ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH
DEPARTMENT OF REPRODUCTIVE, FAMILY AND POPULATION HEALTH

THE ASSESSMENT OF THE CONTRIBUTION OF PROXIMATE AND DISTAL DETERMINANTS TO REDUCE FERTILITY FROM ITS NATURAL LEVEL DURING THE PAST TWO DECADES IN ETHIOPIA

BY

GELILA SAMUEL (B.Sc.)

A RESEARCH THESIS SUBMITTED TO THE GRADUATE PROGRAM OF ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH, DEPARTMENT OF REPRODUCTIVE, FAMILY AND POPULATION HEALTH FOR THE FULFILMENT OF THE MASTERS DEGREE OF PUBLIC HEALTH IN REPRODUCTIVE FAMILY AND POPULATION HEALTH.

OCTOBER, 2024

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ADVISORS: - WUBEGZIER MEKONEN (B.Sc., M.A., PhD)

SOLOMON EMYU (MD, MPH)

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Name of the Investigator	Gelila Samuel
Name of Advisor	Wubegzier Mekonnen (PhD, Associate Professor) Solomon Emyu (MD, MPH, Assistant Professor)
Full Title of the Thesis	The assessment of the contribution of proximate and distal determinants to reduce fertility from its natural level during the past two decades in Ethiopia.
Duration of the study	July 2023-October 2024
Study Area	Ethiopia
Address of the investigator	Email: -gelilasamuelniko@gmail.com Phone No: - 251-9-49-78-51-05

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APPROVED BY THE BOARD OF EXAMINERS

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

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External examiner	Signature	Date
_____	_____	_____
Internal examiner	Signature	Date

Chairperson of the Department

_____	_____	_____
Name	Signature	Date

ACKNOWLEDGMENT

My gratitude goes to the almighty God we paved the way to complete this research work on time. I would also like to pass my deepest gratitude to my advisors Dr. Wubegzier Mekonnen and Dr. Solomon Emyu for their unreserved support, constructive comments, assistance, timely guidance, and willingness to mentor me to use my potential in the process of thesis writing up. Last but not least I would also like to thank Addis Ababa University, School of Public Health, Department of Reproductive, Family and Population Health for providing the opportunity to prepare this research work. I would also like to thank ICF Macro and Central Statistical Service of Ethiopia for making EDHS datasets available in the public domain.

LIST OF ACCRONYMS

AIC	Akaike Information Criteria
ASFR	Age Specific Fertility Rate
BIC	Bayesian Information Criteria
CEB	Children ever born
CORHA	Consortium of Reproductive Health Associations
CPR	Contraceptive Prevalence Rate
CSA	Central Statistics Agency
DHS	Demographic and Health Survey
EAs	Enumeration Areas
EDHS	Ethiopian Demographic and Health Survey
FP	Family Planning
GDP	Gross Domestic Product
HEP	Health Extension Program
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
IRR	Incident Rate Ratio
MCH	Maternal and Child Health
PHS	Population and Housing Survey
RH	Reproductive Health
SDGs	Sustainable Development Goals
SRH	Sexual and Reproductive Health
SSA	Sub Saharan Africa
TF	Total Fecundity
TFR	Total Fertility Rate
TMFR	Total Marital Fertility Rate

UN	United Nations
ZINB	Zero Inflated Negative Binomial
ZIP	Zero Inflated Poison

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ABSTRACT

Background: - In Ethiopia TFR has been declining over the years from 6.4 in 1990 to 4.6 in 2016. There has been national paucity in available evidence regarding the influence of proximate and distal determinants over the trend of fertility decline and past evaluation of family planning programs and resource allocation through understanding the pattern in the contribution of other proximate determinants on fertility decline.

Objectives: - The study aims to measure the contribution of family planning and other proximate and distal determinants to reduce fertility from its natural level during the past twenty years in Ethiopia.

Methods: - The study used the data sets of four rounds of EDHS. A total of 15367, 14070, 16515 and 15683 women were interviewed on the four rounds. The John Bongaart's proximate determinants model has been employed. The contribution of contraception, marriage, post-partum infecundity and abortion ranging from 0 to 1 is determined by selected background characteristics and the significance of the trends were tested. Socioeconomic determinants affecting fertility were identified using children ever born as outcome variable by employing multi-level zero inflated negative binomial regression. Point estimates for incidence rate ratio are used to identify distal factors associated with fertility.

Results: - Delayed marriage inhibited fertility by 35%, 36%, 37% and 34.4% while contraception use reduced fertility from its natural level by 8%, 14%, 29% and 37% in 2000, 2005, 2011 and 2016. Postpartum infecundity inhibited fertility by 48%, 43%, 43% and 42%. Induced Abortion inhibited fertility by 0.61% and 0.73% in 2011 and 2016. Rural residence, Somali Region (IRR= 1.55 95% CI: 1.41, 1.71), Muslim (IRR=1.12, 95%CI: 1.06, 1.19) and Traditional Religion (IRR=1.1, 95% CI:1.02, 1.19) women with no education (IRR=2.1 95% CI: 1.92, 2.31) and age of women (IRR= 1.057, 95% CI: 1.055, 1.059) were positively associated with fertility while employment (IRR= 0.96, 95% CI: 0.93, 0.99)is negatively associated with it.

Conclusion: -. The inhibition effect of delayed marriage has declined from 2011 while the effect of contraception has been increasing over the four survey years. Post-partum infecundity was the highest contributing determinant on the four surveys with declining trend over the time.

Key words: - Trend, Fertility, proximate, distal, determinants, Ethiopia

1. INTRODUCTION

1.1. BACKGROUND

Fertility is the number of children a woman bears during her lifetime. It is the most essential component of population dynamics and plays a vital role in altering the size and structure of a certain population (1).

Globally the total number of women of reproductive age was 1.9 billion in 2021. Among them, the number of women with a need for family planning increased to 1.1 billion in 2021 from 0.7 billion in 1990. In 2021, 874 million women used modern contraceptive methods while 164 million of women of reproductive age had an unmet need for family planning (2). The global fertility rate declined from 3.2 live births in 1990 to 2.5 in 2019, but in Sub-Saharan Africa with the highest fertility levels TFR fell from 6.3 births per woman to 4.6 between 1990 and 2019 while the prevalence of contraceptive usage in SSA increased from 13% in 1990 to 29% in 2019 (3)..

Many of the Sustainable Development Goal (SDG) targets in 2030 are related to women and their empowerment. Health and family planning is crucial in attaining most of the goals. Worldwide nearly three-quarters of governments of the 197 member and non-member states of the UN had policies to influence fertility levels. Among them, 69 had policies to lower fertility (3). In four countries of SSA, there were task-sharing pilot programs for family planning that involved community health workers, midwives, and nurses. These professionals are trained in the provision and administration of contraceptive pills and long-acting reversible contraceptives such as implants. This program yielded an increase in family planning indicators in Burkina Faso, Ethiopia, Ghana, and Nigeria despite the challenges in financial barriers, documentation problems and data capturing on service provision(4).

Ethiopia's national population policy has a specific objective of reducing TFR to 4 per woman in 2015 from the 1993 level of 7.7 children per woman and aspired to increase the prevalence of contraception from 4% to 44% in 2015 although it was not achieved. The basic strategy to achieve the objective was to expand clinical and community-based contraceptive distribution services by mobilizing public and private resources (5). Ethiopia emphasizes fertility reduction and FP utilization to achieve the SDGs of lowering the maternal mortality ratio to less than 70 per 100,000 live births and ensuring equal access to sexual and reproductive health (SRH) care services

including family planning, information, education, and integration of reproductive health issues into national strategies and programs by 2030 (6). There have been several efforts made by the Federal Ministry of Health and Non-governmental organizations to expand community-based family planning service provision by training volunteers and community health agents. The health sector Development program in 2002 gave priority for Family planning by introducing health extension package and refining it to establish health infrastructures to be managed by health extension workers. The third HSDP from 2005-2010 focused on health extension program, improving logistics management, and strengthening stakeholders' collaboration. Hence Family Planning was among the sixteen packages of the Ethiopian Health Service extension program (7). The level of TFR in Ethiopia was 6.4, 5.9, 5.4, 4.8, and 4.6 children per woman in 1990, 2000, 2005 2011, and 2016 The percent proportion of women with needs satisfied by modern methods has a trend of 4.7%, 17.4%, 18.7% and 24.9% consecutively in 2000, 2005, 2011 and 2016 (8-11) .

1.2. STATEMENT OF THE PROBLEM

Globally Total Fertility Rate dropped from 3.2 births in 1990 to 2.5 births per woman in 2019 while in the Sub-Saharan region with the highest fertility level the pace of fertility decline is very slow. The Total Fertility Rate in the region declined from 6.3 to 4.6 children per woman. Among ten countries experiencing the highest reductions in TFR from 2010 to 2019 seven countries are located in SSA. Since 2010 next to Afghanistan, Uganda, Malawi, and Sierra Leon Ethiopia experienced the fifth-highest decline in TFR by -1 live birth per woman (12).

It is widely accepted that biological and socioeconomic factors highly influence the dynamics of fertility levels. The Bongaart's proximate determinants of fertility model describe proximate determinants of fertility as the biological and behavioral factors having a direct effect on fertility by which a proximate determinant such as contraception use changes, then fertility necessarily changes assuming that other proximate determinants remain constant. The proximate determinants of fertility models indicate the four main proximate determinants of contraceptive use, fetal wastage, sexual exposure, and post-partum infecundity as inhibiting fertility from reaching its maximum level (13). The biological determinants of marriage, contraception, post-partum infecundity, and abortion can be highly influenced by changes in socioeconomic factors such as education, residence, employment, urbanization and macro-level fertility policies and family

planning programs (14), for instance, available data indicated that countries with high fertility having policies focused to lower fertility provided public and non-governmental family planning programs (15).

This study assesses the impact of determinants of fertility over time addressing the gaps in understanding the disparities in interventions to lower fertility, insufficient evaluation of family planning programs, and policy effectiveness. The other gap addressed by the study is the relationship between contraception use and fertility swayed by other important determinants of fertility such as abortion, post-partum breastfeeding, and proportion of marriage. This gap is substantiated by the change in the pattern of the relationship between increased levels of contraception use and high levels of fertility in SSA countries (12). The study employed multiple rounds of EDHS data sets to foster the knowledge of shifting dynamics of determinants such as reproductive health behaviors and socioeconomic factors.

High fertility and low use of family planning have major individual and programmatic maternal and child health-related consequences. Utilization of contraception has an important role on maternal and child survival and health, a rise in contraceptive use results in the reduced number of births assuming that all other factors are equal which ultimately lowers maternal mortality by reducing key risk factors such as short birth intervals, high parity and maternal age below 18 or above 35 (16). Evidence indicated that in most countries as birth order increases the level of maternal and child health care services utilization such as institutional delivery and skilled birth attendance decreases showing a significant inverse relationship between MCH services utilization and parity even if other factors such as poverty are present (17).

1.3. RATIONAL AND SIGNIFICANCE OF THE STUDY

One of the strategies to attain the objectives of the national population policy of Ethiopia is facilitating research program development in reproductive health with priority attention on improving and strengthening domestic capacity for generating, analyzing, and disseminating demographic and population-related knowledge (5). On the other hand, decreasing TFR from 4.1 to 3.2 children per woman is one of the impact targets of the Ethiopian reproductive health (RH) strategic plan through the outcome target of increasing contraceptive prevalence rate among married women from 41% to 50% from 2019 to 2025 (6). To achieve the TFR reduction from 4.1 to 3.2 there needs to be a clear synthesized insight into how much family planning contributed to

the reduction of fertility until recent years by acquiring lessons on the achievement of family planning programs in fulfilling demographic rationale.

Family planning has a positive impact on women’s and children's health through preventing pregnancy and birth complications. Evidence indicated that 25% of maternal mortality ratio reduction is attributed to family planning interventions(18).

Due to the above scenarios, this study aims to generate a clear understanding on the trend of net contribution offered by family planning on reducing fertility and the ultimate impact of reducing high fertility and enhancing contraceptive use on maternal and child mortality reduction and promoting health care service utilization.

The findings of this study yield knowledge regarding the net effect of family planning on fertility reduction, and the distal factors affecting fertility and yield additional knowledge in the existing body of literature by assessing the trend of the effect of proximate determinants over fertility by using all rounds of Ethiopian Demographic and Health Survey and combining more than one model to assess the direction and magnitude of association between fertility and selected distal determinants by another fertility indicator. The study in the long run benefits family planning program stakeholders, policymakers, and planners in decision-making regarding family planning and population issues contributing to the enhancement of strategies and service delivery modalities to achieve the desired level of fertility reduction and family planning coverage and evaluate the quality of provisions.

2. LITERATURE REVIEW

2.1. GLOBAL OVERVIEW OF FERTILITY

The total fertility rate globally declined from 5.29 to 2.74 between the 1960s and 2020. The TFR in Western Europe has declined from 2.89 in the 1960s to 1.68 children per woman in 2020 while Eastern Europe has declined from 2.83 to 1.59 children per woman during the same period. The Latin American and Caribbean region TFR declined from 5.91 to 2.33 children per woman. The Arab states having the highest fertility rates in the 1960s showed a decline from 7.06 to 3.11. In the SSA region, the TFR declined from 6.78 in the 1960s to 4.78 during 2010-2020 having the current highest fertility rate. Asian region showed a decline from TFR 5.82 to 2.32 during the same period (19).

2.2. REGIONAL OVERVIEW OF FERTILITY RATE

Between 2010 and 2019 among countries witnessing the largest reduction in total fertility rate seven were found in Sub-Saharan Africa. Uganda had a reduction of 1.3 children per woman, Malawi with 1.2, and Sierra Leone, and Ethiopia by 1 child per woman while in Kenya, Chad, and Somalia the fertility rate fell by 0.9 live births per woman (20). A study on the estimate of TFR for 33 countries in SSA from 2010-2018 DHS data showed that the pooled estimate of TFR was 5 children per woman while 4.74 children per woman for East Africa, 5.59 for Central Africa, 3.18 for Southern Africa, 5.38 for West Africa (21).

2.3. NATIONAL OVERVIEW OF FERTILITY RATE

The TFR level in Ethiopia declined from 5.5 children per woman in 2000, 5.4 in 2005, 4.8 in 2011, and 4.6 in 2016 (8-11).

2.4. MODELS TO STUDY FERTILITY AND ITS DETERMINANTS

The natural fertility control model proposed by Henry showed that the actual age-specific fertility rates in a population that does not control fertility are proportional to the schedule of differed level of fertility with similar age profile(22). Coale also discovered that there is a deviation in the pattern of fertility from the natural fertility in the population that controls their fertility(23). Coale and Trussell combined the model of marital fertility with the model of marriage assuming that there is no fertility outside marriage, according to this model the general fertility rate is the product of the proportion of marriage at age “a” by age-specific marital fertility rate(24).

The model of marital fertility proposed by Page showed that the level of natural fertility depends on a woman's age but the degree of fertility control depends on the duration of marriage rather than age(25). On the other hand, Brass proposed the relational Gompertz model to transform the proportion of cumulative fertility achieved by age "a" using a log-log transformation(26). Scheuermann proposed a quadratic spline model with four graphically intuitive parameters representing the age of fertility above zero, fertility peak, fertility falls to half of its peak, and peak of fertility(27).

2.5. THE PROXIMATE DETERMINANTS OF FERTILITY

According to the model proposed by John Bongaart in 1984, $TFR = C_m{*}C_c{*}C_i{*}C_a{*}TF$ where TFR = Observed total fertility rate (from surveys); C_m= Marriage index (sexual exposure); C_c= Contraception index; C_i= Postpartum infecundity index; C_a= Induced abortion index and TF = Total fecundity rate (the natural fertility level without any parity specific control). He also revised the formula in 2015 to calculate the above indices of proximate determinants of fertility.

	Equation	Variables
Original aggregate model	$TFR = C_m C_c C_i C_a\, TF$	*TFR*=total fertility rate *TF*= total fecundity rate
Marriage index	$C_m = \frac{\sum m(a) f_m(a)}{\sum f_m(a)}$	*m(a)*= proportion married by age f_m(a)= age-specific marital fertility rate *a*=age
Contraception index	$C_c = 1 - 1.08\, u\, e$	*u*=contraceptive prevalence (married women) *e*=average effectiveness
Postpartum infecundability index	$C_i = \frac{20}{18.5 + i}$	*i*=average duration of postpartum infecundability
Abortion index	$C_a = \frac{TFR}{TFR + b\, TAR}$ $b = 0.4(1 + u)$	*TAR*= total abortion rate *b*=births averted per abortion

Figure 1: Proximate Determinants of fertility model by Jhon Bongaarts.

2.5.1. CONTRACEPTION USE AND FERTILITY

According to the revised Bongaart's formula index of contraceptives is calculated using the formula

C_c = 1-r(a) (u(a) – o(a)) e(a); where r(a) is fecundity adjustment which is 1.08, u(a) = contraceptive prevalence among married women, o(a) = contraceptive use that overlaps with lactation amenorrhea and e(a) = average contraceptive effectiveness.

A publication in 2020 on how education and family planning accelerate fertility decline showed that there is a larger effect size for contraceptive prevalence compared to educational attainment while a faster increase in contraceptive prevalence in SSA corresponds to a smaller decrease in TFR than non-SSA countries(28). Similarly, another publication on human fertility about education, economy, religion, contraception, and family planning programs showed that in 2014 in four regions of the globe, TFR was negatively associated with strong family planning utilization while the coefficient of variation ranged from the weakest 0.07 in SSA to relatively strong relation in the remaining regions (29).

A study done on the effects of family planning and other factors such as abortion, miscarriage, and stillbirths on fertility in Mali, Kenya, Indonesia, and Ukraine using a spectrum model with two assumptions to illustrate the effects of contraceptive prevalence results showed that constant use of contraception the number of children under five would increase by 33% from 2015 to 2025 in Mali, by 27% in Kenya, 1% in Indonesia and 19% in Ukraine. But with an increase in contraceptive use, the number of under-five children would increase by only 8% in Mali, 14% in Kenya, 21% in Indonesia, and 29% in Ukraine (16).

An Indian study using data from a national family health survey conducted in 2015-16 using Bongaart's proximate determinants model resulted in a finding that contraception has the second highest contribution to reducing fertility (24%) next to marriage(30).

Another publication in 2018 on family planning and fertility decline in Africa from 1950 to 2010 indicated that globally it is estimated that without contraception 7 children per woman are expected. A detailed analysis of 32 African countries showed that the increase in modern contraceptives explains 50.9% decline in fertility in urban areas and a 41.4% reduction in rural settings (31).

The findings of a study on structural equations modeling to quantify the effect of direct and intermediate factors on fertility changes in Egypt between 2000 and 2014 using a cross-sectional design on EDHS 2000 and 2014 data showed that the total effect of having an unmet need for family planning resulted in an increase of 196 and 161 births per 1000 women in 2000 and 2014 respectively (32).

A study conducted in Burundi on determinants of fertility differentials using evidence from 2016-17 DHS employing poison regression showed that the incidence of higher fertility was 1.583 times higher among non-contraceptive users compared with contraceptive users (33). A study done in Uganda in 2015 on the contribution of contraception, marriage, and postpartum infecundity using Bongaart's aggregate fertility model applied to the 2006 and 2011 DHS datasets showed that the net effect of contraception in reducing fertility was 22% and 28% in 2006 and 2011, respectively (34).

In Ethiopia, a study on the roles of the proximate determinants in recent fertility decline using data from 2005, 2011, and 2016 EDHS by applying John Stover revised Bongart's fertility model indicated that the inhibition effect of contraception was 15%, 29%, and 37% in 2005, 2011 and 2016 consecutively(35). A similar finding was yielded by another study done in Ethiopia by analyzing the 2011 and 2016 EDHS datasets showing that the use of contraceptive inhibition effect was 28.5% in 2011 and 30.7% in 2016 (36).

Another result of a sub-national analysis of trends in contraceptive use and distribution of births with demographic risk factors in Ethiopia indicated that there is a significant negative relationship between TFR and contraceptive use. The TFR has declined by an average of one child per woman for a 13% increase in the prevalence rate of modern contraceptives. The result also shows that the TFR would be around 6.2 if there were no contraceptive use (37).

2.5.2. MARRIAGE AND FERTILITY

Cm = m(a) + ex(a) or TFR/TMFR; Where m(a) is the proportion of married women, ex(a) is proportion of sexual exposure outside marriage, TFR=Total Fertility Rate; and TMFR = total marital fertility rate according to the revised John Bongaart's model.

A study using data from the Indian National Family Health survey in 2015-16 using Bongaart's proximate determinants model showed that marriage makes the largest relative contribution to

reducing TFR with the smallest index (0.59) which implied a 41% reduction of fertility from its natural level (30).

A study on the role of proximate determinants of fertility in Asian countries indicated that delay in marriage held down fertility in the Philippines by 66% in 1998 and 73% in 2008 (38). A study conducted to see the changes in the relationship between TFR and CPR in Jordan between 2012 and 2017 using validated survey data collected nationally on fertility and contraceptive distribution showed that there is a significant decrease in both fertility and contraceptive use as the number of married women who are not living with their husbands increase (39).

On the other hand, a longitudinal prospective study on trends in marriage and contraception and factors of fertility decline in SSA showed that there is no correlation between changes in age at marriage and speed of fertility decline for both urban and rural areas (31).

A study in Egypt using DHS data from 2000 and 2014 employing structural equation model results indicated that a one-year increase in the duration of marriage resulted in a decrease in the number of births in three years before survey years having a negative coefficient of -0.023 and -0.014 for survey years 2000 and 2014 (32).

A study on determinants of fertility differentials using the DHS of Burundi from 2016-17 showed that women whose age at first marriage is 16-19 years (IRR=0.967) and greater than 201 years (IRR=0.864) have a lower chance of bearing more children than women whose age at first marriage is less than 15 years (33).

The study on the contribution of contraception, marriage, and postpartum infecundity in Uganda using 2006 and 2011 DHS data showed that delayed marriage has a constant effect in reducing fertility by 28% both in 2006 and 2011 having the highest effect compared to other proximate determinants in 2006 as contraception and post-partum infecundity inhibited fertility by 22% and 27% respectively in the same year (34).

In Ethiopia, the findings of a study using data from three consecutive 2005, 2011 and 2016 EDHS on proximate determinants of fertility showed that the effect of delayed sexual exposure increased from 36% in 2005 to 37% in 2011 but declined to 35% in 2016 (35). The other study in Ethiopia on proximate determinants of fertility by analyzing 2011 and 2016 EDHS data showed that both

delayed marriage and non-marriage inhibited fertility by 37.8% and 34.4% in 2011 and 2016 respectively (36).

2.5.3. POST PARTUM INFECUNDABLITY AND FERTILITY

According to the revised John Bongaart's model, Ci = 20/ (18.5 + average total duration of postpartum infecund ability).

A study explaining the role of proximate determinants of fertility among poor and non-poor households in Asian countries indicated that in Nepal the contribution of postpartum infecund ability among the poor increased from 1996 to 2006 and increased slightly more among the non-poor. However, in Vietnam, its inhibition effect decreased from 1997 to 2002 among the poor and increased a little more among the non-poor(38). Another study in India on key drivers of fertility showed that postpartum infecundity has a 16% contribution which is the lowest (30).

On the other hand, research on inequality in TFR and its proximate determinants in 21 SSA countries showed that 14 out of 21 countries showed that both the poor and rich groups decreased their reliance on postpartum infecund ability (40). The Ugandan study on the contribution of proximate determinants to reduce fertility showed that postpartum infecund ability contributed 26% reduction in 2006 and 24% in 2011 (34).

The study done in Ethiopia on proximate determinants of fertility showed that postpartum infecund ability reduced fertility by 34.7% in 2011 and 34.5% in 2016 (36). The other study done in Ethiopia on proximate determinants of fertility using 2005, 2011, and 2016 EDHS data indicated that postpartum infecund ability contributed 43% reduction in 2005 and 2011 then a 42% reduction in 2016 (41).

2.5.4. INDUCED ABORTION AND FERTILITY

The index of induced abortion is calculated using Ca = TFR/ (TFR + B * ab(a); where B = births averted due to induced abortion, ab(a) = abortion rate according the John Bongaart's revised model in 2015 (13).

- Percent reduction due to induced abortion= (proportion of terminated pregnancy* proportion of induced abortion from previous studies) * 100
- Ca= ((percent reduction by abortion/ 100)-1) *-1

Utilization of the above formula in various settings showed different results. For instance, induced abortion has a minimal effect on fertility reduction in South Asia (38). The Indian study on key drivers of fertility levels using Bongaarts' fertility model using the national family survey conducted from 2015 to 2016 showed that induced abortion has reduced fertility by 29%f from its natural level (30).

The study on inequalities in TFR among SSA countries indicated that induced abortion has contributed to 10%, 40%, 30%, and 50% in the reduction of fertility from its natural level among the poorest population in Mozambique, Rwanda, Kenya, and Ethiopia whereas no contribution was witnessed among the richest in Mozambique, Kenya, and Ethiopia and 40% reduction was observed in Rwanda from 1992 to 2010 (40).

In Ethiopia fetal wastage in both 2011 and 2016 inhibited 9.2% of births (36). The other study in Ethiopia showed that Abortion had a 0.3% effect on the reduction in fertility in 2005, 2011 and 2016 (35).

2.5.5. STERILITY AND FERTILITY

According to the revised Bongaarts fertility model, a woman is considered as sterile if not menopausal, postpartum in fecund, not pregnant, has not given birth during the past five years, and has not used any contraceptive. However, the revised model does not discuss the index of sterility because there is minimal variation in the role of sterility across societies to be applied in different settings.

2.6. THE DISTAL DETERMINANTS OF FERTILITY

2.6.1. AGE AND FERTILITY

A study in Bangladesh using the 2014 Demographic and Health Survey dataset using zero turned poison and negative binomial regressions showed that women in age groups 20-24 and 25- 29 had 4 and 6 times more children than women in the age group 15-19(42).The other study in Bangladesh revealed that women who first gave birth above 20 years were 0.54 times less likely to have three or more children in their lifetime than those who gave birth to the first child under 20 years (43).A study in Egypt to quantify the effect of direct and intermediate factors on fertility showed that when a woman's age increases by one year the number of births per woman in the 3 years before the survey decreases by 32 and 33 births per 1000 women in 2000 and 2014 (32).

A study on socioeconomic determinants of cumulative fertility in Ghana showed that the current age of a woman has a positive association with cumulative fertility with 2.67, 5.31, and 7.38 times higher risk among women aged 20-29, 30-39 and 40-49 years respectively compared to women aged less than 20 (44).

A cross-sectional study on determinants of fertility desire among married individuals in Uganda showed that ages 30-39 and 40 years and above are negatively associated with fertility desire (45).

In Ethiopia, a study on determinants of fertility using EDHS 2011 showed that for a year increase in the current age the women's births in the last five years have decreased by 2.1% (1). Another study in Ethiopia using a poison regression showed that for every unit increase in current age of women children ever born increase by 2.4%(46).

2.6.2. FERTILITY AND EMPLOYMENT STATUS OF WOMEN

A publication on women's employment and fertility from a global perspective from 1960-2015 showed that there is a statistically significant negative relationship between TFR and employment, after disaggregation by region in all four regions of the World, there is a negative association. However, the magnitude of correlation is considerably smaller in Europe and North America than in the other three regions (47).

A study in England analyzing data from the Office of National Fertility showed that female unemployment is positively associated with fertility, one percent increase in female unemployment leads to a 6.26% increase in birth rates for age group 25-34 (48).

Research conducted on how female employment reduces fertility in rural Senegal using data from a socioeconomic survey of rural households in Senegal indicated that in 2005 number of births per woman was 0.15 for the northern area and 0.14 for the southern area while it decreased more sharply in the northern area to 0.08 in 2013 where female employment increased most (49).

A study done in Ethiopia by analyzing EDHS 2016 data showed that the odds of having fertility desire among unemployed women were 0.94 times lower than those women who have household manual working status (50).

2.6.3. FERTILITY AND EDUCATIONAL STATUS

A study analyzing 201 countries' world population prospects data using Granger causality on how education and family planning accelerate fertility decline showed that there is a significant positive relationship between TFR decrement and educational level increment(28). The other study on human fertility about education, economy, religion, and contraception showed that in five regions of the globe, TFR decreased with increasing school years having the weakest result in Eastern Europe and strongest in SSA (29).

A research paper on socio-economic and demographic determinants of fertility in six selected Pacific Iceland countries showed that female secondary school enrolment rate has a significant positive impact on fertility (51).

A systematic review on education and fertility in South Asia shows that the emerging trend for countries with female literacy rates similar to male literacy rates to have a lower TFR compared to countries where female literacy rate is lower than the male (52). Another study on trends in fertility and fertility preferences in SSA indicated that women's education has a significant negative effect on wanted TFR but not on unwanted TFR (53).

A causality and co-integration analysis on determinants of fertility in Tunisia showed that women's secondary school enrolment have a negative impact on fertility by contributing to innovative shock of 11.69%(54). A secondary data analysis of 2010 Rwanda DHS on determinants of fertility in the context of fertility transition showed that more education was associated with fewer children with IRR of 0.96, 0.90 and 0.66 for women with primary, secondary and higher education respectively compared to women with no education(55).

2.6.4. FERTILITY BY REGION AND RESIDENCE TYPE

The study in Bangladesh indicated that women living in rural regions have sooner subsequent births with a 1.105 higher hazard ratio than women living in urban regions (56). The other study in Iran on socioeconomic determinants influencing TFR showed that the urbanization rate had a negative association with TFR. However, this study's finding is not statistically significant (57).

Overviewing African studies focusing on socioeconomic determinants of fertility using the Nigerian DHS data set study showed that the gap in fertility level between urban and rural settings is not similar to other findings in other countries (58). The study in Ghana showed that women

from rural places had 1.05 times higher cumulative fertility risk compared to women from urban residence(44).

East African studies showed more or less similar findings while a Ugandan study on the contribution of contraception, marriage, and postpartum infecundity to fertility levels showed that the TFR level in rural settings is 6.9 children per woman while it was 3.9 children per woman in the urban settings (34). Although the finding is not statistically significant the study in Rwanda on determinants of fertility transition indicates that of women in urban residences 54.2%, 44.8% and 1% of them had no children, 1-3, and more than 4 children consecutively while 48.2%, 49.3% and 2.4% of women in rural settings had no, 1-3 and more than 4 children (55).

The study in Ethiopia on proximate determinants of fertility showed that the highest estimated TFR was observed in the Somali region (8.211) and the least estimated TFR was on Addis Ababa (1.49) while the other study in Ethiopia on proximate determinants of fertility indicated that estimated TFR was higher on rural (5.2) and lower on urban residence (2.3) for EDHS survey year 2016(41) (36).

2.6.5. RELIGION AND FERTILITY

A multivariate analysis study on demographic, socioeconomic, and cultural factors affecting fertility conducted in Nepal revealed that Muslim women had greater mean children ever born (3.52) compared to Hindu (3.03) and women with other religions (2.97), while the multivariate analysis found that religion had a significant positive association with the great number of children where (Muslim women:$\beta = 0.07$: $p < 0.001$) (59).

A study in Ghana showed that the risk of cumulative fertility was 1.12 times higher among women who follow traditional religions compared to Christianity(44) . However, the study in Rwanda indicated that there is no significant relationship between religion and children ever born (55).

The research conducted in Ethiopia on determinants of fertility showed that Muslim women had 1.7% higher fertility compared to women with traditional beliefs while Catholic (-0.118), Orthodox (-0.047), and Protestant women (-0.019) had the lowest fertility compared to women with traditional religion (1).

2.7. CONCEPTUAL FRAMEWORK

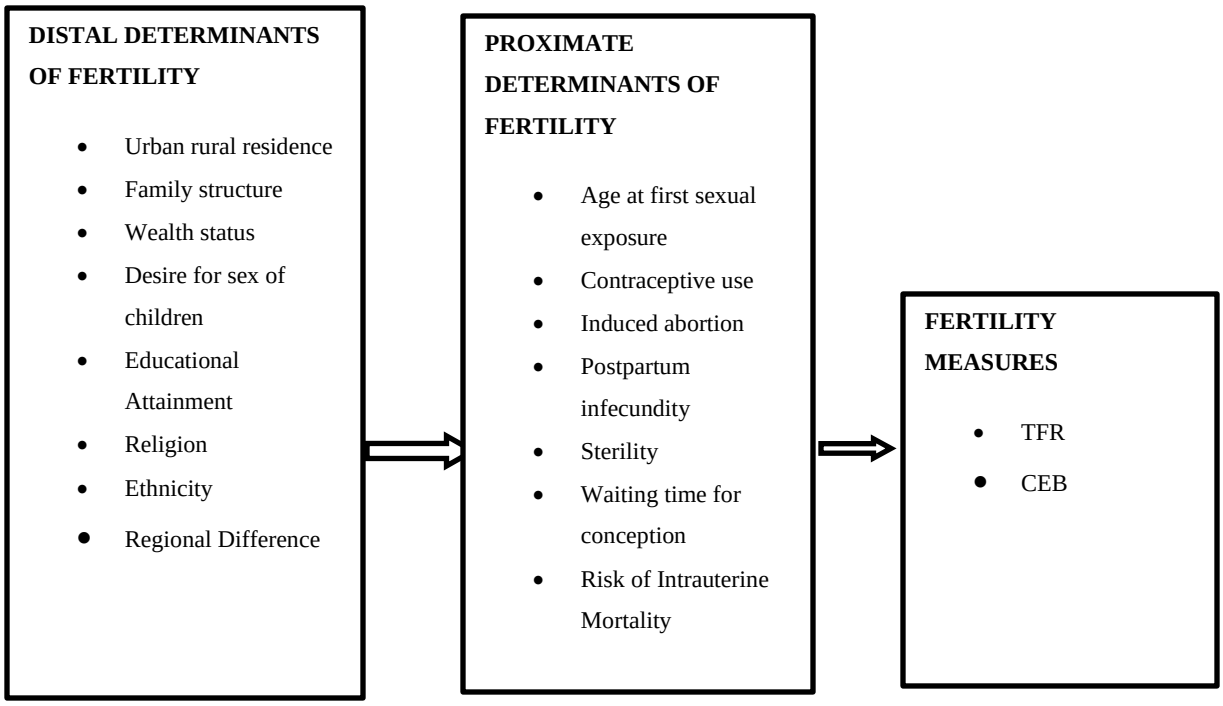

Figure 2: Conceptual framework on the influence of proximate and distal determinants over fertility measures (John Bongaart's Proximate Determinants of fertility model).

2.7.1. VARIABLES SELECTED AMONG THE BACKGROUND AND PROXIMATE DETERMINANTS OF FERTILITY

Among the intermediate determinants of fertility, the study will analyze the four main inhibiting factors depriving fertility from reaching its maximum which are age at first sexual intercourse (which is measured by age at first marriage proximally), contraception, induced abortion, and postpartum Infecundity. Of the background distal determinants, the study will focus on age, religion, region of residence, employment, and educational status of women as these variables influence the reproductive health behaviors of women affecting fertility dynamics upon life stages of women, the decision-making regarding fertility and reproductive health care access and differentials in beliefs about fertility.

3. OBJECTIVES

3.1. GENERAL OBJECTIVE

- To measure the contribution of family planning and other proximate determinants in reducing fertility from its natural level and identify the distal determinants having significant effect during the past twenty years in Ethiopia.

3.2. SPECIFIC OBJECTIVES

- To assess the trend in the contribution of family planning to reduce fertility from its natural level during the past two decades.
- To assess the trend of the inhibition effects of other proximate determinants of fertility.
- To identify the distal determinants of fertility having significant effect over the years

4. METHODS

4.1. STUDY SETTING

The study is conducted in Ethiopia located in the horn of Africa with a neighborhood by Sudan and South Sudan on the West, Eritrea, and Djibouti on the Northeast, Kenya on the South and Somalia on the East covering an area of 1.1 million square kilometers. With an estimated total population of 102,403,196 in 2020 by which 24,991,034 of the total population are women of reproductive age (60).

The country had been subdivided into 12 regions and two city administrations during the times of data collection used for this analysis. Having a Three-Tier health care delivery system according to 2022 data there are more than 420 hospitals, 3,706 public health centers and 17561 health posts, among them 353 are public and 67 are non-government hospitals. There are also more than 5000 other facilities such as private for profit and nonprofit health facilities (61).

4.2. STUDY DESIGN

The study used secondary data analysis of Ethiopian Demographic and Health Survey which is country wide cross-sectional data repeated on average of five years that assesses sets of individuals' and households' characteristics on the utilization of maternal and child health services including family planning and fertility behaviors.

4.3. SOURCE AND STUDY POPULATION

The source population of the study is all women of reproductive age who are living in Ethiopia meeting the eligibility criteria and the study populations are women of reproductive age (15-49) who live in Ethiopia and who were interviewed in the five rounds of Ethiopian Demographic and Health Survey.

4.4. SAMPLE SIZE DETERMINATION AND SAMPLING PROCEDURE

The series of EDHS rounds interviewed the following size of women of reproductive age group. Overall, the response rates were greater than 90 % for all survey years.

Table 1. Summary of samples of women interviewed in five rounds of EDHS

	EDHS 2000	EDHS 2005	EDHS 2011	EDHS 2016
Enumeration Areas	**540**	**540**	**624**	**645**
Selected Households	**14642**	**14500**	**18720**	**16650**
All women of reproductive age eligible for the survey	**15716**	**14117**	**17385**	**16663**
Number of women interviewed in urban and rural areas	**15367**	**14070**	**16515**	**15683**

The sampling frame for 2000 and 2005 EDHS was using Enumerations Areas of 1994 population and housing survey (8, 9) and for 2011 and 2016 sampling frame of 2007 PHS conducted by CSA was used (10, 11). The EDHS sample design has two steps, during the first step stratification of sampling frame containing complete list of all sampling units into sub groups as urban and rural to reduce sampling error is done. Within each stratum households to be selected are allocated per cluster. In the second stage households listing is conducted per selected clusters then fixed number of households is selected by systematic sampling in selected cluster (8-11).

4.5. MEASURMENT OF VARIABLES

4.5.1. DEPENDENT VARIABLE FOR SPECIFIC OBJECTIVE 1 AND 2

The proximate indicator to assess the fertility inhibition effects of proximate determinants of fertility is TFR. The Bongaart's model assumes that Total Fecundity is the maximum natural level of fertility in the absence of the four proximate determinants of fertility. It defined TFR as the product of the total fecundity rate with the four indices implying that it is the mean number of births anticipated from women of reproductive age who are married, don't use contraception, who are not breastfeeding and don't have induced abortion (62).

$TFR=C_m*C_c*C_i*\ C_a*TF$

Whereas C_m corresponds to the marriage index, C_c stands for the contraception index, C_i denotes the index of postpartum infecundity, and C_a corresponds to the index of induced abortion.

4.5.2. VARIABLES REQUIRED TO CALCULATE INDICES

To calculate the marriage index (C_m) the proportion of married women in the age group 15-49 is required. The variable marital status from all rounds of the EDHS dataset is needed to get the proportion of married women.

To calculate the contraception index, we need contraceptive prevalence among married women, average contraceptive method effectiveness, fecundity adjustment, and contraceptive use that overlaps with postpartum infecundity. To get these proportions the variables current use of contraception and specific methods used by women from all EDHS rounds are used. Mean contraceptive effectiveness is calculated by multiplying the specific method effectiveness constant of each method obtained from Bongaart's study and the proportion of women using a given method which can be found in EDHS reports. Contraceptive use that overlaps with postpartum infecundity is considered zero since the prevalence of using is low during the postpartum period. The fecundity adjustment is estimated as 1.08 by Bongaart.

To calculate the Index of postpartum infecundity the variable median duration of post-partum insusceptibility from all EDHS rounds is obtained. The sub-interval time of infecundity is 1.5 months, waiting time for conception is 7.5 months; time due to intrauterine mortality is 2 months, nine months of gestation, and the difference between total birth interval and postpartum infecundity without lactation is 18.5 months are used.

To calculate the index of induced abortion the variable "terminated pregnancy during the past three years" from EDHS rounds 2011 and 2016 was used to yield the proportion of terminated pregnancy. The proportion of induced abortion for the respective years was obtained from two separate previous studies from Guttmacher's reproductive health database done on the magnitude of induced abortion disaggregated by regions (63, 64).

4.5.3. SELECTED BACKGROUND VARIABLES TO ASSESS THE VARIATION OF INDICES

The selected background variables to measure the variation of all indexes across certain characteristics of women are age group, type of place of residence, region of residence, and educational attainment.

4.5.4. OUTCOME VARIABLE FOR THIRD SPECIFIC OBJECTIVE

To measure the association between fertility and selected distal determinants the outcome variable for the dependent variable is children ever born. Children ever born is a count variable providing information about total number of children a woman gives birth. The reported values of children ever born run from zero up to 14.

4.5.5. INDEPENDENT VARIABLES FOR THIRD SPECIFIC OBJECTIVE

The explanatory variables are coded and ordered according to their category, the variable place of residence is coded as 1 for urban and 2 for rural, Regions were coded as 1= Tigray, 2= Afar, 3= Afar, 4= Oromia, 5= Somali, 6= Benishangul-Gumuz, 7= SNNPR, 8= Gambella, 9= Harari, 10= Addis Ababa and 11= Dire- Dawa, religion was coded as Orthodox= 1, Muslim=2, Protestant= 3, Catholic=4, Traditional= 5 and Others= 6, educational status is coded as 0= no- education, 1= primary education, 2= secondary education and 3= higher education, Employment status was coded as 0= unemployed and 1= employed.

4.6. DATA PROCESSING AND ANALYSIS

4.6.1. DATA ANALYSIS FOR SPECIFIC OBJECTIVE ONE AND TWO

The data set of EDHS 2000,2005,2011 and 2016 in STATA format were received after a formal request The data set for women recode was used to obtain the proportions of marriage, sexual exposure outside marriage, current contraceptive use, method-specific use of contraception and median duration of postpartum in susceptibility which are essential to calculate the indices of marriage, contraception, and postpartum infecundity. The proportions of marriage, sexual exposure outside marriage, current contraceptive use, method-specific contraceptive use and median duration of post-partum infecundity by selected background variables were obtained by cross tabulation of variables expressing the proportion on EDHS data and variables expressing the

background variables using STATA version 17 software. The calculated proportions were exported to Microsoft Excel 2019 to calculate the appropriate indices.

The four indices are measures of inhibitors of fertility; fertility is lower than its maximum because of delayed marriage, use of contraception, induced abortion, and postpartum abstinence. The inhibiting effect of each index ranges from 1 indicating no fertility inhibition effect to 0 indicating total fertility inhibiting effect. The inhibition effect of a proximate determinant is the complement of the value of the index (1- index) times 100. The proximate determinant with the lowest index has the most inhibiting effect (13). Bongaart's suggested a formula to calculate the Total fertility rate as

- $TFR = C_m * C_c * C_i * C_a * ff$

Where C_m corresponds to marriage (sexual exposure), C_c= Contraception index, C_i= Index of postpartum infecundity, C_a= index of abortion, and ff= total fecundity which has a constant value of 15.3The trends in fertility inhibition effect of each proximate determinant were assessed and significance of the trend was tested by Linear regression while the coefficient of regression shows the direction of the trend and the p-value < 0.05 indicated a statistically significant trend for a specific characteristics. The patterns of the fertility inhibition effects are presented by an Excel graph for each background characteristic.

4.6.2. MODEL SELECTION CRITERIA

Declaration of survey data was conducted and the sampling weight was incorporated to manage the cluster sampling of DHS data. Weighted proportion of number of children ever born was obtained which shows that 32.5% of women of reproductive age had no child for the survey year 2016 explaining there are excess number of zeros in the data.

Model selection was according to the distribution of the data and the nature of the outcome variable. There are possible regression models to analyze count data such as Poisson, Negative binomial, zero-inflated Poison, and zero-inflated negative binomial regression. The poison regression model assumes that the mean of the outcome variable is equal to the variance of the distribution, whereas Negative binomial regression best fits with outcome distribution with overdispersion where the variance exceeds the mean. Zero-inflated poison regression assumes that there is an excess number of zeros but does not consider overdispersion hence there could be a

limitation when the variance exceeds the mean. Based on the assumptions of zero-inflated negative binomial regression the dependent variable needs to be a discrete count variable that differs from time to time and region to region having a lower bound of zero, the observations are independent of one another, there are excess zeros in the data distribution lowering the mean of the data and the variance exceeds the mean of the distribution. The event of having a child is not dependent on previously having a child or not or a woman can't have zero children and more than one child simultaneously (65, 66). To check the assumption Histogram of the outcome variable children ever born was plotted and summary statistics were done to observe the mean and the variance of the distribution. The covariates are analyzed by zero inflated negative binomial model with multilevel adjustment to manage the interclass correlation of community and individual level variables, multicollinearity was checked and linearized standard error is employed to manage heteroscedasticity, address the complex survey sampling of the data, and ensure accuracy

Table 2. Model selection of zero-inflated negative binomial regression model

Models	AIC	BIC
Poison	8.52 e+10	8.52e+10
Negative Binomial	6.91e+10	6.91e+10
ZIP	5.92e+10	5.92e+10
ZINB	5.61e+10	5.61e+10

Akaike Information Criteria describes the information lost if a model approaches the exact data-generating process and Bayesian Information Criteria balances the complexity of the model and goodness to fit in data with large sample size. These model selection criteria can be interpreted relatively, the model with the lower value of BIC is the best model to fit. According to the above table, the model with the lowest AIC and BIC is Zero-inflated Negative Binomial Regression.

The association between selected distal determinants and fertility was assessed by taking exponents of ratios. Results are interpreted by adjusted and unadjusted Incident rate ratios. The statistical significance of the association was confirmed by a 95% Confidence interval. IRR> 1 indicates a certain background characteristic has a greater risk of getting the outcome event having children ever born compared to counter group.

4.7. ETHICAL CONSIDERATION

The study is conducted using the four rounds of EDHS datasets, before accessing these datasets agreement of access for each dataset were received. The issues of ensuring privacy, beneficence, maleficence and confidentiality were primarily ensured during each survey. Ethical clearance was received from Addis Ababa University College of Health Sciences School of Public Health Research Ethics Committee.

4.8. DISSEMINATION OF FINDINGS

The findings of this study is presented to Addis Ababa University School of Public Health Department of Reproductive Family and Population Health after that the findings will be addressed to family planning program stakeholders and policy makers working on maternal and child health issues through presenting on conferences such as Consortium of Reproductive Health Associations students research conference on reproductive health and for wider access it will be published on international journal of research.

5. RESULTS

A total of 15367, 14070, 16515, and 15683 women of reproductive age participated in EDHS 2000, 2005, 2011, and 2016 respectively. The majority 81.8%, 82.2%, 76.1%, and 77.8% of women of reproductive age live in rural settings. More than half 75.2% and 65.9% of women had never attained any educational level for the years 2000 and 2005, whereas 50.8% and 47.8% of women had no education in the 2011 and 2016 survey years. More than half of the women 62.8%, 63.4%, 58.1% and 63.9% in all surveys are married, while 50.5%, 49.2%, 47.5%, and 43.3% of women are Orthodox Christians during the four survey years respectively. Among the women who participated in four rounds of surveys 12.8%, 6.9%, 8.6%, and 7.9% of them have ever faced terminated pregnancy. The percentages of women using modern family planning methods were 4.7%, 9.7%, 18.7%, and 24.9% respectively for the four survey years.

Table 3. Background characteristics of women of reproductive ages in Ethiopia in 2000, 2005, 2011 and 2016.

Characteristics	EDHS 2000	EDHS 2005	EDHS 2011	EDHS 2016
Type of place of residence				
Urban	2,791.4 (18.20)	2,499 (17.80)	3,947 (24.00)	3,476 (22.2)
Rural	12,576 (81.83)	11,571 (82.2)	12,568 (76.1)	12,207 (77.8)
Educational Attainment				
No Education	11,551 (75.2)	9,271 (65.9)	8,394 (50.8)	7498 (47.80)
Primary Education	2,425 (15.80)	3,123 (22.2)	6276 (38.1)	5490 (35.00)
Secondary Education	1,304 (8.50)	1,481 (10.5)	1,117 (6.80)	1817 (11.60)
Higher Education	87,00 (0.60)	194.00 (1.4)	728.0 (4.40)	877.00 (5.6)
Marital Status				
Never Married	3,688 (24.0)	3,516 (25.0)	4,469 (27.1)	4,036 (25.7)
Married	9,653 (62.8)	8,914 (63.4)	9,594 (58.1)	10,014 (63.9)
Living together	136.0 (0.90)	152.0 (1.10)	694. (4.20)	209.0 (1.30)
Divorced	954.0 (6.20)	674.0 (4.80)	883.0 (5.30)	764.0 (4.90)
Widowed	546.0 (3.60)	556.0 (4.00)	536.0 (3.30)	429.0 (2.70)
Religion				
Orthodox	7,763 (50.5)	6,921 (49.2)	7,847 (47.5)	6,786 (43.3)
Catholic	175.0 (1.10)	173.00 (1.2)	179.0 (1.10)	120.0 (0.80)
Protestant	2,432 (15.8)	2,654 (18.9)	3,634 (22.0)	3,674 (23.4)
Muslim	4,455 (29.0)	4,008 (28.5)	4,588 (27.8)	4,893 (31.2)
Traditional	503.0 (3.30)	189.00 (1.3)	128.0 (0.80)	123.0 (0.80)
Others	37.00 (0.20)	123.00 (0.9)	126.0 (0.80)	87.0 (0.60)
Age Group				

15-19	3,710 (24.1)	3,266 (23.2)	4,009 (24.3)	3,381(21.6)
20-24	2,859 (18.6)	2,547 (18.1)	2931 (17.80)	2,762 (17.6)
25-29	2,585 (16.8)	2,517 (17.9)	3,147 (19.1)	2,957 (18.9)
30-34	1,840 (12.0)	1,807 (12.9)	2,054 (12.4)	2,345 (14.9)
35-39	1,716 (11.2)	1,602 (11.4)	1,916 (11.6)	1,932 (12.3)
40-44	1,392 (9.10)	1,187 (8.40)	1,261 (7.60)	1,290 (8.20)
45-45	1,264 (8.20)	1,143 (8.10)	1,196 (7.20)	1,017 (6.50)

Table 4. Reproductive health characteristics of women of reproductive ages in Ethiopia, 2000-2016.

Characteristics	**EDHS 2000**	**EDHS 2005**	**EDHS 2011**	**EDHS 2016**
Ever Terminated Pregnancy				
Yes	1,969 (12.80)	970.0 (6.90)	1,420 (8.60)	1,236 (7.90)
No	13,397 (87.2)	13,099 (93.1)	15,092 (91.4)	14,447 (92.1)
Current Family Planning Use				
No method	14,457 (87.2)	12,616 (89.7)	13,281 (80.4)	11,709 (74.7)
Traditional	181 (1.2)	92 (0.66)	139 (0.84)	75 (0.5)
Modern method	720 (4.7)	136 (9.7)	3,088 (18.7)	3899 (24.9)

5.1. PROXIMATE DETERMINANTS OF FERTILITY

According to the analysis delayed marriage and marital instability inhibited biological fertility by 35%, 36%, 37%, and 34.4% on the four respective survey years. Contraception use inhibited natural fertility by 8%, 14%, 29%, and 37% respectively while postpartum infecundity reduced fertility by 48% in the survey year 2000, 43%, in the 2005 and 2011 survey years, and by 42% in 2016. The highest attainable biological fertility level was reduced by 0.61% and 0.73% due to induced abortion in the years 2011 and 2016.

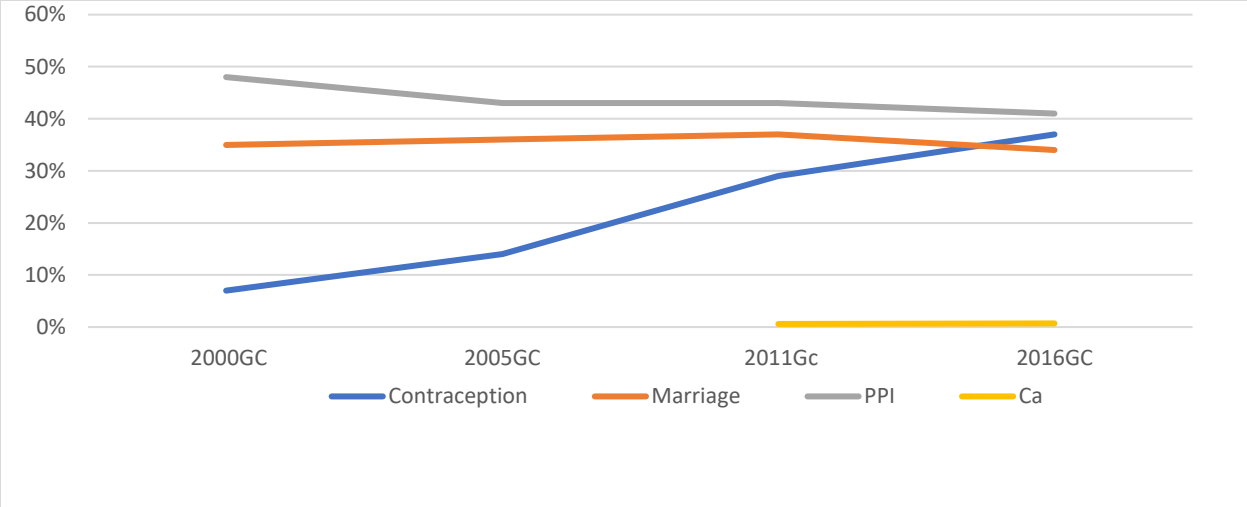

Figure 3: The trend in percent reductions of fertility from its natural level due to delayed marriage, contraception use, post-partum infecundity, and induced abortion in Ethiopia, 2000- 2016.

5.1.1. DELAYED MARRIAGE AND MARITAL INSTABILITY

Further disaggregation of the fertility inhibition effect of proximate determinants of fertility in the survey years 2000, 2005, 2011, and 2016, showed that the trend in fertility reduction of fertility from its natural level due to delayed marriage and marital instability in women in urban residences increased from 52% in 2000 to 58% in 2005 then decreased to 48% and 47% in 2011 and 2016. Whereas among rural women, the fertility inhibition effect of it has been 29%, 27%, 30%, and 28% for the respective survey years.

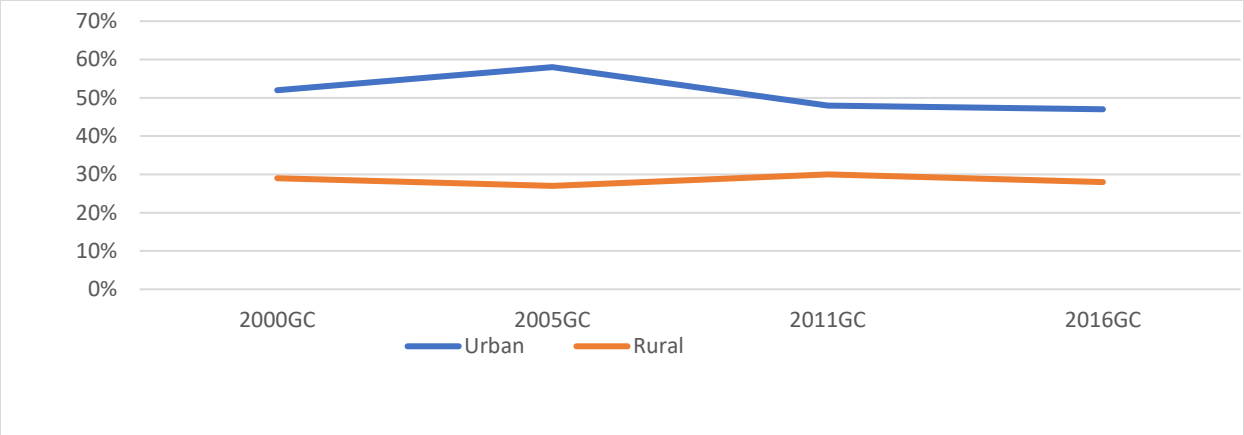

Figure 4: Trend of percent reduction of delayed marriage by residence type in Ethiopia, 2000-2016.

The trend in fertility reduction effect of delayed marriage and marital instability for the four survey years among women living in Tigray region it was (31% to 34%, 39% and 39%) respectively while it was (27%, 21%, 25% and 23%) in Afar region. In Amhara region the inhibition effect was (29%, 32%, 34% and 32%). The reduction effect in Oromia region was (34%, 33%, 32% and 29%) in Somali region the percent reduction of natural fertility level by delayed marriage and marital instability decreased from31% in 2000 to 23% and 26% in 2005 and 2011 while it increased to 30% in 2016. Among women residing in Benishangul-Gumz region the fertility reduction effect declined from 26% in 2000 to 23% in 2005 while it increased to 27% and 28% in 2011 and 2016. For the region SNNPR delayed marriage and marital instability inhibited fertility level by 35% in 2000 while its effect declined to 33% in 2005 and again raised to 35% and 34% for the years 2011 and 2016. In Gambella region fertility reduction due to delayed marriage and marital instability was 22% in 2000 while it increased to 26% for the years 2005, 2011 and 2016. In Harari region the fertility inhibition effect of delayed marriage and marital instability declined over the years from 43% in 2000 to 42%, 39% and 35% in 2005, 2011 and 2016, for women living in Addis Ababa the inhibition effect of delayed marriage raised from 58% to 67% from 2000 to 2005 then decreased to 56% and 55% in 2011 and 2016. The fertility reduction effect of delayed marriage in Dire-Dawa city declined from 45% in 2000 to 44% and 39% in 2005 and 2011 then increased to 44% in 2016.

Significant increasing trend in the reduction effect of delayed marriage and marital instability was observed on Tigray region (Coefficient= 0.54, P= 0.04) while significant declining trend was

observed on Oromia Region (Coefficient= -0.29, P= 0.048), Harari region (Coefficient= -0.45, P= 0.03).

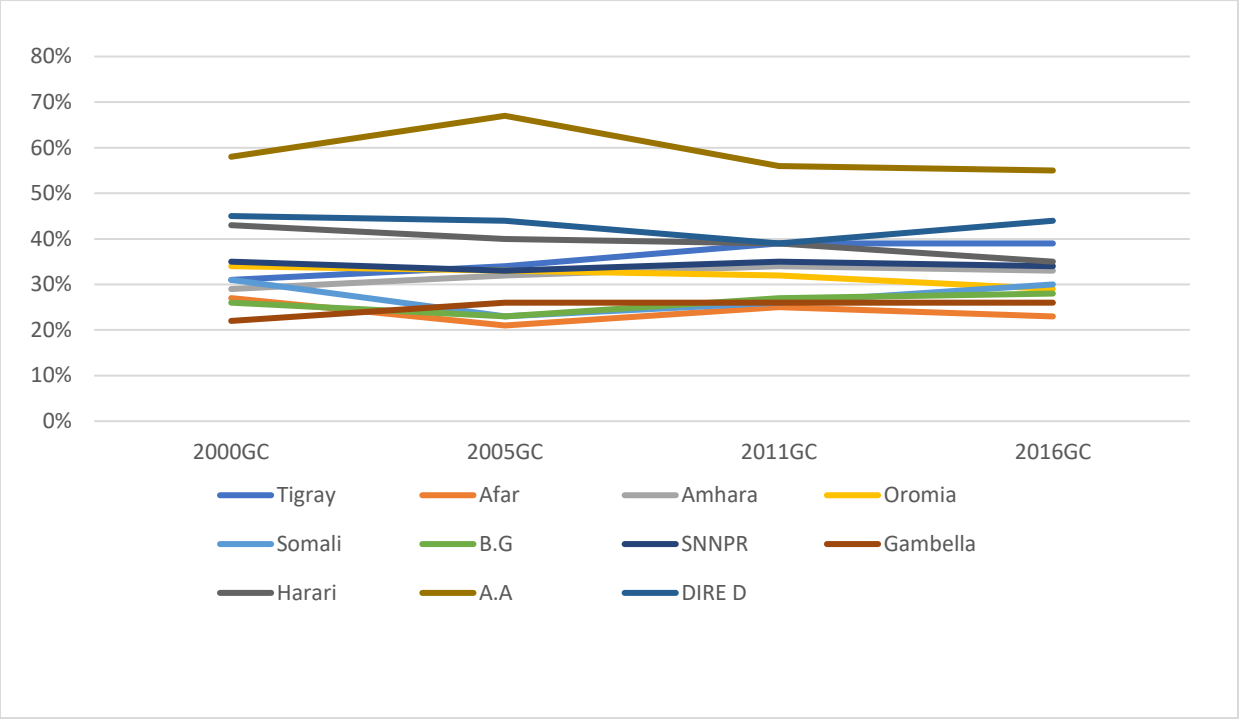

Figure 5: Trend of percent reduction of delayed marriage and marital instability by regions in Ethiopia, 2000-2016.

The extended analysis of fertility reduction effect of delayed marriage and marital instability across educational attainment of women reveals that among women with no education delayed marriage and marital instability inhibited biological fertility by 28% in 2000 showing decline to 23%, 19% and 18% in 2005, 2011 and 2016. The inhibition effect on women with primary education increased from 49% in 2000 to 53% in 2005 while it decreased to 49% and 45% in 2011 and 2016, among women with secondary education delayed marriage reduced fertility by 56% in 2000 while the reduction effect increased to 61% in 2005 and decreased to 57% and 55% in 2011 and 2016. The fertility reduction level by delayed marriage among women with higher education increased from 33% in 2000 to 57% and 52% in 2005 and 2011 while it decreased to 45% in 2016.

Significant decline in the trend of fertility inhibition effect of delayed marriage and marital instability was observed among women with no education (Coefficient= -0.63, P= 0.03).

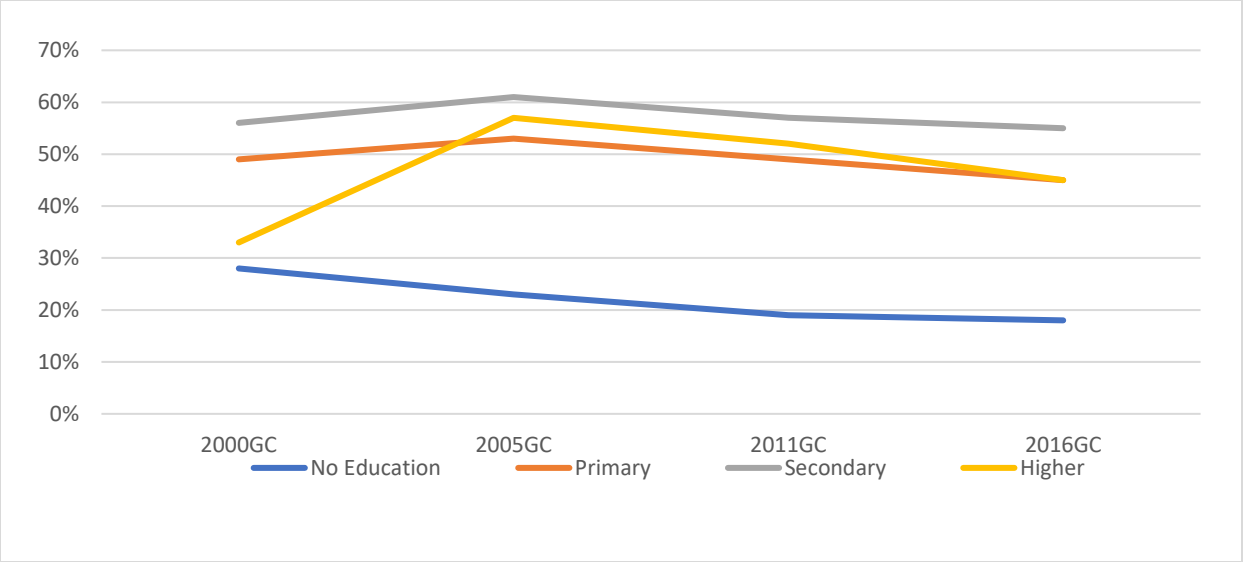

Figure 6: The trends in percent reduction of Delayed marriage and marital instability by educational status of women in Ethiopia, 2000-2016.

The detailed analysis also showed that the fertility inhibition effect of delayed marriage among women in age group 15-19 increased from 71% in 2000 to 78%, 77% and 80% in 2005, 2011 and 2016 while it declined from 37% in 2000 to 36% in 2005 and 34% in 2011 and 2016 among women in age group 20-24. Across women in age group 25-29 the reduction effect declined from 20% in 2000 to 16% in 2005 then remained 18% in the years 2011 and. The inhibition effect among women in age group 30-34 declined from 15% in 2000 to 14% in 2005 while it remained 15% for the years 2011 and 2016. Among women in age group 35-39 the reduction effect increased from 16% in 2000 to 17% in 2005, 2011 and 2016. The reduction effect among women in age group 40-44 was 22% in 2000 while it decreased to 19% in 2005 and 21% in 2011 and 2016. The fertility inhibition effect of delayed marriage or marital instability among women in age group 45-49 decreased from 28% in 2000 to 25% in 2005 while it remained 28% in 2011 and 2016.

Significant decline in the trend of fertility inhibition effect by delayed marriage and marital instability was observed among women in age group 20-24 (Coefficient= -0.2, P= 0.04).

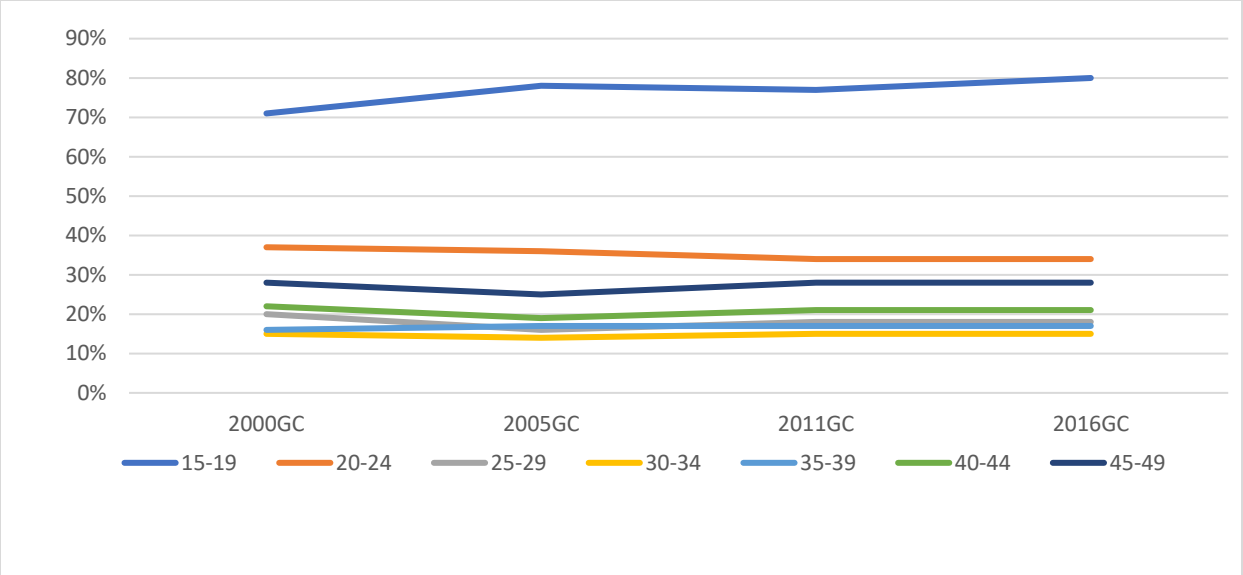

Figure 7: The trends in the percent reduction of Delayed Marriage and Marital instability by Age group of women in Ethiopia, 2000-2016.

5.1.2. CONTRACEPTION USE

The detailed findings about the fertility inhibition effect of contraception use disaggregated by each background characteristics over the survey years indicated that contraception use inhibited natural fertility level by (33%, 44%, 51% and 52%) in urban areas while it reduced fertility by (3%, 11%, 23% and 34%) in rural areas.

The fertility inhibition effect of contraception significantly increased over the years both in urban residence (Coefficient= 1.18, P= 0.05) and rural residence (Coefficient= 2.52, P= 0.009).

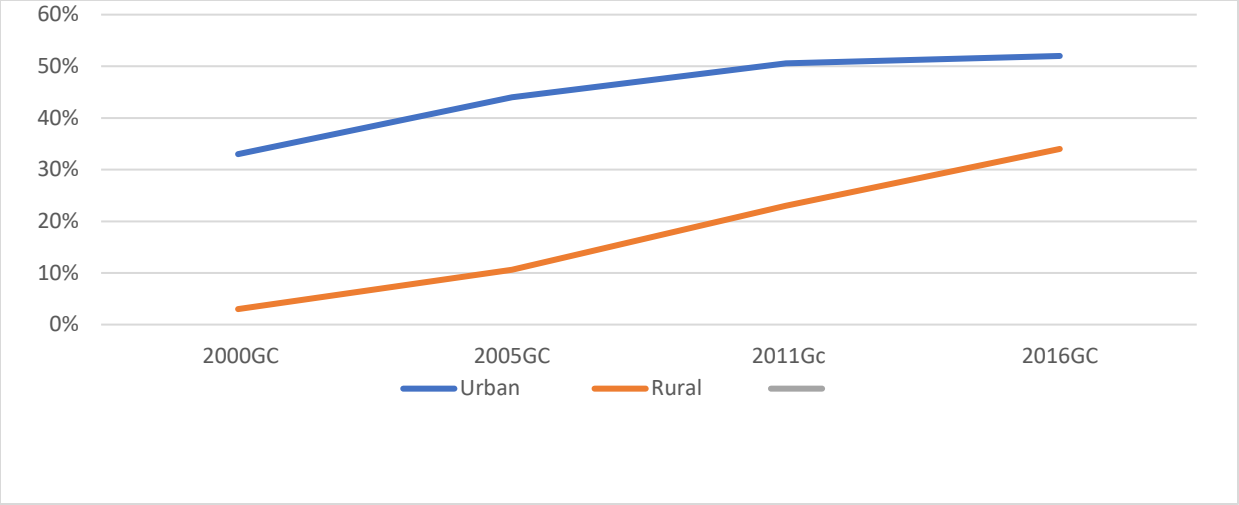

Figure 8: The trends in fertility inhibition of Contraception use by Residence Type in Ethiopia, 2000-20016.

Over the respective years, the inhibition effect was (10%, 17%, 22% and 36%) in Tigray region, while it was (8%, 6%, 9% and 11%) in Afar region. The reduction effect was (8%, 15%, 34% and 47%) in Amhara region while it was (7%, 13%, 26% and 29%) in Oromia region, (3%, 1%, 5% and 1%) in Somali region, the trend in percent reduction was (9%, 3%, 26% and 29%) in Benishangul-Gumz. The trend in the percent reduction declined from 6% in 2000 to 4% in 2005 then raised to 24% and 41% in 2011 and in 2016 in SNNPR, while it was (13%, 15%, 33% and 34%) in Gambella, in Harari the percent reduction raised from 21% to 32%, 33% and decreased to 30% while it raised from 43% in 2000 to 52%, 60% in 2005 and 2011 and 58% in 2016 in Addis Ababa and it was (27% to 32%, 33% and 32%) in Dire Dawa.

The fertility reduction effect of contraception use has been significantly increasing on Tigray region (Coefficient= 1.52, P= 0.03), Amhara region (Coefficient= 2.52, P= 0.009), Oromia region (Coefficient= 1.47, 0.018).

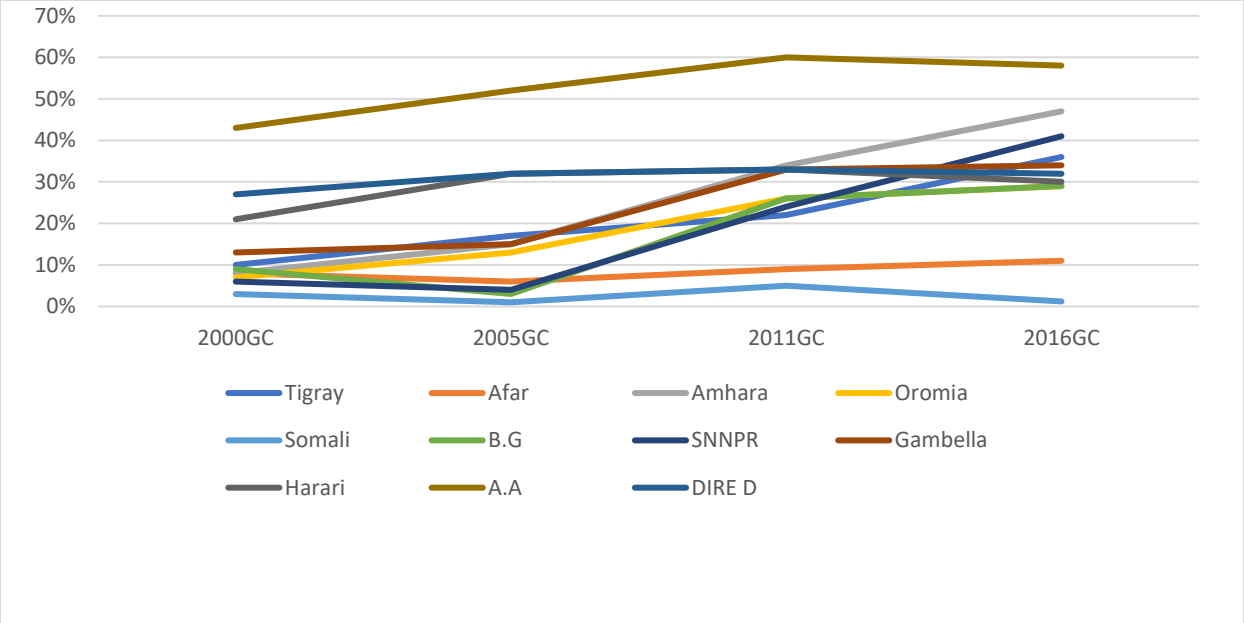

Figure 9: The trends in the fertility inhibition effects of Contraception use by Regions in Ethiopia, 2000-2016.

Analysis of the fertility inhibition effect of contraception by the highest education attainment of women indicated variable results. The fertility inhibition effect of contraception use was 4% in 2000, 10%, 22%, and 33% in 2005, 2011, and 2016 on women with no education while it was (12%, 23%, 36%, and 43%) on women with primary education, (22%, 54%, 57% and 51%) on women with secondary and (30%, 54%, 66% and 58%) on women with higher education.

Significant increasing trend in the inhibition effect of contraception use was observed among women with no education (Coefficient= 1.83, P= 0.006), primary education (Coefficient= 1.96, P= 0.004).

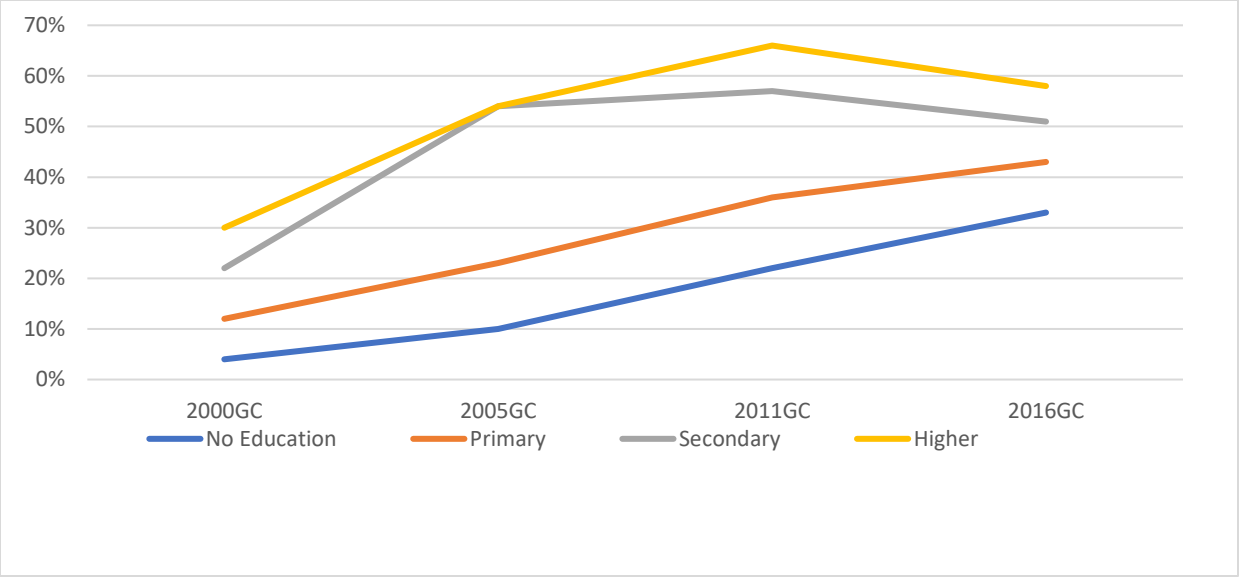

Figure 10: The trend in the fertility inhibition effect Contraception Use by Educational status of women in Ethiopia, 2000-2016.

The fertility reduction effect of contraception use also varies across women in different age groups and four survey years, by which it was (4%, 9%, 24% and 33%) on women in age group 15-19, (13%, 16%, 36% and 39%) on women in age group 20-24, (9%, 17%, 36% and 42%) on women in age group 25-29, (9%, 14%, 31% and 38%) on women in age group 30-34 and (10%, 17%, 29% and 35%) on women in age group 35-39. Across late reproductive age women, the inhibition effect was (8%, 13%, 24% and 34%) on women in age group 40-44 and (4%, 8%, 13% and 20%) on women in age group 45-49.

There was significant increasing trend in fertility inhibition effect of contraception use among women in age group 15-19 (Coefficient= 2.1, P= 0.01), 20-24 (Coefficient= 1.83, P= 0.004), 25-29 (Coefficient= 2.1, P= 0.01), 30-34 (Coefficient= 1.93, P= 0.01), 35-39 (Coefficient= 1.61 P= 0.004), 40-44 (Coefficient= 1.65, P= 0.008) and 45-49 (Coefficient= 0.97, P= 0.009).

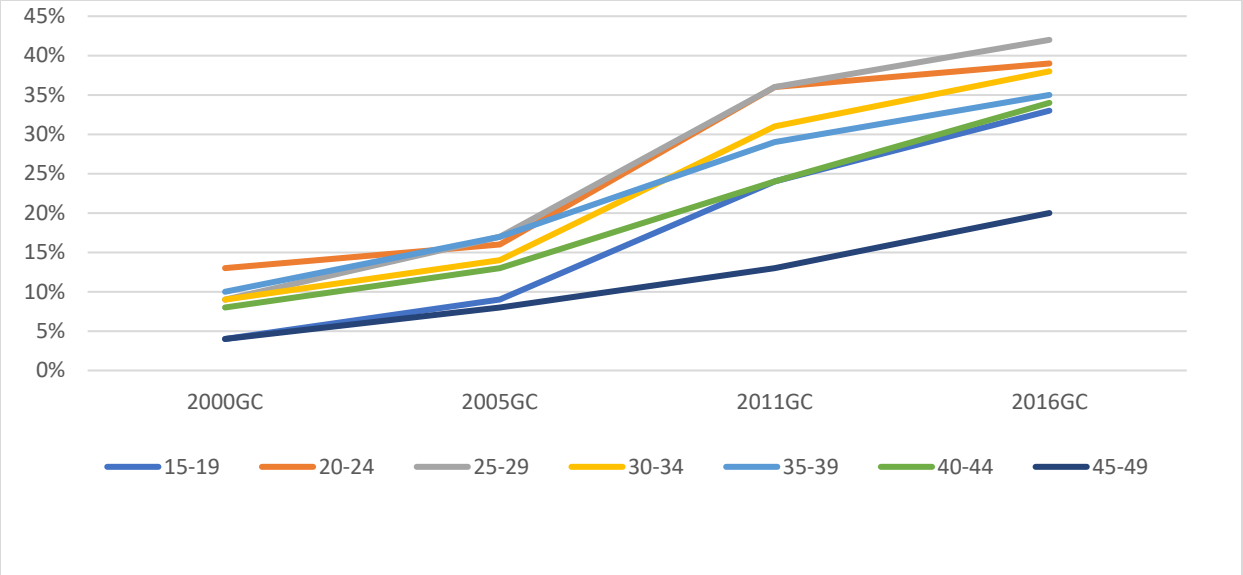

Figure 11: The trend in percent reduction of Contraception Use by Age group of women in Ethiopia, 2000-2016.

5.1.3. POST-PARTUM INFECUNDITY

Asper the further analysis conducted on the effect of post-partum infecundity over fertility levels of different background characteristics in 2000, 2005, 2011, and 2016, post-partum infecundity contributed to fertility level reduction by 31%, 30%, 34%, and 22% in urban settings while it reduced fertility by 49%, 45%, 44% and 42% in rural residence from its natural level.

Significant decline in the inhibition effect of post-partum infecundity was observed on rural residence (Coefficient= -0.4, P= 0.04).

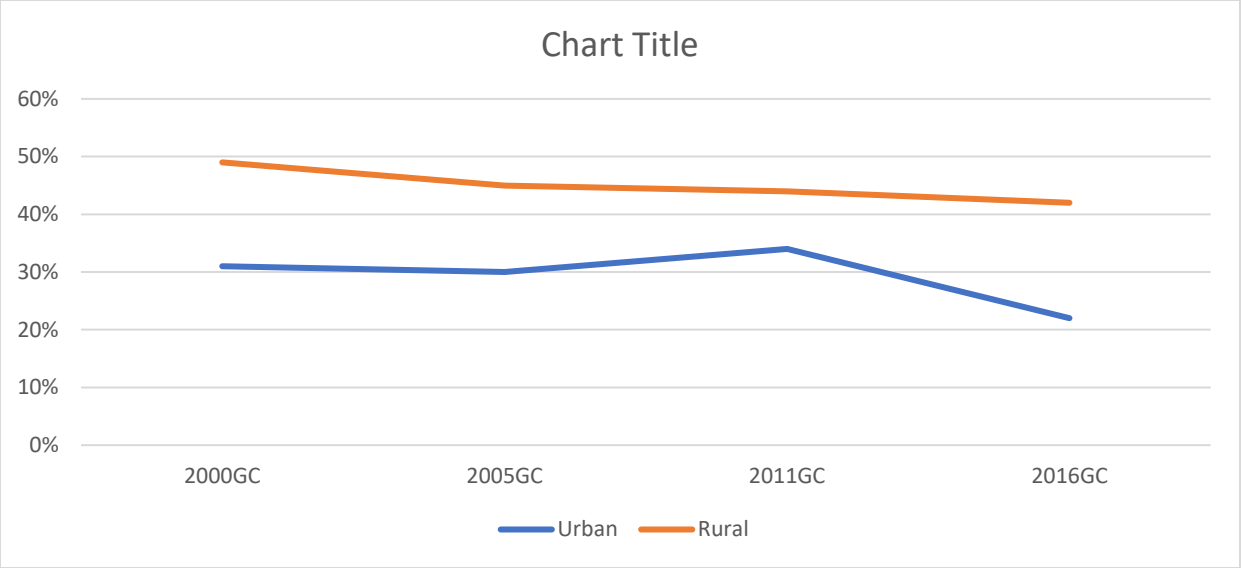

Figure 12: The trend in fertility inhibition effect of post-partum Infecundity by residence type in Ethiopia, 2000-2016.

The inhibition effect of post-partum infecundity was (50%, 50%, 48% and 43%) in Tigray region while it was (44%, 40%, 38% and 40%) in Afar region the reduction effect was (51%, 50%, 47% and 41%) in Amhara region the trend in the percent reduction contributed by post-partum infecundity was (46%, 41%, 41% and 41%) in Oromia region while it was (30%, 43%, 27% and 29%) in Somali region the trend in percent reduction of fertility from its natural level due to PPI was (45%, 40%, 38% and 44%) in Benishangul-Gumz and (45%, 45%, 44% and 43%) in SNNPR. Post-partum infecundity inhibited fertility by (53%, 52%, 52% and 47%) in Gambela region while it inhibited by (40%, 31%, 28% and 83%) in Harari, (29%, 32%, 15% and 16%) in Addis Ababa and (34%, 31%, 38% and 40%) in Dire- Dawa.

The declining trend in fertility inhibition effect of post-partum infecundity was significant on Amhara region (Coefficient= -0.61, P= 0.05).

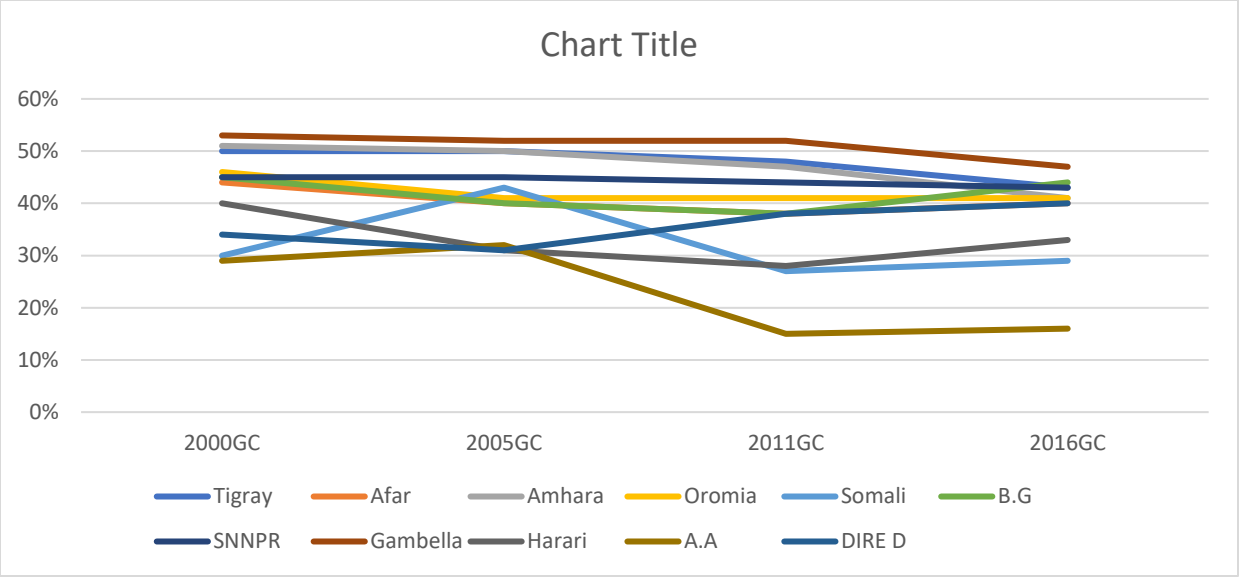

Figure 13: The trend in the fertility inhibition effect of post-partum Infecundity by Regions in Ethiopia, 2000-2016.

The change in the percent reduction of fertility level attributed to post-partum infecundity over the years was (49%, 45%, 45%, and 43%) for women with no education, (42%, 41%, 36% and 40%) for women with primary education showing a significant declining trend, (35%, 31%, 16% and 22%) for women with secondary education and (35%, 31%, 25% and 19%) for women with higher education.

Significant declining trend in the inhibition effect od post-partum infecundity was observed among women with higher education (Coefficient= -1, P= 0.003).

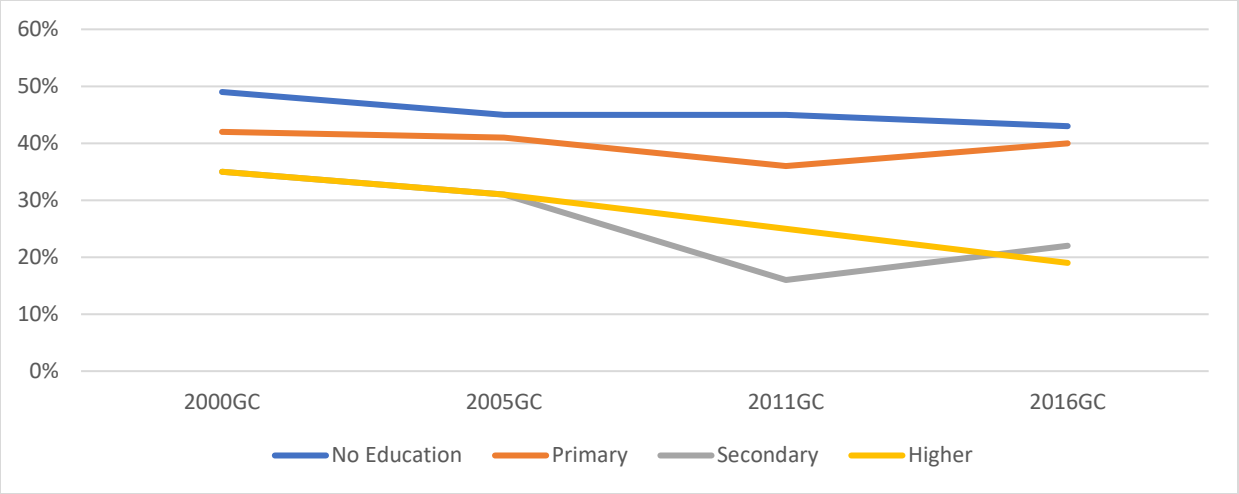

Figure 14: The trend in the fertility inhibition effect of post-partum infecundity by the educational status of women in Ethiopia, 2000-2016.

Women in age group 15-19, 20-24, 25-29 had (47%, 42%, 41% and 40%) fertility inhibition effect of post-partum infecundity while women in age group 30-34, 35-39, 40-44 and 45-49 had fertility inhibition effect of (49%, 48%, 45% and 42%).

Significant declining trend was observed among women in age group 30-49 (Coefficient= -0.04, p= 0.02).

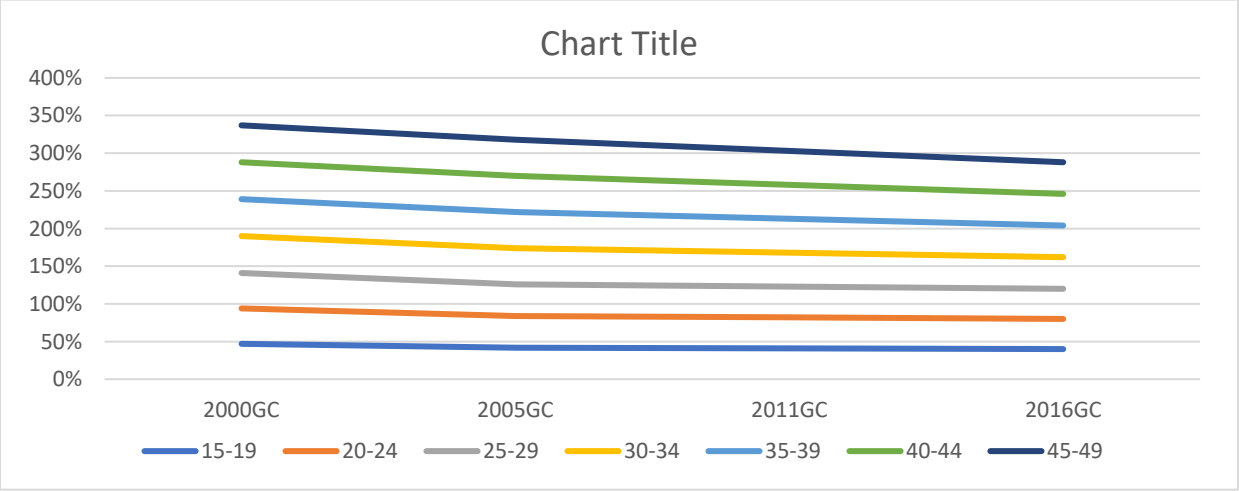

Figure 15: The trend in percent reduction of post-partum infecundity by Age group of women in Ethiopia, 2000-2016.

5.1.4. INDUCED ABORTION

The natural fertility level inhibition effect disaggregated by regions for survey years of 2011 and 2016 showed that, the inhibition effect for the two years is (0.88% and 1,24%) in Tigray,(0.2% and 0.12%) in Afar, (0.48% and 1.4%) in Amhara, (0.59% and 0.36%) in Oromia, (0.55% and 0.09%) in Somali, (0.33% and 0.05%) in Benishangul-Gumz, (0.49% and 0.8%) in SNNPR, (0.19% and 0.06%) in Gambella, (5.2% and 1.59%) in Harari, (4.93% and 7.5%) in Addis Ababa and (6% and 2.65%) in Dire Dawa.

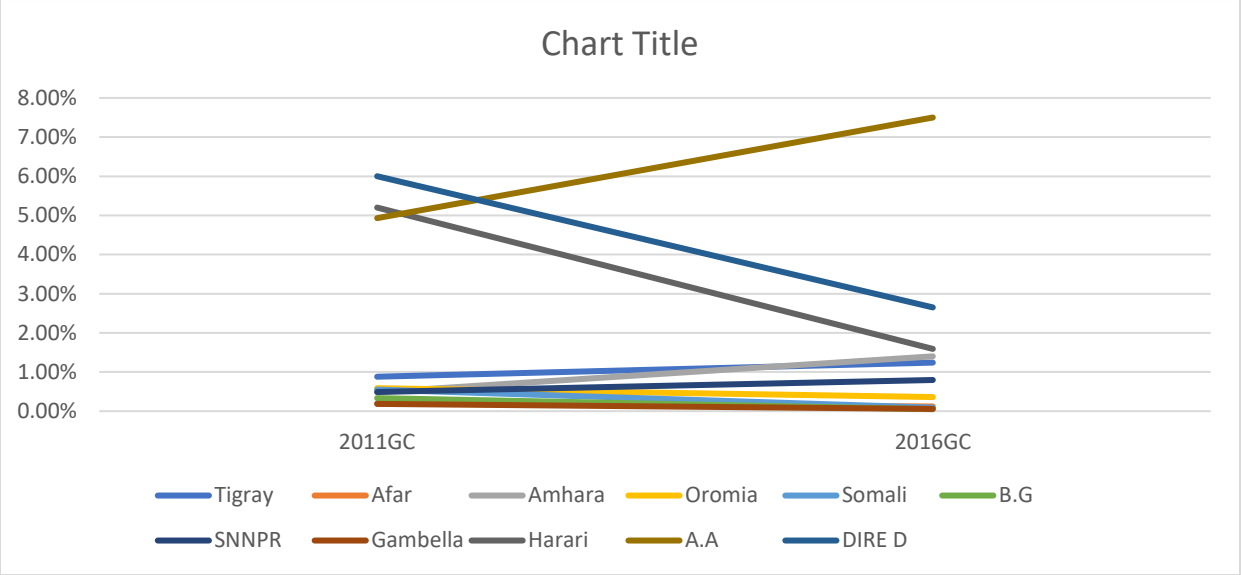

Figure 16: The trend in the fertility inhibition effect of induced abortion by regions in Ethiopia, 2000-2016.

Table 5. Indices of the proximate determinants of fertility by different background characteristics of women in Ethiopia in 2000, 2005, 2011, and 2016.

Variables		Cm				Cc				Ci				Ca		TF
		2000	**2005**	**2011**	**2016**	**2000**	**2005**	**2011**	**2016**	**2000**	**2005**	**2011**	**2016**	**2011**	**2016**	
Residence	**Urban**	0.48	0.42	0.52	0.53	0.66	0.56	0.49	0.48	0.69	0.7	0.66	0.78	0.948	0.9997	15.3
	Rural	0.71	0.73	0.7	0.72	0.97	0.89	0.7	0.66	0.51	0.55	0.56	0.58	0.998	0.9998	15.3
Regions	**Tigray**	0.69	0.66	0.61	0.61	0.9	0.83	0.78	0.63	0.5	0.5	0.52	0.57	0.991	0.989	15.3
	Afar	0.73	0.79	0.75	0.77	0.92	0.94	0.9	0.89	0.56	0.6	0.62	0.6	0.998	0.998	15.3
	Amhara	0.71	0.68	0.66	0.67	0.93	0.85	0.66	0.53	0.49	0.5	0.53	0.59	0.995	0.985	15.3
	Oromia	0.66	0.67	0.68	0.71	0.93	0.87	0.74	0.71	0.53	0.59	0.59	0.59	0.994	0.996	15.3
	Somali	0.69	0.77	0.74	0.7	0.97	0.99	0.95	0.98	0.7	0.57	0.73	0.71	0.994	0.999	15.3
	B.G	0.74	0.77	0.73	0.72	0.91	0.97	0.74	0.71	0.55	0.6	0.62	0.56	0.996	0.999	15.3
	SNNPR	0.65	0.67	0.65	0.66	0.93	0.96	0.75	0.59	0.55	0.55	0.56	0.57	0.995	0.992	15.3
	Gambella	0.78	0.74	0.74	0.74	0.86	0.85	0.67	0.65	0.47	0.48	0.48	0.53	0.998	0.999	15.3
	Harari	0.57	0.6	0.61	0.65	0.78	0.68	0.66	0.69	0.6	0.69	0.72	0.67	0.947	0.984	15.3
	Addis	0.42	0.33	0.44	0.45	0.56	0.48	0.4	0.42	0.71	0.69	0.85	0.84	0.952	0.924	15.3
	Dire Dawa	0.55	0.56	0.61	0.56	0.73	0.68	0.67	0.67	0.66	0.69	0.62	0.6	0.939	0.973	15.3
Age group	**15-19**	0.29	0.22	0.23	0.2	0.96	0.91	0.75	0.67	0.53	0.58	0.59	0.6		0.73	15.3
	20-24	0.63	0.64	0.66	0.66	0.87	0.84	0.65	0.6	0.53	0.58	0.59	0.6		0.996	15.3
	25-29	0.8	0.84	0.82	0.82	0.91	0.83	0.64	0.58	0.53	0.58	0.59	0.6		0.989	15.3
	30-34	0.85	0.86	0.85	0.85	0.91	0.85	0.69	0.62	0.51	0.52	0.55	0.58		0.986	15.3
	35-39	0.84	0.83	0.83	0.83	0.89	0.83	0.71	0.64	0.51	0.52	0.55	0.58		0.988	15.3
	40-44	0.78	0.81	0.79	0.79	0.92	0.86	0.76	0.65	0.51	0.52	0.55	0.58		0.991	15.3
	45-49	0.72	0.75	0.72	0.72	0.96	0.92	0.86	0.8	0.51	0.52	0.55	0.58		0.994	15.3
Education	**No**	0.72	0.77	0.81	0.82	0.96	0.9	0.78	0.67	0.51	0.55	0.55	0.57			15.3
	Primary	0.51	0.47	0.51	0.55	0.88	0.77	0.64	0.56	0.58	0.59	0.64	0.6			15.3
	Secondary	0.44	0.39	0.43	0.45	0.78	0.46	0.43	0.49	0.65	0.69	0.84	0.78			15.3
	Higher	0.67	0.43	0.48	0.55	0.7	0.46	0.34	0.42	0.65	0.69	0.75	0.81			15.3

5.2. DISTAL DETERMINANTS OF FERTILITY

The average number of children ever born is 2.63 with standard deviation of 2.84. The maximum number of children ever born is 14 while the minimum value is 0. The value of kurtosis that measures the peak of the distribution of children ever born is 0.1283

Table 6. The mean and dispersion of Children Ever Born in Ethiopia, 2016.

	Mean	Variance	SD	Min	Max	Kurtosis
CEB	2.63	8.0656	2.84	0	14	0.1283

5.2.1. MEAN CHILDREN EVER BORN BY AGE GROUPS OF WOMEN

The Mean number of Total children significantly increases over the age cohorts for all consecutive survey years. There is a statistically significant increase in Mean children ever born among women in age group 25-29 2.36 (2.3, 2.43) from 2000 to 2.52 (2.45, 2.56) in 2005 while there was significant decline among women in age groups 40-44 from 6.7 (6.21, 6.52) in 2000 to 6.02 (5.86, 6.19) in 2005 then from 6.17 (6, 6.33) in 2011 to 5.67 (5.51, 5.82) in 2016 and among women in age group 45-49 from 2011 to 2016.

Table 7. The trend and age pattern of mean children ever in Ethiopia from 2000 to 2016.

Age Group	EDHS 2000G.C Mean CEB with 95% CI	EDHS 2005G.C Mean CEB with 95% CI	EDHS 2011G.C Mean CEB with 95% CI	EDHS 2016 G.C Mean CEB with 95% CI
15-19	0.15 [0.13, 0.16]	0.17 [0.15, 0.18]	0.14 [0.13, 0.15]	0.12 [0.11, 0.13]
20-24	1.03 [0.99, 1.07]	1.05 [1, 1.09]	1.01 [0.97, 1.05]	0.96 [0.92, 1.01]
25-29	2.36 [2.3, 2.43]	2.52 [2.45, 2.56]	2.46 [2.4, 2.52]	2.37 [2.31, 2.44]
30-34	4.13 [4.03, 4.23]	4.1 [4, 4.21]	3.97 [3.87, 4.06]	3.8 [3.71, 3.99]
35-39	5.42 [5.3, 5.54]	5.24 [5.11, 5.37]	5.16 [5.04, 5.3]	4.97 [4.85, 5.09]
40-44	6.37 [6.21, 6.52]	6.02 [5.86, 6.19]	6.17 [6, 6.33]	5.67 [5.51, 5.82]
45-49	6.87 [6.7, 7.04]	6.77 [6.69, 6.95]	6.88 [6.7, 7.6]	6.13 [5.94, 6.32]

5.2.2. DISTAL DETERMINANTS OF FERTILITY ON EDHS SURVEY YEAR 2000G.C

To assess the factors associated with fertility, zero-inflated negative binomial regression was performed. Variations in fertility across different categories of socioeconomic determinants are described by IRR and its 95% confidence interval compared to reference categories. IRR value greater than one implies that a certain category has a higher chance of having higher fertility

compared with the reference category while IRR value less than one means a given category has fewer fertility relative to the reference category. According to the analysis performed on EDHS 2000 data rural residence (IRR of 1.21 95% CI: 1.14 – 1.29 p=0.000), Tigray (IRR= 1.20, 95% CI: 1.11- 1.296 , p= 0.000), Amhara (IRR= 1.20, 95% CI: 1.11- 1.296, p= 0.000), Oromia region (IRR= 1.296, 95% CI: 1.195- 1.41, p= 0.000), Somali (IRR= 1.46, 95% CI: 1.23- 1.73, P= 0.000), Benishangul Gumz (IRR= 1.21, 95% CI: 1.09- 1.35, p= 0.000), SNNPR (IRR= 1.21, 95% CI: 1.11-1.32, p= 0.000), Gambella (IRR= 1.11, 95% CI: 1.02- 1.21, p= 0.001), Harari region (IRR= 1.21, 95% CI: 1.11- 1.31, P= 0.000) and Dire Dawa city (IRR= 1.09, 95% CI: 1.01- 1.19, p= 0.036) have statistically significant positive association with having higher number of children. Another statistically significant positive association was observed among women with no education (IRR= 1.46, 95% CI: 1.12- 1.91, P= 0.006), women with primary education (IRR= 1.46, 95% CI: 1.11- 1.93, p= 0.008), and current age of women (IRR= 1.062, 95% CI: 1.061- 1.064, P= 0.000)

This shows that the likelihood of having higher number of children is 0.21 times higher in rural women than women in urban settings. Oromia, Somali, Gambella regions and Dire Dawa city had 0.296, 0.46, 0.11- and 0.09-times higher chance of having greater number of children. The chance of having higher number of children is 0.2 times higher on women in Tigray and Amhara regions while women in regions of Benishangul- Gumz, SNNPR and Harari have 0.21times higher chance of having more children compared to women living in Addis Ababa. Women with no education and primary education had greater chance of having more children by 46% relative to women with higher education. A one unit increase on the age of women is associated with 0.06 times greater chance of having higher number of children.

Table 8. The Unadjusted and Adjusted Incident Rate Ratio of associations between Distal Determinants and Fertility in Ethiopia, 2000.

Variables	Null Model Fitted			Model I			Model Fitted with All Variables		
	IRR (95 %C I)	SE	P valu	IRR (95 %C I)	SE	P valu	IRR (95 %C I)	SE	P valu
Null	4.04 [3.96, 4.12]	0.04		_	_	_	_	_	_
Type of place of residence									
Urban	_	_	_	1			1		
Rural	_	_	_	1.31 [1.21, 1.42]	0.05	**0.000**	1.21 [1.14, 1.29]	0.04	**0.000**
Regions									
Tigray	_	_	_	1.09 [0.98, 1.2]	0.05	0.104	1.20 [1.11, 1.296]	0.05	**0.000**
Afar	_	_	_	0.98 [0.86, 1.13]	0.07	0.842	1.04 [0.94, 1.16]	0.06	0.4
Amhara	_	_	_	1.06 [0.95, 1.18]	0.06	0.242	1.20 [1.11, 1.296]	0.05	**0.000**
Oromia	_	_	_	1.17 [1.05, 1.31]	0.06	**0.004**	1.296 [1.195, 1.41]	0.05	**0.000**
Somali	_	_	_	1.37 [1.12, 1.68]	0.14	**0.003**	1.46 [1.23, 1.73]	0.13	**0.000**
B-Gumz	_	_	_	1.04 [0.92, 1.18]	0.06	0.494	1.21 [1.09, 1.35]	0.06	**0.000**
SNNPR	_	_	_	1.18 [1.06, 1.31]	0.07	**0.003**	1.21 [1.11, 1.32]	0.05	**0.000**
Gambella	_	_	_	0.88 [0.79, 0.99]	0.05	**0.044**	1.11 [1.02, 1.21]	0.05	**0.016**
Harari	_	_	_	1.12 [1.01, 1.04]	0.06	**0.027**	1.21 [1.11, 1.31]	0.05	**0.000**
A.A	_	_	_	1			1		
Dire Dawa	_	_	_	1.03 [0.93, 1.13]	0.05	0.59	1.09 [1.01, 1.19]	0.05	**0.036**
Religion									
Orthodox	_	_	_	_	_	_	1		
Catholic	_	_	_	_	_	_	1 [0.89, 1.13]	0.06	0.97
Protestant	_	_	_	_	_	_	1 [0.95, 1.07]	0.03	0.75
Muslim	_	_	_	_	_	_	1.02 [0.97, 1.06]	0.02	0.515
Traditional	_	_	_	_	_	_	0.97 [0.89, 1.05]	0.04	0.413
Others	_	_	_	_	_	_	0.88 [0.68, 1.12]	0.1	0.301
Educational Attainment									
N.E	_	_	_	_	_	_	1.46 [1.12, 1.91]	0.2	**0.006**
Primary	_	_	_	_	_	_	1.46 [1.11, 1.93]	0.2	**0.008**
Secondary	_	_	_	_	_	_	1.28 [0.98, 1.01]	0.17	0.066
Higher	_	_	_	_	_	_	1		
Employment Status									
Unemploye	_	_	_	_	_	_	1		
Employed	_	_	_	_	_	_	0.99 [0.96, 1.01]	0.01	0.35
Age	_	_	_	_	_	_	1.062 [1.061, 1.064]	0.0008	**0.000**

5.2.3. DISTAL DETERMINANTS OF FERTILITY ON EDHS SURVEY YEAR 2016G.C

According to the zero-inflated negative binomial regression performed on EDHS 2016 data the incidence of higher fertility was (IRR= 1.22, 95% CI: 1.13- 1.32, P= 0.000) in rural areas, (IRR= 1.29, 95% CI: 1.19- 1.42, P= 0.000) in Tigray, (IRR= 1.31, 95% CI: 1.17- 1.47, P= 0.000) in Afar, (IRR= 1.18, 95% CI: 1.08- 1.29, P= 0.000) in Amhara, (IRR= 1.44, 95% CI: 1.31- 1.58, P= 0.000) in Oromia, (IRR= 1.55, 95% CI: 1.41- 1.71, P= 0.000) in Somali, (IRR= 1.43, 95% CI: 1.28- 1.59, p= 0.000) in Benishangul Gumz, (IRR= 1.46, 95% CI:1.32- 1.61, P= 0.000) in SNNPR, (IRR= 1.31, 95% CI: 1.17- 1.47, P= 0.000) in Gambella, (IRR= 1.29, 95% CI: 1.18- 1.43, P= 0.000) in Harai and IRR= 1.25, 95% CI: 1.14- 1.38, P= 0.000) in Dire Dawa compared with the level in Addis Ababa. Women who confess to the Muslim religion had an (IRR= 1.12, 95% CI: 1.06- 1.19, P= 0.000) of higher fertility while those in the traditional region had (IRR= 1.10,95% CI: 1.02- 1.19, P= 0.016). The incidence of higher fertility among women with no education was (IRR= 2.1, 95% CI: 1.92-2.31, P= 0.000), and among those who attained primary education it was (IRR= 1.67, 95% CI: 1.53- 1.83, P= 0.000 and among those who attained secondary level of education was (IRR= 1.15, 95% CI: 1.04- 1.28, P= 0.007). The incidence of higher fertility among employed mothers was (IRR= 0.96, 95% CI: 0.93- 0.99, P= 0.026). Age has positive association with high fertility (IRR= 1.057, 95% CI: 1.055, 1.059, P= 0.000).

This shows that women in rural areas have 22% higher fertility than women in urban areas. Women in Tigray, Amhara, Afar and Oromia had 29%, 31%, 18% and 44% higher fertility compared to women in Addis Ababa while women in Somali, Benishangul- Gumz, SNNPR, Gambella, Harari and Dire Dawa had 55%, 43%, 46%, 31%, 29% and 25% higher fertility than women residing in Addis Ababa. Muslim women and women with traditional religion had 12% and 10% higher fertility than Orthodox women. Women with no education 1.1 times higher fertility while women with primary and secondary education had 0.67- and 0.15-times higher chance of greater number of children compared to women with higher education. Employed women had 0.04 times lower chance of high fertility compared to unemployed women. For every year increase in age there is 5.7% higher chance of having greater number of children.

Table 9. The Unadjusted and Adjusted Incident Rate Ratio of Associations Between Distal Determinants and Fertility in Ethiopia, 2016.

Variables	Null Model			Model I			Model II		
	IRR (95%CI)	SE	P value	IRR (95%CI)	SE	P value	IRR (95%CI)	SE	P value
Null Model	**3.79 [3.69,3.89]**	**0.05**	**0.00**	_	_	_	_	_	_
Type of place of residence									
Urban	_	_	_	1			1		
Rural	_	_	_	1.56 [1.42, 1.71]	0.07	**0.000**	1.22 [1.13, 1.32]	0.05	**0.000**
Regions									
Tigray	_	_	_	1.33 [1.18, 1.49]	0.08	**0.000**	1.29 [1.19, 1.42]	0.06	**0.000**
Afar	_	_	_	1.38 [1.23, 1.54]	0.08	**0.000**	1.31 [1.17, 1.47]	0.075	**0.000**
Amhara	_	_	_	1.25 [1.12, 1.41]	0.07	**0.000**	1.18 [1.08, 1.29]	0.05	**0.000**
Oromia	_	_	_	1.49 [1.34, 1.66]	0.08	**0.000**	1.44 [1.31, 1.58]	0.07	**0.000**
Somali	_	_	_	1.80 [1.62, 2.01]	0.09	**0.000**	1.55 [1.41, 1.71]	0.08	**0.000**
B-Gumz	_	_	_	1.43 [1.26, 1.62]	0.09	**0.000**	1.43 [1.28, 1.59]	0.08	**0.000**
SNNPR	_	_	_	1.56 [1.38, 1.78]	0.1	**0.000**	1.46 [1.32, 1.61]	0.07	**0.000**
Gambella	_	_	_	1.21 [1.08, 1.3]	0.07	**0.001**	1.31 [1.17, 1.47]	0.08	**0.000**
Harari	_	_	_	1.3 [1.17, 1.44]	0.07	**0.000**	1.29[1.18, 1.43]	0.06	**0.000**
A.A	_	_	_	1			1		
Dire Dawa	_	_	_	1.35 [1.2, 1.53]	0.08	**0.000**	1.25 [1.14, 1.38]	0.06	**0.000**
Religion									
Orthodox	_	_	_	_	_	_	1		
Catholic	_	_	_	_	_	_	1.08 [0.91, 1.29]	0.09	0.354
Protestant	_	_	_	_	_	_	1.04 [0.97, 1.12]	0.04	0.261
Muslim	_	_	_	_	_	_	1.12 [1.06, 1.19]	0.03	**0.000**
Traditional	_	_	_	_	_	_	1.1 [1.02, 1.19]	0.04	**0.016**
Others	_	_	_	_	_	_	1.09 [0.9, 1.33]	0.01	0.346
Educational Attainment									
No Edu	_	_	_	_	_	_	2.1 [1.92, 2.31]	0.1	**0.000**
Primary	_	_	_	_	_	_	1.67 [1.531, 1.83]	0.08	**0.000**
Secondary	_	_	_	_	_	_	1.15 [1.04, 1.28]	0.06	**0.007**
Higher	_	_	_	_	_	_	1		
Employment status									
Unemployed	_	_	_	_	_	_	1		
Employed	_	_	_	_	_	_	0.96 [0.93, 0.99]	0.02	**0.026**
Age	_	_	_	_	_	_	1.057 [1.055, 1.059]	0.001	**0.000**

6. DISCUSSION

The study assessed the roles of proximate determinants of fertility over the natural level of fertility along with the variation of the roles of these determinants among selected socioeconomic characteristics in Ethiopia. Bongaart's proximate determinants of fertility model which is applied on this study is used to determine the reduction effects of each proximate determinant in percentage. This study also examined the most contributing socioeconomic factors affecting fertility in Ethiopia. The overall findings of this study show that the effects of proximate determinants vary across the selected characteristics and there is a remarkable change in the effect of these determinants across time.

The findings of the study indicated that during the survey years 2000, 2005, 2011 and 2016 delayed marriage and marital instability inhibited fertility by 35%, 36%, 37% and 34%. Contraception use inhibited fertility by 8%, 14%, 29% and 37% respectively while post-partum infecundity reduced fertility by 48%, 43%, 43% and 42%. The maximum attainable fertility level was reduced by 0.61% and 0.73% due to induced abortion. The contribution of delayed marriage was highest among women in urban areas (52%, 58%, 48% and 47%), Addis Ababa (58%, 67%, 56% and 55%), women with secondary education (56%, 61%, 57% and 55%) and women in age group 15-19 (71%, 78%, 77% and 80%)

The contribution of contraception use across the survey years was highest among urban areas (33%, 44%, 51% and 52%), Addis Ababa (43%, 52%, 60% and 58%), women with higher education (30%, 54%, 66% and 58%) and women in age group 20-24 (13%, 16%, 36% and 39%) and 25-29 (9%, 17%, 36% and 42%) while the contribution was lowest among women in rural areas (3%, 11%, 23% and 34%), Somali region (3%, 1%, 5% and 1%), women with no education (4%, 10%, 22% and 33%) and women in age group 45-49 (4%, 8%, 13%, 20%).

The contribution of post-partum infecundity over the survey years was highest among rural women (49%, 45%, 44% and 42%), women in Gambella region (53%, 52%, 52% and 47%), women with no education (49%, 45%, 45% and 43%) and women in age group 15-29 (47%, 42%, 41% and 40%).

The highest contribution of induced abortion was observed on Harari region (5.2%) in 2011 and Addis Ababa (7.5%) in 2016.

The results of this study showed that delayed marriage and marital instability inhibited fertility from its natural level by 35%, 36%, 37%, and 34.4% in the survey years 2000, 2005, 2011, and 2016. This finding aligns with findings of similar studies done in Ethiopia indicating the same reduction effect of delayed marriage (36, 41) and another study conducted in India showed the fertility inhibition effect of delayed marriage and marital instability by 36% (30). The fertility inhibition effect of delayed marriage and marital instability declined over the years might be attributed to the high incidence of divorce occurring in recent years as compared with the past years. However the study in Uganda indicated that delayed marriage inhibited fertility by 28% which is lower than the level in Ethiopia, the reason for the variation can be due to the more early marriage and universal marriage norm in Uganda and the practice of polygamy (34).

The detailed analysis of this study shows that the reduction effect of delayed marriage is higher among women in urban settings, Addis Ababa, women with secondary education, and women in the age group 15-19. This finding is supported by the study on proximate determinants of fertility in India where the inhibition effect is higher in urban settings (43.1%), women in higher levels of education (42.4%), and women in the age group 15-19 (83.5%) (30). Another similar finding is observed in the study done in Uganda showing that the reduction effect is higher among urban women (41%), Kampala City (44%), and women with secondary and higher education (40.2%). So also, Ethiopian studies indicate that the inhibition effect of delayed marriage is higher on urban women, Addis Ababa, and women with higher education and secondary education (35, 36). The implication for this is that women in urban settings tend to be married lately since they have a greater tendency to spend more years in education and are more likely to be employed. Women in Addis Ababa have greater access to education, most women are employed and there is also a higher divorce rate in Addis Ababa than in other regions which can make the time they get married delayed or cause marital instability. Women with higher education have greater proportion of sexual exposure outside marriage than women with secondary education which hinders the fertility inhibition effect of delayed marriage. Enrollment in primary and secondary levels of education has been increasing implying that teenage women aged 15-19 delay their marriage which leads to the pronounced fertility inhibition effect of delayed marriage and marital stability in this age group.

The findings of this study showed that contraception use inhibited fertility by 8%, 14%, 29%, and 37% across survey years 2000, 2005, 2011, and 2016. The same findings were observed in study

done in Ethiopia where contraception inhibited fertility by 15%, 29%, and 37% in survey years 2005, 2011, and 2016 (41) and 28.5% and 30.7% in survey years 2011 and 2016 (36). The other study in Uganda showed that contraception inhibited fertility by 28.2% in 2011 which is similar to the finding of this study in the same year (34). The research done in India showed different findings that in 2016 contraception inhibited fertility by 24% (30). This variation can be explained by the reason that India is top country with largest rate of unmet need. There is insufficient concern for birth spacing methods and narrow space of short and long-acting family planning methods provision in family planning program in India while there were successful programs in Ethiopia such as Health Extension Programs for substantial coverage in Family planning (67-69).

According to the extended findings of this study the percent reduction of fertility due to contraception use was higher among urban residents, Addis Ababa, women with higher education, and women aged 25-29. Similarly, the inhibition effect of contraception is highest on urban areas, Kampala (the political capital city of Uganda), and women with secondary and higher education according to the study conducted based on DHS data of Uganda (34). Another aligning result was observed in studies done in Ethiopia that the reduction effect of contraception is higher on women in urban residence, Addis Ababa, women with secondary and higher education (36, 41). A different finding was observed in the study conducted in India that the reduction effect of contraception is highest in the age group 30-39 (30). The reason for this finding can be the reason that contraception use is highest among women in this age group in India. This finding implies that access to family planning, knowledge and practice about family planning, and information on family planning is higher in urban settings, Addis Ababa, and in women with higher education. The higher effect on women in the age group 25-29 implies that marital and extramarital contraception use is higher among women in the age group 25-29.

The findings showing the trends in fertility inhibition effect of contraception shows a remarkable increment in reducing fertility levels from 2000 to 2016 while the reduction effects of other proximate determinants remain the same and even decline. There was significant increment in the reduction effect of contraception among women in rural residence, Tigray region, Amhara region, Oromia region, women with no education, primary education and women in all groups of reproductive age. This implies that the age at marriage is becoming later among women with some characteristics, average postpartum abstinence and amenorrhea are becoming lower while

contraception use is majorly contributing to the reduction of fertility level. Similar findings indicated that major fertility decline in countries like Mali is due to high contraceptive use. The other finding in this study shows that fertility in countries like Ukraine is low but there is moderate use of contraception (16). The other study in Jordan also finds that the contraceptive reduction effect decreased from 2012 to 2017 while TFR is also declining (39). This variation can be explained by the high induced abortion rate and the contribution of induced abortion in countries like Ukraine and Jordan, furthermore the rational for family planning programs in countries like Ukraine don't include demographic rational as the population policy of the country aims to increase fertility whereas the government of Ethiopia has a population policy aimed to lower fertility, adopted global commitments such as FP 2030, developed national plans, strategies, guidelines and implemented programs such as HEP and women development armies. Evidences showed the implication that HEP increased utilization of family planning across women including adolescents compared to the standard service modalities in urban areas (70, 71).

The finding of this study on the third proximate determinant shows that the percent reduction due to postpartum infecundity is 48%, 43%, 43%, and 42% in survey years 2000, 2005, 2011, and 2016. This finding is supported by the studies done in Ethiopia (36, 41). Different findings were observed in the study done in India and Jordan where postpartum infecundity inhibited fertility by 16.4% in India and by only 4% in Jordan (30, 39). The variation can be because the average duration of postpartum amenorrhea among women in India and Jordan is shorter than women in Ethiopia. Breastfeeding in Ethiopia is almost universal and exclusive breastfeeding has also increased over the years which could have contributed to the higher fertility inhibition effect of postpartum infecundity in our country. Hence this finding implies that the median duration of postpartum amenorrhea and abstinence is becoming lower.

The contribution of postpartum infecundity to the reduction of fertility level is higher among women in rural settings, women with no education, and women in the age group 30-49 years. The finding of the study done in India aligns with this finding showing that the fertility inhibition effect of postpartum infecundity is higher in rural settings, women with the lowest level of education (30). Another similar finding was observed in the study done in Uganda where the inhibition effect is higher on rural women and women with no education (34). However different finding was observed in the study done in India where the reduction effect is higher on women in the age group

25-29 (30). This variation can be due to the reason that in India average duration of postpartum insusceptibility is longer in women in the age group 25-29 while the average duration is longer in women in the age group 30-34 in Ethiopia. Studies done in Ethiopia also support the findings showing that the reduction effect is higher on women in rural areas and women with no education (36, 41). This finding implies that women in rural settings, women with no education, and women in the age group 30-49 have a longer duration of postpartum insusceptibility, the duration can be long due to factors such as the absence of school and job commitments which are less among women in rural women, women with no education and women in the age group 30-34. The other implication is in Ethiopia post-partum breast feeding is majorly contributing for fertility reduction in contexts such us rural residence, no education and older age of reproductive age where contraception prevalence is very low (72).

Findings of this study indicated that Percent reduction due to induced abortion is 0.61 in the years closer to 2011 and 0.73 in the years closer to 2016 where its effect is higher on urban women, Addis Ababa and women in age group 15-19. Similar finding was observed on the study conducted in Vietnam showing that induced abortion is common on urban settings and there is strong association between age group and 15-19 and induced abortion (73). The study in India where the reduction effect of induced abortion is higher on urban women while the effect is higher on women in age group 40-44 (30). This can be explained by the reason that majority of women in India seek abortion service to limit family size (74). The finding implies that in Ethiopia abortion is common among young women due to the legal grounds and there is unmet need of contraception among adolescents (75).

This study also examined the most contributing determinants affecting fertility in Ethiopia, over the years 2000-2016, the associations between the majority of the determinant categories and fertility did not significantly change over the years as the confidence intervals for the categories overlap, hence the findings from the survey year 2016 showing the recent figure for the contribution of these determinants are discussed. The findings show that in Ethiopia children ever born ranges from 0 to 14 while the mean number of children ever born is 2.63 with a standard deviation of 2.84. This aligns with the finding of the study based on DHS data on Burundi where the mean number of children ever born is 2.7 with a standard deviation of 2.8 (33). According to the findings of this study, the mean CEB across age groups of women of reproductive age

significantly increases as women get to older reproductive age groups for all survey years, while assessing the change in the average number of children ever born by age groups over time there is a significant increase in mean children ever born among women in age group 25-29 from 2000 to 2005 and there is a significant decline in mean children ever born among women in age group 40-44 from 2000 to 2005 and 2011 to 2016. Another significant decline in mean children ever born was witnessed among women in age group 45-49 from 2011 to 2016. This finding is supported by findings of studies conducted in Rwanda and Burundi showing that the mean children ever born are higher for women in late reproductive age groups (33, 76). This finding implies that in Ethiopia the focus of family planning programs is birth spacing or delaying rather than birth limiting and permanent contraceptive methods shall be expanded.

Determinants such as rural residence, living in Somali region, women with no education, Muslim women, and age of women have significantly stronger positive associations with having a higher number of children. Living in a rural residence has a greater risk of having a higher number of children, this finding is supported by studies done in Burundi, Ghana, Rwanda, Nigeria, and Ethiopia indicating that women who reside in rural settings have more risk of having a greater number of children (33, 44, 50, 58, 76). The program and policy implication for this finding is that women in rural settings have lower access to family planning and knowledge regarding family planning suggesting that the government of Ethiopia shall intervene to strengthen addressing the unmet needs of women in rural settings and ensure the effectiveness of family planning programs.

The finding that fertility is higher in the Muslim religion is also supported by the findings of the study in Nigeria showing that the Muslim religion category is associated with a high level of fertility (58) which might be related to polygamy among Muslims and the fighting of co-wives to have more births and more male children since women in this community are less entitled to property rights. Inconsistent findings with this study were observed in studies done in Ghana indicating that high fertility is associated with Traditional religious groups and Burundi showing that fertility is higher among protestants (33, 44). The non-significant finding that women with protestant, other and Catholic religion have risk of having greater number of children implies that among the topics addressed by family planning programs and population policy much has to be done on social marketing to address communities with various socio-cultural beliefs and equity in provision of contraception (69).

The result of this study shows that a lower level of education is associated with having a higher number of children, women with no education have a greater chance of having a higher number of children. Results aligning with this finding were yielded on the studies done in Burundi, Ethiopia, Ghana, Nigeria, and Rwanda showing that a higher level of education among women is associated with a lower level number of children and women with lower level of education have greater risk of having greater number of children (33, 44, 50, 55, 58). This finding implies that educated women tend to control their fertility than uneducated women and educated women have better decision-making on reproductive health behaviors hence educating women and increasing school enrolment is crucial in reducing fertility.

According to the findings of the study one unit increase in age of women is associated with having a higher number of children. Similarly, the studies done in Rwanda, Nigeria, Ghana, and Ethiopia indicated that as the age of women increases the risk of both having a higher number of children and the desire for more children become higher(44, 50, 55, 58). This finding implies that family planning decisions and fertility preferences were low on older women.

In this study employment is negatively associated with having a higher number of children, employed women tend to have a lower number of children than unemployed women, this finding is supported by studies done in England showing that female unemployment increases the risk of high fertility (48) and study done in Senegal indicating that female employment reduces fertility (49). This result implies that employed women have better decision-making about family planning and better knowledge, attitude, and access to services and unemployed women perceive flexible time for maternity and parental responsibilities there should be multisectoral collaboration to foster women's empowerment in employment.

7. STRENGTH AND LIMITATION OF THE STUDY

A. STRENGTHS

- The study used EDHS data sets with a large sample size increasing the validity of results.
- The analysis is guided by a standard fertility determinants framework
- The study utilized a series of DHS surveys to assess the impact of innovative programs such as the HEP.

B. LIMITATIONS

- The primary data may have recall bias for variables requesting retrospective information.
- Causality cannot be established due to the cross-sectional nature of the design
- Samples might be inadequate for certain disaggregation since the sample size is made adequate by residence type and region only.

8. CONCLUSION AND RECOMMENDATION

A. CONCLUSION

The overall findings of this study indicated that the proximate determinants of fertility in Ethiopia vary by selected background characteristics and over time. The contribution of delayed marriage and marital instability to reduce fertility from its natural level nationally is declining over time and it is higher among urban settings, women in Addis Ababa, women with secondary education, and women in the age group 15-19. The fertility reduction effect of contraception nationally has remarkably increased over the past four rounds of surveys while the effect is higher among women in urban areas, Addis Ababa, women with higher education, women in the age group 25-29, 20-24 and 25-29 for survey years 2005, 2011 and 2016. The percent contribution of postpartum infecundity in reducing fertility nationally has been declining over the years. The effect is higher in rural areas, Gambella region, women with no education, and women in the age group 30-49. The fertility inhibition effect of induced abortion had the least contribution to reducing fertility compared with other proximate determinants. However, its impact in reducing fertility from its natural level has increased between 2011 and 2016 while it has the greatest effect on urban areas, Addis Ababa, and among women in the age group of 15-19. Generally, the effect of contraception is majorly contributing to inhibiting fertility while the effects of other proximate determinants decline over time. The mean number of children ever born is 2.63 with SD of 2.84 in Ethiopia while Mean children ever born increases as the age group of women increases while the mean completed fertility level among women aged 45-49 is 6.13 which is still very high. Over the past four surveys mean children ever born increased across older reproductive age groups. Women in rural residences, women residing in the Somali region, Muslim women, and women with no education have a stronger positive relationship with having a higher number of children, age of women also has a positive relationship with having high fertility, while employment has a negative association with having a higher number of children.

B. RECOMMENDATIONS FOR POLICYMAKERS AND PROGRAM MANAGERS

- Strengthen family planning program effectiveness by shifting approaches to address groups of women with rural residence, younger age groups, and women with no education, and foster data driven monitoring and evaluation of family planning programs such as the Health Extension Program that address women in areas of minorities.
- Ensure equity in distribution of access and services of family planning over the geographical distributions of the country.
- Adopt multiple approaches in addressing unmet needs of women by incorporating social and religious leaders and stakeholders.
- Create Economic opportunities, encourage women startups, and invest in the education and skill development of women through multi-sectoral collaboration.
- Create enquiry and experience sharing programs about productive fertility reduction strategies and promote embedding the strategies into local contexts

C. RECOMMENDATIONS FOR FUTURE RESEARCHERS

- Consider cross-national comparative studies to assess the similarities and differences in the patterns of the trends in effect of proximate determinants of fertility across different countries.
- Conduct cross-country policy analysis studies assessing the influence of various national policies over determinants of fertility.
- Executing researches targeted on high fertility contexts shall be considered by incorporating multiple research approaches (qualitative and quantitative) to trace the detailed understanding of the factors behind.

9. REFERRENCES

1. Ayele DG. Determinants of fertility in Ethiopia. Afr Health Sci. 2015;15(2):546-51.
2. United Nations Economic and Social Affairs. World Family Planning 2022: Meeting the Changing Needs for Family Planning: Contraceptive Use by Age and Method: UN; 2023 [Available from: https://books.google.com.et/books?id=h0rDzwEACAAJ.
3. United Nations Economic and Social Affairs. World Population Policies 2021: Policies Related to Fertility: UN; 2023 [Available from: https://books.google.com.et/books?id=Hl7EzwEACAAJ.
4. Ouedraogo L, Habonimana D, Nkurunziza T, Chilanga A, Hayfa E, Fatim T, et al. Towards achieving the family planning targets in the African region: a rapid review of task sharing policies. Reproductive Health. 2021;18(1).
5. Priminister Ofice Ethiopia. National Population Policy of Ethiopia Ethiopia: Ethiopian Office Of Primninster 1993 [Available from: https://books.google.com.et/books?id=geqCah9Pw-UC.
6. Federal Democratic Republic of Ethiopia Ministry of Health. National reproductive health strategic plan 2021-25 Ethiopia2021 [Available from: https://platform.who.int/docs/default-source/mca-documents/srh-policy-documents/eth-reproductive_health_strategic_plan_2021-2025.pdf.
7. United States Agency for Improved Development Africa EFMOH, Malawi Ministry Of Health, Rwanda Ministry Of Health,. Three sucessful Sub-Saharan Africa Family Planning Programs: Lessons for meeting the MDGs 2012 [Available from: https://pdf.usaid.gov/pdf_docs/PA00HQSV.pdf.
8. Central Statstical Authority and ORC Macro. Ethiopian demographic and health survey 2000. Report. Addis Ababa, Ethiopia and Calverton Maryland, USA; 2001.
9. Central Statistical Autority and ORC. Ethiopia Demographic Health Survey 2005. Addia Ababa , Ethiopia and Calverton, Maryland, USA; 2006.
10. Central Statistical Authority and ORC Macro. Ethiopian demographic and health survey 2011. Addis Ababa Ethiopia annd Calverton, Maryland, USA; 2012.
11. Central Statstical Agency (CSA) and ICF. Ethiopian demographic and health survey 2016. . Addis Ababa, Ethiopia, and Rockvile, Maryland USA; 2016.

12. United Nations Department of Economic and Social Affairs. Population Division (2020). World Fertility and Family

Planning 2020 2020 [Available from: https://www.un.org/en/development/desa/population/publications/pdf/family/World_Fertility_and_Family_Planning_2020_Highlights.pdf.

13. Bongaarts J. Modeling the fertility impact of the proximate determinants: Time for a tune-up. Demographic Research. 2015;33:535-60.

14. United Nations Department of Economic and Social Affairs. Prospects for Fertility Decline

in High Fertility Countries 2007 [Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Jan/un_2002_population_bulletin_46-47.pdf.

15. United Nations Department of Economic and Social Affairs Population Division. Population Division (2021). World Population

Policies 2021: Policies related to fertility 2021 [Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2021_wpp-fertility_policies.pdf.

16. Stover J, Winfrey W. The effects of family planning and other factors on fertility, abortion, miscarriage, and stillbirths in the Spectrum model. BMC Public Health. 2017;17(Suppl 4):775.

17. Sonneveldt E, DeCormier Plosky W, Stover J. Linking high parity and maternal and child mortality: what is the impact of lower health services coverage among higher order births? BMC Public Health. 2013;13 Suppl 3(Suppl 3):S7.

18. Ahmed S, Li Q, Liu L, Tsui AO. Maternal deaths averted by contraceptive use: an analysis of 172 countries. Lancet. 2012;380(9837):111-25.

19. Cheng H, Luo W, Si S, Xin X, Peng Z, Zhou H, et al. Global trends in total fertility rate and its relation to national wealth, life expectancy and female education. BMC Public Health. 2022;22(1):1346.

20. United Nations Economic and Social Affairs. World Fertility and Family Planning 2020: Highlights: UN; 2021 [Available from: https://books.google.com.et/books?id=1OAkzgEACAAJ.

21. Tesfa D, Tiruneh SA, Gebremariam AD, Azanaw MM, Engidaw MT, Kefale B, et al. The pooled estimate of the total fertility rate in sub-Saharan Africa using recent (2010-2018) Demographic and Health Survey data. Front Public Health. 2022;10:1053302.

22. Henry L. Some data on natural fertility. Eugenics Quarterly. 1961;8(2):81-91.

23. Coale AJ. The development of new models of nuptiality and fertility. Population. 1977:131-54.

24. Coale AJ, Trussell TJ. Model fertility schedules: variations in the age structure of childbearing in human populations. Popul Index. 1974;40(2):185-258.

25. Page HJ. Patterns underlying fertility schedules: A decomposition by both age and marriage duration. Popul Stud (Camb). 1977;31(1):85-106.

26. Brass W, CELADE. Methods for Estimating Fertility and Mortality from Limited and Defective Data: Based on Seminars Held 16-24 September 1971 at the Centro Latinoamericano de Demografía (CELADE) San José, Costa Rica: International Program of Laboratories for Population Statistics, Department of Biostatistics, School of Public Health, Carolina Population Center, University of North Carolina at Chapel Hill; 1975.

27. Schmertmann C. A system of model fertility schedules with graphically intuitive parameters. Demographic Research. 2003;9(5):81-110.

28. Liu DH, Raftery AE. How Do Education and Family Planning Accelerate Fertility Decline? Popul Dev Rev. 2020;46(3):409-41.

29. Gotmark F, Andersson M. Human fertility in relation to education, economy, religion, contraception, and family planning programs. BMC Public Health. 2020;20(1):265.

30. Singh S, Shekhar C, Bankole A, Acharya R, Audam S, Akinade T. Key drivers of fertility levels and differentials in India, at the national, state and population subgroup levels, 2015-2016: An application of Bongaarts' proximate determinants model. PLoS One. 2022;17(2):e0263532.

31. Garenne M. Family Planning and Fertility Decline in Africa: From 1950 to 2010. In Z. Amarin (ed.), Family Planning, -. InTechOpen, London,. (2018);Chapter 7, :p 119.

32. Abdelghany A, El Abbbasy AM, El Shabrawy A. Structural equations modelling to quantify the effect of direct and intermediate factors on fertility changes in Egypt during 2000-2014. East Mediterr Health J. 2020;26(10):1210-7.

33. Jean Claude Nibaruta NE, Mohamed Chahboune, Milouda Chebabe, Saad Elmadani, , Abdellatif Baali HA. Determinants of fertility differentials in Burundi:

evidence from the 2016-17 Burundi demographic and

health survey. 2021.

34. Rutaremwa G, Galande J, Nviiri HL, Akiror E, Jhamba T. The contribution of contraception, marriage and postpartum insusceptibility to fertility levels in Uganda: an application of the aggregate fertility model. Fertil Res Pract. 2015;1:16.

35. Ahmed Shallo S. Roles of Proximate Determinants of Fertility in Recent Fertility Decline in Ethiopia: Application of the Revised Bongaarts Model. Open Access J Contracept. 2020;11:33-41.

36. Laelago T, Habtu Y, Yohannes S. Proximate determinants of fertility in Ethiopia; an application of revised Bongaarts model. Reprod Health. 2019;16(1):13.

37. Shiferaw S, Abdullah M, Mekonnen Y, Maiga A, Akinyemi A, Amouzou A, et al. Trends in contraceptive use and distribution of births with demographic risk factors in Ethiopia: a sub-national analysis. Glob Health Action. 2015;8:29720.

38. Majumder N, Ram F. Explaining the role of proximate determinants on fertility decline among poor and non-poor in Asian countries. PLoS One. 2015;10(2):e0115441.

39. Bietsch K, Arbaji A, Mason J, Rosenberg R, Al Ouri M. Shifting dynamics: Changes in the relationship between total fertility rate and contraceptive prevalence rate in Jordan between 2012 and 2017. Gates Open Res. 2020;4:160.

40. Finlay JE, Mejia-Guevara I, Akachi Y. Inequality in total fertility rates and the proximate determinants of fertility in 21 sub-Saharan African countries. PLoS One. 2018;13(9):e0203344.

41. Ahmed Shallo S. Roles of Proximate Determinants of Fertility in Recent Fertility Decline in Ethiopia: Application of the Revised Bongaarts Model</p>. Open Access Journal of Contraception. 2020;Volume 11:33-41.

42. Kiser H, Hossain MA. Estimation of number of ever born children using zero truncated count model: evidence from Bangladesh Demographic and Health Survey. Health Inf Sci Syst. 2019;7(1):3.

43. Rahman A, Hossain Z, Rahman ML, Kabir E. Determinants of children ever born among ever-married women in Bangladesh: evidence from the Demographic and Health Survey 2017-2018. BMJ Open. 2022;12(6):e055223.

44. Nyarko SH. Socioeconomic determinants of cumulative fertility in Ghana. PLoS One. 2021;16(6):e0252519.

45. Matovu JK, Makumbi F, Wanyenze RK, Serwadda D. Determinants of fertility desire among married or cohabiting individuals in Rakai, Uganda: a cross-sectional study. Reprod Health. 2017;14(1):2.

46. Cherie N, Getacher L, Belay A, Gultie T, Mekuria A, Sileshi S, et al. Modeling on number of children ever born and its determinants among married women of reproductive age in Ethiopia: A Poisson regression analysis. Heliyon. 2023;9(3):e13948.

47. Behrman J, Gonalons-Pons P. Women's employment and fertility in a global perspective (1960-2015). Demogr Res. 2020;43:707-44.

48. Aksoy CG. The Effects of Unemployment on Fertility: Evidence from England. The BE Journal of Economic Analysis & Policy. 2016;16(2):1123-46.

49. Van den Broeck G, Maertens M. Female employment reduces fertility in rural Senegal. PLoS One. 2015;10(3):e0122086.

50. Muluneh MW, Moyehodie YA. Determinants of desire for more children among women in Ethiopia. BMC Womens Health. 2021;21(1):408.

51. Lal S, Singh R, Makun K, Chand N, Khan M. Socio-economic and demographic determinants of fertility in six selected Pacific Island Countries: An empirical study. PLoS One. 2021;16(9):e0257570.

52. Sheikh SM, Loney T. Is Educating Girls the Best Investment for South Asia? Association Between Female Education and Fertility Choices in South Asia: A Systematic Review of the Literature. Front Public Health. 2018;6:172.

53. Bongaarts J. Trends in fertility and fertility preferences in sub-Saharan Africa: the roles of education and family planning programs. Genus. 2020;76(1).

54. Audi M, Ali A. A Causality and Co-integration Analysis of Some Selected Socio-Economic Determinants of Fertility: Empirics from Tunisia. Bulletin of Business and Economics (BBE). 2015;5(1):20-36.

55. Ndahindwa V, Kamanzi C, Semakula M, Abalikumwe F, Hedt-Gauthier B, Thomson DR. Determinants of fertility in Rwanda in the context of a fertility transition: a secondary analysis of the 2010 Demographic and Health Survey. Reprod Health. 2014;11:87.

56. Khan JR, Bari W, Latif AH. Erratum to: Trend of determinants of birth interval dynamics in Bangladesh. BMC Public Health. 2016;16(1):1088.

57. Jafari H, Jaafaripooyan E, Vedadhir AA, Foroushani AR, Ahadinejad B, Pourreza A. Socio-Economic Factors Influencing on Total Fertility Rate in Iran: A Panel Data Analysis for the Period of 2002-2012. Electron Physician. 2016;8(6):2551-6.

58. Mberu BU, Reed HE. Understanding Subgroup Fertility Differentials in Nigeria. Popul Rev. 2014;53(2):23-46.

59. Adhikari R. Demographic, socio-economic, and cultural factors affecting fertility differentials in Nepal. BMC Pregnancy and Childbirth. 2010;10(1):19.

60. Federal Ministry of Health. National health sector transformation plan 2021 [Available from: https://extranet.who.int/countryplanningcycles/planning-cycle-files/health-sector-transformation-plan-ii-hstp-ii-202021-202425.

61. Ashenif Tadele HSRD, Ethiopian Public Health Institute, Addis Ababa, Ethiopia, Tefera Taddele HSRD, Ethiopian Public Health Institute, Addis Ababa, Ethiopia , Shegaw Mulu P, Plan, Monitoring & Evaluation Directorate, Ministry of Health, Addis Ababa, Ethiopia, Tamrat Awel P, Plan, Monitoring & Evaluation Directorate, Ministry of Health, Addis Ababa, Ethiopia, Tsedeke Mathewos Rs, Global Financing Facility, Addis Ababa, Ethiopia , Dessalegn Melesse (PhD) CtfWs, Children's and Adolescents' Health /University of , et al. National and subnational coverage and other service statistics for reproductive, maternal, newborn and child

health using health facility data and surveys 2022 [Available from: https://www.countdown2030.org/publications/child-health-category/national-and-subnational-coverage-and-other-service-statistics-for-reproductive-maternal-newborn-and-child-health-using-health-facility-data-and-surveys-in-ethiopia.

62. Bongaarts J. A simple method for estimating the contraceptive prevalence required to reach a fertility target. Stud Fam Plann. 1984;15(4):184-90.

63. Singh S, Fetters T, Gebreselassie H, Abdella A, Gebrehiwot Y, Kumbi S, et al. The estimated incidence of induced abortion in Ethiopia, 2008. Int Perspect Sex Reprod Health. 2010;36(1):16-25.

64. Moore AM, Gebrehiwot Y, Fetters T, Wado YD, Bankole A, Singh S, et al. The Estimated Incidence of Induced Abortion in Ethiopia, 2014: Changes in the Provision of Services Since 2008. Int Perspect Sex Reprod Health. 2016;42(3):111-20.

65. Yang S, Berdine G. Poisson Regression. The Southwest Respiratory and Critical Care Chronicles. 2015;3:61.

66. Young D, Roemmele E, Yeh P. Zero-inflated modeling part I: Traditional zero-inflated count regression models, their applications, and computational tools. WIREs Computational Statistics. 2020;14.

67. National Health Mission. Annual report 2015-2016 - Family Planning [Available from: https://nhm.gov.in/images/pdf/programmes/family-planing/annual-report/annual-report-fp-division-2015-16.pdf.

68. Family Health International. The status of Family Planning in India: An Introduction [Available from: https://www.fhi360.org/wp-content/uploads/drupal/documents/india1-family-planning-status.pdf.

69. Hellwig F, Moreira LR, Silveira MF, Vieira CS, Rios-Quituizaca PB, Masabanda M, et al. Policies for expanding family planning coverage: lessons from five successful countries. Frontiers in Public Health. 2024;12.

70. Thomas J. Bossert DMB, Asta M. Kenney, Laurentiu M. Stan, Anthony A. Hudgins, . The Rationale for

Family Planning in Ukraine:

Evidence from Europe, Eurasia and the US

2007 [Available from: https://www.hsph.harvard.edu/international-health-systems-program/wp-content/uploads/sites/1989/2020/04/AdvocacyPackage-FINAL-FINAL_eng.pdf.

71. Addisie M, Nega A, Tassew B, Assefa D, Siraw D, Tebekaw Y, et al. Degree of adherence of the urban health extension service delivery process to the standards set nationally. The Ethiopian Journal of Health Development. 2020;34(2).

72. Mekonnen W, Worku A. Levels and proximate determinants of fertility in Butajira District South Central Ethiopia. Ethiopian Journal of Health Development. 2011;25:184-91.

73. Ha NT, Giang DT, Ha DH, Thuong PH, Dat DT, Ngoc NB, et al. Knowledge, Attitudes and Practices on Reproductive Health Among Abortion Adolescents in Vietnam. Med Arch. 2024;78(2):139-45.

74. Stillman M. Abortion in India

Guttmacher Institute. 2014.

75. Sully E, Dibaba Y, Fetters T, Blades N, Bankole A. Playing it Safe: Legal and Clandestine Abortions Among Adolescents in Ethiopia 2018 [updated Jun; cited Conflicts of Interest:The authors do not have financial relationships with any organizations that might have an interest in the submitted work. They have no other relationships or activities that could influence or appear to have influenced the submitted work. PMC6166408]. 20180314:[729-36]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29550154.

76. Vedaste Ndahindwa1* CK, MS, FA, , Bethany Hedt-Gauthier1, 5 and Dana R Thomson1,5. Determinants of fertility in Rwanda in the context

of a fertility transition: a secondary analysis of the

2010 Demographic and Health Survey. 2014.

10.ANNEX

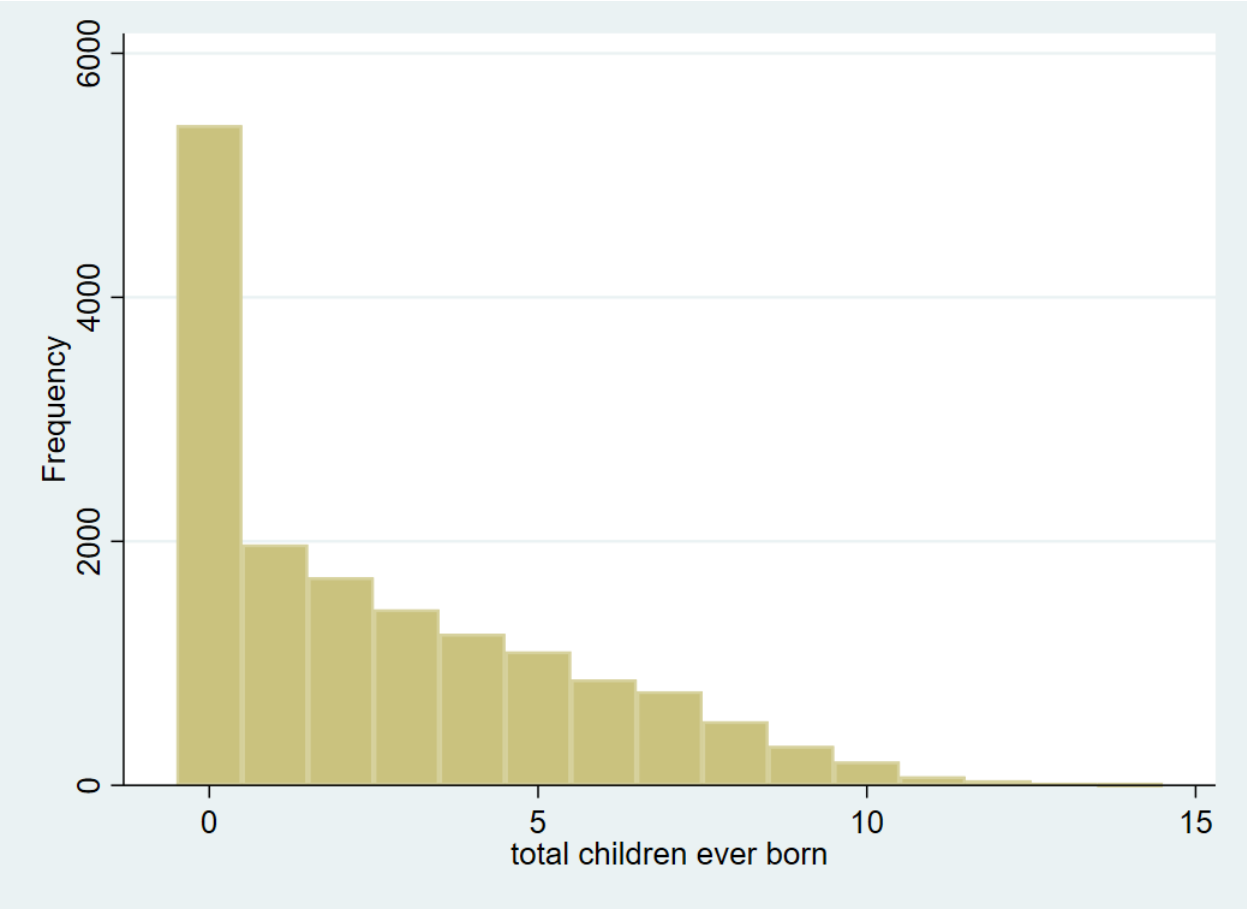

Figure 17: - The distribution of total Children Ever Born in Ethiopia, 2016 (11)

Declaration

ASSURANCE OF PRINCIPAL INVESTIGATOR

I, the undersigned, declare that this is my original work, has never been presented in this or any other university and all the people and institutions who gave support for this thesis work are fully acknowledged.

Name of the student: _____

Date _____ Signature _____

APPROVAL OF THE PRIMARY ADVISOR

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

Name of the primary advisor: _____

Date _____ Signature _____