DEBRE BERHAN UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

POST GRADUATE STUDIES

DEPARTMENT OF STATISTICS

FERTILITY DIFFERENTIALS: THE CASE OF SOMALIA REGION, EASTEREN ETHIOPIA: APPLICATION OF COUNT REGRESSION MODELS

By:

WUBAYIEHU BANTE

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF DEBRE BERHAN UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THEDEGREE OF SCIENCE IN STATISTICS (BIOSTATISTICS)

JUNE, 2021

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DECLARATION

I, the undersigned, declare that the thesis is my original work, has not been presented for degrees in any other University and all sources of materials used for the thesis have been duly acknowledged.

Name: Wubayiehu Bante

Signature __________

This thesis has been submitted for examination with my approval as a University advisor

Dr.A.R.Murali Dharan __________ __________

Name of advisor Signature Date

APPROVAL SHEET

We, the undersigned member of the broad examiners of the final open defines by **Wubayiehu Bante** have read and evaluated her thesis entitled "**Fertility Differentials: The Case of Somalia Region, Eastern Ethiopia: Application of Count Regression Models**" and examined the candidate. This is therefore to certify the thesis has been accepted in partial fulfilment of the requirement for the degree of master of sciences in statistics with specialization of biostatistics.

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Final approval and acceptance of the thesis is contingent up on the submission of the thesis of the final copy of the thesis to the college of graduate studies (CGS) through the department of graduate committee (DGC) of the candidate's

Stamp of CGS

Date--------------------

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LIST OF ABBREVIATIONS

AIC	Akakie Information Criteria
AIC	Bayesian Information Criteria
CSA	Central Statistical Agency
CEB	Children Ever-Born
DF	Degree of Freedom
EA	Enumeration area
EDHS	Ethiopian Demographic and Health Survey
FFS	Family Fertility Survey
GLM	Generalized Linear Model
IRR	Incidence Rate Ratio
LRT	Likelihood Ratio Test
NB	Negative Binomial
OCHA	Office for the Coordination of Humanitarian Affairs
PRB	Population Reference Bureau
SE	Standard Error
TFR	Total Fertility Rate
TVET	Technical Educational Vocational Training
UN	United state
UN DESA	United Nations Department of Economic and Social Affairs
USA	United States of America

ABSTRACT

Fertility is defined as the ability to conceive and bears children. It is one of the major components of population growth and age structure change globally fertility. Total fertility rate globally decreasing but in sub Saharan African countries still were increasing. Although there is a significant reduction in Ethiopia over the past decades, but in Somali region of Ethiopia the fertility still high. To assess the determinants of fertility in Somalia region, Eastern Ethiopia by count regression model. A community based-cross sectional study was conducted.1, 391 eligible women were from Somalia region of Ethiopia. Among thus, 1,002 are gave live birth in their life time. This study was undertaken using secondary data from the Ethiopian demographic and health surveys 2016 dataset, which was collected by Central statistical agency of Ethiopia from January 18 to June 27, 2016.data analysis, was done by using count regression model. In this study fertility was treated as count data and determinants of high fertility including the socio-economic and demographic variables were assessed using counted data analysis models. The variance (8.195) is higher than mean of child ever born per mother (5.08) and the counted data has no zero value. This is an indication for over dispersion. In this study zero truncated negative binomial better fits the data. The result showed that, the variables like; current age of mothers ,age of mother at first birth, place of residence, number of house hold members, number of died children for both sex, religion, mother education level had significant factors on child ever born fertility. Factors that was high effect on fertility for Somali region, Ethiopia were, mothers first birth is in girl hood age, give birth until natural suspension, their religion, most mothers were uneducated, their residence, intent to increase their household members and high number of dead children in the region were factors to high number of child ever born. By using Zero truncated negative binomial mode.

Keywords: Fertility, child ever born, Ethiopian demographic health survey, Somalia region of Ethiopia, zero truncated negative binomial.

1. INTRODUCTION

1.1. Background

Fertility is defined as the ability to conceive and bears children. It is one of the major components of population growth and age structure change (CSA, 2016). The global total fertility rate trend ranges from 4.4 births in 1970-75 to 2.5 in 2005-2010, and further projected to be 2.4 births by the year 2025-2030 (UN, 2013). The current fertility rate for World in 2021 is 2.4 births per woman, a 0.41% decline from 2020 (world population data, 2020). It is the highest fertility level that results in high population growth rate and thereby becomes the impediments to rapid social and economic development. On the other hand, declining population growth rate is the consequence of low fertility and low fertility level, which are the results of modernization and developments (Lehohla, 2014).

According to the 2020 world population data sheet report currently, the world population is estimated to 7.8 billion and projected to increase 8.5, 9.9 and 11.2 billion in 2030, 2050 and 2100 respectively. The World Population Data Sheet is released annually by the Population Reference Bureau (PRB) and the 2020 edition tracks 24 population indicators for more than 200 countries and territories (world population data, 2020).

In the past few decades have witnessed that there is a major decline in world fertility though global and regional aggregates that mask widespread diversity in fertility change (UN, 2014). However, the 2020 World Population Data Sheet revealed that many sub-Saharan Africa and some in Asia countries experienced rapid population growth and high fertility rates (world population data, 2020). The average total fertility rate for sub-Saharan Africa is more than five (5.1) children per women, which is a little bit higher than twice of that of the global average of 2.4 (PRB, 2011), DCs have fertility levels below replacement (1.6) (PRB, 2012).

Most of the projected increase in the world's population can be attributed to a short list of high-fertility countries, mainly in Africa, or countries with already large populations. During 2015-2050, half of the world's population growth is expected to be concentrated in nine countries: India, Nigeria, Pakistan, Democratic Republic of the Congo, Ethiopia, United Republic of

Tanzania, United States of America (USA), Indonesia and Uganda, listed according to the size of their contribution to the total growth (World Population Prospects, 2015 Revision).

The fertility rate of Ethiopia declined gradually from 7.02 children per woman in 1971 to 4.05 children per woman in 2020.Ethiopia, like most countries in sub-Saharan Africa, are characterized by rapid population growth, which is influenced by a high level of fertility. Ethiopia (The current population of Ethiopia is 116,987,437 as of Sunday, March 21, 2021, based on (Worldo- meter elaboration of the latest United Nations data) is the second populace country in Africa next to Nigeria. According to PRB's estimation, by 2050 Ethiopia will have a total population of 166 million and ranks the tenth most populous country in the world (PRB, 2012).

According to the 2016 (EDHS) the TFR has declined in Ethiopia over time, from 5.5 children per woman in 2000 to 4.6 children per woman in 2016, a decrease of 0.9 children but in Somalia region is the highest (7.2) and Addis Ababa is the lowest (1.8) total fertility rate of children per women (EDHS, 2016). Henceforth, the purpose of this study is to investigate the socio-economic and demographic factors that influence fertility level in Somalia using the 2016 EDHS data.

1.2. Statement of the Problem

Overpopulation is one of the most basic causes of underdevelopment in developing countries, which are already facing shortage of resources. In rapidly increasing population, the resources available per person are reduced further, leading to increased poverty, malnutrition, and other large population related problems. The relation between population growth and socio-economic and demographic factors has linkages. That is, fertility behavior influences population growth, which has consequences on resources, employment situation, health and other social facilities and saving and investment. In turn, such consequences have great bearing on socio-economic variables that affect fertility behavior (Kidus, 2012).

Even though there are some studies that address the fertility differentials, all of them exclude variables like; income/wealth, marital status, household size, desire for children, contraceptive use and intension, knowledge of any method, visited in last twelve months by fieldworkers, fertility preference and number of dead children. And, the scopes of previously conducted studies that address the determinants of fertility are limited in Ethiopia were limited to specific areas and regional level studies are spares, especially in Somalia region. Particularly there is a dearth of evidence in Somalia region. As, the four consecutive EDHS of Ethiopia consistently reported that the weighted TFR of Somali region has been 5.7, 6.0, 7.1 and 7.2 in EDHS 2000, 2005, 2011 and 2016 respectively (CSA, 2001; CSA, 2005, CSA, 2012 and CSA, 2016). Almost all previously conducted studies dichotomize fertility and use logistic regression that results in data shrinkage and loss of data(kidus ,2012),and in other study the inclusion of only married women's(Eyasu, 2015).

This study provides the analysis of examine whether the fertility is high and which factors (socio-economic and demographic factors) are associated with fertility level using an appropriate count regression model. Since the dependent variable (fertility , children ever born) is count data it was analyzed using count data analysis method by including all women's with age 15-49 who are born at least one in their life time of Somalia region, Ethiopia and by including variables that were not addressed in the previous studies. Therefore this study was aimed to identify determinants of fertility level in Somalia region of Ethiopia.

Research Questions

- What is the average or mean fertility level in the study area in terms of children ever born?
- What are the socio-economic and demographic factors that influence fertility in the study area, and to what extent?

1.3. Objective of the Study

1.3.1. General Objective

To assess the determinants of fertility in the case of Somalia region, Eastern Ethiopia by using count regression models.

1.3.2. Specific Objectives

More specifically, the study aspires:

- To identify the determinants of fertility in the case of Somalia region, Eastern Ethiopia
- To determine the level of fertility in the case of Somalia region, Eastern Ethiopia. by fit with appropriate count regression models.

1.4. Significance of the Study

Fertility has to do with a number of socio-economic issues. It is associated with population growth, economic growth and development, poverty, maternal and infant morbidity and mortality. As this study's primary objective was to point out the major socio-economic and demographic factors influencing fertility and measure the level of effects of each factor. Getting reliable information on fertility level and its determinants by using the national data from large study area and population have paramount importance for researchers, policy makers, planners and professionals who are engaged in designing and implementation of plans and strategies related to fertility and development. Moreover, the statistical information and findings of this study was useful for policy making, monitoring and evaluation of fertility oriented activities of the government at different levels. Furthermore, the methods used in this study may serve as a benchmark to scale up or conduct fertility studies in areas of similar setup and/or further similar studies.

2. RELATED LITERATURE REVIEW

Fertility is one of the major components of population growth and age structure change (EDHS, 2016). Since the past few decades a major decline in world fertility has been observed. But global and even regional aggregates mask widespread diversity in fertility change (UN, 2014). The global total fertility rate trend ranges from 4.4 in 1970-75 to 2.5 in 2005-2010, and further projected to be 2.4 by the year 2025-2030 (UN, 2013). The current fertility rate for World in 2021 is 2.438 births per woman, a 0.41% decline from 2020(UN, 2015).

Compositional or individual demographic and socioeconomic factors explained substantial, but not all of the variation. At individual level, the results suggests a significant inversely association of household wealth index, level of education, age at first birth with fertility / children ever born (Chemhaka and Odimegwu, 2020).Demographic studies in the societies, especially where there is little or no use of contraception, show a positive relationship between age and fertility level of women but when there is a good practice of use of contraception fertility and current age may not have direct relationship in Nigeria (Oyefara , 2012).The socioeconomic factors that affect the fertility in Ethiopia include place of residence, education, region, economic status, contraceptive use, age of mother at first birth and current age of mothers (Yayeh and Muluneh, 2015, Eyasu, 2015, Kidus, 2012).

Fertility differences among countries are larger, with some completing the transition to replacement fertility in record time (e.g., China, Hong Kong, Singapore, South Korea), and much of the developing world, over the past four decades reproductive behavior has changed rapidly and the average total fertility rate (TFR) has fallen by half from the traditional six or more to near three today and recently fertility declines have been more rapid than had been expected (UN, 2015). But the average TFR for sub-Saharan Africa is more than five (5.3) children per women which is more than threefold and double of that of more developed countries (1.6 which is below replacement levels of fertility) and the global average of 2.4 (PRB, 2012).

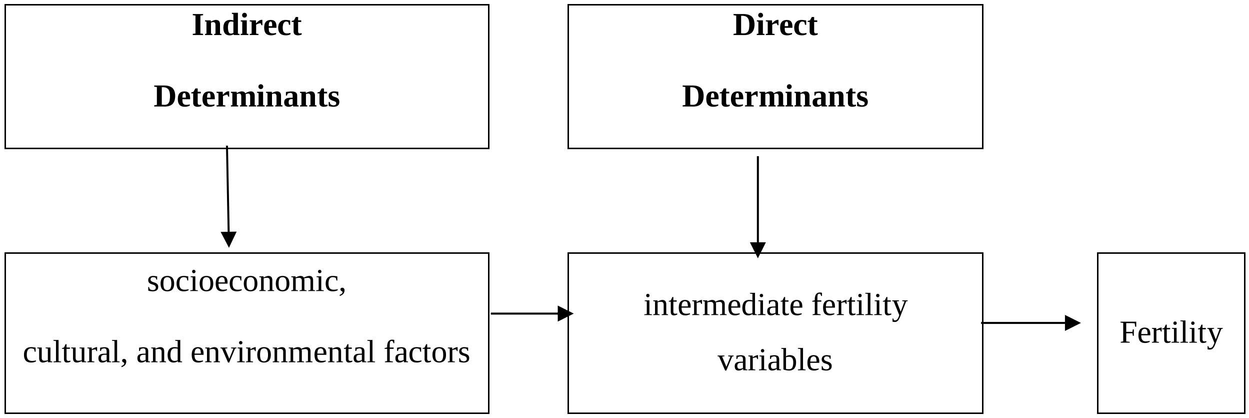
In 2020, fertility rate for Ethiopia was 4.05 children per woman. Fertility rate of Ethiopia fell gradually from 7.02 children per woman in 1971 to 4.05 children per woman in 2020.

Ethiopia like most sub-Saharan countries characterized by rapid population growth which is a result of high of fertility level (EDHS, 2016), many factors have been contributing to this decline. Understanding the factors contributing to the fertility decline and their level of fertility inhibiting effect has a paramount policy implication in any country. This study aimed to assess the contribution of the determinants of fertility, i.e., contraception use, postpartum infecundity, marriage and abortion rate, to fertility decline in Ethiopia since 2005. Many factors have been contributing to this decline (Shallo, 2020). In 2016 EDHS high in Somalia region weighted TFR (7.2) in high fertility level causes high population growth rate and hence becomes the barriers to rapid social and economic development (http://www.statssa.gov.za).this is the implication to study in Somali region.

This study used publicly available data from the Ethiopia Demographic and Health Surveys (EDHS) of 2005, 2011 and 2016. In Ethiopia, the fertility rate declined from 5.4 in 2005 to 4.6 by 2016 and TFR has declined in Ethiopia over time, from 5.5 children per woman in 2000 to 4.6 children per woman in 2016, a decrease of 0.9 children. (EDHS, 2016).

The TFR among women in rural areas declined from 6.0 children in 2000 to 5.2 children in 2016. In urban areas, the TFR declined from 3.0 children in 2000 to 2.3 children in 2016 (EDHS, 2016). Among women of teenagers with age 15-19, 10% are already mothers and 2% are pregnant with their first Child and in based on age specific in all survey of EDHS the age specific fertility rate is high in women age 20-34(EDHS, 2016).

Bongaarts has classified factors affecting fertility into two broad categories: as those which affect fertility directly or with the primary characteristic of influencing fertility directly termed as proximate determinants or intermediate variables. The other category consists of those variables which affect fertility indirectly called socioeconomic, cultural, and environmental factors. According to J. Bongaarts, proximate determinants or intermediate variables are the biological and behavioral factors through which socioeconomic, cultural, and environmental variables affect fertility. J. Bongaarts further explained that, assuming the other intermediate fertility variables remain constant, if an intermediate fertility variable change, such as the prevalence contraception, then fertility level necessarily changes, while this is not necessarily the case for an indirect determinant such as income or education, and this issue can be summarized in the following simple diagram the relationships among the determinants of fertility (Bongaarts, 1978).

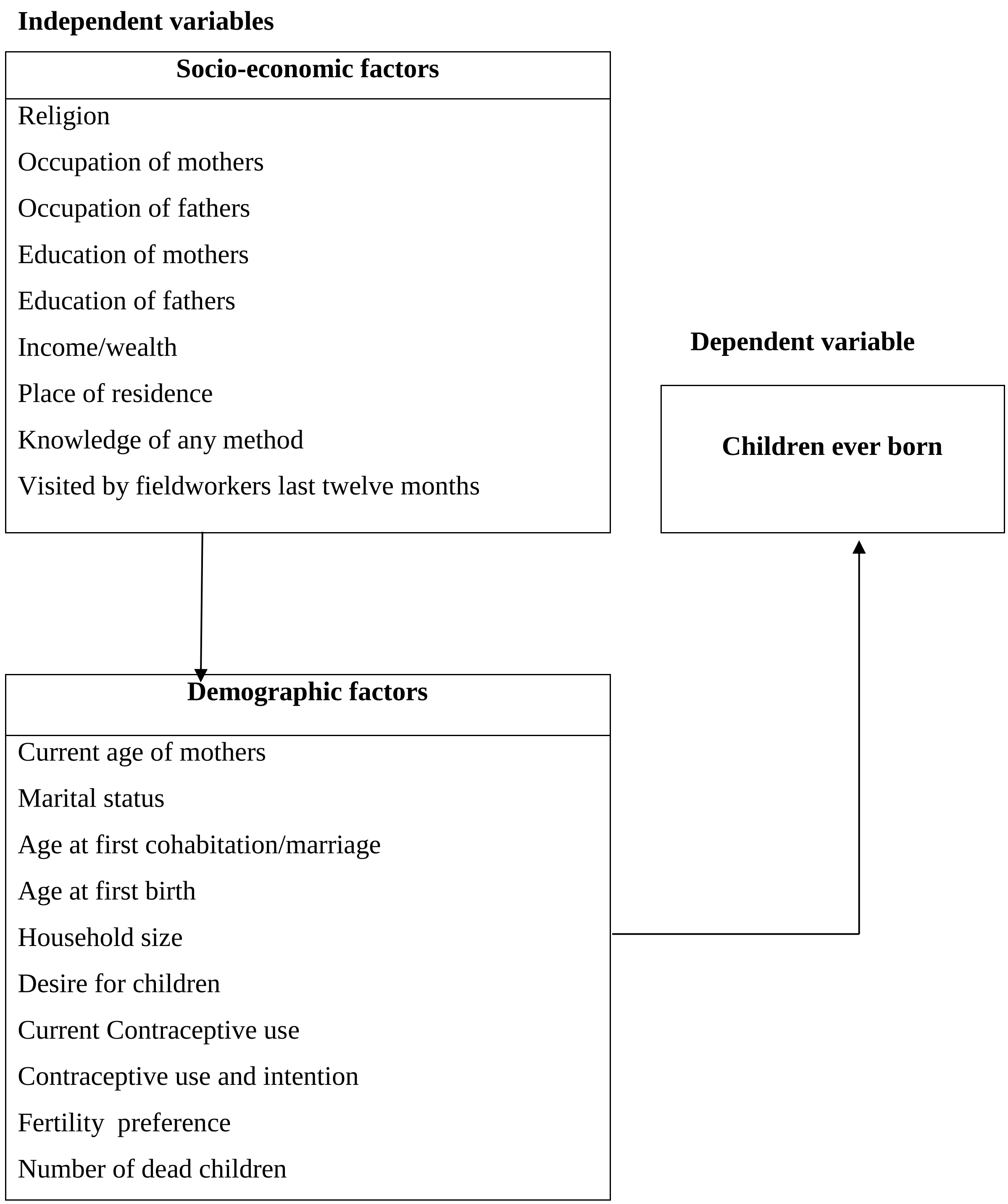


Source: John Bongaarts, (1978) A Framework For Analyzing The Proximate Determinants Of Fertility.

Figure 2.1: Framework for analyzing the proximate determinants of fertility

2.1. The conceptual Framework

Analysis and interpretation of data need to be guided by a conceptual framework that explains associations among different variables. In this study socioeconomic and demographic factors are identified based upon their theoretical importance. The analytical conceptual framework that is going to be employed in this study is developed / based on or by reviewing the related literature.



Source: Developed by the author based on literature review

Figure 2.2: Conceptual framework of the study

3. DATA AND METHODOLOGY

3.1. Description of the study area

The study was carried of Somali region. The Somali regional state of Ethiopia is the second largest region of Ethiopia and ranks second next to Oromia regional state in area.(http://www.ethiopia.gov.et/statesomali, 2015).Somali Region is subdivided into 11 administrative zones and 6 Special administrative zones(OCHA retrived,2017)Jijiga is the capital city of the State.

The Somali regional state is located in the eastern part of Ethiopia. The State has common boundaries with Afar and the Republic of Djibouti in the north, Kenya in the south, the State of Oromia in the west, and Somalia in the east and in the South and it has an estimated area of about 250,000 square kilometers (http://www.ethiopia.gov.et/statesomali, 2015). According to the population projection (the latest statistical abstract report of CSA) the population of the region was forecasted in July, 2017, being 5,748,462of which 3,093,885 were males and 2,654,577 were females and In July 2037 8,769,106 of which 4,545,918 were male and 4,223,188 were females (CSA, 2012 projection).

The region is known for its livestock resources from which most of the Somali people earn their livelihood. Though most of the people of the regional state of Somali mainly earn their livelihood from livestock, they also practice crop production as well as their major economic activities (http://www.ethiopia.gov.et/statesomali, 2015).

3.2. Data Source and Study Design

In this study, secondary data was used; the latest Ethiopian Demographic and Health surveys (EDHS, 2016) dataset, which was collected by Central Statistical agency (CSA) of Ethiopia. The data was collected primarily using a Community-based cross-sectional study design from January 18 to June 27, 2016. The data were collected from nine regional states and two city administrations of Ethiopia after clustering into 68 zones, 817 districts and 16,253 kebeles (lowest local administrative units of the country).The 2016 EDHS sample was stratified and selected in two stages. Each region was stratified in to rural and urban. In the first stage, a total of 645 enumeration areas (EAs) (202 in urban areas and 443 in rural areas at national level) were selected with probability proportional to EA size (based on the 2007 population census) and with independent selection in each sampling stratum. Out this a total of 69 EA were from Somali region (13urban and 56rural).

A household listing operation was carried out in all of the selected EAs from September to December 2015. Then individual households were selected from each EAs based on their size. In the second stage of selection fixed numbers of 28 households per cluster were selected with an equal probability systematic selection from the newly created household listing and the interviewer with pre-selected household. All women aged 15-49 who are usual members of the selected households or who spent the night before the survey in the selected households were eligible for the female survey. Out of the total of 18,008 households randomly selected and 15,683 eligible interviewed women, 1,876households randomly selected and 1,391 eligible interviewed women were from Somali region respectively.

3.3. Study Population

Women aged 15-49 who are usual members of the selected households or who spent the night before the survey in the selected households were eligible (1,391 women) for the female survey who gave live birth at least once in their life time of Somalia region were considered as the study population for this study. Those 1002 women who gave live birth at least once in their lifetime were included.

3.4. Study Variables

The dependent variable for this study was children ever-born (CEB) comprise information on the number of all children born alive (life time fertility) up to the survey date. The independent/ explanatory variables that were selected and included in this study include: the demographic factors that are supposed to influence fertility (Current age of mothers ,marital status, age at first marriage, age at first birth ,household size, desire for children ,fertility preference of Children and number of dead children) and the socio-economic determinants/factors (occupation of wife & husband, education level of wife & husband, knowledge about any method, current contraceptive use, contraceptive usage and intention ,income/wealth ,place of residence ,Visited by health field workers in last 12 months and religion)(Table 3.1).

Dependent variable: Children ever-born (CEB)

Independent or the explanatory variables

Table 3.1: Independent variables

S/n	Variables	Category	Description
		Demographic factors	
1	Current age of mothers	1=15-19 5=35-39 2=20-24 6=40-44 3=25-29 7=45-49 4=30-34	Current age of mothers
2	Age at first birth	1 = Below 15 5=30-34+ 2 = 15-19 3= 20-24 4 =25-29	Mother age at first birth
3	Marital status	1=Single 2=Married 3= Divorced 4= Widowed 5= Separated	Mothers marital status
4	Age at first marriage	1 = Below 15 5=30-34 2 = 15-19 3= 20-24 4 =25-29	Mother age at first Marriage
5	Fertility preference of Children	1=Have another 2=Undecided 3=No more 4=Declared in fecund	Fertility preference for more children
6	Household size	Household number in house	Household size

7	Desire for more children	1=Wants with two& more year 2=Wants with unsure time 3=Undecided 4=Want no more 5=Sterilized and declared in fecund	Desire for more children
8	Number of dead children	Counts of children died	Number of died children
9	Current contraceptive Use	1 =Using 2=Not using	Current contraceptive use(any type)
10	Contraceptive use and intention	1=Using modern traditional method 2=Non user and intend to use it 3=Does not intend to use	Contraceptive usage and intention for use
Socio-economic factors			
1	Place of residence	1= Rural 2= Urban	Place of residence
2	Religion	1=Orthodox 2= Protestant 3= Muslim 4= Traditional	Religion
3	Education level (mother)	1=No education 2=Primary 3=Secondary 4=Higher	Mothers education level
4	Occupation status (mother)	1=Non-Working 2=Working	Occupational status of mother
5	Education level (father)	1=No education 4=Higher 2=Primary 5=Don't know 3=Secondary	Fathers education level
6	Occupation status (father)	1=Non-Working 2=Working	Occupational status of father

		3=Don't know	
7	Income/wealth	1= Poor 2 =Middle 3 = Rich	House hold income
8	Knowledge about any method (birth control)	1= Knows no method 2= Knows only traditional method 3= Knows modern method	Mothers knowledge about any method for family planning
9	Visited by health field workers in last 12 months	1= No 2= Yes	Mothers Visited by field workers in last 12 months

3.5. Data Analysis Technique

In this study count model analysis was employed to assess the association and thereby how each factor influences or determine of fertility level of the study area. There are several alternative statistical models for conducting researches, some models may not be appropriate to deal with some specific types of data which is mainly depending on the types and nature of the data. Then in this study, the variable of interest were Children ever-born (CEB) comprise information on the number of all children born alive (life time fertility) which has non-negative integer value and non-zero (count data), which is most often characterized as non-normal distribution.

Count is none-negative integers (0, 1, 2...) then it is not preferred to use binary logistic regression which is not two outcomes (0, 1). They represent the number of occurrences of an event with a known average and these events are occurring fertility also represent the occurrence of CEB. So if the outcome variable is count we use statistical Models for Count Data (Muoka et al, 2016).

3.5.1. Poisson Regression Model

Poisson regression model is widely used for the analysis of count data. Which first used in regression context by letting the mean parameter in the Poisson distribution depend on some covariates (Frome et al.,1973).

The Poisson regression model is assumed to be the mean and the variance of our response variable is equal or equi-dispersion, the observed variance of the data may be larger than the corresponding mean then in case of this over dispersion, then in this case Poisson regression is not appropriate the negative binomial regression model is appropriate. (Berk and MacDonald, 2008) if we use Poisson regression model in over depression data the model is less adequate.

Suppose we have an independent sample of n pairs of observation (y_i,x_i) i∈1, 2…, n. then assume $y_i\sim$ Poisson (μ_i),i=1,2….n. the probability density function of the poisson random variables , y_i is

$$\{(y_i, \mu_i) = \frac{e^{-\mu_i}{\mu_i}^{y_i}}{y_i!}, y_i = 0,1,2,..\mu_i > 0\} \quad (1)$$

Where , y_i is the number of children ever-born (fertility) for i^{th} mother in a given time with mean parameter μ_i and x_i is the variance determinant factor of fertility for the i^{th} mother with equi dispersion or equal mean and variance of the number of children ever-bornE(y_i) = $Var(y_i)$=μ_i and one specification mostly used for the mean parameter μ_i is the exponential specification which ensures that μ_i is E(y_i) $= e^{{x_i}^t}\beta$.

The appropriate estimation method for Poisson model is maximum likelihood estimation to find the maximum likelihood function E $(y_i) = \mu_i = e^{{x_i}^t}\beta$ of the function likelihood and loglikelihood is given below respectively.

$$L = l(\mu_i, \beta) = \prod_{i=1}^{n} \frac{e^{-\mu_i}{\mu_i}^{y_i}}{y_i!} = \prod_{i=1}^{n} \frac{e^{-e^{{x_i}^t}\beta}(e^{{x_i}^t}\beta)^{y_i}}{y_i!} \quad (2)$$

By taking log for both sides

$$L = \log(l(\mu_i, \beta)) = \sum_{i=1}^{n}[\, y_i x_i^t\beta - e^{{x_i}^t}\beta - \log(y_i!) \quad (3)$$

The first and second derivative the log likelihood function

$$\frac{\partial L}{\partial \beta_j} = \sum[\, y_i - e^{{x_i}^t}\beta]x_{ij} \text{ , and} \frac{\partial^2 L}{\partial \beta_J \beta_K} = -\sum e^{{x_i}^t}\beta\, x_{ij}x_{ik} \quad (4)$$

The log-likelihood function of the Poisson regression model is nonlinear in β, so they can be obtained by using an iterative algorithm which is most commonly used iterative algorithms are either Newton-Raphson or Fisher scoring. In practice $\hat{\beta}$ is the solution of the estimating equations obtained by differentiating the log likelihood, in the above in terms of β and equating them to zero. Therefore, β will be obtained by maximizing using numerical iterative method (McCullagh and Nelder, 1989).

Poisson model is a special case of negative binomial model. The negative binomial regression model reduces to the Poisson regression model when the over dispersion happen.

3.5.2. Negative Binomial Regression Model

Negative binomial regression is for modeling count variables, usually for over-dispersed count outcome variables. Over dispersion occurs when, for a random variable $Y \sim \text{Pois}(\lambda)$,$E(Y) < Var(Y)$:In other words, for a Poisson model, if our variance is larger than our expected value, we have over dispersion. In the presence of Poisson over dispersion for count data, an Alternative distribution called the Negative Binomial Distribution may avail a better model. Negative binomial regression fits a negative binomial regression model for a nonnegative count dependent variable. In this model, the count variable is believed to be generated by a Poisson-like process, except that the variation is allowed to be greater than that of a true Poisson. This extra variation is referred to as over dispersion (Hilbe, 2011).

The negative binomial distribution, especially in its alternative parameterization described above, can be used as an alternative to the Poisson distribution. It is especially useful for discrete data over an unbounded positive range whose sample variance exceeds the sample mean. In such cases, the observations are over dispersed with respect to a Poisson distribution, for which the mean is equal to the variance. Hence a Poisson distribution is not an appropriate model. Since the negative binomial distribution has one more parameter than the Poisson, the second parameter can be used to adjust the variance independently of the mean.

The traditional negative binomial, which is now commonly symbolized as NB2 (Cameron and Trivedi, 1986), is derived from a Poisson–gamma mixture distribution.

The Poisson distribution may be generalized by including a gamma noise variable which has mean and a scale parameter (plays the role the dispersion factor and it is constant) of v. Means that when $v \rightarrow 0$, the NB distribution reduces to the usual standard Poisson distribution with parameter μThe Poisson-gamma mixture (negative binomial) distribution that results is

$$f(\, y_i, \mu_i, v) = \frac{\Gamma(y_i + \frac{1}{v})}{y_i!\Gamma(\frac{1}{v})}(1 + v\mu_i)^{-\frac{1}{v}}\left(\frac{v\mu_i}{1+v\mu_i}\right)^{y_i}, y \geq 0 \qquad (5)$$

Unlike the Poisson model, the NB model has a less restrictive property that the variance is not equal to the mean (μ) with mean E $(y_i) = \mu_i = \exp(x_i t\, \beta)$ and var $(y_i) = \mu_i(1 + v\mu_i)$.

In negative binomial regression model there is a linked to covariates $\mu_i = \exp(x_i t\, \beta)$.in negative binomial generalized linear model, the mean response for the number of ever born children (fertility) is to have a log linear relationship with the covariates and is

$$\ln(\mu_i) = \beta_0 + \sum_{i=1}^{q} \beta_i x_i \qquad (6)$$

Where μ_i,= the determinant factors of the fertility per i^{th} individual mothers;$'s$ = regression coefficients to be estimated and q = total number of covariates in the model.

The likelihood function for Negative binomial model based on a sample of n independent observations is given:-

$$\text{L}\,(y_i, \mu_i, v) = \prod_{i=1}^{n}\left[\frac{\Gamma(y_i + \frac{1}{v})}{y_i!\Gamma(\frac{1}{v})}(1 + v\mu_i)^{-\frac{1}{v}}\left(1 + \frac{1}{v\mu_i}\right)^{-y_i}\right] \qquad (7)$$

And, the log likelihood function is given by

$$l = \sum_{i=1}^{n}\left\{\sum_{k=1}^{y_i}(vy_i - vk + 1) - \left(y_i + \frac{1}{v}\right)\log(1 + v\mu_i) - y_i \log(\mu_i) - \log(y_i!)\right\} \qquad (8)$$

3.5.3. Zero Truncated Models

Zero truncated count data is the count response variable which cannot contain zero count value. We can test the response variable cannot have a value of zero using graphical method. When people want to use regression on these count variables, they may want to use negative binomial regression and Poisson first because it is a useful model for the count data. However, the underlying assumption of negative binomial distributions may cause a problem because the range of these distributions include zero. If the mean of the response is small, and it does not contain zeros, then the estimated parameters and standard errors obtained by generalized linear model may be biased, which may cause bad effects when interpreting the results using the estimated parameters. In this situation, the Zero-Truncated poison or zero truncated negative binomial regression models can be used to solve this problem (Cameron and Trivedi, 1998).

3.5.3.1. Zero Truncated Poisson (ZTP) Regression

Zero-truncated poison regression is used to model count data for which the value zero cannot occur and which over dispersion dose not exists. Consider the situation that the event y_i = 0 cannot be observed. Under the assumption of observed heterogeneity we obtain the zero-truncated Poisson regression model,

$$pr^{(p)}(Y_i = y_i/y_i > 0, \mu_i) = \frac{pr^{(p)}(Y_i = y_i/\mu_i)}{1 - pr^{(p)}(Y_i = 0/\mu_i)} \quad (9)$$

Where $pr^{(p)}(Y_i = 0/\mu_i) = e^{-\mu_i}$

And the conditional expectation

$$E(Y_i/y_i > 0, \mu_i) = E(y_i/\mu_i)/\, [1 - pr^{(p)}(Y_i = 0/\mu_i)] \quad (10)$$

And

$$var(Y_i = y_i/y_i > 0) = E(Y_i/y_i > 0, \mu_i)[1 - pr^{(p)}(Y_i = 0/\mu_i)E(Y_i/y_i > 0, \mu_i)] \quad (11)$$

The log-likelihood of model is given by

$$L = log\big(l(\beta)\big) = \sum_{i=1}^{n}(y_i ln\mu_i - \mu_i - lny! - \ln[1 - e^{-\mu_i}]) \quad (12)$$

3.5.3.2. Zero Truncated Negative Binomial (ZTNB) Regression

Zero-truncated negative binomial regression is used to model count data for which the value zero cannot occur and for which over dispersion exists. Under the assumption of unobserved heterogeneity the count probabilities are given by the zero truncated NB regression model.

Given the importance of accounting for over dispersion in the truncated count context, we present a model for truncated counts based on the negative binomial distribution. This negative binomial probability model can be written as

$$pr^{(NB)}(Y_i = y_i/y_i > 0, \mu_i, \alpha) = \frac{pr^{(NB)}(Y_i=y_i/\mu_i,\alpha)}{1-pr^{(NB)}(Yi=0/\mu_i,\alpha)} \quad (13)$$

Where $pr^{(NB)}(Y_i = 0/\mu_i, \alpha) = (1 + \alpha\mu_i)^{-\frac{1}{\alpha}}$

And the conditional expected value of y_i is given by

$$E(Y_i/y_i > 0, \mu_i, \alpha) = \frac{pr^{(NB)}(Y_i=y_i/\mu_i,\alpha)}{1-pr^{(NB)}\left(Yi=\frac{0}{\mu_i},\alpha\right)} \quad (14)$$

The likelihood function of the model

$(pr^{(NB)}(Y_i = y_i/y_i > 0, \mu_i, \alpha) = \frac{pr^{(NB)}(Y_i=y_i/\mu_i,\alpha)}{1-pr^{(NB)}(Yi=0/\mu_i,\alpha)}$is given by

$$L = log\big(l(\beta, \alpha)\big) = \sum_{i=1}^{n}\{\sum_{j=0}^{y_i} \ln\left(j + \frac{1}{\alpha}\right) + lny! - (y_i + \frac{1}{\alpha})\ln(1 + \mu_i\alpha)$$

$$+y_i ln\alpha\mu_i - \ln[1 - (1 + \alpha\mu i)^{-\frac{1}{\alpha}}]\} \quad (15)$$

Where

$\sum_{j=0}^{y_i} \ln\left(j + \frac{1}{\alpha}\right) = \ln\Gamma\left(y_i + \frac{1}{\alpha}\right) - \ln\Gamma(\frac{1}{\alpha})ify_i$ is an integer (Cameron and Trivedi, 1998)

3.6. Parameter Estimation

The regression models often use ordinary least squares to estimate the parameters. For count data, the regression model uses maximum likelihood (ML) to estimate the parameters. The parameters of the zero-truncated Poisson and NB regression models can be estimated by maximization of the respective log-likelihoods and using the Newton–Raphson method (Cameron and Trivedi, 1998). The method maximum likelihood parameter estimation is to determine the parameters that maximize the probability (likelihood) of the sample data. MLE methods are versatile and apply to most models and to different types of data. The principle of MLE, originally developed by R.A. Fisher in the 1920's states that the desired probability distribution is the one that makes the observed data ''most likely,'' which means that one must seek the value of the parameter vector that maximizes the likelihood function (Enders,2005) provides a particularly readable introduction to ML estimation.

3.7. Methods of Variable Selection

A variable selection method is a way of selecting a particular set of independent variables for use in a regression model. It is intended to select the "best" subset of predictors. This selection might be an attempt to find a 'best' model, or it might be an attempt to limit the number of independent variables when there are too many potential independent variables.

The main objective of a variable selection procedure is to identify the correct predictor variables, which have an important influence on the response variable. There are a number of commonly used methods are forward selection, backward selection and stepwise regression.

3.7.1. Stepwise Regression

Stepwise regression is a combination of the forward and backward selection techniques. It was very popular at one time, Stepwise regression is a modification of the forward selection so that after each step in which a variable was added, and all candidate variables in the model are checked to see if their significance has been reduced below the specified tolerance level. If a non-significant variable is found, it is removed from the model. Stepwise regression requires two significance levels: one for adding variables and one for removing variables. The cutoff probability for adding variables should be less than the cutoff probability for removing variables so that the procedure does not get into an infinite loop.

In this study Stepwise variable selection were used, which is a combination of backward elimination and forward selection to identify the predictors in the model. Stepwise selection method addresses where variables were added or removed with respect to the p-value in the process.

3.8. Model Comparison

From the models used for the count data analysis; model comparison tests BIC and AIC, with the smallest value were used to select the appropriate model for the data (EDHS 2016)used for this study and once a model has been developed, we would like to know how effective the model is in describing the outcome variable. This is referred to as goodness of fit. For comparison of nested models based on maximum likelihood, several authors beginning with Akaike 1973 have proposed model selection criteria based on the fitted log-likelihood function (Deleeuw, 1992.).Because we expect the log-likelihood to increase as parameters are added to a model, these criteria penalize models with larger *p*, the number of parameters in the model. This penalty function may also be a function of *n*, the number of observations.

3.8.1. Akakie Information Criteria (AIC)

The most common means of identifying the model which fits well by comparing two or more than two models. It is given by the following formula:

$$\mathrm{AIC} = -2\ell + 2\mathrm{k} \qquad (16)$$

Where $\ell$is the log-likelihood of a model k is the number of parameters estimated including the intercept in the model (Konishi and Kitagawa, 2008), relatively small value of AIC is preferred for the fitted model (Ismail and Jemain, 2007).

3.8.2. Bayesian Information Criteria (BIC)

Unlike AIC, the BIC accounts the size of the data under consideration. Type of information criteria it penalized by total number of sample size (Cameron and Trivedi, 1998).

It is given by:

$$\mathrm{BIC} = -2\ell + \mathrm{k}\log(\mathrm{n}) \qquad (17)$$

Where ℓ is the fitted log likelihood of a model, n is the sample size of the data and k is the number of parameters in the model including the intercept. The good model is the one which has the minimum BIC value (Konishi and Kitagawa, 2008).

3.9. Goodness of Fit

Once a model has been developed, we would like to know how effective the model is in describing the outcome variable. This is referred to as goodness of fit. Assume that estimation method is maximum likelihood. Tests for the validity for the null hypothesis can be based on Likelihood ratio test (LRT).

3.9.1. Likelihood Ratio Test

The maximum likelihood estimation method is used to assess the adequacy of any two or more than two nested models by using the likelihood ratio test. It compares the maximum likelihood under the alternative hypothesis with the null hypothesis. For instance, the null hypothesis can be the over-dispersion parameter is equal to zero (i.e. the Poisson distribution can be fit the data well) and the alternative hypothesis is that the data would be better fitted by the Negative binomial regression (i.e. the over dispersion parameter is different from zero).

$$H_0: \delta=0$$

$$H_1: > 0$$

$$where\ \delta \text{ is over dispersion parameter}$$

The likelihood ratio test is defined as:

$$\mathrm{G}^2 = -2(\mathrm{LL}_0 - \mathrm{LL}_1) \tag{18}$$

Where $LL_0$and $LL_1$are the log likelihood of null and alternative hypothesis respectively, p is number of parameters and $X^2p{-}1$ is a chi-square distribution with p-1 degree of freedom. If the test statistics exceeds the critical value, the null hypothesis is rejected. That means the overall model is significant or (p-value $<\alpha$ –value).

In this study, to compare ZTP with ZTNB regression models, since, zero-truncated Poisson is nested in zero-truncated negative binomial.
The statistic of likelihood ratio test for is given by the following equation:

$$LRT= -2(LL_1 - LL_2) \tag{19}$$

This statistic has a Chi-squared distribution with 1 degrees of freedom and LL is log-likelihood. If the test statistic is greater than the critical value then, the model 2 is better than the model 1or p- value less than α –value (Ismail and Jemain, 2007).

3.10. Statistical Software Packages

In this study mainly STATA 14, were used for statistical analysis and graphics. For statistical tests, 5% level of significance was used.

4. STATISTICAL DATA ANALYSIS

4.1. Descriptive Statistics

Based on Information on the number of fertility obtained from Ethiopian Demographic and Health Survey2016 data ,total 1391 women's were identified from Somalia region of Ethiopia From the total,1002are women who gave live birth in their life time(Table 4.1).

Table 4.1: Number of mothers that experienced at least one birth

Total children ever born per mother	Frequency	Percent
1	119	11.88
2	116	11.58
3	104	10.38
4	119	11.88
5	108	10.78
6	110	10.98
7	117	11.68
8	80	7.98
9	51	5.09
10	43	4.29
11	22	2.20
12	8	0.80
13	3	0.30
14	2	0.20
Total	1,002	100.00
Mean	5.08	
Variance	8.195	

The result showed in table 4.1showed that, descriptive statistics of number and percentage of children ever born per mothers. Based on information from 1002 mother's119 (11.88%), 116(11.58%), 104(10.38%), 119(11.88%), 108(10.78%), 110(10.98%), 117(11.68%), 80(7.98%), 51(5.09%), 43(4.29%), 22(2.20%), 8(0.80%), 3(0.30%) and 2(0.20%) of mothers birth 1, 2, 3 , 4, 5,6,7,8,9,10,11,12,13 and 14 of their child birth respectively.

Further screening in table 4.1 showed that, for 1002mothers the mean number of total child ever born per mothers is 5.08 and thus showed that the variance (8.195) is greater than the mean (5.08) indicating there is an over-dispersion.

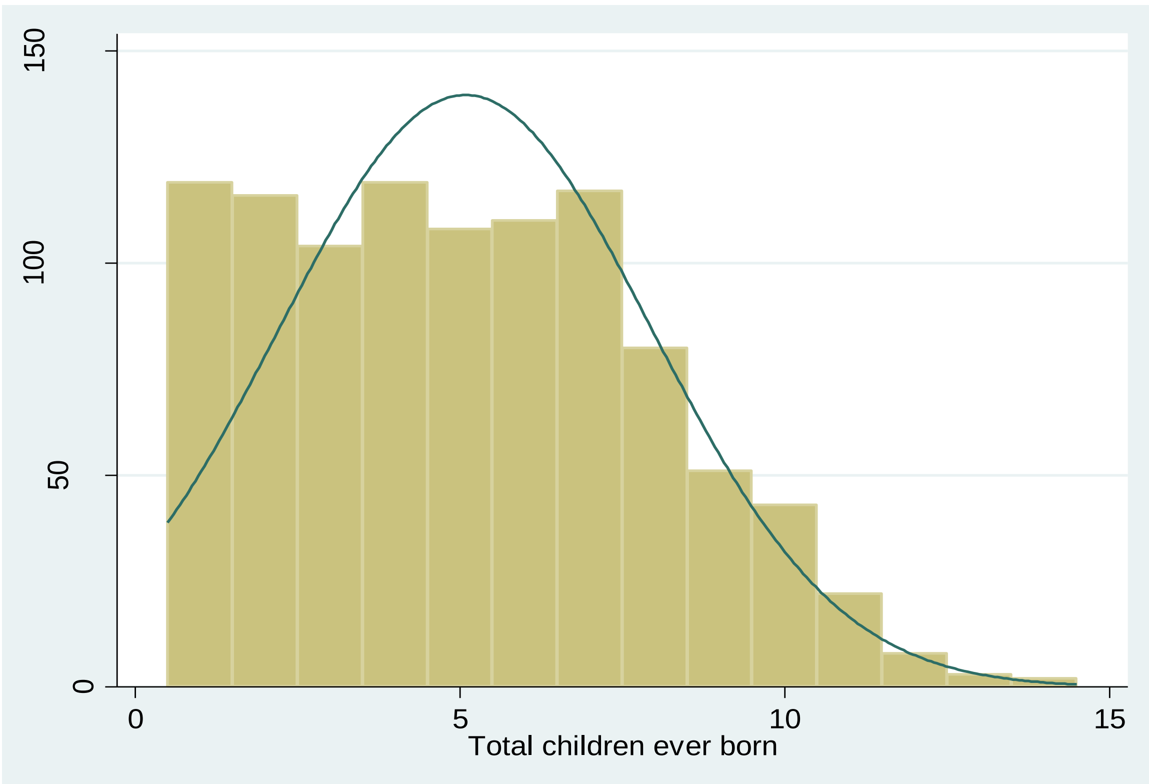


Figure 4.1: Histogram of number of child ever born per mother

As in figure 4.1: showed, there are no counts of zero outcomes, the histograms are picked around the beginning this leads to have a positively (right) skewed distribution giving as evidence for the absence (truncation) of zero value in the data.

Tabulate category, summarize (total child ever born) produces a summary table by category containing the means and standard deviations of (fertility) total child ever born (Table 4.2A and Table 4.2B).

Table 4.2A: Summary statistics of categorical predictor variables related (versus) to fertility (total child ever born) in Somalia region, Ethiopia for mothers

Variables	Categories	Observation	Child ever born (fertility)	
Demographic factors			Mean	Std.Dev
Current age of mothers	15-19	49	1.24	0.43
	20-24	176	2.26	1.23
	25-29	219	3.98	1.57
	30-34	181	5.63	2.08
	35-39	163	6.99	2.35
	40-44	132	7.11	2.54
	45-49	82	8.12	2.52
Age at first birth	Below 15	54	6.49	2.88
	15-19	531	5.06	2.98
	20-24	312	4.99	2.70
	25-29	92	4.89	2.60
	30-34 +	13	3.30	1.54
Marital status	Single	4	2.75	1.5
	Married	899	5.16	2.83
	Widowed	45	6.18	3.08
	Divorced	44	2.98	2.27
	Separated	10	3.00	2.21
Age at first marriage (cohabitation)for mothers	Below 15	172	5.45	2.84
	15-19	580	5.00	2.92
	20-24	194	5.02	2.72
	25-29	46	5.06	2.67
	30-34	10	4.2	2.78

Fertility preference of Children	Have another	791	4.65	2.63
	Undecided	53	4.83	3.10
	No more	117	7.34	2.88
	Declared in fecund	41	7.36	2.58
Desire for more children	Wants with two& more year	723	4.64	2.60
	Wants with unsure time	68	4.70	2.96
	Undecided	53	4.3	3.10
	Want no more	117	7.34	2.88
	Sterilized and declared in fecund	41	7.37	2.57
Current contraceptive usage	Not using	986	5.11	2.86
	Using	16	3.31	2.18
Contraceptive use and Intention	Using modern &traditional method	16	3.31	2.18
	Non user and intend to use	50	4.48	2.70
	Does not intend to use	936	5.14	2.87
Socio- economic factors				
Place of residence	Rural	786	5.13	2.88
	Urban	216	4.89	2.78
Religion	Orthodox	6	2.16	0.98
	Protestant	5	3.40	2.30
	Muslim	990	5.10	2.86
	Traditional	1	5.00	0
Education level (mother)	No education	847	5.39	2.08
	Primary	106	3.70	2.59
	Secondary	36	2.63	2.41
	Higher	13	3.15	2.51
Occupation status(mother)	Non-Working	789	4.93	2.83
	Working	213	5.61	2.91

Wealth index	Poor Middle Rich	745 57 200	5.23 4.40 4.70	2.85 2.72 2.88
Knowledge about any method (birth control)	Knows no method Knows only traditional method Knows modern method	201 2 799	5.44 4.5 5.07	3.06 3.53 2.81
Visited by health field workers in last 12 months	No Yes	854 148	5.15 4.70	2.89 2.63

In table 4.2A, socioeconomic and demographic related factors to the number of child ever born per mother were summarized. The mean number of child ever born for mother's have aged shown in brackets along with age groups as 15-19 (1.24),mother with age 20-24 (2.26), mother with age 25-26 (3.88), mother with age 30-34 (5.63), mother with age 35-39 (6.99),mother with age 40-44 (7.41) and mother with age 45-49 (8.12). This means that as the mother's age increases, the average child born also increased. Thus it is possible to say that the child birth is in the same direction of the mother's age.

Again from the table 4.2A, the mean number of child ever born for mother's have aged at first birth shown in brackets along with age groups as age under 15 (6.49), mother with age at first birth 15-19 (5.06), mother with age at first birth 20-24 (4.99), mother with age at first birth 25-29 (4.89), mother with age at first birth 30-34+ (3.30). This means that mothers who birth sooner have more children than if they are late for birth.

In table 4.2A, the mean number of child ever born per mother on average for married mothers (5.16) and widowed (6.18) have more children than single (2.75),divorced and separated mothers 2.98 and 3.00 respectively.

As shown table 4.2A,the mean number of child ever born for mother's have aged shown in brackets along with age groups as with age groups as age under 15 (5.45), mother with age 15-19 (5.00),mother with age 20-24 (5.02) ,mother with age 25-29 (5.06) and mothers with age 30-

34 have mean number of child ever born(4.2). This means that mothers who get married sooner or cohabitation will have more children than if they are late for marriage or cohabite.

According to table 4.2A, the mean numbers of child ever born for mothers have another preference (4.64), undecided (4.83) , mothers who have no more fertility preference (7.34) and mothers who are declared in fecund(7.36)So, mothers who have no more fertility preference have more children, and mothers who have another preference have lower children.

From the result in table 4.2A, can be observed that, the mean number of child ever born per mothers who wants to have more child with in two and above two year (4.64), wants with in unsure time (4.70), mothers who are not decided (4.83), mothers who cannot want more children and mothers who are declared in fecund mean number of child ever born per mothers 7.34 and 7.36 respectively. So, mothers who have desire for more children have more children, and mothers who have another preference have lower children.

According to table 4.2A, indicated that, mothers who had not using contraceptive have higher mean number of child ever born (5.11) than mothers who had using contraceptive (3.31).and similarly, mothers who had not using contraceptive and intend to use (4.48) and does not intend to use (5.14) have higher mean number of child ever born than mothers who had using modern and traditional contraceptive method (3.31).

Table 4.2A shows that, the mean number of child ever born for mothers whose residence is rural (5.13) is higher as compared to mothers whose residence is urban (4.89).

In table 4.2 A, the highest mean number of child ever born per mothers whose religion is Muslims (5.10) as compared to mean number of child ever born per mothers whose religion is orthodox (2.16), protestant (3.40) and traditional (5.00).

As the result showed in table 4.2A, the mean number of child ever born for uneducated mother (5.39) was higher than mothers with primary (3.69), secondary (2.63) and higher (3.15) education level and similarly, the mean number of child ever born for mothers who are not working (4.93) was lower than mothers who are working (5.61).

Table 4.2A,revealed that, the mean number of child ever born for poor ,middle and rich income level were 5.23,4.40 and 4.70, respectively, Therefore, Compared to Mothers living rich and middle-income, living in low-income mothers give birth more.

The result in table 4.2 A, indicated that, mothers who have no knowledge about any method have highest mean number of child ever born (5.14) than mothers who have knowledge about any method, knows only traditional method (4.5) and modern method (5.07).

Furthermore in table 4.2A, mothers who had not visited by field workers in last 12 months have higher mean number of child ever born (5.15) than mothers who had visited by field workers in last 12 month (4.70).

Table 4.2 B: Categorical predictor variables related (versus) to fertility (total child ever born) in Somalia region, Ethiopia for fathers

Variables (socio economic factors)	Categories	Observation	Child ever born (Fertility)	
			Mean	Std.Dev
Education level (father)	No education	645	5.47	2.83
	Primary	128	4.15	2.48
	Secondary	66	4.21	2.48
	Higher	57	4.91	3.09
	Don't know	6	5.16	3.37
Occupation status(father)	Non-Working	223	5.82	2.93
	Working	663	4.96	2.75
	Don't know	16	3.88	3.05

Table 4.2B,the mean number of child ever born for uneducated father (5.47) was higher than fathers with primary (4.15), secondary (4.21), higher education level (4.91) and do not know(5.16) (in case of husband or partner is not in house hold). And similarly the mean number of child ever born for uneducated father who not working (5.82) was higher than fathers who are working (4.96),and do not know(3.88) (in case of husband or partner is not in house hold).

Table 4.3: summary statistics of continuous predictor variables

Variable (demographic variables)	Observation	Mean	Std. Dev.	Min	Max
Number of died children	1,002	0.6067864	1.069547	0	7
Household members	1,002	6.11477	2.391251	1	19

As in table 4.3, the number of died children for both sex with mean approximation value of 0.60 per mothers of range from no death to 7 death.

Table 4.3 showed that, the numbers of household members of both sexes with mean value of 6.11 members per household with of minimum 1 member and maximum 19 members of household members.

4.2. Variable Selection

In this study Stepwise variable selection method were used, which is a combination of forward selection and backward elimination. Stepwise selection method addresses where variables were added or removed with respect to the p-value in the process at 5% level of significance. The result recognized that: predictor variables age of mother, place of residence, educational status of mothers, religion, number of household members, current marital status , mother age at first birth, mother's age at first cohabitation or marriage, mother occupation and number of died children are statistically significant effect for number of child ever born .While, other variables like; wealth index, current contraceptive usage, contraceptive use and intention to use it, fertility preference, desire for more children, husband or partner occupation, husband or partner education, visited by fieldworkers in last twelve months and mothers knowledge about any method which uses for birth control are not statistically significant and thus excluded from analysis.

4.3. Model Selection Criteria

4.3.1. Information Criteria's

In order to select the best model which fits the data well, different models were considered, but child ever born data is a non-zero count data. So, for this data zero- truncated Poisson (ZTP) and zero-truncated negative binomial (ZTNB) is appropriate model but fit with the bench mark model for count data which is Poisson .In this study, different model selection criteria were considered like the log-likelihood, AIC and BIC in order to identify the most well fitted model (Table 4.4).

Table 4.4: model selection criteria for count regression models

Model	D.f	Selection criteria		
		AIC	BIC	Log likelihood
Poisson	29	3738.961	3881.344	-1840.48
NB	30	3703.346	3850.639	-1821.673
ZTP	29	3592.676	3735.059	-1767.338
ZTNB	**30**	**3573.779**	**3721.072**	**-1756.89**

The result displayed in table 4.4 ,depict that for count data analysis the first model bench mark as standard Poisson regression and if there is over dispersion then so; that negative binomial regression model based on collected data .but the collected data is non -zero count data which is child ever born is non- zero count data, so the expectation moves on zero truncated Poisson and zero truncated negative binomial models all above models (Poisson and negative binomial model are not non zero count models, which is not appropriate so reject here and next made a model comparison between two truncation (zero) zero truncated negative binomials and zero truncated Poisson, which is excluding zero value from the data(Johnson, 2012, Hilbe, 2011)(Table 4.5).

Table 4.5: model selection criteria for non-zero count regression models

Model	D.f	Selection criteria		
		AIC	BIC	Log likelihood
ZTP	29	3692.676	3735.059	-1767.338
ZTNB	**30**	**3573.779**	**3721.072**	**-1756.89**

To select an appropriate model, the model present in table 4.5, from the models ZTP and ZTNB, The appropriate model as to select one model which the data fits better than the other by reminding in addition to zero truncation there is over dispersion (variance of response variable greater than mean). ZTNB model is more appropriate than the ZTP count models to fit number of child ever born per mother. Hence ZTNB model is the most appropriate which is used to model count data for which the value zero cannot occur and for which over dispersion exists. ZTNB model has a lowest value of AIC (3573.779) and BIC (3721.072) and also it has higher log -likelihood **(-**1756.89) value.

4.3.2. Likelihood Ratio Test (LRT)

For nested model the likelihood ratio test will be used and the condition will bep_value<$\alpha_value$reject null hypothesis it indicated that there was an over dispersion problem in the data. To compare ZTP with ZTNB regression models, since, zero-truncated Poisson is nested in zero-truncated negative binomial. From (table 4.5), the statistic of log likelihood ratio test is given by $-2(-1767.338-(-1756.89)) = 20.9$which is different from zero with p-value=0.000, then reject the null hypothesis indicted that there was over-dispersion problems the ZTNB is better than the ZTP. If the test statistics exceeds the critical value, the null hypothesis is rejected. That means the overall model is significant (p-value <α –value) (Table 4.6).

Table 4.6: likelihood ratio test for nested models

Model	LRT test statistic(P-value)	Preferable model
ZTP versus ZTNB	0.0000	ZTNB

The result in table 4.6 showed that, likelihood ratio test for nested model with p_value=0.0000 it is smaller than α_value it implies that ZTNB is better than the ZTP model. Therefore, ZTNB model is more appropriate model than the ZTP count models to fit number of child ever born per mother. The AIC, BIC and log likelihood also supported ZTNB model from the others count model.

4.4. Parameter Estimation of ZTNB Model for Fertility in Somalia Region, Ethiopia

Estimated zero truncated Negative Binomial regression model fit results of incident counts, the coefficients can be interpreted as follows: for a one unit change in the predictor variable, the log of the response variable is expected to change by the value of the regression coefficient .In ZTNB model, for every one unit increase in a unit's of the significant predictors, the log number of total child ever born is expected to increase or decrease by approximately the corresponding coefficient in the column of coefficient. In this model the variables whose p-value < 0.05, were considered statistically significant. To interpret the count data we used the incidence rate ratios (IRR=exp ($coef$)) (Table 4.7).

The other ZTP model output was presented in appendix which is not overblown difference that means, almost the same significant variables to ZTNB model output. On the data there is not overblown over dispersion. Even so, ZTNB model is more appropriate model than ZTP count models to fit number of child ever born per mother. The AIC, BIC and log likelihood also supported ZTNB model from the others count model.

Table 4.7: Parameter estimation of ZTNB model for fertility in Somalia region, Ethiopia

	Estimate	Std.err	Z- value	p-value	IRR	95%Confidenceinterval	
Mothers age in five year group)							
15-19 (reference)							
20-24	1.409	0.285	4.93	0.000	4.091	2.337	7.163
25-29	1.986	0.281	7.04	0.000	7.288	4.194	12.666
30-34	2.253	0.282	7.98	0.000	9.521	5.475	16.560
35-39	2.410	0.283	8.51	0.000	11.141	6.394	19.415
40-44	2.515	0.283	8.87	0.000	12.367	7.096	21.554
45-49	2.631	0.285	9.23	0.000	13.885	7.944	24.270

Place of residence							
Urban(reference)							
Rural	0.098	0.038	2.60	0.009	1.103	1.025	1.186
Mother education							
No education (reference)							
Primary	-0.054	0.059	-0.91	0.364*	0.948	0.844	1.064
Secondary	-0.297	0.126	-2.36	0.018	0.743	0.580	0.950
Higher	-0.182	0.180	-1.01	0.311*	0.833	0.585	1.186
Religion							
Orthodox (reference)							
Protestant	0.800	0.448	1.79	0.074*	2.228	0.926	5.355
Muslim	0.717	0.360	2.00	0.046	2.049	1.013	4.146
Traditional	0.755	0.583	1.30	0.195*	2.128	0.679	6.668
Household member	0.086	0.007	12.45	0.000	1.090	1.075	1.104
Age first birth							
Below 15(reference)							
15-19	-0.109	0.065	-1.67	0.094*	0.897	0.790	1.019
20-24	-0.291	0.073	-3.94	0.000	0.748	0.648	0.863
25-29	-0.409	0.091	-4.51	0.000	0.665	0.556	0.794
30-34+	-0.740	0.220	-3.37	0.001	0.477	0.310	0.734
Marital status							
Single (reference)							
Married	0.220	0.343	0.64	0.521*	1.246	0.636	2.441
Widowed	0.144	0.349	0.41	0.681*	1.154	0.583	2.288
Divorced	-0.111	0.357	-0.31	0.755*	1.895	0.447	1.800
Separated	0.008	0.400	0.02	0.985*	1.008	0.460	2.206
Age at first cohabit /marriage							
Below 15(reference)							

15-19	-0.055	0.044	-1.27	0.204*	0.946	0.869	1.030
20-24	-0.048	0.061	-0.79	0.431*	0.953	0.846	1.073
25-29	-0.140	0.090	-1.56	0.118*	0.870	0.729	1.036
30-34	-0.191	0.210	-0.91	0.361*	0.826	0.549	1.245
Mothers occupation							
Not working(reference)							
Working	0.043	0.036	1.20	0.231*	1.044	0.973	1.120
Number of died Children	0.100	0.012	8.20	0.000	1.105	1.079	1.132
Cons	-1.970	0.570	-3.44	0.001	0.140	0.049	0.429

* non-significant variables at 5% level.

According to table 4.7, the result showed that truncated ZTNB model variables like; respondents current age (age in five year group), place of residence, mothers highest educational level, religion, number of household members, mothers age at first birth and number of died children for both sex are statistically significant effect child ever born, whereas age at first cohabitation, mothers current marital status and mothers occupation are not significant effect on fertility (child ever born).

4.4.1. Interpretation of ZTNB Regression Model

The result in table 4.7 showed that, Age of mother has significant factors on number of child ever born. Mothers with age of (20-24), (25-29), (30-34), (35-39), (40-45) and mothers with age of (45-49) increased by a factor of 4.09, 7.29, 9.52, 11.14, 12.37 and 13.89 respectively, as compared to the reference category (15-19).

In table 4.7 also showed, Place of residence has a significant effect on fertility (child ever born). The expected number of child ever born for mothers with live in rural was increased by a factor of 1.10 as compared to with live in urban (reference group) controlling other variables in the model.

The result in table 4.7 showed that, Mother's level of education has significant factors on number of child ever born. The expected number of child ever born for mothers with primary education was decreased by a factor of 0.74 as compared to with no education (reference group) controlling other variables in the model.

Table 4.7 results also showed that, religion has significant factors on fertility. The expected number of child ever born for Muslim mothers was increased by a factor of 2.05 as compared to orthodox mothers.

In this study as in table 4.7, age of mother at first birth has significant factors on number of child ever born. Mothers with age of (20-24), (25-29) and mothers with age of (30-34) decreased by a factor of 0.75, 0.66 and 0.48 respectively, as compared to the reference category (below 15 year).

According to the finding of this study in table 4.7 that, household member has significant factor to increasing the number fertility. The rate ratio tells us that the average child ever born of mothers is increased by 1.09 as one-unit increment of household members, given the other variables are held constant. This indicates that child ever born of mothers has positive relationship with household members of household heads.

Finally the finding of this study in table 4.7 that, number of died children has significant factor to increasing the number fertility. The rate ratio tells us that the average child ever born of mothers is increased by 1.10 as one-unit increment of number of died children, given the other variables are held constant. This indicates that child ever born of mothers has positive relationship with number of died children of household heads.

5. DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Discussions

The purpose of this study was to identify, socioeconomic and demographic determinants on fertility in Somali region, Ethiopia based on EDHS 2016 data. Total number of women include in this study was 1002 which experienced at least one live birth in their life time. The most appropriate count regression model was selected from possible count models. Finally among two non- zero data count models the zero truncated Negative Binomial regression model was selected as more appropriate model for fertility or child ever born in Somalia region of Ethiopia. This discussion part aims some explanation of the results of Zero Truncated Negative Binomial regression model of proximate and socioeconomic and demographic related determinates impact on child ever born in related to theoretical background and previous researches.

The variables like; respondents current age (age in five year group), place of residence, mothers highest educational level, religion, number of household members, mothers age at first birth and number of died children for both sex are statistically significant effect child ever born, whereas age at first cohabitation, mothers current marital status and mothers occupation are not significant effect on fertility (child ever born). The results obtained from ZTNB are discussed as follows.

The finding of this study showed that as the mother's age increases, the average child born also increased. Thus it is possible to say that the child birth is in the same direction of the mother’s age. And the same to mother’s age at first birth who birth sooner especially below 15 and 15-19 year have more children than if they are late for birth. This is risk for mothers who birth premature mother’s health and headache for the Somalia region as well as the country economy. The mothers who had early birth (or sooner at first birth) are more likely to have more children than birth mothers having late in first birth (Eyasu, 2015), (Kidus, 2012) (Chemhaka and Odimegwu, 2020), (Oyefara, 2012).

The finding of this study showed that being born to educated mother was associated with decreased number of child ever born compared to being born to with not educated mothers. Thus educational level of mothers was an important and significant factor of number of child ever born in Somalia region of Ethiopia.

As educational level of mothers are increased the number of child ever born decreased because it takes time to learn as well as the age at first birth of educated mothers are late than non-educated mothers. This finding is in line or consistent with (Eyasu, 2015) and (Kidus, 2012).

According to the results, place of residence was found to statistically significant impact on fertility, such that mother's living in the rural areas had an increased number of child ever born compared to those mother's living in the urban .mothers live in rural are non-educated than live in urban mothers this tends to place of residence has effect on increase the number of children ever born in rural or their fertility preference or desire for more children is more than urban.This study consistent with (Eyasu, 2015), (Kidus, 2012) (Yayeh and Muluneh, 2015).

According to the result religion has significant factors on fertility. Most of the mothers in this of Somali region of, Ethiopia are Muslims they are live in rural area and most of them have children above five than Orthodox and other religion(protestant and traditional) . This means that they need to teach religious childbearing. This study also consistent with (Kidus, 2012)

According to the result number of household members is an important predictor of fertility that is, number of household members increases with increase fertility rate and mothers' birth more if increase their household members. Mothers in Somalia region are intent to increase their household members by birth more children.

The result also showed that, number of died children is an important predictor of fertility that is, fertility rate increase with increase in number of died children's and mothers birth more if their children are died. Mothers in Somalia region are intent to increase their child ever born by birth more children if their children's are died. They will have many children, thinking that they will die.

5.2. Conclusions

The purpose of this study based on socioeconomic and demographic related determinants factors of number of child ever born per mother in Ethiopia based on 2016 EDHS dataset. In Somalia region of Ethiopia 1,391 women's with the age of 15-49 were considered. Among those this study were considered 1002 women are who gave live birth in their lifetime.

The descriptive results showed that there is no mothers had no experienced child ever born in their life means that, all 1002 has experienced child ever born at least one times. The better fitted model was selected from two models count regression models: ZTP and ZTNB using different comparison techniques. by using log-likelihood, LRT, information criteria AIC, BIC for nested model, since ZTP and ZTNB are nested model it is not necessary to use test for non-nested model because the final two models are non-zero count model which is appropriate models are ZTP and ZTNB are nested models.

The result also revealed that ZTNB model was found to be more appropriate model to predict the number of child ever born per mother in Somalia region of Ethiopia. Zero truncated negative binomial regression model is better fitted the data which is characterized by non -zero and variability in the outcome than any other count regression models.

This study also used to identify predictor variables that had significant effects on child ever born per mother under ZTNB models variables like; age of mothers, place of residence, mother education level, age of mothers at first birth, number of house hold members, religion and number of died children for both sex per mother are significant effect on fertility, While, variables like ; mothers age at first cohabit , marital status, mother occupation not statistically significant are not statistically significant on child ever born in Somalia region , Ethiopia. And also wealth index, father educational level ,father occupation, current contraceptive usage, contraceptive use and intention to use it, fertility preference, desire for more children , visited by fieldworkers in last twelve months and mothers knowledge about any method which uses for birth control are not statistically significant are not statistically significant.

Finally, factors that was high effect on fertility for Somali region, Ethiopia were, mothers first birth is in girl hood age, give birth until natural suspension, their religion, most mothers were uneducated, their residence, intent to increase their household members and high number of dead children in the region were factors to high number of child ever born.

5.3. Recommendations

Based on the findings of the study, and then forward the following possible recommendations

- Efforts are needed to extend educational programmers aimed at educating mothers on the benefits of minimizing the number of child ever born per mothers in Somalia region of Ethiopia.
- Effort are need too late for cohabit and birth of mother's age at first birth, especially mothers age with under 18 years in order to reduce fertility and health mothers and children in Somalia region of Ethiopia.
- Effort should be made for providing better knowledge for any method used for number of children ever born or family planning which is not antagonistic to their religious teaching for mothers nearest to their residence place especially in rural area that the gab in child ever born per mothers is bridged in Somalia region of Ethiopia. Mothers need to use a religious teaching which is inconsistent to their religion to prevent them from having more than enough children This requires religious teaching.
- Ministry of Health (Federal and Regional) and health workers should plan and implement properly by increasing access of health facility nearest to the community, to improving the awareness of women knowledge for family planning to minimize number of child ever born, work on Childs health to minimize child death, and work on premature birth for both child and mother's health in Somalia region of Ethiopia.
- Both Regional and Federal Ministry of Education should plan and implement making mothers have access to educations and improve their educational status by expanding schools and services throughout the region.
- Private sector, civil society and religious fathers also should plan implement to teach(not antagonistic to their religious teaching) households all-round the region, to have sufficient knowledge and awareness on fertility to have proportionate family size and mechanisms of reduction died children in their vicinity of Somalia region , Ethiopia.

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APPENDIXES

Table A. 1: Parameter estimation of zero truncated Poisson model

	Estimate	Std.err	Z- value	p-value	IRR	95% Confidence Interval	
Mothers age in five year group)							
15-19 (reference)							
20-24	1.350	0.285	4.73	0.000	3.861	2.207	6.755
25-29	1.865	0.282	6.62	0.000	6.459	3.720	11.216
30-34	2.148	0.282	7.62	0.000	8.586	4.923	14.886
35-39	2.316	0.283	8.19	0.000	10.134	5.820	17.644
40-44	2.403	0.283	8.49	0.000	11.054	6.348	19.252
45-49	2.522	0.285	8.86	0.000	12.489	7.127	21.741
Place of residence							
Urban (reference)							
Rural	0.096	0.037	2.57	0.010	1.101	1.023	1.185
Mother education							
No education (reference)							
Primary	-0.028	0.059	-0.47	0.635*	0.972	0.866	1.092
Secondary	-0.260	0.126	-2.07	0.039	0.771	0.603	0.986
Higher	-0.176	0.180	-0.98	0.329*	0.839	0.589	1.194
Religion							
Orthodox(reference)							
Protestant	0.806	0.448	1.80	0.072*	2.238	0.931	5.383
Muslim	0.74	0.360	2.07	0.038	2.108	1.041	4.260
Traditional	0.773	0.582	1.33	0.185*	2.166	0.691	6.783
Household member	-0.064	0.007	-8.64	0.000	0.938	0.925	0.952

Age first birth							
Below 15(reference)							
15-19	-0.096	0.065	-1.48	0.139*	0.908	0.800	1.031
20-24	-0.277	0.073	-3.76	0.000	0.758	0.656	0.875
25-29	-0.397	0.091	-4.37	0.000	0.672	0.562	0.804
30-34	-0.841	0.224	-3.74	0.000	0.431	0.278	0.669
Marital status							
Single(reference)							
Married	0.113	0.344	0.33	0.743*	1.119	0.571	2.196
Widowed	0.078	0.350	0.22	0.823*	1.081	0.545	2.146
Divorced	-0.144	0.357	0.40	0.688*	0.866	0.430	1.745
Separated	-0.082	0.401	0.20	0.838*	0.921	0.420	2.020
Age at first cohabit /marriage							
Below15(reference)							
15-19	-0.055	0.044	-1.25	0.211*	0.947	0.869	1.031
20-24	-0.066	0.061	-1.07	0.282*	0.936	0.830	1.056
25-29	-0.112	0.090	-1.25	0.210*	0.894	0.749	1.066
30-34	-0.032	0.213	-0.15	0.882*	0.969	0.638	1.471
Mothers occupation							
Not working (reference)							
Working	0.051	0.036	1.42	0.157*	1.052	0.980	1.129
Number of died Children	0.101	0.012	8.28	0.000	1.106	1.080	1.132
Cons	-2.637	0.570	-4.63	0.000	0.072	0.023	0.219

* non-significant variables at 5% level.