The Determinants of Birth Interval in Rural Ethiopia

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Abstract

Studying the dynamics of spacing of births is important for several reasons including an understanding of completed family size. For instance, making longer between successive births used to allow less competition between existing children for breastfeeding, food, nutrition, the mother's time, and other resources. In this paper the length of birth interval between successive children that is called inter-birth interval in rural community of Ethiopia was considered. The data for the study was obtained from Ethiopian Demography and Health survey (EDHS) data conducted in 2010/11. The data contains 9647 rural women aged from 15-49 years. The approach of the study was fitting probability density functions to identify better distribution that provide adequate fit for all birth interval data; and among those distributions lognormal distribution seem best fit. Identifying variables that affect birth intervals was done by parametric survival analysis technique called "accelerated failure time" model. The result shows that the duration time between successive births is different for different regions, religion groups and education level. The median length of birth intervals in rural community of Ethiopia is 28 months and more than 75% of births occur within 3 years.

Key Words: Birth Interval, Lognormal distribution, Accelerated Failure Time Model

Introduction

Fertility depends not only on the decision of couples but also on socioeconomic, demographic, health-related as well as tradition-related and emotional factors. These factors affecting fertility may have varying effects on child spacing. Hence, birth history analysis undoubtedly provides useful information on reproduction and family formation. More in less developing countries longer gap between births allows a mother more time to recover from pregnancy and delivery; the next pregnancy and birth are more likely to be at full conception and growth; there is less competition between existing children for breastfeeding, food, nutrition, the mother's time, and other resources(National Research Council, 1989). Birth interval is affected by several factors and as a result for some women a birth interval is too short; for some women the interval is too long; and for other women it is just right. In this paper we look at both sides of the coin: what factors contribute to a short birth interval and what are the factors leading to a long birth interval?

Fitting various statistical distributions to birth intervals based on survey data could help to estimate the probability of different fertility levels. And the need for analyzing accelerated failure time model is used to investigating the effects and also relationship between failure time data (inter-birth interval) and important covariates.

Objective of the Study

The major objective is to identify the socio economic and demographic factors that influence intra-birth interval.

The Specific Objectives are:

i. To fit and select the distribution that provides a good fit to different birth intervals; and to calculate probabilities of birth by using the selected pdf

ii. To see the significant variables under consideration by using accelerated-failure-time model.

iii. To find common patterns in the distribution of birth intervals among social and demographic factors.

Data and Methodology

Secondary data from Ethiopian Demographic and Health Survey (EDHS) conducted by the Central Statistical Agency (CSA) during 2011 are used for this study.

Variables in the Study

The influential variables/factors included in the study are classified and coded as follows

No	Factors/ variables	Categories	No.	Factors/ variables	Categories
1.	Region	1 = Group-1 ⇛ {Tigray and Amahra 2 = Group-2 ⇛ {Affar Dire Dawa Harari and Somali 3 = Group-3 ⇛ {Addis Ababa and Oromiya 4 = Group-4 ⇛ {Ben – Gumuz Gambela and SNNP	4.	Sex of the 1st two children in a family	1=both males 2=both females 3=one male and one female
2.	Education level	0=illiterate 1=primary 2=secondary & above	5.	Wealth status	1=poor 2=middle 3=rich
3.	Religion group of a woman	1=Coptic Orthodox 2=Protestant 3=Muslim 4=Others	6	Survival status of index child (SSIC)	0=died as infant (before two years) 1=Survived

Technique of model Selection and Parametric Survival Analysis

Goodness of fit test: describes how well it fits a set of observations. It measures the compatibility of a random sample with a theoretical probability distribution function. Measures of goodness of fit typically summarize the discrepancy between observed values and the values expected under the model in question.

Assume that we have a random sample $t_1, \ldots, t_n$ from some continuous distribution with CDF *F(t)*. The empirical CDF is denoted by

$$F_n(t) = \frac{1}{n}[\text{Number of observation } \leq t]$$

The test problem we consider is given as

H_0: The data follow the specified distribution.

H_A: The data do not follow the specified distribution at a significance α-level.

The test statistic we use in this study is the Anderson-Darling statistic (A^2) defined as

$$A^2 = -n - \frac{-1}{n}\sum_{i=1}^{n}(2i-1).[\ln F(t_i) + \ln(1 - F(t_{n-i-1}))] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

We choose the distribution which proved to be best estimator of the first four or five birth intervals, that is, lognormal distribution.

Lognormal -Accelerated Failure Time Model: The accelerated failure time (AFT) model is a linear regression model in which the response variable is the logarithm or a known monotone transformation of a failure time (Kalbfleisch and Prentice, 1980). AFT model considered comparison intuitively by estimating the effects of covariates in terms of time ratios (TR) by taking one group as reference category (Kalbfleisch and Prentice, 1980).

Thus the lognormal hazard λ(t), survival S(t), and density f(t) functions of the baseline variable of birth interval data are:

$$\lambda_o(t) = \frac{\frac{1}{t\sigma 2\pi} exp\left\{-\frac{1}{2\sigma^2}[\ln(t) - \mu]\right\}}{1 - \Phi\left(\frac{\ln(t) - \mu}{\sigma}\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$S_o(t) = 1 - \Phi\left(\frac{\ln(t) - \mu}{\sigma}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$f_o(t) = \frac{1}{t\sigma 2\pi} exp\left\{-\frac{1}{2\sigma^2}[\ln(t) - \mu]\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where Φ(*z*) is the standard normal cumulative distribution function, σ is the standard deviation and μ is the mean of the normal distribution.

Therefore, under accelerated failure time model, the survivor function for the i^{th} individual corresponding to other explanatory variables is then

$$S_i(t) = P(T_i \geq t) = P\{\exp(\beta_o + \boldsymbol{\beta' Z_i} + \sigma\varepsilon_i) \geq t\}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Now, $S_i(t)$ can be written in the form

$$S_i(t) = P\{\exp(\beta_o + \sigma\varepsilon_i) \geq t/\exp(\boldsymbol{\beta' Z_i})\}$$

and the baseline survivor function, $S_o(t)$, the survivor function of an individual for whom **Z = 0**, is

$$S_o(t) = P\{\exp(\beta_o + \sigma\varepsilon_i) \geq t\}$$

It then follows that

$$S_i(t) = S_o\{t/\exp(\boldsymbol{\beta' Z_i})\} = 1 - \Phi\left(\frac{\ln(t) - Z{i'}\beta - \mu}{\sigma}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

This is the general form of the survivor function for the i^{th} individual in an accelerated failure time model. The factor ' exp(β'Z) is called an acceleration factor which tells us how a change in covariate values changes the time scale from the baseline time scale. To obtain the average time difference between the reference group and another covariates, the coefficients are suitably transformed by exponentiation (e^{β}), so that they can be interpreted as hazard time ratios.

Findings and Discussion

The Effect of Different Demographic and Socio-economic Covariates on Birth-Interval

The result from Table-2 shows the effect of covariates on the first birth interval in a multivariate context and lognormal accelerated failure time technique. The survival analysis indicates that the median duration of inter-birth interval is 28 months (Table-2). This is not similar in different regions, education level or religion groups. For example, Table-2 suggests that about 50 percent of women with no education had a second birth within 28 months after first birth compared with about 36 percent of those with secondary education. Results had been shown for all intervals; that is, secondary educated women space births more widely than their counterpart non-educated women, the effect being largest at higher parities.

Maternal education can influence birth spacing through a number of pathways. Mothers space births more widely because they may have better knowledge of contraception and are more likely to use more efficient methods. As demonstrated in the Ethiopian 2005 DHS published report, about 52.6 and 23.4 percent of women with secondary and primary education respectively were current users of contraception compared with only 10.0 percent of those with no education.

Table-2*: Summary results from Lognormal-accelerated failure-time model for the effect of Covariates on Birth Interval (First Birth Interval)*

Effect	**DF**	**Wald-Chi-Square**	**P-value**
Wealth	2	2.0134	0.3654
Education	2	22.505	<0.0001
Region	3	54.9922	<0.0001
Religion	3	25.9824	<0.0001
SSIC	1	6.5800	0.0103

Predictor		$\hat{\beta}$	S.E($\hat{\beta}$)	Z-Score	p-value	95.0% CI of β Lower	Upper	exp(β)
	Intercept	3.361	0.02697	120.59	0.000	3.308	3.414	28.817
Region	Group-2(ref)							
	Group-1	0.1365	0.0245	5.53	0.000	0.0883	0.1845	1.1460
	Group-3	0.0054	0.0212	-0.01	0.798	-0.0471	0.0362	1.0054
	Group-4	0.0723	0.0225	3.16	0.001	0.0281	0.1165	1.0749
Education level	Illiterate							
	Primary	-0.0305	0.01908	-1.08	0.110	-0.06791	0.0068	0.9699
	Sec.& above	0.249	0.0568	4.25	0.000	0.1376	0.3605	1.2827
Religion	Coptic-Orthodox(ref)							
	Protestant	-0.0160	0.0217	-0.87	0.459	-0.0586	0.0265	0.9841
	Muslim	-0.0836	0.0188	-4.46	0.000	-0.1206	-0.0467	0.9197
	Others	-0.0677	0.0373	-1.21	0.069	-0.1408	0.0054	0.9345

Wealth	Poor(ref)							
	Middle	-0.0256	0.0188	-1.43	0.174	-0.0625	0.0112	0.9747
	Rich	-0.0074	0.0155	-0.73	0.635	-0.0379	0.0231	0.9926
Survival status of index child (SSIC)	Survived(ref)							
	Died as infant	-0.0452	0.0175	-2.58	0.010	-0.0795	-0.0109	0.9558
	Scale	0.4814	0.0043			0.47312	0.48998	

Note: All the first groups of categorical covariates are used as reference groups.
exp (β) stands for time ratio.

Variations of the length of birth interval by region difference are also noticeable. The time to the second birth is 14.60 percent longer among group-1, 0.54 percent longer among group-3, and 7.49 percent longer among group-4 regions than group-2 regions (Table-2). The explanation should rather be sought through ethnic norms and practices that traditionally influence intervals between successive births.

There is an expected effect of the survival status of the index child on the transition to subsequent births. The death of the index child significantly reduces the transition time to subsequent births. For instance, in Table-2 the interval between the first and the second birth is 4.42 percent shorter if the first child died as an infant than if the child survived. The theoretical pathways through which childhood mortality affects fertility have been identified as physiological and behavioral replacement effects (e.g., Montgomery and Cohen, 1998). The physiological effect mainly operates through premature weaning (accustom) and shorten of the inter-birth interval following an infant death. In its usual interpretation, the behavioral hypothesis refers to the deliberate efforts a couple makes to bear another child in the hope of replacing the lost one. Again, within the framework of the behavioral effect, women with child loss experience are less likely to use contraception and, more likely to discontinue if they are already using contraception.

Further, some significant religions differences are also visible. Although not always significant Coptic-orthodox, Protestant, and Others like catholic and traditionalists tend to space births more distantly than Muslims. For instance in Table-2 about 50 percent of Coptic-orthodox women had a second birth within 28 months after first birth compared with about 54 percent of Muslims. At all parities there is no significant difference of length of birth-interval between successive children by sex-composition and wealth variation.

Conclusions

This study has highlighted the relative significance of socio-economic, demographic and socio-cultural factors on the duration of birth intervals in rural Ethiopia. For all birth intervals, the log likelihood ratios suggest that region, education level, survival status of index child and religion affiliation explain more of the variance in the dependent variable than the two other variables, namely sex composition and wealth variation. Although the modernizing effects of the education seem to be powerful influence on the timing of births variation, demographic background or difference in region are also supported by these findings.

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