UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

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SPATIAL MODELLING AND MAPPING OF ANTENATAL CARE SERVICE UTILIZATION IN ETHIOPIA: AN ANALYSIS OF ETHIOPIAN DEMOGRAPHIC AND HEALTH SURVEY, 2011.

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Declaration

I, Asnake Yohannes Dumicho, declare that this research report is my work, conducted under the supervision of Dr. Thomas Achia and Dr Njeri Wabiri. This is being submitted in partial fulfilment of the requirements for the degree of Master of Science in Epidemiology under division of Epidemiology and Biostatistics, School of Public Health, Faculty of Health Sciences, University of the Witwatersrand. It has not been submitted for any degree or examination in any other University.

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Signature

Date:.....

Abstract

BACKGROUND: Adequate antenatal care (ANC) is an important indicator to improve maternal and their infant health in a given region. However, ANC coverage varies markedly within geographical locations due to different social and health determinants. Evaluating and documenting such variations provide useful information to improve ANC uptake.

OBJECTIVE: To identify socio-economic and demographic factors associated with ANC service utilization, to investigate spatial clustering in ANC service utilization and to develop maps of spatial variation in ANC service utilization in Ethiopia.

METHODS: Data was drawn from the 2011 Ethiopian Demographic and Health Survey (EDHS). The two aspects considered under ANC service utilization include the time of first ANC visit and the number of ANC visits. Time of first ANC visit was coded as late (0) when the first visit took place after 16 weeks of gestation otherwise early (1). Number of ANC visit was ordered and coded as no visit (0), inadequate (1) for one to three visits and adequate (2) for greater than or equal to four visits. Alternatively, number of ANC visit was coded as no visit (0) and at least one visit (1) for mapping of spatial variation in number of ANC visit. Spatial scan statistical analysis was carried out on enumeration areas (EAs) aggregated data by using SaTScan to investigate significant clusters of time of first ANC visit and number of ANC visit. High and low rates of ANC service utilization clusters were detected. For time of first ANC visit, the cluster with relative risk (RR) less than one indicates the early visit is lower than late. The number of ANC visits ordered in to three categories, due to this RR in every cluster is represented by three different numbers: the first one stands for (no visits), second for (inadequate visits) and third for (adequate visits). The clusters with RR decrease from low valued category (no ANC visits) to high valued category (adequate number of ANC visits) indicate the rate of number of ANC visits decreases in the clusters. Ordinal logistic regression used to investigate factors associated with the number of ANC visits. Bayesian hierarchical spatial logistic models were used to investigate factors associated with time of first ANC visit and develop maps of spatial variation in the time of ANC visit and the number of ANC visits across Ethiopia.

RESULTS: The overall prevalence of time of first ANC visit and adequate number of ANC visits were 26.38% and 19.14% respectively. The result revealed significant spatial variation in ANC service utilization. Women in the West [RR=0.33, P<0.0001] and South-West [RR=0.52, P<0.0001] of Ethiopia were least likely to start ANC early. Those in North-West

[RR=1.26,1.03,0.43; P=0.0001], South-East [RR=1.64,0.46,0.03; P=0.0001], North-East [RR=1.81,0.05,0;P=0.0001] and tip of West [RR=1.46,0.67,0.24;P=0.0001] of Ethiopia had lowest numbers of ANC visits. In these parts of the country the rates of number of ANC visits decreases from low- valued category (no ANC visit) to high-value category (adequate number of ANC visits). Age at birth of last child, place of residence, education, religion, marital status and household-wealth were significantly associated with time of first ANC visit. Age at birth of last child, place of residence, region, education, ethnicity, marital status, household-wealth and party were significantly associated with number of ANC visits.

CONCLUSION: The finding of this study has potential to assist government, policy makers and other collaborative organizations on resource allocation and improvement of ANC services.

Key words: ANC, Spatial variation/cluster, SatScan, Purely Spatial Bernoulli/Ordinal Probability Model, Bayesian spatial Hierarchical model, INLA and Ordinal logistic regression.

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Abbreviation

AIDS: Acquired Immune deficiency Syndrome

ANC: Antenatal Care

CSA: Central Statistical Agency

DIC: Deviance Information Criteria

EDHS: Ethiopian Demographic and Health Survey

EAs: Enumeration Areas

FMOH: Ethiopian Federal Ministry of Health

HEP: Health Extension Programme

HEW: Health Extension Worker

HIV: Human Immunodeficiency Virus

HSDP: Health Sector Development Programme

HREC: Human Research Ethics Committee

INLA: Integrated Nested Laplace Approximation

LMICS: Low and Middle Income Countries

MDG: Millennium Development Goal

MMR: Maternal Mortality Rate

SNNP: Southern Nations Nationalities and Peoples

PMTCT: Prevention of Mother to Child Transmission of HIV/AIDS

UN: United Nations

UNICEF: United Nations Children's

UNFPA: United Nations Population Fund

WHO: World Health Organization

Chapter one

1. Introduction and Literature review

1.1. Background

The quality and levels of access to ANC, skilled birth attendants and family planning services are key indicators for monitoring the improvement in maternal and new-born health in a region (Campbell and Graham 2006, WHO 2007). Furthermore, information about ANC services are essential for devising public Health initiatives geared towards improvement in the health of mothers and their infants (WHO & UNICEF 2003).

During ANC, women who have high risk pregnancy are identified and appropriate preventive measures are taken to ensure they have safe delivery. Complications of pregnancy are usually identified early during ANC visits (Berg et al 2001). Such complications of pregnancy include hypertension, diabetes and Human Immunodeficiency Virus (HIV) status of the pregnant woman. Others includes early treatment of malaria, anaemia and malnutrition in pregnancy (Bernis et al 2003, Khan et al 2006). Moreover, adequate access to ANC service in Sub-Saharan Africa may be the only opportunity a woman and her family have to enjoy the benefit of orthodox health facility. Such opportunities usually provide a window for health promotion and this increases her chance of having a skilled birth attendant during labour and delivery. A woman with inadequate ANC care breaks a crucial link in the continuum of maternal health care that includes preconception, ANC, postnatal care and family planning (Gayawan et al 2014).

The coverage of ANC usually depends on a Country's income (WHO & UNICEF 2003). Access to ANC is higher in developed countries as compared to low and middle income countries (LMICS). In most African countries, it was found that 70% of pregnant women had at least one ANC visit (WHO & UNICEF 2003). However, the World Health Organisation (WHO) recommended that women should have at least four routine ANC visits. The first visit was recommended to be at 13 weeks of gestation. At the ANC visit, some clinical examination and laboratory investigations are conducted for pregnant women. These include measuring the blood pressure, height and weight, urinalysis for protein and glucose, blood test for syphilis and anaemia. Opt out method of HIV counselling and testing is also done to reduce Mother to Child Transmission of HIV/AIDS (PMTCT) (UN 2008).

In Ethiopia, the Ministry of Health (EMOH) , recommends four routine ANC visits with the first visit takes place at 16 weeks and subsequent visits at 24-28 weeks, 30-33weeks and 36-40 weeks (EMOH part 2 2013). However, there are exceptions to this recommendation. Every woman with some complication of pregnancy like hypertension in pregnancy, diabetes in pregnancy may be advised at more frequent intervals. Also, some symptoms of serious complications of pregnancy are usually explained to the women. They are further advised to visit the hospital if they notice those signs for prompt attention even if it is not their usual ANC visiting date (EMOH part 2 2013).

Despite the benefit of adequate use of ANC, maternal mortality is still a leading cause of death among women in the reproductive age group in the developing Countries (Hogan et al 2010). Maternal mortality is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes (WHO, UNICEF 2012).

In 2010, there were about 287,000 maternal deaths globally. Maternal deaths in the Sub Saharan Africa region accounted for more than half (56%) of the global deaths (WHO, UNICEF 2012). Thus, the Maternal Mortality Ratio (MMR) in the sub Saharan Africa is unacceptably high. Ethiopia was among the 19 nations that had the highest MMR in Sub-Saharan Africa (Alvarez et al 2009). The MMR for Ethiopia decreased from 871 per 100,000 live births in 2000 to 673 per 100,000 live births in 2005 but later increased to 676 per 100, 000 live births in 2011 2005 (Tsegay et al 2013). All these value are very high as compared to the MMR of developed countries like Sweden which was 5 per 100,000 women in 2010. The major causes of the disparity in the MMR between the developing and developed countries are lack of awareness, constraint in resource and trained health professionals, weak management of health service and poor uptake of ANC service (WHO, UNICEF 2012).

Spatial epidemiological analysis is an invaluable tool to describe the spatial patterns, to identify clusters and to explain or predict risk of adverse health events or diseases. This approach has been used to identify variations in environmental determinants, health services utilizations and access. Spatial analysis using geographic coordinates (latitudes and longitude) enables epidemiologists, public health experts and researchers to properly investigate the geographic relationship(s) between health outcome(s) and its determinants. For instance, understanding the regional distribution of ANC service utilization assists public

health experts to monitor and allocate available resources based on the needs, burden and risks of each region (Ansariadi and Manderson 2015, Pfeiffer et al 2008).

It is possible to improve maternal and infant health care substantially by allocating resources according to the health need and burden of a region. This may include training of qualified health professionals, funding researches on maternal health to engender translation of policy statements into action (Kvåle et al 2005). The current knowledge about the awareness and level of utilization of ANC in Ethiopia will greatly assist policy makers to better understand the dynamics of maternal health in the country. This will also assist in the development of well-tailored strategies that will reduce the high levels of maternal deaths in the country.

1.2. Statement of the problem

The WHO on its focused ANC program recommended 75% of pregnant mothers who are at low risk of complication should attend at least four ANC visits during the pregnancy. On the other hand, WHO also recommended at least one ANC visit for 69% pregnant mothers in Sub-Saharan Africa due to socioeconomic and demographic factors (Gayawan et al 2014). However, the coverage of ANC in Ethiopia appears to be very low and there was no sign of rapid increase in the period before the DHS survey of 2011. Thus, for 2000, 2005 and 2011 the coverage of at least one ANC visit that attended by skilled providers (doctor, nurse or midwife) was estimated to be 26.7%, 28% and 34% respectively (CSA [Ethiopia] and ICF International 2012).

Some studies had previously investigated the factors that affect of ANC service utilization in Ethiopia (Abosse et al 2010, Birmeta et al 2013, Dagne 2010, Ejigu et al 2013, Tarekegn et al 2014). However, these studies did not investigate the regional variations in the ANC service utilisation in Ethiopia. Thus, deployment of peculiar Public health interventions to meet the special needs of each region based on robust evidence from previous researches is lacking.

1.3. Justification of the study

The utilization of ANC by pregnant women is complex interplay between several socio-demographic and regional factors. Government of Ethiopia have recently shown commitment to improve the utilization of ANC service. There has also been demographic transition in over the years that have affected the perception and health care utilization services in Ethiopia .Also, some studies have attempted in the past to investigate the factors that determines ANC service utilization, but did not utilise spatial analysis.

This study is designed to document the risk factors affecting the time of first ANC visit and the number of ANC visits. The present study utilise both ordinal logistic regression and spatial statistical approach that was not utilised before in Ethiopia. The results from the present research hope to better evaluate regional variations in ANC uptake to provide further information on the peculiar need(s) of each region. Furthermore, by establishing the spatial variation in ANC service utilization; the finding of this research can provide government, policy makers and stakeholders with focused evidence to maximize provision of ANC service to women in different localities.

1.4. Literature review

Adequate uptake of ANC is the main bedrock of the safe motherhood initiative and it has been shown to help in the reduction of maternal morbidity and mortality. The millennium Development Goal 5 (MDG-5) was to improve maternal and child health. Furthermore, one of the indicators of the MDG-5 was to reduce maternal mortality ratio by 75% of the 1990 estimates. ANC service has been identified as a major means of achieving this goal (Jat et al 2011). However, several factors militate against wide coverage of ANC services in most developing countries like Ethiopia. Such factors include socio-demographic, health systems, cultural values and the status of women in the country (Jat et al 2011, Shaikh and Hatcher 2005, Sugathan et al 2001). The literatures on the uptake of ANC were reviewed based on the recognised explanatory variables.

The age of a woman at her last childbirth is among the demographic factors that influence ANC service utilization. Researchers have stated that pregnant women older than 35 years at delivery were less likely to attend ANC visits as compared to women who were younger than 35 years (Bell et al 2003, Regassa 2011). In contrast of above, women in the age group 20-34 had a higher likelihood of attending ANC visits than women that were younger than 20 years in the urban regions of Ethiopia (Dagne 2010). Similarly, a study in southern Ethiopia revealed that women in age group 25-29 years were less likely to utilize ANC service than those 35 years and older women (Abosse et al 2010). Also, women with teenage pregnancy are less likely to attend ANC because they are likely to be single and may be carrying unintended pregnancy (Ochako et al 2011).

Place of residence also influences ANC service utilization. For example, living in a rural area has been found to be associated with late start of early ANC visit and less number of ANC visits (Toan 2012, WHO & UNICEF 2003). Similarly, a study in Indonesia showed half of

rural women had less than four ANC visits; while, around two thirds of urban women had at least four ANC visits (Ansariadi and Manderson 2015). A study in Southern Ethiopia showed that urban women were more likely to use ANC services compared to rural women (Abosse et al 2010).In contrast, rural women had slightly higher early ANC visit than urban women (Ansariadi and Manderson 2015, Wabiri et al 2013).

The previous number of pregnancies that a woman had carried beyond the age of maturity (beyond 28 weeks of gestation) is known as the parity of the woman. Studies revealed that women with high parity are less likely to attend ANC service than women with low parity (Abbas and Walker 1986) (Abbas and Walker 1986, Bell et al 2003, Regassa 2011, Simkhada et al 2008). Also, study in Ethiopian found that women with parity lower than three were eight times more likely to utilize ANC service than women with parity greater than three (Abosse et al 2010). The reason for the poor utilization of ANC among women with higher parity was because most of them were over confident about the process of pregnancy and delivery since they had uneventful pregnancies before. Thus, they usually decide to shun ANC during subsequent deliveries. However, most of them may develop pregnancy- related complications that could have been identified and prevented if they had promptly attended ANC (Kwast and Liff 1988). Another reason that was attributed for the low ANC uptake among women with high parity was that they were usually over burden with the care of the many living children and hence may be constrained by lack of resources and time to be able to give adequate attention to the subsequent pregnancy (Sonneveldt et al 2013).

The household's wealth is also well recognized determinant of ANC service utilization. Studies in Ethiopian and other Countries showed that the number of ANC visit was higher among wealthier women as compared to the poor women (Abosse et al 2010, Dagne 2010, Getachew et al 2014, Victora et al 2010, Wabiri et al 2013). Also, wealthy women were shown to commence early ANC visit in the first trimester as compared to the poor women (Victora et al 2010).

Majority of studies have found that married women were more likely to attend regular ANC visit than unmarried (single) women (Ochako et al 2011, Wabiri et al 2013). This is because married women are more likely to have family support and be well motivated than to support their pregnancy as compared to unmarried (single) women (Dagne 2010, Toan 2012). In contrast, a study in Ethiopia found that single or divorced women were four times more

likely to access focused ANC service than married women among rural women (Getachew et al 2014).

Educational status of pregnant women has been found to be a strong predictor of ANC service utilization. The likelihood of an educated woman being able to access ANC service was higher than less educated woman. Most educated women were more likely to be aware about health promotion and the benefit of ANC than less educated women (Abosse et al 2010, Dagne 2010, Getachew et al 2014). Moreover, an educated women were more likely to be empowered and economically positioned to afford to even pay for ANC services in places where such service is not free (Toan 2012)

Religion is another important social factor that affected health care utilization including ANC visits (Johnson and Way 2006). Studies have shown that women who have firm believe in traditional religion had about 50% reduced chance of accessing ANC when compared with those who were believe in orthodox or catholic religion (Dagne 2010). Most orthodox or catholic organisations promote access to quality health care while believers in the traditional religion have lesser faith in the access to quality health practice (Dagne 2010).

Geographical factors are also well known factors that affect maternal health utilization. Studies revealed that there were spatial variations in ANC service utilization in various countries around the world. For instance, significant spatial variations in ANC utilization have been reported in Nigeria (Gayawan et al 2014) , Indonesia (Ansariadi and Manderson 2015) and France (Charreire and Combier 2009). However, to the best of our knowledge, no study has investigated the spatial variation in ANC service utilization in Ethiopia.

1.5. Aim and Objectives

1.5.1. Overall aim

To identify socio-economic and demographic factors associated with ANC service utilization, to investigate spatial clustering in ANC service utilization and to map the spatial variation in ANC service utilization in Ethiopia.

1.5.2. Specific objectives

The specific objectives of the study are:

1. To investigate spatial clustering in the time of first ANC visit and the number of ANC visits in Ethiopia.
2. To develop maps of spatial variation in the time of first ANC visit and the number of ANC visits in Ethiopia.
3. To identify socio-economic and demographic factors associated with the time of first ANC visit and the number of ANC visits in Ethiopia.

Chapter Two

2. Materials and Methods

2.1. Study setting

This study was conducted in Ethiopia. Ethiopia is a country with about 96 million people living in a geographically diverse environment (Caglia et al 2014). Ethiopia is located between altitudes 4,550 above sea level and 110 below sea level. About 16% lives in urban area with the others living in Rural and semi-urban settlements. Agricultural practices is the main occupation of Ethiopian and this accounts for about 43% of the gross domestic product (GDP) of the country (CSA [Ethiopia] and ICF International 2012). The Country also gained foreign earnings from exportation of Agricultural products like coffee. The predominant religion in Ethiopia is orthodox christian religion and about half of the population are its adherents. About one-third of the population are muslins while about 18% are christian protestants and 3% practice traditional religion (CSA [Ethiopia] and ICF International 2012, EMOH 2013).

Administratively, Ethiopia is organized into nine state of regions: Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations Nationalities and Peoples (SNNP), Gambela, and Harari; and two administrative cities: Addis Ababa and Dire Dawa (See Figure 1) (CSA [Ethiopia] and ICF International 2012).

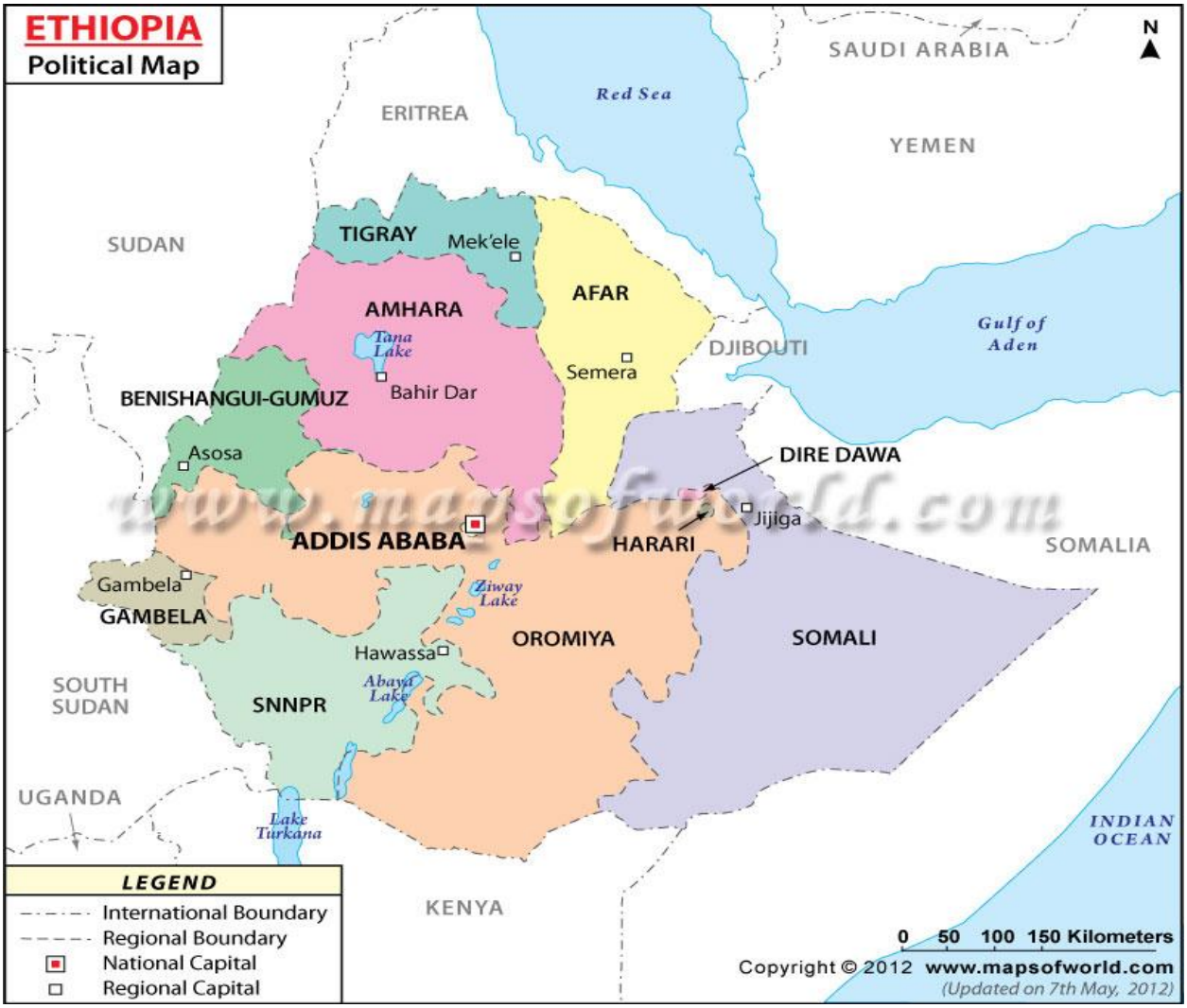

Figure 1 political map of Ethiopia: Presenting the international boundary, ethnically based states and self-governing administrations boundaries with their capitals and national capital
Taken from http://www.mapsofworld.com/ethiopia/ethiopia-political-map.html

The Health System in Ethiopia is structured into a three-tier system. Primary level: Woreda or District Health System which includes a Primary Hospital that serves 60,000–100,000 populations, Health Centres that provide health services for 15,000– 25,000 populations and Health Posts in kebele-level which gives health services for 3,000–5,000 populations. Secondary level: General Referral Hospitals in larger cities that each of the hospitals provides health services for 1–1.5 million populations. Tertiary level: Specialized Hospitals: each of them give health services for patient population of 3.5–5 million (Caglia et al 2014).

Development and strengthening of the preventive and curative part of the health care; democratisation and decentralisation of the health care system; establishing of accessible health care for all populations and, encouragement of participation of private and

collaborative organizations in the health sector are the main elements of the Health Sector Development Programme (HSDP) in Ethiopia (CSA [Ethiopia] and ICF International 2012).

2.1.1. Maternal health and ANC in Ethiopia

The maternal and child health care is a major priority area of the HSDP and the main aims is to reduce the prevalence and complications of HIV/AIDS, TB and Malaria among the pregnant women and children in particular and the general population of Ethiopia.

The Ethiopian government commenced the Health Extension Programme (HEP) to help improve the health service delivery of the country. HEP was designed to serve as the main source of both preventive and curative health service delivery for the country especially in the rural areas. The HEP is an innovative health service delivery program that aims to improve the quality and coverage of primary health care (CSA [Ethiopia] and ICF International 2012, EMOH 2013). The leading causes of maternal mortality in Ethiopia include postpartum haemorrhage, sepsis, eclampsia, obstructed labour, and unsafe abortion. Low uptake of maternal health services, poor quality of healthcare services and inadequate empowerment of the women are some of the reasons responsible for the pattern of maternal deaths in Ethiopia (Caglia et al 2014).

Focused ANC is the accepted model in Ethiopia. HEWs are trained to provide primary health care in a country including focused ANC service during pregnancy (FMOH and UNICEF 2013). HEWs are responsible for identifying pregnant women, providing ANC service, liking them to the next level of care in the event of high risk or complications and following up during postnatal period within their catchment area (FMOH and UNICEF 2013).

The coverage of at least one ANC visit has increased in Ethiopia from 26.8% in 2000 (FMOH and UNICEF 2013) to 34% in 2011 (CSA [Ethiopia] and ICF International 2012). This gain is achieved due to expansion and deployment of the HEWs cadre (FMOH and UNICEF 2013). Also the coverage for greater than four or four ANC visits has increased from 10% in 2000 to 19% in 2011 (Caglia et al 2014). These converges of ANC utilization are still too far from WHO recommendations which state that at least four ANC visits for 75% of pregnant women who are at low risk of complication and at least one ANC visit for 69% pregnant mothers in Sub-Saharan Africa (Gayawan et al 2014)

2.2. Study design

In this study, the dataset used was the 2011 EDHS. This was community based cross-sectional study designed to provide data on demographic and health indicators to promote studies on population, health, and nutrition of women and children in the country. It was funded by the United States Agency for International Development (USAID) and was conducted by the Ethiopian Central Statistical Agency (CSA [Ethiopia] and ICF International 2012, Tarekegn et al 2014).

2.3. Study population and Sampling

The 2011 EDHS used two-stage cluster stratified sampling techniques. From a sampling frame of 85,057 Enumeration Areas (EAs), 624 EAs were selected using probability proportional to size method. From each of 624 EAs, 30 household were selected by systematic random sampling method resulting to a total of 17,817 households. All women 15-49 years who were usual residents or who slept in the selected households the night before the survey were eligible for the survey. In the selected households, 17,385 eligible women were identified for individual interview and 16515 (95%) were interviewed (CSA [Ethiopia] and ICF International 2012).

Pre-tested and structured questionnaire, developed in English and translated into three different local languages (Amharic, Oromiffa and Tigrigna) was used as a tool for data collection. Specifically, this study focused on data obtained from the women aged 15 to 49 years who gave at least one birth in the last 5 years preceding the survey (CSA [Ethiopia] and ICF International 2012, Tarekegn et al 2014).

2.4. Study variables

The Andersen Health Seeking Behavioural Model was used as bases for selection of the study variables. The base of the model is characteristics of the population including predisposing factors, enabling factors and the needs factors for ANC service utilization of the mothers that influenced by the external environment. Generally, the choice of ANC services by a mother is determined by population characteristics and external environmentally factors directly or indirectly (See Figure 2) (Toan 2012).

Contextual or Environmental factors →	Predisposing factors →	Enabling factors →	Need factors →	Health Behaviour Choice
Environmental and Health care system	Socio-demographic	Family and community level	Obstetric history and current pregnancy	Utilization of ANC services
Region, Place of residence	Age, marital status ,Education, Ethnicity, Religion and sex of household heads	Household wealth and mother working status	Parity	Time of first and number of ANC visits

Figure 2 Conceptual framework for factors influencing ANC service utilization in Ethiopia (Toan 2012)**.**

2.4.1. Summary of variables

2.4.1.1. Dependant variables

The time of first ANC visit was coded as late (0) when the first visit took place after 16 weeks of gestation, and early (1) when the first visit took place during 16 weeks of gestation. The number of ANC visits was ordered and coded as no (0) for those who did not visit; inadequate (1) for one to three visits and adequate (2) for four or more number of visits. The alternative coding for the number of ANC visits includes: no (0) for those who did not visit and (1) for at least one ANC visit. This was used for mapping of spatial variation in number of ANC visits.

2.4.1.2. Independent variables

- ✓ Age: refers to age of the woman at the birth of last child
- ✓ Place of residence: refers to urban or rural
- ✓ Region: refers to 11 administrative areas in the country: Tigray, Affar**,** Amhara**,** Oromiya**,** Somali**,** Benishangul-gumuz**,** SNNPR**,** Gambela and Harari regions, and Addis Ababaand and Dire Dawa administrative cities
- ✓ Educational status: refers to the highest educational level of the woman attained; None, Primary, Secondary & Higher
- ✓ Religion: categorised in to Catholic, Muslim, Orthodox, Protestant, Traditional and Others

- ✓ Ethnicity: ethnic group of the woman classified as Amhara, Oromo, Sidama, Guragie, Somalia, Wolaita, Tigray and Others
- ✓ Household-wealth: grouped in to poorest, poorer, middle, richer and richest
- ✓ Marital status: refers to never in union, married and widowed
- ✓ Parity/Birth order: refers to the rank of the child at birth
- ✓ Sex of household head: classified as male or female and
- ✓ Mother working status: refers to mother's employment status, that is, Yes or No (CSA [Ethiopia] and ICF International 2012).

2.5. Statistical methods

2.5.1. Data management and Cleaning

A STATA dataset was downloaded from ICF international website and thereafter, all the relevant variables were extracted. Data cleaning and management, (renaming, recoding and range checking of variables) was done in STATA 13 (StataCorp 2013) and R version 3.1.3 (R Development Core Team 2015) to generate new variables relevant to the study objectives.

2.5.2. Data analysis

Data was analysed using STATA version 13, R version 3.1.3 and SaTScan version 9.4 (Kulldorff 2015), considering complex multilevel sampling design. Weighting of the sample by cluster was applied to ensure the study estimates were representative of the general population. Survey weighted descriptive statistics was used to describe the data. Cross-tabulation analysis was done by taking each independent variables and calculating the proportion of use of ANC services. Univariable analysis was done to identify candidate variables for multivariate analysis. In addition to Andersen Health seeking Behavioral Model, statistically significant variables at a p-value of <0.2 were considered important factors to be included in the multivariable regression analyses. Forward stepwise model building strategies were used. The best model was selected based on the likelihood ratio test (lrtest), and Akaike International Criterion (AIC). Models with significant lrtest p-values or lower AIC were considered better than those with insignificant p-values or higher AIC.STATA survey commands svy and gsvy for taking account complex survey analysis data were used.

2.5.2.1. Cluster Analysis

Spatial scan statistical analysis was carried out on EAs aggregated data by using SaTScan to investigate significant clusters of time of first ANC visit and number of ANC visits. The spatial scan statistical analysis based on the likelihood ratio test is extensively used for

detecting whether the observed disease or health event pattern is clustered or random in space, time or space-time. The most likely cluster is the area associated with the maximum value of the likelihood ratio test statistics. The methodological detail was explained elsewhere (Pfeiffer et al 2008, Yung et al 2007).

Bernoulli based scan statistics are used for the analysis of binary response variables such as cases and non-cases, or case with two different stages such as early and late. The purely Spatial Bernoulli model is used to detect and evaluate clusters by gradually scanning a window across space, noting the number of observed and expected observations inside the window at each location. The detail statistical theory for this model used in SaTScan was described elsewhere (Kulldorff 1997).

The purely spatial Bernoulli model requires information on case (1), control (0) and their geographical location or coordinates (Kulldorff 1997, 2015). Early ANC visit was considered as case and late ANC visit was considered as control. The case file, control file and coordinate (latitude and longitude) file were imported to SaTScan to assess high and low rates of the time of first ANC visit clusters. The p-values for maximum likelihood ratios were based on Gumbel approximation with 9999 replications, at p-value 0.0001. The Gambel approximation was preferred because for purely spatial scan statistics with Bernoulli Probability Model, Gumbel distribution fit the data perfectly and generates extremely precise p-values (Kulldorff 1997).

For the number of ANC visits the study used the Purely Spatial Ordinal Probability Model as opposed to Purely Spatial Bernoulli Probability Model, because cutting or dichotomizing ordinal outcome variable result in loss of information (Yung et al 2007). In this model, the case file containing EAs aggregated data in each category for each location and coordinate files were imported to the SaTScan to detect high and low rates of number of ANC visits clusters. The high cluster with excess cases in high –valued categories (adequate ANC visit) and low cluster with excess cases in low–valued categories (none ANC visit) were investigated simultaneously. The general statistical theory for this model used in SaTScan was described elsewhere (Yung et al 2007).The p-values for maximum likelihood ratios were based on 9999 Monte Carlo replications, at p-value 0.0001 (Kulldorff 2015, Yung et al 2007).

2.5.2.2. Bayesian Model

A Bayesian spatial Hierarchical model was developed using the R package Integrated Nested Laplace Approximation (INLA) (Bivand et al 2015).This model was used to investigate the relationship between the outcome variables of interest and the selected predictors, accounting for spatial autocorrelation in the data (Achia 2014, Pfeiffer et al 2008).The objective here is to investigate factors that influence time of first ANC visit (early/late) at the regional level. When modelling the binary data (time of first ANC visit), independent variables used to predict the probability of a woman use early ANC visit. To do this, Hierarchical spatial logistic regression models were used. The log transformation of the probability of the outcome ***(p)*** is modelled as a linear function of a set of independent variables.

In this study, **Model 1** stands for the (Bayesian) or ordinary logistic regression:

$$\text{logit}\,(p_i) = \beta_0 + \mathbf{X}_i'\boldsymbol{\beta}$$

Model 2 stands for the generalized linear mixed model with spatially unstructured random effect:

$$\text{logit}\,(p_i) = \beta_0 + \mathbf{X}_i'\boldsymbol{\beta} + f_u(s_i)$$

Model 3 stands for the generalized linear mixed model with spatially structured random effect:

$$\text{logit}\,(p_i) = \beta_0 + \mathbf{X}_i'\boldsymbol{\beta} + f_s(s_i)\ \textbf{;}\ \text{and}$$

Model 4 stands for the generalized linear mixed model with both spatially structure and unstructured random effects:

$$\text{logit}\,(p_i) = \beta_0 + \mathbf{X}_i'\boldsymbol{\beta} + f_s(s_i) + f_u(s_i),$$

where β_o is constant, $\boldsymbol{\beta} = (\beta_1,\ldots,\beta_p)$ is the (p x 1) vector of parameter estimates, $\boldsymbol{X_i}$ corresponding linear effects of covariates, $f_u(s_i)$ is spatially unstructured components and $f_s(s_i)$ is spatially structured component. The detail is explained elsewhere (Achia 2014, Pfeiffer et al 2008).

The unadjusted and adjusted odd ratios were fitted for all covariates. The deviance information criteria (DIC) which is a measure of model complexity and fit was used to select

best model. Smaller values of DIC indicates a better model (Achia 2014, Bivand et al 2015, Pfeiffer et al 2008).

2.5.2..3. Univariate and multivariate ordinal logistic regression

For the variable number of ANC visits that was ordered into three categories, univariate and multivariate ordinal logistic regression model was used. The cumulative logistic regression for ordinal response data (number of ANC visits) is given by;

$$\textbf{Logit } [P(Y \leq i)] = \alpha_1 + \beta_{i1}X_1 + ... + \beta_{im}X_m, \textbf{ i=1,...k}$$

Where $k=3$ is number of categories in the outcome variable, α_1 are intercepts, $\beta_{i1},\ldots,\beta_{im}$ are coefficients and $X_1,\ldots,X_m$ are covariates. The detail for this model was explained elsewhere (Bender and Grouven 1997). This model is preferred than multinomial logistic regression because it prevent loss of ordered information. The Brant test was used to test the parallel line assumption, based on which the ordered logit model is founded (Brant 1990). Following violation of this assumption, a partial proportional odds model was fitted. The STATA command gologit2 was used to fit the partial proportional odds model. A p-value < 0.05 was considered statistically significant (Khanal et al 2014, Ochako et al 2011).

2.6. Limitation of study

This study used the survey data that was drown from women aged 15 to 49 years who gave at least one birth in the last 5 years preceding the survey, which is subjected to information bias. This is because; it is difficult to recall all information (which was happened in five years interval) during interview. While the study identifies socio-economic and demographic factors associated with the time of first ANC visit and the number of ANC visits, does not include contents of ANC service. Moreover, the modelling and mapping were done in large geographical areas (regions) due to absence of data in lower boundaries (zones).

The EAs includes all part of the country, but due to drought and security reason in Somali region all the listed households were not included in the interview. Thus, makes the data not representative for the region. But, it may not affect the national sample because of the small proportion of the region's population (CSA [Ethiopia] and ICF International 2012, Tarekegn et al 2014).

2.7. Ethical considerations

The previous study was approved by the Ethiopian Health and Nutrition Research Institute (EHNRI) Review Board, the National Research Ethics Review Committee (NRERC) at the Ministry of Science and Technology, the Institutional Review Board of ICF International, and the CDC. Further, this study was approved by ICF international and University of Witwatersrand Human Research Ethics Committee (HREC) with clearance certificate number M140924.

Chapter Three

3. Results

Of the 16,515 women aged 15-49 years interviewed, 7,908 (47.9%) women provided response to the question concerning *number of ANC visits*, but for the 27 (0.34%) the response was unknown or missed. Of the 7,908 women aged 15-49 years interviewed for number of ANC visits, 3,391 (42.88%) women provided response to the question concerning *time of first ANC visit*, but for the 27 (0.34%) the response was unknown or missed (see Figure 3).

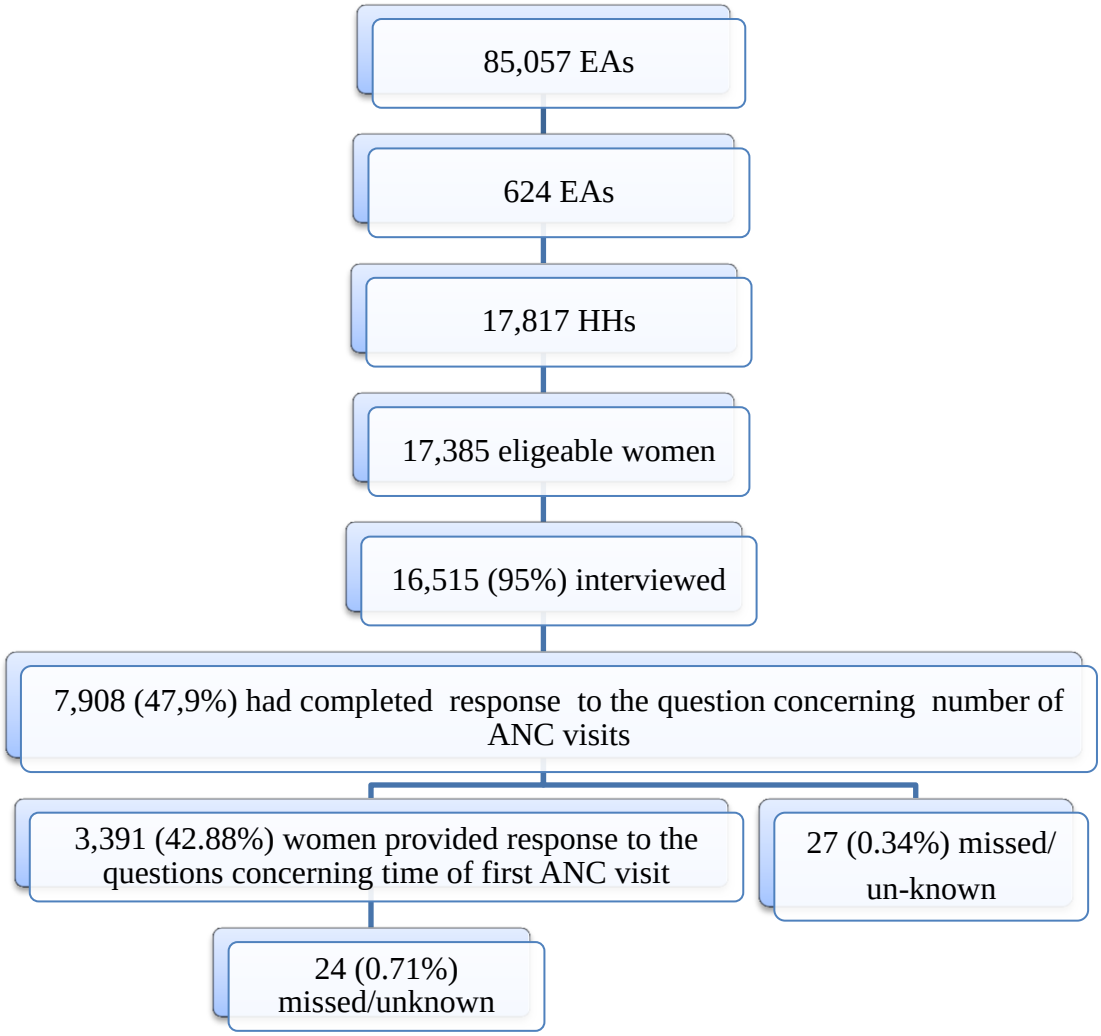

Figure 3: ANC service utilisation for women who had at least 1 birth in the last 5 years preceding the survey in Ethiopia, 2011.

3.1. Time of first ANC visit

3.1.1. Descriptive statistics

Table 1 shows the characteristics of time of first ANC visit by different covariates for the sample of 3,368 women aged 15-49 years who gave at least one birth in the last five years and had at least one ANC visit. The national prevalence of early ANC visit was 26.38%. Apart from mother's age at birth at the last child and ethnicity, all the other covariates used in this study were significantly associated with time of ANC visit. We found significant (P<0.001) regional variation in time of ANC visit. The prevalence of early ANC visit was highest (56.25%) in Dire Dawa administrative city; and lowest (16.22%) in Benishangul-gumuz region. The prevalence of early ANC visit increased with increasing education and household wealth status. As expected, the prevalence of late ANC decreased with increasing level of education.

Table 1 Prevalence of time of first ANC visit by different covariates among women aged 15 -49 years who gave at least 1 birth in the last 5 years in Ethiopia, 2011.

Covariates	Time of ANC visit		P value
	Late N (%)	Early N (%)	
Age at birth of last child			
Less than 20	265 (74.02)	93 (25.98)	0.304
20-24	712(75.82)	227 (24.17)	
25-29	657 (70.04)	281 (29.96)	
30-34	523 (73.66)	187 (26.34)	
Greater than 35	322 (76.30)	100 (23.70)	
Place of residence			
Rural	1941 (78.87)	520 (21.13)	<0.001
Urban	539 (59.43)	368 (40.57)	
Region			
Tigray	257 (75.81)	82 (24.19)	<0.001
Affar	19 (70.37)	8 (29.63)	
Amhara	591 (73.93)	208 (26.07)	
Oromiya	931 (75.87)	296 (24.12)	
Somali	32 (64.00)	18 (36.00)	
Benishang-gumuz	31 (83.78)	6 (16.22)	
SNNPR	512(77.22)	151(22.78)	
Gambela	11 (57.89)	8 (42.11)	
Harari	5 (45.45)	6 (54.56)	
Addis Ababa	86 (47.25)	96 (52.74)	
Dire Dawa	7 (43.75)	9 (56.25)	
Education			
None	1395 (78.37)	385 (21.63)	<0.001
Primary	899 (71.69)	355 (28.31)	
Secondary	122 (61.00)	78 (39.00)	
Higher	63 (47.37)	70 (52.71)	
Religion			

	Orthodox	1077 (67.95)	508 (32.05)	<0.001
	Catholic	27 (75.00)	9 (25.00)	
	Protestants	581 (81.60)	131 (18.40)	
	Muslim	754 (76.94)	226 (23.06)	
	Traditional	24 (85.80)	4 (14.29)	
	Others	15 (57.69)	11 (42.31)	
Ethnicity				
	Amhara	709 (69.12)	317 (30.88)	0.066
	Guragie	92 (68.59)	42 (31.41)	
	Oromo	865 76.37)	268(23.63)	
	Sidama	87 (84.67)	16 (15.33)	
	Somalia	29 (66.18)	15 (33.82)	
	Tigrie	255 (75.09)	85 (24.91)	
	Wolaita	57 (70.79)	24 (29.21)	
	Others	386 (75.77)	124 (24.23)	
Household Wealth				
	Poorest	343 (79.77)	87 (20.23)	<0.001
	poorer	481 (81.39)	110 (18.61)	
	Medium	501 (81.20|)	116 (18.80)	
	Richer	533 (76.58)	163 (23.42)	
	Richest	622 (60.21)	411(39.79)	
Marital Status				
	Never in union	16 (59.26)	11 (40.74)	0.008
	Married	2288 (74.53)	782 (25.47)	
	Widowed	176 (64.94)	95 (35.06)	
Parity				
	1	495 (66.08)	254 (33.92)	0.011
	2-3	822 (75.40)	268 (24.60)	
	4-5	588 (74.92)	197 (25.08)	
	≥ 6	575 (77.24)	169 (22.76)	
Sex of house hold head				
	Male	2068 (75.11)	685 (24.89)	0.003
	Female	411 (66.94)	203(33.06)	
Mother working status				
	No	1547 (75.45)	503 (24.55)	0.053
	Yes	931 (70.73)	385 (29.27)	

Key:
Under marital status: Married include (married and living with partner) and Widowed includes (Widowed, divorced and separated)

3.1.2. Cluster detection

Table 3 shows the results of the spatial scan statistics analysis of Bernoulli Probability Model. Cluster 1 was the most likely cluster and cluster 2 & 3 were the secondary clusters ordered by their statistical significance or log-likelihood ratio. Cluster 1 had highest rate RR=2.14 (P<0.0001) of early ANC visit compared to other parts of the country. Alternatively, women in cluster 1 were RR=2.14 (P<0.0001) times more likely to start early ANC visit than other part of the country. Respectively, women in Cluster 2 and 3 were

RR=0.33 (P<0.0001) and RR=0.52 (P<0.0001) times less likely to start early ANC visit than other part of the country. The clusters correspond to West and South-west of the country. The detail and approximate geographical location of the clusters are also shown in table 2.

Table 2 Cluster detection analysis result for time of ANC visit using the Bernoulli scan statistics.

Clusters	Radius (km)	#O/#E	RR	LLR	p-value	Approximate location of clusters by Regions (Zones) from Google Earth
Cluster 1	378.70	1.51	2.14	119.25	<0.0001	Oromiya(N.balle, E.Arsi, North of E.Shawa,W&E.Hararge&N.Shawa Zones); Affar(Zone 1,2, & 5);Amhara (N.Shawa&Wollo, S.Wollo&Oromiya Zones); Addis Ababa;DireDawa& Harari regions
Cluster 2	151.24	0.35	0.33	33.07	<0.0001	Benishangul-gumuz (Tongo, W.asosa, S.Metekel&kamashi zones) &Oromiya(W & east of E.Wollaga&Illubabor zones)
Cluster 3	175.56	0.56	0.52	25.50	<0.0001	SNNP(sidama, gedio, Burgi,Nconso, Dirashe, N.oma, north of S.Omo, Shaka, Kambata, Hadiya & Gurage zones, (Halaba&yamliyuworeda) &Oromiya(Jimma, W Shawa, South of E Shawa, W Arsi, E balle& N Borena

Key: #O/#E, ratio of numbers observed vs expected; RR, relative risk ; LLR, log-likelihood ratio

3.1.3. Spatial modelling and mapping

Table 3 illustrates the results of the Bayesian spatial hierarchical models of the time of first ANC visit. The best model was selected based on the small value of DIC. The DIC values were almost the same for **Model 3** (3997.03) and **Model 4** (3997.02). Model 3 is preferred than model 4 because it has a fewer number of effective parameters.

The adjusted output of Model 3 suggest that age at birth of the last child, place of residence, religion, education and household-wealth and marital status were significantly associated with time of first ANC visit. The Early ANC visit increases with education, but decreases with marital status and parity (see table 4). Women 34 years and older were (AOR: 1.57, 95% CI: 1.03-2.39) times more likely to start early ANC visit than other age groups. Also, early ANC visit increases with age group starting from 20-24 years old. Urban women were found to be (AOR: 1.43, 95% CI: 1.09-1.87) times more likely to use early ANC service than

their rural counterparts. As expected the richest women were (AOR: 1.36, 95% CI: 1.01-1.91) times more likely to start early ANC visit than their counterparts. However, poorer, medium and richer women were consecutively 22%, 19% and 3% less likely to start early ANC visit than poorest women.

Table 3 Odds ratios and 95% Credible Interval (CI) of various covariates by time of ANC visit among women aged 15 to 49 years who gave at least one birth in the last 5 years in Ethiopia, 2011.

Covariates	OR (95% CI)	Model 1	Model 2	Model 3	Model 4
		AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age at birth of last child					
Less than 20 (Ref)					
20-24	1.05(0.82-1.34)	1.00 (0.76-1.32)	0.96(0.73-1.27)	0.98(0.74-1.30)	0.98(0.74-1.30)
25-29	1.24(0.97-1.59)	1.41(1.04-1.93)*	1.33(0.98-1.82)	1.38(1.00-1.89)	1.38(1.00-1.89)
30-34	1.06(0.82-1.38)	1.44(1.01-2.04)*	1.30(0.91-1.85)	1.34(0.93-1.92)	1.34(0.93-1.92)
Greater than 34	0.90(0.66-1.21)	1.67(1.10-2.52)*	1.49(0.98-2.26)	1.57(1.03-2.39)*	1.57(1.03-2.39)*
Place of residence					
Rural (Ref)					
Urban	3.51(3.03-4.08)*	1.61(1.25-2.09)*	1.46(1.12-1.90)*	1.43(1.09-1.87)*	1.43(1.09-1.87)*
Education					
None(Ref)					
Primary	1.61(1.38-1.89)*	1.27(1.06-1.53)*	1.24(1.04-1.49)*	1.28(1.06-1.54)*	1.28(1.06-1.54)*
Secondary	3.46(2.68-4.47)*	1.64(1.22-2.22)*	1.53(1.13-2.08)*	1.55(1.14-2.11)*	1.55(1.14-2.11)*
Higher	5.58(3.99-7.85)*	2.42(1.65-3.58)*	2.38(1.61-3.53)*	2.37(1.60-3.53)*	2.37(1.60-3.53)*
Religion					
Orthodox(Ref)					
Catholic	0.76(0.36-1.52)	0.87(0.39-1.86)	0.77(0.34-1.64)	0.85(0.37-1.85)	0.85(0.37-1.85)
Protestants	0.68(0.55-0.84)*	0.77(0.58-1.02)	0.72(0.54-0.95)*	0.76(0.57-1.03)	0.76(0.57-1.03)
Muslim	0.81(0.69-0.95)*	0.82(0.67-1.01)	0.81(0.66-1.00)	0.74(0.59-0.94)*	0.74(0.59-0.94)*
Traditional	0.23(0.04-0.86)*	0.35(0.07-1.32)	0.38(0.07-1.44)	0.40(0.08-1.56)	0.40(0.08-1.56)
Others	1.35(0.49-3.59)	1.89(0.65-5.29)	1.73(0.60-4.89)	2.11(0.72-6.00)	2.11(0.72-6.00)
Ethnicity					
Amhara(Ref)					
Guragie	1.24 (0.90-1.71)	0.99(0.70-1.40)	0.77(0.54-1.10)	0.86(0.59-1.26)	0.86(0.59-1.26)
Oromo	0.83(0.66-0.99)*	1.15(0.91-1.45)	0.99(0.78-1.27)	0.90(0.67-1.20)	0.90(0.67-1.20)
Sidama	0.28(0.14-0.54)*	0.57(0.26-1.16)	0.50(0.23-1.01)	0.66(0.29-1.41)	0.66(0.29-1.41)
Somalia	1.01(0.72-1.42)	1.46(0.98-2.16)	1.25(0.83-1.85)	1.10(0.65-1.86)	1.10(0.65-1.86)
Tigrie	0.52(0.41-0.66)*	0.66(0.51-0.85)*	0.94(0.70-1.24)	0.77(0.47-1.31)	0.77(0.47-1.31)
Wolaita	0.76(0.41-1.35)	0.97(0.50-1.85)	0.93(0.48-1.76)	1.09(0.55-2.14)	1.09(0.55-2.14)
Others	0.64(0.52-0.78)*	1.14(0.88-1.48)	1.02(0.78-1.34)	1.02(0.75-1.39)	1.02(0.75-1.39)
Household Wealth					
Poorest (Ref)					
Poorer	0.68(0.51-0.92)*	0.70(0.52-0.95)*	0.72(0.53-0.97)*	0.78(0.57-1.06)	0.78(0.57-1.06)
Medium	0.73(0.55-0.96)*	0.75(0.56-1.00)	0.74(0.55-1.00)	0.81(0.60-1.10)	0.81(0.60-1.10)
Richer	0.98(0.75-1.28)	0.89(0.68-1.18)	0.89(0.68-1.18)	0.97(0.73-1.28)	0.97(0.73-1.28)
Richest	2.94(2.37-3.65)*	1.48(1.08-2.02)*	1.36(0.99-1.86)	1.38(1.01-1.91)*	1.38(1.001.91)*
Marital Status					
Never in union(Ref)					
Married	0.43(0.23-0.81)*	0.60(0.30-1.21)	0.66(0.32-1.35)	0.62(0.31-1.26)	0.62(0.31-1.26)

Widowed	0.61(0.31-1.21)	0.77(0.37-1.59)	0.83(0.39-1.72)	0.76(0.36-1.57)	0.76(0.36-1.57)
Parity					
1(Ref)					
2-3	0.75(0.62-0.90)*	0.84(0.67-1.04)	0.85(0.68-1.07)	0.83(0.67-1.04)	0.83(0.67-1.04)
4-5	0.56(0.45-0.69)*	0.74(0.55-0.99)*	0.78(0.58-1.05)	0.77(0.57-1.04)	0.77(0.57-1.04)
≥ 6	0.46(0.37-0.57)*	0.64(0.45-0.90)*	0.71(0.50-1.02)	0.70(0.49-1.00)	0.70(0.49-1.00)
Sex of house hold head					
Male(Ref)					
Female	1.59(1.35-1.88)*	1.19(0.97-1.45)	1.22(1.00-1.50)	1.20(0.98-1.47)	1.20(0.98-1.47)
Mother working status					
No(Ref)					
Yes	1.28(1.10-1.47)*	1.00(0.84-1.17)	1.00(0.85-1.17)	1.03(0.87-1.21)	1.03(0.87-1.21)
Random Effect					
Unstructured(τ_u)			1.10(1.07-1.13)		18355.49(1273.46 -6559970)
structured(τ_s)				5.82(1.94-13.61)	5.91(1.92-13.43)
DIC		4074.26	4041.42	3997.03	3997.02
PD		31.69	32.68	40.28	40.25
Key: ***=p≤0.05** **Under marital status: Married include (married and living with partner) and Widowed includes (Widowed, divorced and separated)**					

Figure 4 shows the prevalence map of early ANC visits for eleven administrative states namely: Tigray, Affar, Amhara, Oromiya, Somali, Benishang-gumuz, SNNPR, Gambela and Harari regions, and Addis Ababa and Dire Dawa cities. The prevalence of early ANC visit was greater than 50% in Harar, Addis Ababa and Dire-Dawa administrative area. Figure 5 presented smoothed prevalence of time of first ANC visit. The result was almost similar with Figure 4 (there is no such difference with crude prevalence) and support the result of spatial cluster analysis.

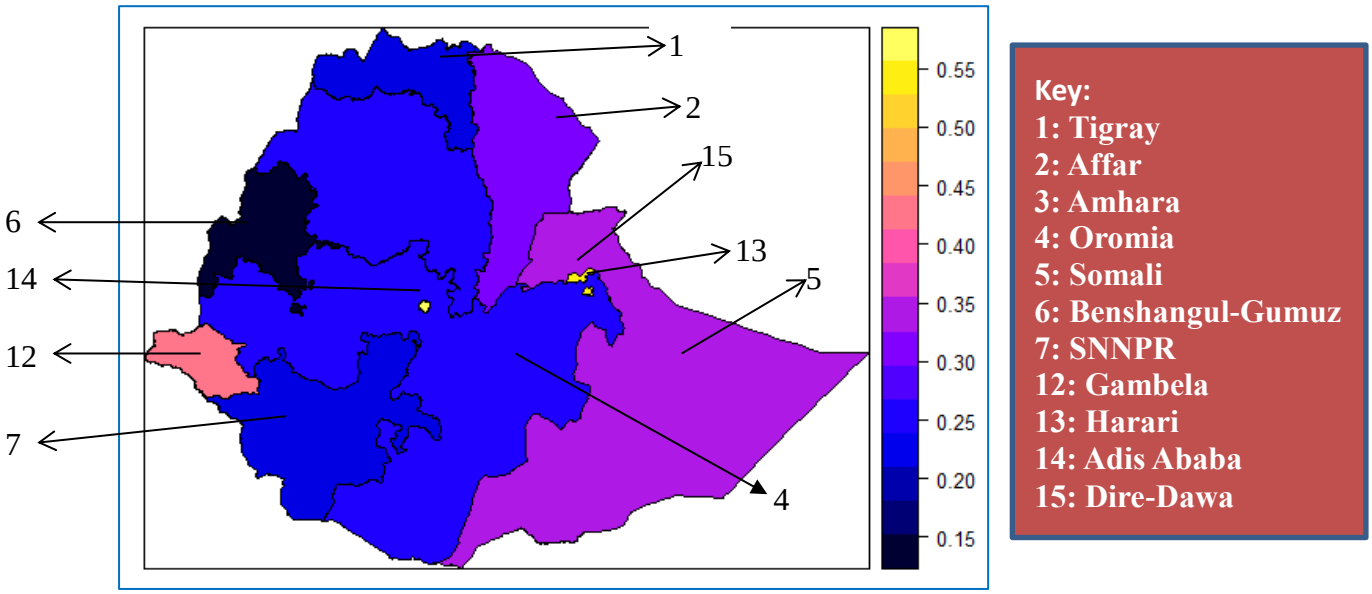

Figure 4 Crude prevalence map of early ANC visit by region for women aged 15-49 years who gave at least one birth in the last five years in Ethiopia, 2011.

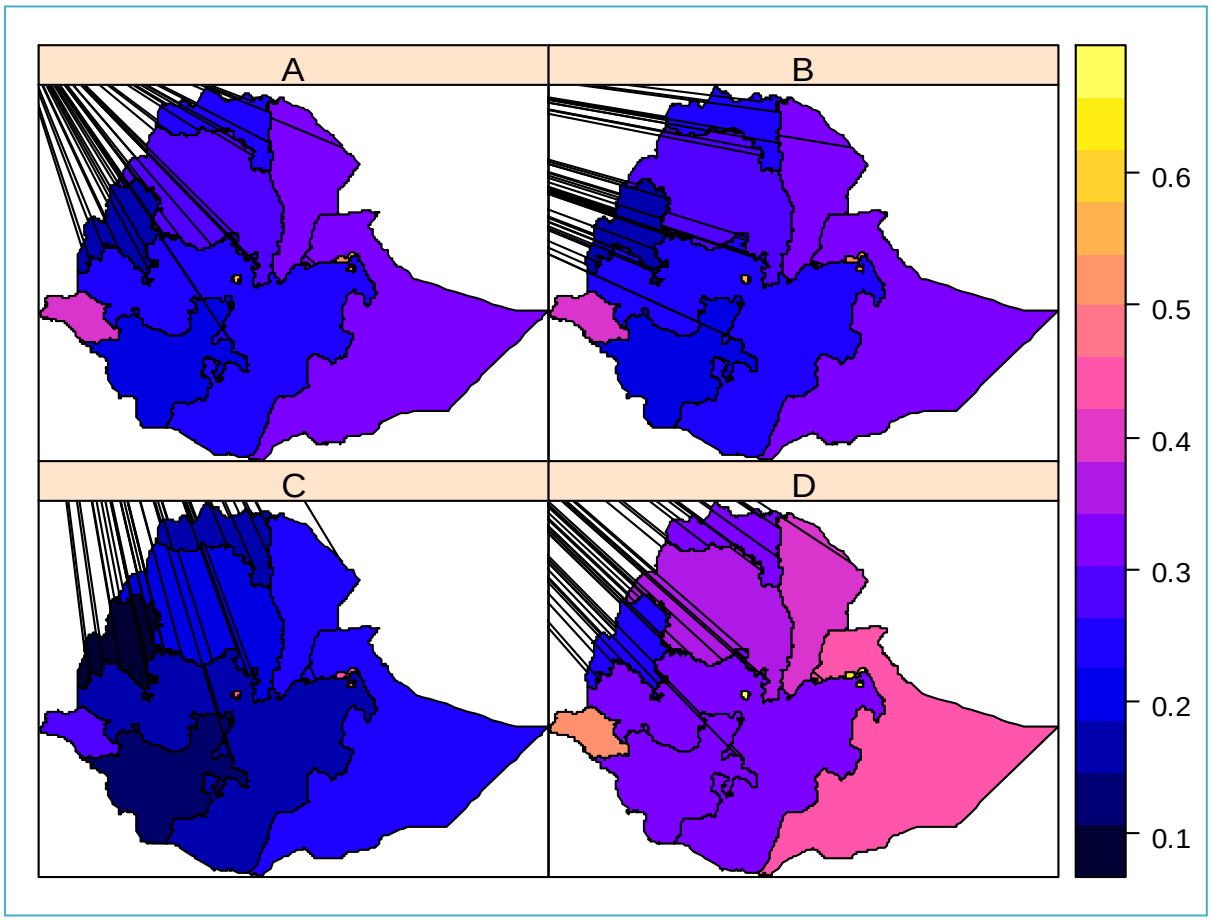

Figure 5: Prevalence of early ANC visit by region predicted from parsimonious Bayesian spatial structured model:

A: Mean posterior prevalence rates; B: median posterior prevalence rates; C: 2.5% quantile posterior prevalence rates and D: 97.5% quantile posterior prevalence rates

3.2. Number of ANC visit

3.2.1. Description of Sample

Table 4 shows also the characteristics of number of ANC visits by different covariates for the sample of 7881 women aged 15-49 who gave at least one birth in the last five years. Only 19.14% of the women made the adequate numbers of ANC visits. Majority of the women (57.31%) had not visited health facilities for ANC at all. Except marital status, all the covariates were significantly associated with number of ANC visits. In adequate number of ANC visits decreased linearly with age. Number of ANC visits also vary with region, the prevalence of adequate number of ANC visit was highest 87.27% in Addis Ababa city, and lowest 7.02% in Somalia region. The prevalence of women who did not visit for ANC decreased by education and household wealth status, however it increased with parity. On other hand adequate number of ANC visit linearly increases with education status and household wealth, however it linearly decline with parity.

Table 4 Prevalence of number of ANC visits by different covariates among women aged 15 -49 years who gave at least 1 birth in the last 5 years in Ethiopia, 2011.

Covariates	Number of ANC visit			P value
	No N (%)	Inadequate N (%)	Adequate N (%)	
Age at birth of last child				
Less than 20	454(55.78)	217(26.66)	143(17.56)	0.011
20-24	1086(53.86)	507(25.15)	424(20.99)	
25-29	1231(56.51)	495(22.72)	453(20.77)	
30-34	993(58.41)	382(22.46)	325(19.13)	
Greater than 34	753(64.20)	256(21.79)	164(14.02)	
Place of residence				
Rural	4242(63.19)	1504(22.41)	968(14.41)	<0.001
Urban	274(23.48)	352(30.17)	541(46.35)	
Region				
Tigray	188(35.57)	178(33.61)	163(30.81)	<0.001
Affar	51(65.11)	19(23.45)	9(11.44)	
Amhara	1178(59.75)	547(27.76)	246(12.49)	
Oromiya	1884(60.47)	653(20.95)	579(18.58)	
Somali	148(74.71)	36(18.27)	14(7.02)	
Benishang-gumuz	55(59.61)	23(24.42)	15(15.97)	
SNNPR	971(59.54)	370(22.71)	290(17.75)	
Gambela	13(42.71)	8(26.33)	9(30.96)	
Harari	8(40.64)	5(24.21)	7(35.15)	
Addis Ababa	11(5.74)	13(7.00)	167(87.27)	
Dire Dawa	10(39.33)	6(21.31)	11(39.35)	
Education				
None	3470(66.10)	1135(21.62)	645(12.28)	<0.001
Primary	1014(44.76)	627(27.65)	625(27.60)	
Secondary	24(10.48)	55(24.35)	147(65.16)	
Higher	9(6.26)	40(28.47)	92(65.27)	
Religion				
Orthodox	1726 (52.23)	826(24.99)	753(22.79)	0.010
Catholic	44(55.98)	22(27.59)	13(16.44)	
Protestants	1049(59.55)	423(23.99)	290(16.46)	
Muslim	1577(61.56)	550(21.45)	435(16.99)	
Traditional	54(65.83)	21(24.90)	8(9.27)	
Others	61(70.40)	16(18.57)	10(11.03)	
Ethnicity				
Amhara	1217(54.40)	612(27.32)	409(18.28)	<0.001
Guragie	46(25.73)	29(16.13)	104(58.14)	
Oromo	1629(58.97)	590(21.36)	543(19.67)	
Sidama	232(69.28)	69(20.64)	34(10.08)	
Somalia	151(77.87)	32(16.52)	11(5.61)	
Tigrie	183(34.99)	172(32.83)	169(32.18)	
Wolaita	132(62.03)	40(18.76)	41(19.21)	
Others	927(64.44)	313(21.78)	198(13.78)	
Household Wealth				
Poorest	1301(74.91)	292(16.81)	144(8.29)	<0.001
Poorer	1101(64.13)	394(23.27)	199(11.74)	

Medium	1010(62.13)	392(24.10)	224(13.77)	
Richer	790(52.88)	383(25.67)	321(21.45)	
Richest	314(23.62)	395(29.70)	621(46.68)	
Marital Status				
Never in union	45(62.62)	15(20.86)	12(16.52)	0.966
Married	4096(57.22)	1692(23.63)	1370(19.14)	
Widowed	375(57.65)	150(22.37)	126(19.37)	
Parity				
1	640(45.94)	369(26.50)	384(27.55)	<0.001
2-3	1369(55.70)	591(24.02)	499(20.28)	
4-5	1024(56.78)	444(24.63)	335(18.60)	
≥ 6	1484(66.62)	453(20.33)	291(13.05)	
Sex of house hold head				
Male	3838(58.26)	1536(23.32)	1213(18.41)	0.017
Female	679(52.45)	320(24.74)	295(22.82)	
Mother working status				
No	3069(59.97)	1222(23.88)	827(16.15)	<0.001
Yes	1443(52.34)	634(23.00)	680(24.66)	

Key:

No: No ANC visit; Inadequate: 1 to 3 ANC visits and adequate: ≥ 4 ANC visits

Under marital status: Married include (married and living with partner) and Widowed includes (Widowed, divorced and separated)

3.2.2. Cluster detection

Table 5 presents the result of the special scan statistics analysis for number of ANC visit of Ordinal Probability Model. The most likely cluster was cluster 1 and the rest 2-9 are secondary clusters ordered by their statistical significance or log-likelihood ratio. Cluster 1, 2, 3, 4 & 9 were areas with the rates of number of ANC visit (none - inadequate - adequate) increasing sequentially. Cluster 5-8 were areas with the rates of number of ANC visits (none - inadequate - adequate) decreasing sequentially. As expected, Addis Ababa administrative area and its surroundings of Oromiya region were area with more likely to access RR= 0.10 (none), 0.25 (inadequate) and 4.63 (adequate) (P: 0.0001) high number of ANC visits than other parts of the country. Women in North-West (Amhara region) RR=1.26, 1.03 and 0.43; (P=0.0001, South-East (Oromiya and Somaliya regions) RR=1.64, 0.46 and 0.03; P=0.0001], North-East (Affar region) RR=1.81, 0.05 and 0; (P=0.0001) and tip of West (west of Gambella region) RR=1.46, 0.67 and 0.24 (P=0.0001) of Ethiopia had lowest number of ANC visits. The detail and approximate geographical location of the clusters are also shown in table 5.

Table 5 Cluster detection analysis result for number of ANC visit using the ordinal scan statistics							
Clusters	Radius (km)	Categories	#O/#E	RR	LLR	p-value	Approximate location of clusters by Regions (Zones) from Google Earth
Cluster 1	17.63	(0,1,2)	(0.11,0.26,4.00)	(0.10,0.25 & 4.63)	360.38	0.0001	Addis Ababa city and its surrounding of Oromiya region.
Cluster 2	2.91	(0,1,2)	(0.20,0.61,3.40)	(0.20,0.60 & 3.57)	103.24	0.0001	Harar (Harar city and its surrounding areas of region)
Cluster 3	3.85	(0,1,2)	(0.25,0.93,2.96)	(0.24,0.82 & 3.10)	89.70	0.0001	Dire Dawa city and its proximate Somali and Oromiya regions
Cluster 4	37.17	(0,1,2)	(0.16,1.75,2.34)	(0.15,1.75 & 2.41)	83.20	0.0001	Tigray (East Tigray Zone)
Cluster 5	270.48	(0,1,2)	(1.20,1.02,0.47)	(1.26,1.03 & 0.43)	78.18	0.0001	Tigray (South of West Tigray zone); Amhara (N.Gondor, Wag Hamra, S.Gonder, Bahir Dar, Agaw Awi, West of S & N. Wollo and E&W. Gojam zones); Benishangul.-gumuz (Metekel, N. Asosa & kamashi zones) and Oromiya (N of E.wollega & N of N.shewa zones)
Cluster 6	306.27	(0,1,2)	(1.61,0.46,0.03)	1.64,0.46 & 0.03)	59.11	0.0001	Oromiya (West Borena& South west bale zones) and Somaliya (libe, Afder, North West Gode zones)
Cluster 7	52.44	(0,1,2)	(1.79,0.05,0)	(1.81,0.05 & 0)	47.60	0.0001	Afar (N of Zone 4 & S of zone 2)
Cluster 8	60.13	(0,1,2)	(1.44,0.68,0.25)	(1.46,0.67 & 0.24)	39.95	0.0001	Gambella(Zone 3)
Cluster 9	84.20	(0,1,2)	(0.73,0.86,1.83)	(0.72,0.85 & 1.88)	21.14	0.0001	Gambella (E of zone 2, Zone 4 & Zone 1); SNNPR (N. of Bench Maji, N KefichoShakisho) and Oromiya (south East of W.wollega, S. Illubabor&W.Jimma)
Key: #O/#E, ratio of numbers observed vs expected; RR, relative risk; LLR, log-likelihood ratio.							

3.2.3. Univariate and multivariate ordinal logistic regression analysis

Table 6 presents univariate and multivariate analyses of number of ANC visits. The univariate results showed at least one ANC visit and adequate number of ANC visits linearly decrease, with age from age group 20-24 years to greater than 34 years. However, in multivariate (adjusted) analysis at least one ANC visit and adequate number of ANC visits linearly increase from age group less than 20 years to age group 30 -35 years.

In univariate analysis, place of residence was associated with at least one ANC visit and adequate number of ANC visits ($p < 0.001$). This, urban women were (OR: 5.33, 95% CI: 4.08-6.95) times more likely to go to at least one ANC visit or adequate number of ANC visits than rural women. In adjusted analysis place of residence was only associated with at least one ANC visit. Thus, urban women were (AOR: 1.80, 95% CI: 1.18-2.76) times more likely to go to at least one ANC visit than rural women ($p \geq 0.1$).

Both univariate and multivariate analysis indicated that women from Somali region were less likely to go to at least one ANC visit or adequate number of ANC visits compared to other regions. Univariate result showed women in SNNPR region were 64% less likely to go for at least one ANC visit or 49% less likely to make adequate number of ANC visit compared to women in Tigray region. Also, the adjusted result showed that women in SNNPR region were 29% less likely to go to at least one ANC visit or adequate number of ANC visits compared to women in Tigray region.

Univariate result presented that at least one ANC visit and adequate number of ANC visits linearly increases with education status. However, in multivariate analysis women from secondary education level were (AOR: 4.65, 95% CI 2.75-7.92) more likely to go to at least one ANC visit or adequate number of ANC visits than others ($p \leq 0.001$). Women from Guragie ethnic group were (AOR: 2.24, 95% CI: 1.11-4.49) times more likely to go to adequate number of ANC visit than Amhara ethnic groups ($p \leq 0.05$).

At least one ANC visit and adequate number of ANC visits were linearly increases with household-wealth status. Richest women were (AOR: 3.51, 95% CI: 2.42-5.08) times more likely to go to at least one ANC visit or adequate number of ANC visits relative to poorest women ($p \leq 0.001$). At least one ANC visit and adequate number of ANC visits were linearly decline with parity. Adjusted result showed that women with greater or equal to six parity

were 31% less likely to go to at least one ANC visit or adequate number of ANC visits compared to women with parity one ($p \leq 0.001$).

Table 6 Odds ratios and 95% CI of various covariates on number of ANC visit among women aged 15 to 49 years who gave at least one birth in the last 5 years in Ethiopia, 2011.

Covariates	Univariate analysis		Multivariate analysis	
	No vs.(inadequate/ adequate) OR(95%CI)	(No/inadequate) vs. adequate) OR(95%CI)	No vs.(inadequate/ adequate) AOR(95%CI)	(No/inadequate) vs. adequate) AOR(95%CI)
Age at birth of last child				
Less than 20(Ref)				
20-24	1.12(0.89-1.40)+	Same	1.18(0.92-1.51)+	Same
25-29	1.03(0.72-1.08)+	Same	1.26(0.94-1.69)+	Same
30-34	0.69(0.54-0.87)*	Same	1.46(1.04-2.04)*	Same
Greater than 34	0.65(0.41-1.03)++	Same	1.40(0.98 -1.98)++	Same
Place of residence				
Rural(Ref)				
Urban	5.33(4.08-6.95)**	Same	1.80(1.18-2.76)*	1.18(0.82-1.69)+
Region				
Tigray(Ref)				
Affar	0.28(0.19-0.43)**	Same	0.55(0.24-1.24)+	Same
Amhara	0.35(0.26-0.49)**	Same	0.40(0.19-0.86)*	Same
Oromiya	0.35(0.24-0.49)**	0.54(0.38-0.77)**	0.32(0.14-0.73*	0.48(0.21-1.08)++
Somali	0.18(0.11-0.29)**	Same	0.30(0.10-0.85)*	Same
Benishang-gumuz	0.37(0.25-0.56)**	Same	0.51(0.23-1.13)++	Same
SNNPR	0.36(0.26-0.50)**	0.51(0.35-0.75)**	0.71(0.32-1.57)+	Same
Gambela	0.71(0.44-1.15)+	1.06(0.66-1.71)+	0.95(0.43-2.13)+	1.40(0.62-3.15)+
Harari	0.77(0.54-1.10)+	1.28(0.88-1.86)+	0.40(0.17 -0.94)*	0.61(0.27-1.37)+
Addis Ababa	8.68(5.26-14.31)**	16.19(10.41-25.19)**	1.86(0.75-4.58)+	4.50(1.95-10.39)**
Dire Dawa	0.81(0.54-1.23)+	1.53(1.04-2.26)*	0.51(0.21-1.21)+	0.97(0.41-2.26)+
Education				
None(Ref)				
Primary	2.50(2.11-2.97)**	Same	1.84(1.55-2.20)**	Same
Secondary	13.49(8.50-21.42)**	Same	4.65(2.74-7.92)**	Same
Higher	14.36(8.24-25.03)**	Same	4.06(2.24-7.37)**	Same
Religion				
Orthodox (Ref)				
Catholics	0.81(0.42-1.56)+	Same	1.22(0.63-2.34)+	Same
Protestants	0.72(0.57-0.92)*	Same	0.98(0.72-1.34)+	Same
Muslims	0.68(0.53 -0.89)*	Same	1.04(0.80-1.34)+	Same
Tradition	0.53(0.25-1.10)++	Same	1.20(0.59-2.42)+	Same
Others	0.45(0.25-0.83)*	Same	0.87(0.42-1.82)+	Same
Ethnicity				
Amhara				
Guragie	3.45(2.13-5.58)**	6.17(3.74-10.19)**	1.18(0.58-2.38)+	2.24(1.11-4.49)*
Oromo	0.83(0.62-1.11)+	1.09(0.81-1.46)+	1.07(0.73-1.56)+	Same
Sidama	0.53(0.32-0.86)*	Same	0.38(0.21-0.72)*	Same
Somalia	0.33(0.21-0.53)**	Same	0.47(0.20-1.07)++	Same
Tigrie	2.17(1.61-2.92)**	Same	1.11(0.50-2.44)+	Same
Wolaita	0.73(0.40-1.33)+	1.06(0.65-1.72)+	0.32(0.17-0.59)**	0.52(0.28-0.95)*
Others	0.67(0.50-0.89)*	Same	0.53(0.33-0.86)*	Same
Household Wealth				

Poorest(Ref)				
Poorer	1.58(1.28-1.96)**	Same	1.50(1.19-1.89)**	Same
Medium	1.81(1.45-2.25)**	Same	1.71(1.37-2.15)**	Same
Richer	2.75(2.14-3.54)**	Same	2.24(1.70-2.96)**	Same
Richest	9.63(7.27-12.76)**	Same	3.51(2.42-5.08)**	Same
Marital Status				
Never in union (Ref)				
Married	1.24(0.59-2.60)+	Same	3.54(1.52-8.25)*	Same
Widowed	1.23(0.59-2.54)+	Same	2.61(1.14-6.00)*	Same
Parity				
1(Ref)				
2-3	0.67(0.56-0.81)**	Same	0.79(0.63-1.00)*	Same
4-5	0.63(.53-0.76)**	Same	0.88(0.67-1.14)+	Same
≥ 6	0.42(0.34-0.51)**	Same	0.59(0.43-0.81)**	Same
Sex of house hold head				
Male(Ref)				
Female	1.28(1.08-1.51)*	Same	1.07(0.86-1.33)+	Same
Mother working status				
No(Ref)				
Yes	1.36(1.16-1.60)**	1.70(1.41-2.04)**	1.17(1.00-1.38)*	1.49(1.21-1.83)**

Key:

+=P≥0.1; ++=p<0.1; *=p≤0.05 & **=p≤0.001; No: No ANC visit; Inadequate: 1 to 3 ANC visits and adequate: ≥ 4 ANC visits

Under marital status: Married include (married and living with partner) and Widowed includes (Widowed, divorced and separated)

5.2.4. Spatial modelling and mapping

Like time of first ANC visit, Bayesian hierarchical models was fitted for number of ANC visits (none and at least one ANC visit). This was done for mapping of spatial variation of number of ANC visit. **Model 2** (Hierarchical model with spatial unstructured random effect) was the best model, because its DIC (8690.44) is smaller than other models.

Figure 6 presents the prevalence map of at least one ANC visit in a country level. The prevalence rate of at least one ANC visit was greater than 50% in Tigray, Harar, Addis Ababa and Dire-Dawa administrative states. However, in Affar and Somalia regions the prevalence rate of At least one ANC visit was less than 30%, these are regions that need further attention. Figure 7 presents smoothed prevalence rate of at least one ANC visit and the result was almost similar with crude prevalence (See Figure 6 & 7).

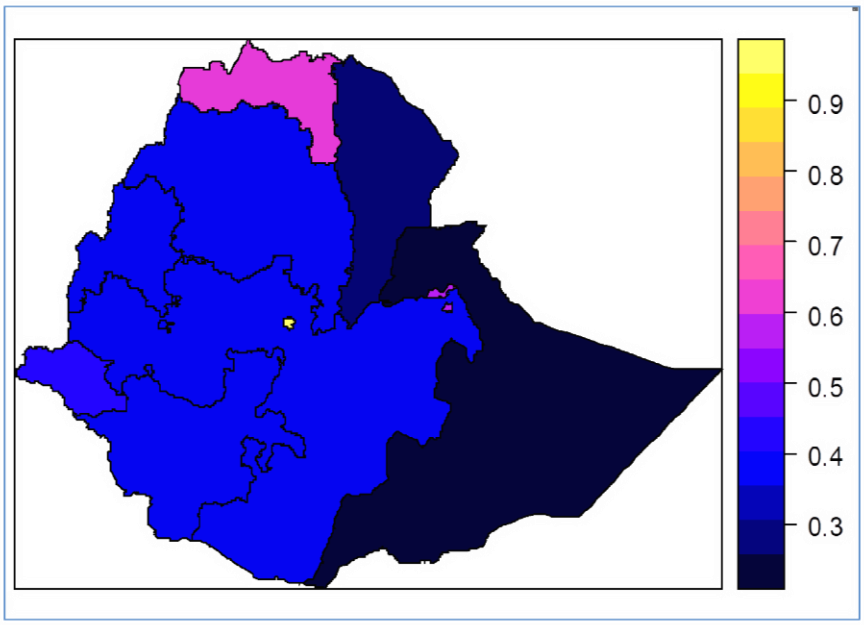

Figure 6 Crude prevalence map of at least one ANC visit by region for women aged 15-49 years who gave at least one birth in the last five years in Ethiopia, 2011.

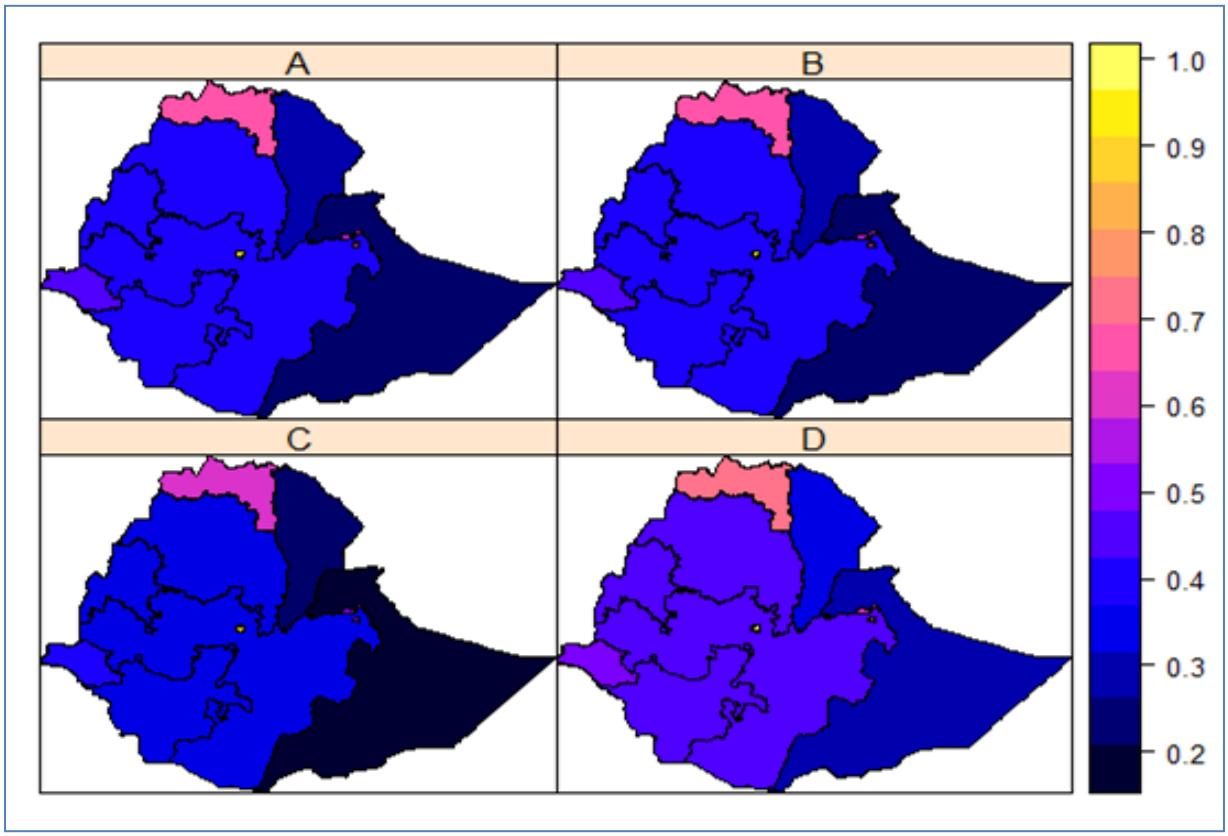

Figure 7 Prevalence of at least one ANC visit predicted from parsimonious Bayesian spatial unstructured model:
A: mean posterior prevalence rates; B: median posterior prevalence rates; C: 2.5% posterior prevalence rates and D: 97.5% posterior prevalence rates.

Chapter Four

4. Discussion and Conclusion

4.1. Discussion

The aim of this study was to identify socio-economic and demographic factors associated with the utilization of ANC services in Ethiopia. The study also aimed to investigate spatial clustering of ANC service utilization and to develop maps of spatial variation of ANC service utilization in Ethiopia using data from EDHS of 2011. ANC is a first entry point to care for pregnant women. Adequate utilization of ANC links women and their families to the formal health system; prevent transmission of HIV and other sexual transmitted diseases. Also, increases the opportunity of having a skilled attendant during labour and delivery. ANC further enhances the utilization of postpartum care services, thereby contributing to health promotion during pregnancy and the immediate post-partum period (Gayawan et al 2014, Ochako et al 2011).

The WHO recommends that pregnant women should attend at least four ANC visits during pregnancy. The recommendation stated that Government should strive to achieve 75% coverage of ANC of low risk pregnant women. The recommendation also stated that at least 69% of low risk pregnant women in Sub-Saharan Africa should have at least one ANC visit (Gayawan et al 2014). The first or early visit for all women is expected to be at 16 weeks of the pregnancy (EMOH part 2 2013). However, in this study the coverage of early ANC visit (26.38%,) at least one to three ANC visits (23.55%) and adequate number of ANC visit (19.14%) were very low as compared to the WHO recommendations. Thus, more efforts are required in Ethiopia to improve the low rate of ANC service utilization.

The coverage of early ANC visit (27.7%) that was documented in Oromiya region of Ethiopia (Getachew et al 2014), is comparable with the coverage of this study. However, the study in SNNPR region of Ethiopia was found (8.7%) coverage of early ANC visit (Abosse et al 2010), which is very low compared to this study. Thus, reveals that a composite figure of the coverage in country may be misleading if the coverage is not aggregated by clusters. Study in Ormiya region reported (12%) of adequate ANC visits (Getachew et al 2014), which is lower when compared to current study.

The mother's age at birth of last child was found to be a factor that influences utilization of ANC service. It was found from this study that women in the age group 25-29 years were

more likely to utilize early ANC visit and adequate number of ANC visits than less age group. However, a different finding was reported by Abosse and colleagues who stated that women in age groups less than 20 and greater than or equal to 35 years were more likely to utilize ANC services than other age groups (Abosse et al 2010).

The Place of the residence is an environmental factor that influences utilization of ANC services. In this study, urban women were more likely to visit ANC early in pregnancy and had at least one and adequate number of ANC visits. This difference may be due to the concentration of health facilities and more qualified health professionals in the urban areas. Also, better transportation systems further aided access to ANC service in urban area. However, most women in the rural areas are likely to be poor and uneducated. Since rural women live in clusters that may be far from the health facility, they may not be able to access easily ANC service. Similar finding has been reported from elsewhere (Abosse et al 2010, Dagne 2010, Ochako et al 2011, Toan 2012, WHO & UNICEF 2003). In contrast, some studies showed the rural women had slightly higher early ANC visit than urban women (Ansariadi and Manderson 2015, Wabiri et al 2013)

Education status is a well-known predisposing factor that influences utilization of ANC services. This study reveals early, at least one and adequate number of ANC visits linearly increases with education status. Study by (Abosse et al 2010, Ansariadi and Manderson 2015, Gayawan et al 2014, Toan 2012), showed women with better education are more likely to use recommended number of ANC visits than less educated. These may be due to educated women are more knowledgeable on the importance of maternal health services and they may cope with traditional cultures and beliefs which hinder maternal health services utilization. Also, educated women may be economically empowered to take decisions about their health than less educated women (Tarekegn et al 2014).

Household wealth is well known enabling factors that influence ANC service utilization. This study finds a linear positive relationship between household wealth, and at least one and adequate number of ANC visits. Similar results have been reported elsewhere (Ansariadi and Manderson 2015, Gayawan et al 2014, Toan 2012, Victora et al 2010). These may be due to medication and transportation cost which hinder women from seeking ANC services (Ahmed et al 2010). In this study richest women were more likely to start early ANC visit than others, which is consistent with study done in Brazil (Victora et al 2010). However, in this study poorest women were more likely to start early ANC visits than poorer, medium and richer

women. Thus, the poorest women were more likely to commence early ANC visits as compared to the middle class women need further investigation.

The religion is among well-known predisposing factors that influence ANC service utilization. In this study, those who believed in traditional religion were more likely to attend at least one ANC visit and adequate number of ANC visits than orthodox, protestant and muslim religion adherent. This result is inconsistent with another study conducted on 2005 EDHS data (Dagne 2010). Thus, the present study may suggest a shift in focus and change in awareness pattern among traditional religion followers on the usefulness of ANC visits. The inconsistency between the two consecutive reports of the DHS on the relationship between religion and number of ANC visits requires further investigation.

Parity is a need factor know to influence utilization of ANC. In this study early, at least one and adequate numbers of ANC visits were linearly decreased with parity. This result is consistent with studies done elsewhere (Ochako et al 2011, Regassa 2011, Simkhada et al 2008). This may be due to greater confidence and commutative experience (Kwast and Liff 1988); shortage on resources, inability to find time to give care to many children (Sonneveldt et al 2013); and may feel confident during pregnancy and thereby consider ANC less important (Gayawan et al 2014).

Marital status of the women is one of the known predisposing factors that influence maternal health utilization. In this study married women were more likely to use adequate number of ANC visits than never in union and widowed. Inconsistent finding has been reported elsewhere (Getachew et al 2014). However, married women were less likely initiate early ANC visit than their counterparts.

The study result reveals significant spatial variation in ANC service utilization. Women in the West and South-West of Ethiopia were least likely to start ANC early. The women in North-West (Amhara region), South-East (Oromiya and Somaliya regions), North-East (Affar region) and tip of West (west of Gambella region) areas of Ethiopia had lowest numbers of ANC visits. These are hotspot areas that need special attention by stakeholders on maternal health. Therefore programs are urgently required to target these groups of women so as to improve the uptake rate of ANC in the community. A few studies also showed geographical variation in ANC service utilization (Ansariadi and Manderson 2015, Gayawan et al 2014). The marked variation in the uptake of ANC may be related to the socio economic status of

the women in those areas. Furthermore, they were not well educated and hence they lack adequate awareness about importance of ANC visits (Getachew et al 2014, Toan 2012, Wabiri et al 2013). The solution to this low uptake is multi-sectoral. Public Health specialist, ministry of information, the ministry of women empowerment and even the ministry of education have various roles to play to improve ANC uptake. Education of the girl, mothers and communities must be emphasised and supported special in those clusters and other parts of the country to reduce the problem (Gayawan et al 2014, Ochako et al 2011, Toan 2012).

4.2. Conclusion

This study reveals that the coverage of early and adequate number of ANC visits in regions and country level were very far from WHO recommendation. Also, study reveals spatial variations in utilization of ANC services. Understanding and documenting of these variations and factors influencing utilization of ANC services are essential to improve ANC service utilization. Therefore, the finding of this study has potential to assist government, policy makers and other collaborative organizations on resource allocation and improvement of ANC service utilization. Enquire

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Appendices

Appendix one

Plagiarism declaration

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY:

I, **AsnakeYohannes Dumicho** (Student number: **872592** am a student registered for the degree of **MSc in Epidemiology under division of Epidemiology and Biostatistics** in the academic year **2014.**

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Signature: _____ Date: _____

Appendix two

Ethics certificate

R14/49 Mr Asnake Yohannes Dumicho

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140924

NAME: (Principal Investigator)	Mr Asnake Yohannes Dumicho
DEPARTMENT:	School of Public Health Epidemiology and Biostatistics
PROJECT TITLE:	Spatial Modeling and Mapping of Utilization of Maternal Health Care Services in Ethopia: Analyisis of Ethiopian Demographic and Health Survey,2011
DATE CONSIDERED:	03/10/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Thomas Achia and Dr Wabiri Njeri
APPROVED BY:	Professor Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	06/10/2014

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES