Determinants of Time to First Birth among women in Ethiopia using Cox Proportional Hazards Model

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Abstract

Background

The age of first birth corresponds to the age of the mother giving birth to the first child. The study aims at access the determinants of timing to age at first birth among Ethiopian women.

Methods

The data for this study was extracted from the published reports of Ethiopian Demographic and Health Survey. The study used15, 683 women aged 15–49 years from nine regions and two city administrations. Cox Proportional hazards model was used for identifying factors associated with age at first birth.

Results

The median time of age at first birth for Ethiopian women was22 years with 95% CI; (21.82, 22.18). Multivariable Cox Proportional Hazards Model shows that region, place of residence, education, wealth index, religion, work status, age at first marriage, age at first sex, and use of contraceptives have significant effects on the age at first birth at 5% level of significance. From region category, Amhara region (p-value = 0.398), Benishangul Gumuz(p-value = 0.112) Region, and Gambella region(p-value = 0.062) were not significant at 5% level of significance.

Conclusions

The age at first birth was positively correlated with the age at first sexual intercourse. A woman who has sexual intercourse much earlier gives birth earlier than a woman who is late for first intercourse.

1 Background

The age at which a mother gives birth to her first child is the age at which a mother gives birth to her first child. According to the report, the age of onset of childbearing in women has a strong influence on the demographic behavior of women and the general population [1].The birth of the first child is an important event that leaves a social mark in a woman's life. It is a woman's clear transition to parenthood with the roles and responsibilities involved.

Early initiation of childbearing may have adverse effects on a woman's socioeconomic well-being in later years [2]. This is because when a woman begins to give birth, a woman has to give up some roles to take on others that can be time and resource intensive [3]. The negative effects of this can be in the areas of career development, educational attainment, marital stability, property and the most important is their health. It also affects the type of care and opportunities available to women and their children, social

changes, reproductive trends and the state of the economy. Adolescent pregnancy due to early first child birth is also associated with maternal mortality [3].

Studying the dynamics of birth timing and spacing is critical for numerous reasons, including understanding overall family size and maternal mortality [4]. Fertility data modeling is one of the greatest benefits of socioeconomic research. Several indicators are used to measure birth patterns, such as the interval between first births after marriage [5]. Many theoretical approaches have been developed to explain changes in fertility rates. The most common indicator of the fertility rate is the total fertility rate, which is defined as the average number of children a woman would have if she lived to reproductive age [3].

Factors that affect the age at which the first child is born are varied and to varying degrees. There are economic, national and international factors as well as personal, familial, and social factors. Personal factors include personal attitudes such as contraceptive use and education. Family factors include socioeconomic characteristics such as parents' education, place of residence, place of birth, religion, social and employment status. Social factors include norms, practices, peer pressure, and acceptance of cohabitation [6].

According to a study on factors determining the time to first childbearing after marriage, [7] found that a woman's occupational status is of great importance in the period after the first child birth. When married, says that women who go to work after marriage are more likely to have their first child longer after marriage than those who remain comfortable after their first marriage. However, these results are in contrast to the conclusion of the study conducted by [8] which analyzed the determinants of marriage at the time of first child birth after marriage, showing that although women Whether a woman works or not after marriage, her chances of having a first child after marriage are not affected.

2 Methods

2.1 Source of Data

The data for this study was extracted from the published reports of Ethiopian Demographic and Health Survey [9]. The 2016 Ethiopia Demographic and Health Survey (EDHS) is designed to provide data to monitor the population and health situation in Ethiopia. EDHS 2016 is the fourth Demographic and Health Survey conducted in Ethiopia since 2000. The objective of the survey is to provide reliable estimates of fertility, marriage, sexual activity, reproductive preferences, family planning methods, breastfeeding practices, nutrition, childhood and motherhood, mortlity, maternal and child health, HIV/AIDS and other sexually transmitted infections (STIs), women's empowerment, female genital mutilation/mutation, and domestic violence without Program managers and decision makers can use to evaluate and improve existing programs.

2.2 Sampling Design

The sampling framework used for EDHS 2016 was the Ethiopian Population and Housing Census (PHC), conducted in 2007 by the Central Statistics Authority (CSA) in Ethiopia. The Census Base is a comprehensive list of 84,915 census tracts (EAs) created for the 2007 PHC. Administratively, Ethiopia is divided into nine geographic regions and two administrative cities. The 2016 EDHS form is designed to provide estimates of key indicators for the country as a whole, for separate urban and rural areas, and for each of the nine regions and two administrative cities.

The 2016 EDHS sample was stratified and selected in two stages. Each region was stratified into urban and rural areas, yielding 21 sampling strata. Samples of EAs were selected independently in each stratum in two stages. Implicit stratification and proportional allocation were achieved at each of the lower administrative levels by sorting the sampling frame within each sampling stratum before sample selection, according to administrative units in different levels, and by using a probability proportional to size selection at the first stage of sampling.

In the first phase, a total of 645 sites (202 urban areas and 443 rural areas) were selected with a probability proportional to the size of the site (based on the 2007 PHC) and with the selection of the site selected independently in each stratum sampling. Household census activities were conducted in selected regions from September to December 2015. The list of households obtained was therefore used as a sampling frame to select households at the second level. All women aged 15-49 who were permanent residents of selected households or guests staying in the household the night before the survey were eligible to be interviewed. In the interviewed households, 16,583 eligible women were identified for individual interviews; interviews were completed with 15,683 women, yielding a response rate of 95 percent [9].Top of FormBottom of Form

2.3 Variables in the Study

The Response Variable

The response variable is the time to first birth, which is measured in years. For analysis, those women gave birth event coded 1 (success) and those who did not give birth 0 (censored).

Explanatory Variables

Several predictors were considered in this study to investigate the determinant factors of age at first birth. These were education, region, religion, work status, wealth index, place of residence, age at first marriage, age at first sex, and use of contraceptive.

2.4 Methods of Data Analysis.

The Survival Model

Survival analysis is a set of statistical data analysis procedures where the outcome variable of interest is the time until an event occurs. By time we mean the year, month, week or day from the start of tracking an

individual until an event occurs; alternatively, time can refer to an individual's age when an event occurs. By case we mean mortality, morbidity, relapse into remission, recovery (e.g. return to work), or any other specified experience of interest that may occur with a individual. The problem of analyzing data over time arises in several application areas such as medicine, biology, public health, epidemiology, engineering, economics, sociology, demographics, etc. The terms lifetime analysis, duration analysis, event history analysis, failure-time analysis, reliability analysis, and transition analysis refer essentially to the same group of techniques, although the emphases in certain modeling aspects could differ across disciplines [10].

The use of survival analysis, as distinct from the use of other statistical methods, is more important when some subjects lose follow-up time or when the observation period ends, and some patients may not know the event of interest during the study period. In the second case, we cannot have complete information about these people. These incomplete observations are believed to have been censored. Most existential analysis considers a major analytical problem to be censorship. Basically, censorship occurs when we have information about the survival time of an individual, but we do not know the exact survival time. Such an event can occur due to either; one did not experience the event until the end of the study, one was lost to follow-up for the duration of the study, and one withdrew from the study for unknown/known reasons. There are three types of censorship.

i. Right censoring: Survival time is said to be right censored when it is recorded from its beginning to a defined time before its end time. This type of censoring is a commonly recognized during survival analysis and considered in this study.
ii. Left censoring: Survival time is said to be left censored if an individual develops an event of interest prior to the beginning of the study.
iii. Interval censorship: Duration is said to be interval censorship when it is known only that the event of interest occurred during a period of time, but the exact time of its occurrence is not known.

2.4.1 Cox PH Regression Model

[11] Proposed a semi-parametric model for the hazard function that allows the addition of covariates, while keeping the baseline hazards unspecified and can take only positive values. With this parameterization, the Cox hazard function is

$$h_i(t) = h_o(t)\exp\left(X_i^T\beta\right)$$

2.1

Where, $h_o(t)$ is the baseline hazard function which is obtained when all $X's$ are set to zero; $\mathbf{X}_i$ is a vector of covariates and β is a vector of parameters.

In this model, no distributional assumption is made for the survival time; the only assumption is that the hazard ratio does not change over time (i.e., proportional hazard model). Even though the baseline hazard

is not specified, we can still get a good estimate for the regression coefficients, β, hazard ratio, and adjusted hazard curves.

The hazard ratio of two individuals with different covariates X and X^* is given by:

$$\hat{HR} = \frac{h_o(t)\exp\left(\hat{\beta}' X\right)}{h_o(t)\exp\left(\hat{\beta}' X^*\right)} = exp\left\{\sum \hat{\beta}'\left(X - X^*\right)\right\} \quad (2.2)$$

This hazard ratio is time-independent, that is why this is called the proportional hazards model. The parameter of the Cox proportional hazard model refers to the hazard ratio of one group in comparison to the other groups for categorical covariates and the change in hazard ratio with a unit change of the covariate for the continuous variables when other covariates are fixed.

The change in hazard ratio for the continuous covariate is given by:

$$\frac{h_i\left(t, x_k + 1\right)}{h_k\left(t, x_k\right)} = exp(\beta_k) \quad (2.3)$$

which represent the change in the hazard when there is a unit change in the covarite while other covariates keep constant.

For categorical explanatory variable X with levels, the model contains (a-1) dummy variables defined as D_i = 1, if x = i, and 0 otherwise for i = 1,2,...,a -1. Let $\beta_1, \beta_2, \ldots, \beta_{a-1}$ denote the coefficient of the levels of dummy variables. The ratio of the hazard of two subjects, one with X at level j and the other with k (j,k = 1,2,..., a-1), provided that the values of all other explanatory variables for this subject are the same, the hazard ratio between these two categories is given by:

$$\frac{h\left(t\, D_j\right)}{h\left(t\, D_k\right)} = \frac{\exp\left(\beta_j\right)}{\exp\left(\beta_k\right)} = \exp(\beta_j - \beta_k) \quad (2.4)$$

The quantity $\exp(\beta_j - \beta_k)100\%$ signifies the ratio of the hazard function for the subject at level j and k of covariates, given that the effect of other covariate keeps fixed.

3 Results

The result (Table 1) showed from the total of 15,683 respondents, 7193 (45.9%) women had given birth and the remaining 8,490 (54.1%) had not given birth at the time of the survey. Of the total, 1682 (10.7%) respondents were from the Tigray region, 1128 (7.2%) were from the Afar region, 1719 (11%) were from the Amhara region, 1892 (12.1%) were from the Oromia region, 1391 (8.9%) were from the Somali region, 1126 (7.2%) were from the Benishangul gumuz region, 1849 (11.8%) were from the southern region, 1035 (6.6%) were from the Gambella region, 906 (5.8%) were from the Harari region, 1824 (11.6%) were from the city government of Addis Ababa and 1131 (7.2%) from the city government of Dire Dewa. The majority of respondents 7033 (44.80%) had no education while 5213 (33.2%) had primary education, 2238 (33.2%) had secondary education, and 1199 (7. 6%) have a higher education.

In terms of the wealth index, about 5940 (37.9%) were classified as poor, about 2002 (12.85%) were in the medium range and the remaining 7741 (49.4%) were rich. More than half (63.8%) of women were unemployed. Of the total study participants, 6413 (40.9%) were Orthodox, 91 (0.6%) were Catholic, 2814 (17.9%) were Protestant, 6209 (39.9%) were Muslim, 84 (0.5%) were traditional and 72 (0.5%) were other. The majority of respondents 10335 (65.9%) were rural residents and 5348 (34.1%) were urban residents. Approximately 12,371 (78.9%) women were not using contraception and 3,312 (21.1%) were using contraception. The median time of age at first birth for Ethiopian women was22 years with 95% CI; (21.82, 22.18) (Table 1).

Table 1
Descriptive Summary of Demographic and Socio-economic Variables

Variable	Categories	Frequency	Percent
Region	Tigray	1682	10.7
	Affar	1128	7.2
	Amahara	1719	11.0
	Oromiya	1892	12.1
	Somali	1391	8.9
	Benshangul-G	1126	7.2
	South	1849	11.8
	Gambella	1035	6.6
	Harari	906	5.8
	Addis Ababa	1824	11.6
	Dire Dewa	1131	7.2
Women education level	No education	7033	44.8
	Primary	5213	33.2
	Secondary	2238	33.2
	Higher	1199	7.6
Wealth index	Poor	5940	37.9
	Middle	2002	12.8
	Rich	7741	49.4
Women work status	Not had work	10011	63.8
	Had work	5672	36.2
Religion	Orthodox	6413	40.9
	Catholic	91	0.6
	Protestant	2814	17.9
	Muslim	6209	39.6
	Traditional	84	0.5
	Others	72	0.5
Residence	urban	5348	34.1

Variable	Categories	Frequency	Percent
	Rural	10335	65.9
Contraceptive	not using	12371	78.9
	using	3312	21.1

3.2 Results of Cox proportional Hazards Model

Multivariable Cox proportional hazards models were fitted by including significant covariates in univariate analysis at 5% significance level. The multivariable Cox proportional hazard model (Table 2) showed regions, residence, education, wealth index, religion, work status, age at first marriage, age at first intercourse and contraceptive use had a significant effect on age at first childbearing at the 5% level of significance. In the regional classification, the Amhara region (p-value = 0.398), the Benishangul Gumuz region (p-value = 0.112) and the Gambella region (p-value = 0.062) were not significant. Primary (p-value = 0.110) and secondary (p-value = 0.652) education levels were also not significant at the 5% level of significance.

Table 2: Results of Multivariable Cox Proportional hazards model

Covariates	Coef	SE(Coef)	P-value	HR	95 % CI for HR
Region					
Tigray	Ref				
Affar	0.135	0.070	0.056	1.144	(0.997, 1.314)
Amahara	0.057	0.068	0.398	1.059	(0.927, 1.208)
Oromia	-0.144	0.070	0.040	0.866	(0.755, .993)
Somali	0.262	0.064	0.000	1.300	(1.147, 1.472)
BenshangulGumuz	0.104	0.065	0.112	1.109	(0.976, 1.260)
South	0.165	0.070	0.019	1.179	(1.028, 1.353)
Gambella	0.131	0.070	0.062	1.140	(0.994, 1.308)
Harari	0.168	0.074	0.023	1.183	(1.023, 1.368)
Addis Ababa	0.157	0.071	0.028	1.170	(1.018, 1.346)
Dire Dewa	-0.199	0.076	0.009	0.819	(0.706, 0.951)
Place of Residence					
Urban	Ref				
Rural	-0.318	0.045	0.000	0.727	(0.666, 0.794)
Education					
No education	Ref				
Primary	0.106	0.066	0.110	1.112	(0.976, 1.266)
Secondary	0.135	0.065	0.039	1.144	(1.007, 1.301)
Higher	0.032	0.071	0.652	1.033	(0.898, 1.187)
Religion					
Orthodox	Ref				
Catholic	-0.571	0.148	0.000	0.565	(0.422, 0.756)
Protestant	-0.440	0.203	0.030	0.644	(0.433, 0.959)
Muslim	-0.398	0.146	0.006	0.671	(0.504, 0.894)
Traditional	-0.272	0.148	0.065	0.762	(0.571, 1.018)
Others	-0.180	0.192	0.348	0.835	(0.573, 1.217)
Wealth index					

Poor	Ref				
Middle	0.258	0.036	0.000	1.295	(1.207, 1.388)
Rich	0.106	0.043	0.013	1.111	(1.022, 1.209)
Age at first marriage	-0.210	0.004	0.000	0.811	(0.805, 0.816)
Age at first sex	0.059	0.003	0.000	1.061	(1.055, 1.067)
Work status					
Not had work	Ref				
Had work	0.245	0.027	0.000	1.278	(1.211, 1.348)
Use of Contraceptive					
Not using	Ref				
Using	-0.500	0.028	0.000	0.606	(0.574, 0.641)
Cof =Coefficient, SE = Standard error, HR=hazard ratio, CI=confidence interval, Ref=Reference					

The hazard ratios for the Oromia region, the Southern region, the Somali region, the Harari region, Addis Ababa and Dire Dewa were 0.866, 1.30, 1.179, 1.183, 1.170 and 0.819 with p-values of 0.040, 0.000, 0.019, 0.023, 0.028 and 0.09 respectively. This showed that women in the Oromia region were 86.6% less likely to have their first child than women in the Tigray region. Women in the southern region are 1.30 times more likely to give birth than women in the Tigray region. Women in the Somali region are 1.179 times more likely to give birth than women in the Tigray region. The probability of giving birth to a first child for women in the Harari region is at least 18.3% higher. Women in Addis Ababa were 17% more likely to have their first child than women in the Tigray region. The risk of age at first birth for women in Dire Dewa was 81.9% lower than for women in the Tigray region.

Cox's multivariable proportional hazard model showed that place of residence significantly affects the time to first birth in women (p-value = 0.000 and HR = 0.727). This shows that women in rural areas were 72.7% less likely to give birth for the first time than women in urban areas. Women with secondary education are 14.4% more likely to have their first child than women with no education.

The risk ratios for Catholic, Protestant, and Muslim religious groups were 0.565, 0.644, and 0.671 with p-values of 0.000, 0.030, and 0.006, respectively. This showed that Catholic women had a 56.5% lower risk of having their first child than Orthodox women. Similarly, the time delay before first childbearing among Protestant and Muslim women was 0.565 times and 0.644 times lower, respectively, compared with Orthodox women. Regarding the wealth index, women in the middle quintile are 1.295 times more likely to have their first child than women in the poor quintile. The risk of giving birth for the first time in rich women is 1.111 times higher than poor.

The hazard ratio for age at first marriage was 0.811 with P-value = 0.000. This indicates that there was an 81.1 decrease in time to first birth with a one year increase in age. The risk of first birth increases with age at first sex. This means that there was a 10.61% increase in the time to first birth relative to a one year increase in age. The hazard ratio for women who had work is 1.278. This suggests that the risk of having a first child in women in labor is 1.278 times higher than in women who are not in labor. Women using birth control had a 60.6% lower risk of having their first child delayed than women not using birth control

4 Discussion

The study aimed to approach the factors determining the age of first childbearing of Ethiopian women. Factors considered in this study were region, educational background, age at first marriage, religion, residence, occupation, wealth index, age of sexual intercourse, and contraceptive use, which were found to be statistically significant. The median age at first birth for Ethiopian women was 22.

The findings of this study showed that region had a significant effect on time to age at first birth at 5% level of significance. Women from Oromia region have been were less likely to have birth compared with women in Tigray region. Women from South region were more likely to have birth than those Tigray region women. Time to first birth in Somali region women was higher than Tigray region women. The chance of first birth was higher in Harari region women. The study by [12] showed that the probability of having a first child immediately after the first marriage was significantly higher in the Oromia and SNNP regions than in the Amhara region.

The results of this study suggest that place of residence is an important predictor of the timing of first childbearing among Ethiopian women. Rural women have a 72.7% lower risk of having their first child than urban women. A study by [13] showed that whether women are in urban or rural areas, the time to give birth after marriage is not affected. The results of this study also indicate that secondary educated females were at higher risk of having their first child than uneducated females. A similar study by [8] found that the level of education of women had a strong positive impact on the timing of their first childbirth, and that women in primary or secondary education were at greater risk of having their first child after marriage than their illiterate colleagues. This contradicts the report [14] that women above primary education are less likely to get married earlier than uneducated women.

The study found that religion to be a risk factor of age at first birth in Ethiopia. The risk of age at first birth was low for Catholic religion, Protestant, and Muslim religion than those Orthodox religion. This contradicts a study by [14], in which it was said that Muslim women are 1.14 times more likely to have their first child at an early age, while Catholics and Women of other religions are less likely to give birth to their first child birth early. Similar results have been reported in Bangladesh by [15]; Women of Muslim religions tend to give birth earlier than women of other religions. We showed that the wealth index significantly affects the time of aging at birth. Women in the middle quintile of the wealth index were 1.295 times more likely to have their first child than the poor. The risk of giving birth to the first child in rich women is 1.111 times higher than in poor women. A study by [16] on the determinants childbirth

interval, noted that the income class of married women had a large influence on the time first child birth after marriage; Women in the high-income group tend to spend more time before having their first child after marriage than do the poorest women.

In this study, age at first childbearing was negatively related to age at first marriage. This shows that there was an 81.1% decrease in time to first birth to every year increase in age. This is consistent with a retrospective study on age at marriage and time of first child birth, [12, 17] which showed that the first marriage significantly determines the risk of having children after first marriage. Women who married at a younger age in their first marriage were less likely to have their first child than women who married slightly older. Age at first birth was positively related to age at first intercourse. Women who begin sexual intercourse much earlier have their first child before women who are late for their first sexual intercourse. A Ugandan study [18] examining the relationship between age of first sexual intercourse, time of marriage and time of first birth [18] found a significant association between age of first sexual intercourse and time of first birth after marriage.

The study found that the risk of having a first child was 1.278 times higher among working women than in women without a job. This is consistent with a study by [7] that found that women's employment status is of great importance during the time of first childbearing after marriage, stating that women go to work after marriage are more likely to have a longer time to give birth to the first child after marriage compared to other partners. However, these results are in contrast to the conclusions of the study conducted by [8] which analyzed the determinants of marriage from first childbearing after marriage, which showed that although women have working or not after marriage, her chances of having her first child after marriage are not affected. Women using birth control had a 60.6% lower risk of having their first child delayed than women not using contraception. A Nigerian study by [19] showed that the correct use of reliable contraception can delay childbearing. We expect women who use contraception to have their first child later than women who do not use contraception.

5 Conclusions

This study tries to examine the determinant factors of the age at first childbearing among Ethiopia women. The study found that the median age at first birth was 22 years. The results of the Cox proportional hazards model showed that region, place of residence, education, religion, wealth index, work status, age at first marriage, age at first sexual intercourse and contraceptive method were the major determinants of age of first birth. The age at first birth was positively correlated with the age at first sexual intercourse.

Abbreviations

CI
Confidence Interval
CSA

Central Statistics Agency
DHS
Demographic and Health Survey
EA
Enumeration area
EDHS
Ethiopian Demographic and Health Survey
HIV/AIDS
Human Immune deficiency Virus/Acquired Immune deficiency Syndrome
PHC
Population and Housing Census
STDs
Sexual Transmitted Diseases

Declarations

Ethics approval and consent to participate

Not Applicable.

Availability of Data and Materials

Data sets were obtained from the CSA website accessed via http://www.statsethiopia.gov.et/.

Conflict of Interest

The authors declare that they have no conflicts interests.

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Consent for publication

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Competing interests

The authors declare that they have no competing interests.

Author's Contributions

YM contributed to the study concept and design, performed the analysis on the data set, as well as wrote the first draft of the paper. MG contributed to the analysis and interpretation of the data, in addition to drafting and critical revision of the manuscript. All authors read and approved the final manuscript.

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