status and women's fertility behaviors remain significant. Others also found better ANC uptake among urban women, educated women, and those from relatively wealthier families [63, 65-67] . Women's fertility behavior and its impact on uptake of ANC is rarely studied [68]. Our analysis shed light to the importance of birth interval and wantedness of pregnancy on ANC uptake. The finding of lower ANC uptake among women with shorter birth interval after controlling for several factors in a multivariate analysis may well reflect lack of women's time to seek care for their health due to competing time demand for child care. We also found lower ANC use among women whose pregnancy was unintended.

Delivery care: levels, trends and determinants:

Skilled birth attendance has been identified as the key indicator to track progress towards maternal mortality for MDG 5. This is because the concentration of maternal deaths around the time of delivery, with an estimated two-thirds occurring in late pregnancy through to 48 hours after delivery [69]. Use of skilled birth attendants not only striking low in Ethiopia but also has shown a staggeringly slow trend. Only 13% of the women who had a live birth in preceding five years of the 2011 survey were assisted by a skilled health worker and 12% were delivered in health facilities. This rate is in the lowest bound by sub-Saharan Africa standard. In about half of the sub-Saharan Africa countries, most births take place in a health facility; the percentage is around 50 percent in several countries, including Mozambique, Rwanda, Tanzania and Zambia. The region's countries with the lowest levels of births in health facilities are Ethiopia, Chad and Niger [63].

Although the country has seen a two fold increase from the 5.5% reported for the same in 2000, this is far off what is expected to achieve the MDG target for skilled birth attendant. We attempted to predict skilled attendance at delivery for the MDG target year of 2015. Skilled assistance at delivery estimated to increase at a low pace of 5.6% per annum and, with this pace, the proportion that will be attended by skilled workers predicted at 21% by 2015. With the limitations in using a simple linear regression analysis for this prediction, one can safely conclude that the 60% skilled birth attendant target set in the MDG [2] for Ethiopia is hardly attainable.

The socio-economic factors that significantly influence antenatal care also work for institutional delivery. Rural women, uneducated, and poor were less likely to deliver in health institutions. These findings are not unique to this present study and are consistent with several studies from else where [70, 71]. A closer look at the reasons for not delivering in the health institutions suggests that women in general were less likely to blame on service costs and accessibility among the major barriers to delivering in health institution although indirect costs can be a real barrier. Rather the vast majority of women with home deliveries saw institutional delivery as "unnecessary" and "not a customary practice". This may present a real opportunity to improve institutional deliveries by dispelling these negative attitudes. Women's negative attitudes towards institutional delivery, as they suggested it is "unnecessary" or "not customary", may be relatively easier than barriers due to physical access and cost to be lifted through effective education and information campaign. In the emerging regions, such as Afar, Somail, Gambela and Benishangul Gumuz physical access was also implicated by a good portion of women on top of the attitudinal barriers.

A higher caesarean section percentage suggests the availability of obstetric care, which is offered primarily in institutional facilities. It is well recognized that very low and or very high levels of caesarean section are dangerous. WHO has proposed that in a country a rate of 5-15 percent of births undergoing a caesarean section is optimal, and a rate above 15 percent in a country is not recommended [35]. Caesarian section delivery is extremely rare in Ethiopia, indicative of the lack of obstetric care services in the country. Only 1.8% of the women had undergone caesarean section delivery according to the 2011 DHS. In the predominantly urbanized regions of the country the rate ranges from 8-20%. While in the big regions that constitute over 75% of the country's population it remained below 2%. By contrast, the 20% caesarean section delivery rate in Addis Ababa is a cause for concern, as it surpasses the WHO threshold of 15%.

Postpartum care: levels, trends and determinants:

Ethiopia has the lowest PPC coverage of 13% compared to any sub-Saharan Africa country. In sub-Saharan Africa countries PPC coverage ranges from 26% to 85% [72]. This is corroborated by the fact that more than 85% of the deliveries in the country took place at home and postpartum care is virtually non-existence for the vast majority women who delivered at home. Only less than 1% of the women who delivered at home received postpartum care within 42 days, as of the most recent DHS. This has declined from the 3.5% reported in the 2000 DHS. The socio-economic and demographic factors that are associated with delivery care are also relevant to PPC uptake.

The relationship between ANC, and delivery and postpartum care:

Our analyses found strong positive correlations between the number of antenatal visits and the use of skilled birth attendants. Women who receive antenatal care are more likely to use skilled birth attendants for delivery as well as receive PPC. Similar findings were reported by others that strengthened the role ANC in influencing institutional delivery and subsequent PPC [73]. In deed, ANC services can provide opportunities for health workers to promote a specific place of delivery or give women information on the status of their pregnancy, which in turn informs their decisions on where to deliver. Risk assessment during ANC may explicitly recommend a place of delivery, for instance to deliver in a hospital for a twin pregnancy [68]. In the whole, this finding reinforces the relevance of ANC as an important component of the continuum of care for maternal and newborn health [74, 75].

VI. Conclusion and Programmatic Implication

6.1. Conclusion

The findings suggest that there are a number of challenges to address in order to achieve the MDG target for maternal mortality in Ethiopia. Women's high-risk fertility behaviors, their health and nutrition status and the use of essential maternal health care services have yet to improve significantly to result in a reduction in maternal mortality in the country. The pervasive inequalities in maternal mortality burden by region, urban-rural residence and socio-economic status of the population further compounded the problem; making efforts to improve maternal health and thereby reduce maternal mortality more challenging.

Yet, there are ample opportunities to improve maternal health, and thereby reduce maternal mortality in the country. Interventions to reduce maternal mortality should either (1) reduce the likelihood that a woman will become pregnant; (2) reduce the likelihood that a pregnant woman will experience a serious complication of pregnancy or childbirth; or (3) improve the outcomes for women with complications [8]. This study underscores that strategies to address maternal mortality in the country requires a multifaceted approach that encompasses several preventive and treatment interventions such as preventing high risk pregnancy, improving the health and nutritional status of women, and improving women's access to quality maternal health care services. Although this study has not contributed to the current status and trend of emergency obstetrics services in the country, it should be emphasized that emergency obstetric care is the most recognized treatment intervention that can result in significant reduction in maternal mortality.

6.2. Implications for programming and research

Preventing high-risk pregnancy:

- There is a need to implement strategy to effectively integrate family planning within maternal health program at different levels, i.e.- at community, health facility and policy levels. Family planning program that targets to prevent high-risk pregnancy can be integrated into antenatal care, delivery care, postpartum care, as well as immunization and nutrition services. The provision of information and appropriate family planning services based on women's fertility pattern and needs should constitute an important part of the integration.

- High-risk pregnancy is common across most regions of the country. This is partcular serious in Somali and SNNP regions . Prevention of high-risk pregnancy through effective family planning method should constitute among the priority interventions to address maternal mortality in these regions.

- Men should be enlisted as important partners in addressing high risk pregnancy. Awareness programs need to target couples; and acknowledge the role of men in influencing women's fertility behavior.

- The short birth interval, which is known to be associated with high maternal mortality risk needs to be addressed through postpartum family planning services. Program thus should be able to reach postpartum women (within a year after delivery) with family planning information and services. Available family planning options such as long acting methods, breastfeeding and modern family planning methods should be promoted based on women's need during and after the postpartum period.

Address women's health and malnutrition:

- Maternal health services need to integrate nutrition intervention for pregnant and postpartum women. Antenatal visit can be used to identify women with nutritional problem and counsel them on appropriate nutrition needs during pregnancy. For critically under-nourished pregnant women, program can enroll them into available supplementary programs. Postpartum vitamin A supplementation can be integrated as part of the delivery and postpartum care programs.

- The control of anemia is one of the most effective interventions to reduce complication during pregnancy and death. Iron intake, control of worms and malaria are highly recommended worldwide to reduce the burden of anemia in pregnancy. One of the elements of Antenatal care is the provision of Iron tablet to pregnant women by assessing their anemia status. Missed opportunity for Iron provision is notably high in Antenatal clinics in Ethiopia. It is unknown whether this is due to shortage of Iron tablets in the facilities or negligence by health workers or a combination of the two. Addressing this problem will improve the prevalence of anemia among pregnant women in the country and there by contributes to the reduction of maternal mortality.

- Under-nutrition and anemia are more common in the lowland regions (such as Afar, Gambela, Somali) than in the highlands. Programmers need to be aware of this fact and prioritize intervention accordingly.

Address unintended pregnancy; and promote healthy pregnancy among HIV positive women:

- Since most women do not know their HIV sero-status, provider initiated HIV counseling and testing programs need to be strengthened within antenatal clinics in order to identify pregnant women who are HIV positive and refer them to the counseling and ART services. Previous studies in Ethiopia found that most HIV-positive women choose to become pregnant despite knowing their positive HIV status [76]. Access to antiretroviral therapy is important for both the mother's health as well as to prevent transmission of HIV to her child. The current expansion of access to ART in the country is a real opportunity to address the ART needs of HIV positive pregnant women.

Improving Antenatal care coverage, its contents and quality

- WHO recommends four antenatal visits for women whose pregnancies are progressing normally, with the first visit in the first trimester. In this regard the ANC uptake in Ethiopia is sub-optimal. Thus women should be well informed and encouraged to initiate antenatal care in the first trimester of pregnancy and receive adequate number of visits.

- ANC services can only be effective if it encompasses preventive measures and supportive care to help maintain normal pregnancy as well as health messages and counseling on potential danger signs of pregnancy complications, birth preparedness, and nutrition counseling, among others. There is a need to improve the antenatal care services in the country in regards to its contents and quality. Program needs to acknowledge the existence of high missed opportunity for essential elements of antenatal care and should find ways to address the problem.

- Younger and unmarried women were found to have the lowest usage of ANC. Targeted promotion of ANC use in these demographics should constitute major priority interventions.

- A lack of antenatal care use among women with high-risk pregnancy is documented by this study. This may further compound the maternal mortality risk of women in high-risk pregnancy. Maternal health program needs to identify such pregnancies in the communities and encourage them to attend antenatal care. This can be achieved by using HEWs and volunteer community health workers (development armies) who can play a key role in identifying and encouraging these women to attend ANC. Health workers need to initiate proactive counseling to such pregnant women and ensure that such women receive adequate care and all the necessary information, counseling and care services during their antenatal visits.

Addressing the low skilled birth attendants and postpartum care services:

- The Ethiopia health system has established a vast network of health infrastructure that extends to rural areas with the establishment of over 15,000 health posts and deployment of over 30,000 health extension workers throughout the country. Although these unprecedented situations made health services more accessible than ever, it is yet to be exploited for improving rural women's access to clean and safe delivery and postpartum care. Indeed, there are real opportunities to improve the coverage of skilled birth attendance, institutional delivery and postpartum care in the country. Strengthening HEWs' capacity on birth preparedness, identification of danger signs, normal delivery, postpartum care, should constitute among the priority intervention as stipulated in the HSDP-IV. There is sufficient evidence on the role of community health workers in linking households with HEWs and higher level services. Enlisting community health workers (development armies) to identify pregnant women in the communities and provide basic information on birth preparedness and danger signs and notify expectant mothers to the HEWs should be solicited among viable strategies. They can also reach out to women within few hours and days after delivery to provide basic postpartum services such as counseling and identification of danger signs, and referral to the HEWs.

- This study found that the lack of usage of delivery care in the country is related not only to accessibility but also acceptability of the services. In fact, the vast majority of women with home deliveries saw institutional delivery as "unnecessary" and a "non-customary practice". This study cannot provide viable interpretation of this important finding but we recommend that women should be informed and made aware of the benefits of delivering in health facilities by dispelling social and cultural barriers.

- Lack of physical access to health facilities was implicated among the main reasons for not delivering in health institutions, especially in the emerging regions (Afara, Somali, Gambela and Benishangul Gumuz). Any effort to improve institutional delivery in these regions needs to focus on improving population access to health facilities.

- Addressing the low skilled birth attendants among high gravida women should constitute among the priority intervention.

- The strong positive correlation between higher numbers of antenatal visits and skilled birth attendance further corroborates the need to promote regular and more ANC visits as one of the strategies to increase institutional delivery.

Regional and socio-economic disparities in maternal mortality:

- Lack of disaggregated data on maternal mortality masks regional disparities, making it difficult to track regional performance towards MDG 5. Cognizant of this data gap, we proposed a simple approach to disaggregate available data and clearly highlighted significant inequalities in maternal mortality burden by region, urban-rural residence, women's education and wealth. A single estimate at the national level is thus inadequate for understanding the scale and heterogeneity of the maternal mortality burden in the country and programs should not be based on national-level statistics, but need to be more focused geographically, and directed to the regions, even at districts and/or communities that exhibit higher burdens of maternal mortality. In particular, it is central that regions adapt tailor-made strategies, prioritize interventions based on evidence and set their own targets in relation to maternal mortality rather than relaying on national target.

- Improved women's education and household economic status often remain a corner stone for better health outcomes. Both women's education and household wealth have emerged as key factors influencing several intermediate determinants of maternal mortality included in this study. While improving women's education is a long-term strategy, in the short-term community-based intervention strategies to educate and counsel mothers toward improving pregnancy outcomes is of paramount importance. Any strategy targeted to address maternal mortality in the country needs to take account of the prevailing disparities by women's education and wealth..

HSDP IV strategies on maternal health: gaps and recommendations:

- The Ethiopia Health Sector Development Program -IV 2006-2015 (HSDP-IV) stipulates strategies and specific actions to reduce maternal mortality [77]. The strategies encompass (1) empowering women, men, families, and communities to recognize pregnancy-related risks, and to take responsibility for developing and implementing appropriate responses to them; (2) ensuring access to a core package of maternal and neonatal health services, especially in rural areas where health facilities are limited and (3) creating an environment supportive to safe motherhood and newborn health. Actions needed at the community, health system and policy levels are also detailed in the policy document (Annex 3). Closer examination of these three broader strategies and the actions vis-à-vis the framework this study adopted and the findings emerged from this present analyses point to the lack of comprehensiveness of the strategy. Gaps and suggested recommendations are discussed below:

- A number of important actions required to address maternal health at community level are included in the HSDP-IV document. Nevertheless, some important interventions needs that have emerged from this study were not recognized in the policy document. Issues that are overlooked by the policy document include: high-risk pregnancy and its health consequences, the need for focused family planning provision for women who are exposed to high-risk pregnancy, increasing women's knowledge

of maternal nutritional issues during pregnancy and enlisting volunteer community health workers (now development armies) in awareness creation, providing counseling and referral services. We recommend that the national strategy document (HSDP-IV) needs to incorporate these important elements of maternal health interventions for its comprehensiveness and also to ensure better results.

- System level intervention components of the HSDP-IV encompass three broader areas (1) ensure the seamless integration of maternal health service from the community to facility level (2) increase human resource capacity through appropriate training and (3) developing norms and standards for service provision. These are important strategies with proven benefits but they are not comprehensive to address the many issues at system level. The failure to acknowledge service integration between maternal health and family planning services is a real gap in the national policy document. For instance, family planning services can be

successfully integrated with postpartum care; both having far-reaching impact on maternal mortality. Postpartum family planning is beneficial for child spacing and prevent unwanted pregnancy and pregnancy complication, resulting in reduction in maternal mortality. Women's contact with health facilities for their own or child's health should be exploited to provide information and counseling on high-risk pregnancy, family planning, and the benefits of antenatal, delivery and postpartum care services. Therefore, service integration needs to be considered at different levels within the health system.

- Another system level challenge identified by this study is the strikingly high missed opportunity for essential elements of antenatal care. This could be due to a lack of availability of essential commodities as well as negligence or lack of knowledge from the side of health care providers. Whichever the reason may be, women are not fully benefiting from the ANC service and is an indication of poor service quality. While ensuring availability of basic equipments is indicated among the strategies in the HSDP-IV, the document makes no mention on how to address the quality of the maternal health care services. We recommend that the national strategy needs to explicitly address the quality of maternal health services as one of the strategy in improving maternal health care services at the system level.

- The HSDP-IV strategy for the reduction of maternal mortality in the country fails to recognize regional disparities in maternal mortality perhaps due to paucity of data. Geographical immensity and socio-cultural diversity in the country mean that maternal mortality can vary across regions, and a one-fit-for-all intervention approach may not be as effective. Maternal mortality reduction strategy in the country can be more effective if it recognizes regional disparities and prioritize intervention accordingly. This doesn't however deter from the relevance of having a national strategic framework that align regional interventions with the national health policy and MDGs #5 target.

Monitoring progress towards MDG 5:

- Monitoring progress towards MDG 5 target on maternal mortality should not focus solely on MMR and skilled birth attendant. Measuring MMR is complicated due to methodological limitations and lack of vital registration system. The DHS MMR provides a single estimate for the entire country without providing disaggregate data to monitor progress by equity parameters, especially region, urban-rural residence, and poverty. In this study, we proposed and presented a simple method of tracking progress in maternal health and mortality by region, urban-rural residence and wealth using 11 well recognized intermediate determinates of maternal mortality that are available in the DHS. There are rooms to improve the proposed method by including service access related data such as availability of emergency obstetric care services and key human recourse, especially the number of midwives. Subsequent DHS surveys can respond to this data demand by collecting more data on obstetric care.

Research needs:

- Operational research is needed to examine system-level factors such as population access to maternal health and emergency obstetric care services, the contents and quality of antenatal and obstetric care services. Assessing the competence and preparedness of health workers and HEWs can provide useful information for programming.
- Most women with home deliveries saw institutional delivery as "unnecessary" or "not customary", as revealed by our analyses. This study couldn't unknot the real meanings of these views by the mothers. Understanding the socio-cultural and attitudinal barriers to maternal health services use, especially the barriers to institutional delivery, has paramount importance for programming. In-depth qualitative study will further help to gain better insight into these.
- The reported high caesarean-section delivery rate in Addis Ababa exceeded the WHO recommendation highest rate of 15% [35] and has been on the rise over the last decade. This can have a detrimental effect on maternal and neonatal health. Investigation into the reasons for the high rate of caesarian section delivery in the public and private facilities of Addis Ababa is suggested.

Annex 1: Maternal death risk factors index (MDRFI) and predicting MMR

Maternal mortality intermediate determinants:

- Eleven variables were included as intermediate determinants of maternal mortality, as detailed below. These determinants are broadly categorized as (1) reproductive status (2) health status (3) maternal health service use and (4) indicator of access to obstetric service. The variables definitions and value labels are also shown in the table below. Since our interest is on a negative outcome, i.e. maternal mortality, we attach a label "1" to indicate poor reproductive or health status as well as the lack of maternal health service use. Caesarian section rate within a certain coverage limit (5%-15%) in a population is identified as an indicator of access to obstetric care services; and it is coded as "1" if vaginal delivery and "0" if caesarian section.

List of variables used in the development of Maternal Death Risk Factor Index (MDRFI)

Determinants	Category of determinants	Variable name in STATA data file	Value label
1. High risk pregnancy (two or more risks)	Reproductive status	*tworisks*	1=2+ risks 0=No 2+ risk
2. Maternal nutritional status	Health status	*lowbmi*	1=BMI<11 0=BMI>=11
3. Anemia	Health status	*anemia*	1=Anemic 0=Non-anemic
4. HIV infection	Health status	*hiv*	1=HIV positive 0=Negative
5. Four or more Antenatal Care (ANC)	Maternal health service use	*nofouranc*	1=Not received 4+ ANC 0=received 4+ ANC
6. Two or more TTI during pregnancy	Maternal health service use	*notti2*	1=Not received 2+ TTI 0=received 2+ TTI
7. Iron tablet during pregnancy	Maternal health service use	*noiron*	1= Did not receive Iron tables 0=Iron tables given
8. Assistance by health worker during delivery	Maternal health service use	*nodelhw*	1= Not assisted by skilled worker during delivery 0=Assisted by skilled worker during delivery
9. Receipt of Postpartum care (PPC)	Maternal health service use	*noppchw*	1=Not received PPC 0=Received PPC
10. Contraceptive use	Maternal health service use	*nofp*	1= Not using family planning 0= Currently using family planning
11. Caesarean section delivery	Indicator for availability of obstetric care services	*nocs*	1= Vaginal delivery 0= Delivery by Caesarean section

The MDRFI:

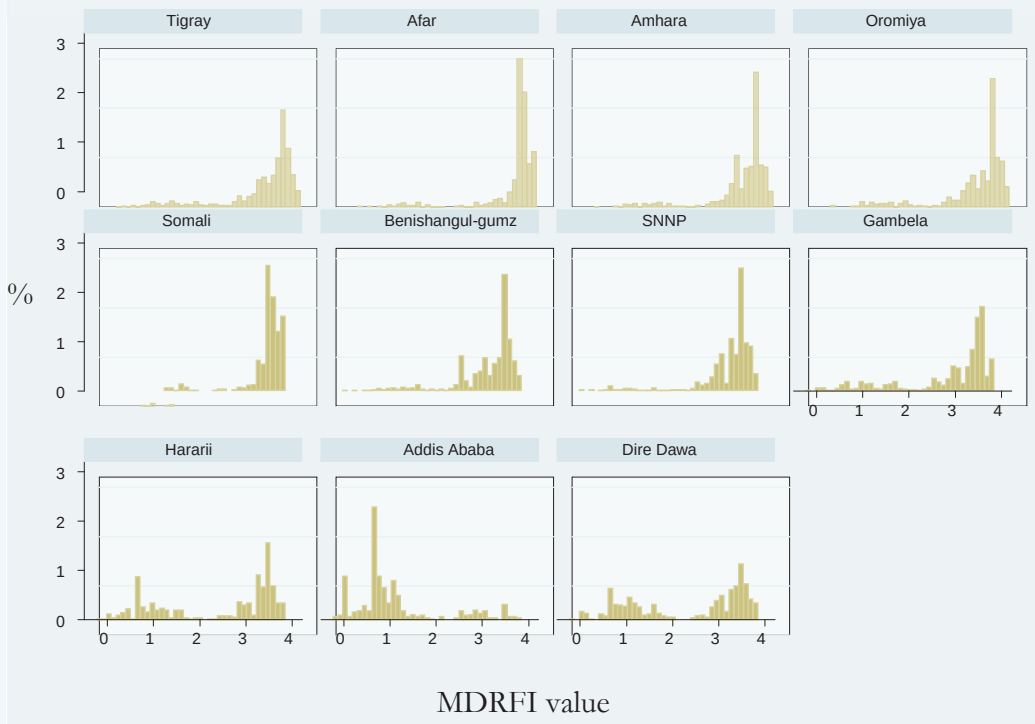
Principal components analysis (PCA) was used to assign the weights for the aforementioned 11 maternal mortality intermediate determinants based on the 2011 DHS data. We used STATA Factor Analysis procedure to generate the factor loadings for each of the determinants. This procedure first standardizes the indicator variables (calculating z-scores); then the factor coefficient scores (factor loadings) are calculated; and finally, for each woman in the sample, the indicator values are multiplied by the loadings and summed to produce the maternal death risk factor index (MDRFI). The resulting MDRFI is a continuous variable that ranges from 0 to higher numbers. Zero value indicates the absence of any of the aforementioned intermediate risk factors. Higher mean values imply the presence of the risk factors in excess. By implication, higher MRDFI suggest high maternal mortality burden while lower MRDFI values suggest low maternal mortality burden.

PCA factors STATA output

Variable	Factor 1	Uniqueness
Tworisks	0.2722	0.9246
Lowbmi	0.1014	0.6457
Anemia	0.0342	0.4499
Hiv	-0.2313	0.8949
Nofouranc	0.4530	0.4437
Noiron	0.0612	0.4630
notti2	0.1389	0.4894
Nofp	0.3360	0.6734
Nodelhw	0.9054	0.1577
Noppchw	0.8997	0.1737
Nocs	0.6475	0.5687

Factor 1values are taken as weights

Frequency distribution of MDRFI by region



The resulting weighted sum (factor 1) equation is as follows (The coefficients are drawn from the factors loading shown in the Table above) :

Weighted_sum (MDRFI)= (0.272*tworisks) + (0.1014*lowbmi) + (0.0342*anemia) + (-0.2313*hiv)+ (0.453*nofouranc)+ (0.0612*noiron)+ (0.1389*notti2)+ (0.336*nofp)+ (0.9054*nodelhw)+ (0.8997*noppchw) + (0.6475*nocs)

Predicting Maternal Mortality Ratio for Regions:

- In order to somehow fill regional data gap in maternal mortality ratio (MMRs) we established a direct relationship between MDRFI and MMR. The premise for this is that regions with higher MDRFI are expected to have lower MMR and vise versa. The unmeasured intermediate and proximate determinants of maternal mortality due to paucity of data (such as access to emergency obstetric care services) are assumed to be either inversely correlated with the MDRFI or equally distributed across regions. This assumption appears fairly valid since it is unrealistic to anticipate a positive relationship between MDRFI and, for example, population access to emergence obstetric service. Such services are expected to be more apparent in urban areas and regions with better access to maternal health services. These regions have lower MDRFI values.

The mathematical relationship between MDRFI and MMR is as follows:

$$\textbf{Predicted MMR}_{i} = [\textbf{MDRFI}_{i} * 676]/3.03$$

Where:

-**MMR**$_i$ denotes the predicted maternal mortality ratio for region i for the year 2011
-**Predicted MDRFI**$_i$ denotes the maternal death risk factor index value for region i
-**676** is the reported maternal mortality ratio value (per 100,000) at the national level (DHS, 2011)
-**3.03** is the average MDRFI value at the national level (based on estimates by this study) for the year

MDRFI values and predicted MMR per 100,000 by region

	MRDFI value for 2011	Predicted MMR per 100,000 for 2011
Addis Ababa	1.05	234
Dire Dawa	2.17	484
Harari	2.37	528
Gambela	2.54	566
Tigray	2.93	653
Benishangul Gumuz	2.99	668
Oromiya	3.08	688
Amhara	3.09	690
SNNP	3.11	694
Affar	3.21	717
Somali	3.33	743
Total	3.03	

DHS 2011 MMR for Ethiopia 676/100,000

Annex 2. Intermediate determinants by region and residence (DHS 2011)

	High risk reproductive status	Poor health status			Lack of use of maternal health services						Indicator of lack of obstetric care
	% two or more pregnancy related risk	% Low BMI	% Anemic	% HIV positive	% Not received 4 ANC	% Not assisted by health worker at delivery	% Did not receive two TTI	% Did not receive Iron tablets	% Not received PPC	% Not currently using family panning	% women in the population Without CS delivery
Residence											
Urban	11.3	17.6	9.2	5.70	54.4	45.6	48.0	72.9	46.3	44.6	90.7
Rural	21.7	24.2	13.6	0.70	85.7	94.7	69.5	84.8	94.4	75.8	99.5
Region											
Tigray	21.0	34.1	10.5	2.40	69.1	85.1	68.4	66.2	84.2		96.6
Affar	22.2	42.9	40.5	2.05	88.6	91.2	78.1	77.0	90.8	77.7	97.5
Amhara	19.2	21.3	9.6	1.90	87.6	88.7	70.8	81.0	88.6	90.8	98.4
Oromiya	18.9	24.4	14.8	0.86	81.5	89.6	67.2	88.2	89.4	66.1	99.6
Somali	34.4	33.0	49.9	1.43	93.1	88.9	72.0	79.8	90.7	73.2	98.7
Benishangul gumuz	18.4	26.9	21.5	0.78	85.5	88.5	66.6	76.9	80.9	96.2	98.4
SNNP	23.9	18.6	9.0	0.96	82.4	91.0	62.4	85.1	91.6	74.4	98.2
Gambela	14.9	41.6	21.1	4.39	69.4	69.2	51.3	72.1	65.6	72.9	90.3
Harari	14.9	23.1	18.8	2.65	65.2	61.3	43.5	66.9	60.6	67.4	91.4
Addis Ababa	3.8	9.4	2.6	6.09	13.5	16.8	27.7	61.1	16.9	63.3	79.9
Dire Dawa	14.3	23.8	33.3	1.74	60.6	50.2	48.9	72.2	51.4	25.6	91.5

percentage weighted

Annex 3. Ethiopia HSDP -IV strategies for maternal mortality

Actions at the Communit y Level

- Support community initiatives to promote RH by encouraging rural communities to take responsibility to identify and implement innovative solutions and support networks for effective communication and transport to EmOC services.
- Develop and implement innovative informational campaigns to heighten community awareness of:
  - the negative health and social consequences of HTPs associated with pregnancy
  - pregnancy-related danger signs and the benefits of seeking skilled care
  - services available to address the negative health consequences of HTPs
  - importance of antenatal care to prevent disease, manage existing medical conditions, ensure proper nutrition and micronutrients, prepare for biths/emergencies, and detect early warning signs

Enlist religious and other leaders to promote RH at the community level

- Seek the support and collaboration of religious and other local institutions to creating awareness of the importance and ethical acceptability of FP; and RH needs of young people, especially those married.
- Use the authority of religious leaders to discourage early marriage

Actions at the Systems Level

Ensure the seamless integration of maternal health services from the community to facility level:

- Establish mechanisms to facilitate the transition from current health extension efforts, which rely heavily on community-based agents, to the outreach activities of HEWs
- Improving community-level referral systems
- Ensure the availability of basic equipment needed for maternal and newborn/child health care.

Increase human resource capacity through appropriate training

- Include in the HEP training curriculum appropriate pre-service instruction on maternal health and the skills needed to attend normal deliveries; manage simple obstetric complications; and detect and refer more severe complications
- Include in the HEP training curriculum appropriate pre-service instruction on essential care for neonates, including hypothermia, resuscitation, or sepsis. Training should also highlight the connections between maternal and newborn health
- Within the context of the HEP, provide in-service training to HEWs who did not receive appropriate pre-service instruction on maternal and newborn health
- Increase the number of midwives trained per year; and amends the midwifery curriculum so that graduates can satisfy the requirements of a "skilled birth attendant".
- Increase the number of health officers trained on comprehensive EmOC.

Developing norms and standards for service provision

- Update and implement service provision guidelines that specify the roles and responsibilities of service providers at each level of the health system.
- Launch multisectoral initiatives to formulate norms and protocols for the treatment of victims of sexual violence, including provisions for EC, prophylactic ART, psychosocial and legal support.

Actions at the Policy Level

Enhance coordination within the health sector

- Employ the framework of the National RH Program to bring about multisectoral involvement and collaboration to strengthen RH service provision overall
- Develop strategies for the appropriate provision of PAC at all levels of the health system, in conjunction with relevant NGOs
- Strengthen the technical and financial capacity of RHBs to coordinate regional health initiatives across the NGO and public sectors
- Develop a National Maternal and Neonatal Mortality Reduction Strategy to prioritize objectives in safe motherhood and identify the sustainable, high-impact interventions required to achieve them.
- Following the endorsement of National Maternal and Neonatal Mortality Reduction Strategy, establish review mechanisms at national and/or regional levels to assure that new health initiatives reflect strategic priorities, are compatible with existing RH initiatives, build on best practices, and incorporate elements (sustainability) deemed essential for long-term success.

References

1. Nawal M.N, Maternal Mortality Rev Obstet Gynecol, 2008. 1(2): p. 77-81.
2. MoFED, Ethiopia: 2010 MDGs reports : Trends and prospects for meeting MDGs by 2015. 2010.
3. The world bank group [Source: http://www.worldbank.org/en/country/ethiopia. Website Visited on July 2012]
4. Central Statistical Agency [Ethiopia], Populating and housing census of Ethiopia. 2007.
5. Central Statistical Agency [Ethiopia] and ICF International, Ethiopia Demographic and Health Survey 2011. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ICF International. 2012.
6. UNDP Ethiopia, Analyzing regional performance and disparities in health outcomes in Ethiopia. 2012(2).
7. McCarthy J and Maine D, A framework for analyzing the determinants of maternal mortality Studies in Family Planning, 1992. 23(1): p. 23-33.
8. Mills A, Bennett S, Bloom G, Angel M, Block G,, Achieving global health goals: The role of health system research. Geneva: WHO & Global Forum for Health Research. 2004.
9. Hogberg U and Wall S, Age and parity as determinants of maternal mortality- impact of their shifting distribution among parturients in Sweden 1781 to 1980. Bull World Health Organization 1986. 64(1): p. 85-91.
10. World Health Organization [Source: http://www.afro.who.int/index.php?option=com_content&view=article&id=871&Itemid, Website Visited on August 2012]
11. World Health Organization, Report of a WHO Technical Consultation on Birth Spacing, 13-15 June 2005: Geneva, Switzerland. Geneva: Department of Making Pregnancy Safer, Department of Reproductive Health and Research, World Health Organization. 2006.
12. DaVanzo, J.Razzaque, A.Rahman, M.Hale, L.Ahmed, K.Khan, M. A.Mustafa, G. Gauzia, K., Pregnancy Outcomes, and Maternal Morbidity and Mortality in Matlab, Bangladesh. RAND, Labor and Population working paper series. 2004.
13. Conde-Agudelo A and Belizan JM, Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. British Medical Journal, 2000. 321: p. 1255-1259.
14. Chen, L. C. Gesche, M. C. Ahmed, S. Chowdhury, A. I. Mosley, W. H., Maternal mortality in rural Bangladesh. Studies in Family Planning, 1974. 5(11): p. 334-341.
15. Michael A. Koenig, Vincent Fauveau, A. I. Chowdhury, J. Chakraborty and M. A. Khan, Maternal mortality in Matlab, Bangladesh: 1976-85. Studies in Family Planning, 1988. 19(2): p. 69-80.
16. Marston C and Cleland J, The effects of contraception on obstetric outcome. Geneva: World Health Organization. 2004.
17. USAID. Family Planning. Saving Lives, Protecting Health. [Source: http://www.usaid.gov/our_work/global_health/pop/index.html, Website Visited on July 2012].
18. All Party Parliamentary Group for Population Development and Reproductive Health. Return of the population growth factor: its impact upon the millennium development goals. 2007.
19. Robert E Black, Lindsay H Allen, Zulfiqar A Bhutta, Laura E Caulfield, Majid Ezzati, Colin Mathers, Juan Rivera,, Maternal and child under nutrition: global and regional exposures and health consequences. Lancet 2008. 371: p. 243-60.
20. Kramer MS, Determinants of low birth weight: methodological assessment and meta-analysis. Bull World Health Organ 1987. 65 (663-737).
21. Brabin BJ, Hakimi M, and Pelletier D, An analysis of anemia and pregnancy-related maternal mortality J Nutr, 2001. 131: p. 604S-615S.
22. Hogan, M. C. Foreman, K. J. Naghavi, M. Ahn, S. Y. Wang, M. Makela, S. M. Lopez, A. D. Lozano, R. Murray, C. J. L., Maternal mortality for 181 countries, 1980-2008: a systematic analysis of progress towards Millenium Development Goal 5. The Lancet, advance online publication, April 12, 2010. 2010.
23. Carroli G, C Rooney, and J Villar, How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. Paediatr Perinat Epidemiol, 2001. 15.
24. Chen X. K., S. W. Wen, Q. Yang, M. C. Walker , Adequacy of prenatal care and neonatal mortality in infants born to mothers with and without antenatal high-risk conditions. Aust N Z J Obstet Gynaecol 2007. 47(2): p. 122-7.
25. World Health Organization, Antenatal care randomized trial: manual for the implementation of the new model. In WHO/RHR/01.30. Geneva: World Health Organization. 2001.
26. Koblinsky MA, Campbell O, and Heichelheim J, Organizing delivery care: what works for safe motherhood? . Bull World Health Organ, 1999. 77: p. 399–406.
27. Central Statistical Authority [CSA] and ORC Macro, Ethiopia Demographic and Health Survey 2000. Addis Ababa 2001.
28. Central Statistical Authority [CSA] and ORC Macro, Ethiopia Demographic and Health Survey 2005. Addis Ababa and Calverton, Maryland: CSA and ORC Macro. 2006.
29. WHO, World Health Organization/United Nations University/UNICEF. Iron deficiency anaemia, assessment, prevention and control: a guide for programme managers. Geneva. 2001.
30. World Health Organization, Report at the UNICEF & WHO. Regional consultation. Prevention and control of iron deficiency anaemia in women and children. Geneva. 1999.
31. Bhatia JC and Cleland J, Self-reported symptoms of gynecological morbidity and their treatment in south India. Stud Fam Plann, 1995. 26: p. 203-216.
32. Sarker, M. Schmid, G. Larsson, E. Kirenga, S. De Allegri, M. Neuhann, F. Mbunda, T. Lekule, I. Muller, O., Quality of antenatal care in rural southern Tanzania: a reality check. BMC Res Notes, 2010. 3(209).
33. WHO, ICM, and FIGO, Making pregnancy safer: the critical role of the skilled attendant. A joint statement by WHO, ICM and FIGO. Geneva: World Health Organization. 2004.
34. WHO, Reduction of maternal mortality: A joint WHO/UNFPA/UNICEF/World Bank statement. Geneva: World Health Organization. 1999.
35. WHO, Monitoring emergency obstetric care: a handbook. Geneva: World Health Organization. 2009.
36. WHO, Postpartum care of the mother and newborn: a practical guide. WHO/RHT/MSM/98.3.
37. WJ Graham, S Ahmed, C Stanton, CL Abou-Zahr and OMR Campbell, Measuring maternal mortality: An overview of opportunities and options for developing countries. BMC Medicine, 2008. 6(12).
38. Bradshaw D, Maternal mortality ratio – trends in the vital registration data. S Afr J OG, 2012. 18(2): p. 38-42.
39. Ross JA and Winfrey WL, Contraceptive Use, Intention to Use and Unmet Need During the Extended Postpartum Period. International Family Planning Perspectives, 2001. 27(1): p. 20-27.

40. DTRC, Addis Ababa University. Report of Community and Family Survey in five zones of SNNPR. Department of Demography, Addis Ababa University. 1999.
41. Ferro-Luzzi A, Saccini C, and Taffesse S, Seasonal Energy deficiency in Ethiopian Rural women. Eur. J.Clin.Nutr., 1990. 44(1): p. 7-18.
42. Taddess, Z.Larson, C. P. Hanley, J. A., Anthropometric status of Oromo women in rural Southwestern Ethiopia. Ethiopian journal of health development, 1998. 12(1): p. 1-7.
43. Tsegaye D., Yared M., and Jemal H., Agroecological comparison of levels and correlates of nutritional status of women. Ethiop.J.Health Dev, 2003. 17(3): p. 189-196.
44. Ezzati, M. Vander Hoorn, S. Lawes, C. M. M. Leach, R. James, W. P. T. Lopez, A. D. Rodgers, A. Murray, C. J. L. , Rethinking "the diseases of affl uence" paradigm: global patterns of nutritional risks in relation to economic development. PLoS Medicine, 2005. 2(e133).
45. Ene-Obong H.N, Enugu G.I, and Uwaegbute A.C., Determinants of Health and Nutritional Status of Rural Nigerian Women. J Health Popul Nutr, 2001. 19(4): p. 320-330.
46. Khalid M, Anthropometric comparison between high- and low-altitude Saudi Arabians. Annals of Human Biology 1995, VOL. 22, NO. 5, 459-465, 1995. 22(5): p. 459-465.
47. Bentley M and Griffiths P, The burden of anaemia among women in India. Eur J Clin Nutr, 2003. 57: p. 52-60.
48. Hassan EO, el-Hussinie M, and el-Nahal N, The prevalence of anemia among clients of family planning clinics in Egypt Contraception 1999. 60: p. 93-9.
49. Massawe SN, Urassa EN, Nyström L, Lindmark G, Anaemia in women of reproductive age in Dar-es-Salaam, Tanzania. East Afr Med J 2002, 2002. 79: p. 461-6.
50. Meda N, Cousens S, and Kanki B, Anaemia among women of reproductive age in Burkina Faso. World Health Forum, 1996. 17: p. 369-72.
51. WHO, Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, (WHO/NHD/01.3) 2001.
52. Gibson RS, Abebe Y, Stabler S, Allen RH, Westcott JE, Stoecker BJ,Krebs NF, Hambidge KM,, Zinc, gravida, infection, and iron, but not vitamin B-12 or folate status, predict hemoglobin during pregnancy in Southern Ethiopia. J Nutr, 2008. 138: p. 581-586.
53. Haidar J and Pobocik R. S, Iron deficiency anemia is not a rare problem among women of reproductive ages in Ethiopia: a community based cross sectional study. BMC Blood Disorders, 2009. 9(7).
54. Gebremedhin M and Birgegård G, Serum ferritin in Ethiopian mothers and their newborn infants. Relation to iron intake and socio-economic conditions. Scand J Haematol, 1981. 27: p. 247-252.
55. Gebremedihin M, Rarity of anaemia of pregnancy in Ethiopia. Scand J Haematol 1976, 16:168-175., 1976. 16: p. 168-175.
56. Wolde-Gabreil Z, West CE, Gebru H, Tadesse AS, Fisseha T, Gabre P, Aboye C, Ayana G, Hautvast JG , Inter-relationship between Vitamin A, iodine, and iron status in school children in Shoa Region, Central Ethiopia. Br J Nutr, 1993. 70: p. 593-607.
57. WebMd. Anemia in Pregnancy [Source: http://www.webmd.com/baby/guide/anemia-in-pregnancy, Website Visited August 2012].
58. ICF International, HIV Prevalence Estimates from the Demographic and Health Surveys. Calverton, Maryland: ICF International. 2012.
59. World Health Organization. Second Generation Surveillance for HIV/AIDS [Source: http://www.who.int/hiv/topics/surveillance/2ndgen/en/, Website visited on July 2012]
60. Rosen J. E., Understanding Methods for Estimating HIV-Associated Maternal Mortality. Journal of Pregnancy 2012. Article ID 958262, 8 pages.
61. WHO, UNICEF, UNFPA and the World Bank, Trends in Maternal Mortality: 1990 to 2008. Estimates Developed by WHO, UNICEF, UNFPA and the World Bank, World Health Organization, Geneva, Switzerland. 2010.
62. Moodley, J. Pattinson, R. C. Baxter, C. Sibeko, S. Abdool Karim, Q. Strengthening HIV services for pregnant women: an opportunity to reduce maternal mortality rates in Southern Africa/sub-Saharan Africa. BJOG 2011. 118(2): p. 219-225.
63. Wang, Wenjuan, Soumya Alva, Shanxiao Wang, Alfredo Fort, Levels and Trends in the Use of Maternal Health Services in Developing Countries. DHS Comparative Reports No. 26. Calverton, Maryland, USA: ICF Macro. 2011.
64. Federal Democratic Republic of Ethiopia Ministry of Health, Antenatal Care: Blended Learning Module for the Health Extension Program. Health Education and Training
65. Behailu T, Factors affecting antenatal care utilization in yem special woreda, southwestern Ethiopia. Ethiop. J Health Sc 2009. 19(1).
66. Van Eijk, A. M. Bles, H. M. Odhiambo, F. Ayisi, J. G. Blokland, I. E. Rosen, D. H. Adazu, K. Slutsker, L. Lindblade, K. A., Use of antenatal services and delivery care among women in rural Western Kenya: a community survey. Reproductive Health 2006. 3(2).
67. WHO, Antenatal care in developing countries: promises, achievements and missed opportunities. ISBN 9241590947.
68. Gabrysch, S. Campbell, O. M. R., Still too far to walk: Literature review of the determinants of delivery service use. BMC Pregnancy and Childbirth 2009. 9(34).
69. AbouZahr C, Maternal mortality overview. In: Murray CJL, Lopez, AD. Health Dimensions of Sex and Reproduction. Global Burden of Disease and Injury Series. Volume III. Geneva: World Health Organization. 1998: p. 111-164.
70. Yared Mekonnen, Utilization of maternal health care services in Southern Ethiopia: Analysis of the user and service factors. MSc Thesis, Addis Ababa University, Ethiopia. 1998.
71. Yared Mekonnen and Asnakech Mekonnen, Utilization of Maternal Health care services in Ethiopia: Further analysis of the 2000 Ethiopian Demographic Health Survey. ORC Macro, Maryland, USA. 2002.
72. Fort, Alfredo L., Monica T. Kothari, Noureddine A, Postpartum Care: Levels and Determinants in Developing Countries. Calverton, Maryland, USA: Macro International Inc. 2006.
73. Gage AJ and Guirlene Calixte M, Effects of the physical accessibility of maternal health services on their use in rural Haiti. Popul Stud (Camb), 2006. 60(3): p. 271-288.
74. Kerber K. J., J. E. de Graft-Johnson, Z. A. Bhutta, P. Okong, A. Starrs, J. E. Lawn, Continuum of care for maternal, newborn, and child health: from slogan to service delivery. Lancet, 2007. 370(9595): p. 1358-69.
75. Tinker A.,P. ten Hoope-Bender, S. Azfar, F. Bustreo, R. Bell, A continuum of care to save newborn lives. Lancet, 2005. 365(9462): p. 822-5.
76. Save the children USA, Formative research among most at-risk population and people living with HIV in Ethiopia. Transaction. June 2010.
77. Federal Democratic Republic of Ethiopia, Health Sector Development Programme IV 2010/11 – 2014/15. October 2010.

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