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SOCIAL-DEMOGRAPHIC AND CULTURAL DETERMINANTS OF NIGERIAN WOMEN'S AGE AT FIRST BIRTH USING THE LOG LOGISTICS ACCELERATED FAILURE TIME MODEL

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ABSTRACT

Early age at first birth has many negative effects on women which includes but are not limited to truncation in education, maternal mortality, sexually transmitted infections, difficulties resulting from pregnancy before a woman is physically mature, cervical cancer, and missing life opportunities in general. In this study, we determined the factors that influence the age at first birth so as to promote child and maternal health in Nigeria. Secondary data from the 2018 Nigeria Demographic and Health Surveys (NDHS) and the Accelerated Failure Time (AFT) model were used in this study to establish the determinants of a woman's age at first birth in Nigeria. The Log logistics AFT model was used after the dataset failed to satisfy the Cox Proportional Hazard (CPH) model's assumption. The results show that women from the North Central (NC) will give birth before the women in the North West (NW) and South South (SS). Those with no education will give birth earlier than those with secondary education. Women who do not know their husband's status will give birth earlier than those that want the same thing as their husband. The women that are more exposed to early first birth as discovered from this study should be empowered and educated so as to discourage early marriage. Policy makers should take decisions to help promote the health of the mother and her child. This will reduce the number of school dropout of women and more opportunities for women over the course of life.

Contribution/Originality: The paper's primary contribution is to provide sufficient information on areas and subjects that have significant effects on age at first birth; and regions that are more susceptible to the negative effect of early age at first birth.

1. INTRODUCTION

Nigeria is a densely populated country with a population estimated to amount to 206 million. By 2050, it is estimated that the population of Nigeria would have risen by 51% which will be 4.12% of the world's total population. Nigeria is experiencing a fertility rate which stands at 5.42 which is the least in recent times, with the highest being 6.76 in 1980 and 1985. The current fertility rate is projected to remain constant in 2030, 2035, 2050. That is an average of 5.42 children per woman of marriageable age. High fertility rate has severe implications on the health and wealth of any developing country, such is the case of Nigeria today, a country having an infant death

of 54.7 for every 1000 live births and about 90.2 death of children before their 5th birthday for every 1000 live births due to inadequate health care of the mother and baby.

Our major concern in this research is to determine the factors that affect the age at first birth in Nigeria as the woman's age at first birth is not only to a large extent a determinant of the fertility of a population, it is also an important determinant of the health and wealth of the mother. The birth of a child is an important event in the life of every woman especially in this part of the world where it signifies the beginning of the journey to motherhood for every female. In the absence of any fertility regulation, the age at which childbearing starts affects the number of children a woman carries during her reproductive period (Ngalinda, 1998). The age at the birth of the first child has a significant impact on population as females who starts giving birth in their adolescent years are more fertile that those in later years (Bumpass, Rindfuss, & Jamosik, 1978).

A delay in first birth has often led to decrease in fertility in researches made in some countries. Yayeh and Muluneh (2015) identified the determinants of fertility in other to reduce high population growth and promote child and maternal health in Ethiopia. They considered the mother's place of residence, education level, region, wealth index, age at first birth, current age, contraceptive use and media exposure. They found them to be significant determinants at 5% level of significance. They concluded that empowering women, encouraging education in women, discouraging early marriage thereby increasing age at first birth are important considerations to be made to reduce high fertility in Ethiopia. Early age at first birth affects negatively mobility, education, maternal mortality, sexually transmitted infections, difficulties resulting from pregnancy before a woman is physically mature, cervical cancer, and life opportunities in general (Nour, 2006). As a result, the young woman's ability to make decisions about her own reproductive health is diminished. The age at first birth has been linked to a slew of health issues for both the mother and the child. Population growth has also been found to be a result of a child's birth at a young age. In order to protect the health of women and their children, it is now necessary to consider the age at first birth (Haque & Sayem, 2009).

Adolescents in schools who give birth at such an early age maybe faced with the option of dropping out of school, women who work may find themselves being unable to cope with work and may have to resign. Young age at marriage and childbearing may limit women's prospects later in life, and young age at first childbearing also poses health hazards to young women. It may also result in lesser investments in each child's health and education, contributing to poverty transmission over generations (Quisumbing & Maluccio, 2003).

Understanding the effects of the various factors that influence the age at first birth and their impact on the survival time is necessary to put policies that will shift (adjust) the child bearing age as the fertility rate of a population which is majorly influenced by the age at first birth is one of the determinants of population growth. The health of a child and its mother is also very crucial. It is therefore important to study the age at first birth as it has dire consequences not only on the health of a child but also on the health of its mother. Hence, it is pertinent to study the factors that determine the age at first birth as this will explain the effects that each of these factors have on the age at first birth and this will in turn help policy makers to make decisions to help curb the issue of high population growth in Nigeria and also make decisions to promote the health of the mother and her child. This study will also provide a solution to the problem of addressing the limitations of the CPH model and provides model that gives an easier interpretation of the output. While the CPH model has proven to be an effective tool for analyzing survival data, any breach of the CPH model's assumptions can cause the model to be biased and unreliable. The AFT model has emerged as a viable option for dealing with non-proportional hazards in a dataset.

The goal of this study is to establish the determinants of a woman's age at first birth in all the 36 states and Federal Capital Territory (FCT) in Nigeria. This will be achieved by: (i) testing the proportional hazard assumption of the CPH model using the mother's age at first birth as the survival time. (ii) modeling the mother's age at first birth as a function of some covariates using the AFT model to test for the significance of the factors on the survival time.

In low fertility countries, deferring birth to later ages is becoming more common.

The female age at first birth has grown in both low and high fertility countries, according to the World Fertility Report 2013. However, in many high-fertility nations, particularly in Sub-Saharan Africa, the average age at first birth is still under 19 years old, according to statistics from nine of the countries studied. In Nigeria, the average age at first birth is 19.73 years, whereas in low-fertility countries, such as England and Wales, where the average age at first birth is 29.9 years, deferral of first birth to later ages is becoming more common. The tendency of women to put off having children until later years is one of the proximal drivers of the overall drop in total fertility rates in OECD countries (OECD, 1999a). The postponement of childbearing also has an effect on the health of a woman; as the age of a woman advances the probability of the woman experiencing pregnancy becomes low. Childbearing at an advanced age also possess a health risk on the child. It is therefore a prerequisite to study the age at first birth to be able to make policies in this area for the overall health of the population as the family is the smallest unit of the population.

Nahar, Zahangir, and Shafiqul (2013) found that illiterates or primary school, rural dwellers, Muslims, and those from middle-class or poor homes have a quicker rate of having their first child. There was a link between the age at first birth and the age difference between the spouses, age at first marriage, ever use of any contraception, respondent's working status, religion, and husband's occupation. They discovered that a woman's age at first birth has a direct association with fertility and plays a key influence in her life. In their late thirties, women face a considerable decrease in fecundity and an increase in the likelihood of infertility. Women who have never conceived at any age above 30 have a reduced chance of becoming pregnant. Because they could be dealing with primary infertility, the negative relationship between female age and fertility is significantly stronger among those that have no record of conception (Steiner & Jukic, 2016).

Ngalinda (1998) argues that rather than age at first birth to be seen to have an effect on fertility through age at first marriage, it rather has a direct relationship since marriage (legal union) is not the only criteria for access to childbearing. The majority of fertility experts believe that childbearing occurs only within the context of marriage. The age at first marriage is then seen as a primary proximal factor of fertility. This belief may have been correct in most traditional communities, when unmarried births were frowned upon and virginity was required for marriage. This premise is no longer valid in today's environment, since a large number of children are born outside of marriage.

Moore and Hofferth (1978) were also motivated to carry out a study where it was hypothesized that the age at first birth would be a better predictor of fertility than the age at first marriage and found that the magnitude of the significance of age at first birth by far exceeds that of the age at first marriage. Bloom and Trussell (1984) fitted survey data to the Coale-McNeil model to determine the factors influencing delay in childbearing. The parameters were allowed to depend on the covariates. Not only was education revealed to be a driver of delayed childbearing, but it also had a positive relationship with heterogeneity among women's ages at first birth, and it was linked to childlessness.

According to Gangadharan and Maitra (2003) neglecting the link between the heterogeneity factors in three variables (age at marriage, time between marriages, and age at first birth) leads to inconsistency in estimates. They also discovered that educated women married later than non-educated women, but that education had no bearing on the time between marriage and the first child. One of the first academics to look into the impact of education found that a woman's first birth signals her taking on the obligations and responsibilities of a mother, frequently at the expense of further education and career-building.

Rindfuss and St John (1983) discovered that education at marriage was the most important predictor of age at first birth, and the relationship was positive. A few social determinants such as race, smoking at young ages, and religion had a direct effect on age at first birth. Variables like the religious status, residence, husband's occupation, husband's age, and wealth index are positively linked to the age at first birth, according to Hossain and Majumder

(2019) showed that the respondent's highest educational level, present age, division, occupation, and husband/educational partner's level are all negatively connected to the mother's age at first birth in Bangladesh. According to Mugarara, Kaberuka, and Atuhaire (2016) Uganda's mean age at first birth is about 18.4 years. In Uganda, age at first sexual intercourse, age of respondent, religion, region, education, and residence are the most important factors that influence the age at which a child is born.

Though many original researches have worked on the determinant factors of age at first birth, their studies focused on other countries; while the few studies that focused on Nigeria either covered selected states, used the outdated NDHS data or considered few factors. In this study, all the states in Nigeria including the FCT were considered, the updated and most recent NDHS data were used, and many factors were considered.

2. METHODS

Secondary data from the NDHS completed in 2018 by the National Population Commission were used in this study. The variables extracted are: age at first birth, region, education, residence, religion, husband's desire for children, age at first sex, age at first marriage, and knowledge of ovulatory cycle.

The CPH Model:

The CPH model (Cox, 1972) is used to investigate the relationship between a subject's survival time and one or more explanatory variables.

The CPH model is given in Equation 1

$$\eta(t/q) = \eta_0(t)e^{q^i\beta} \tag{1}$$

Where,

q is a vector of explanatory variables.

β is a vector of the regression coefficient.

$\eta_0(t)$ is a baseline hazard function, it is the hazard function of the population of subjects with q = 0.

The CPH model can also be expressed as stated in Equation 2:

$$\eta(t/q) = \eta_0(t)\exp(\beta_1 q_1 + \beta_2 q_2 + ... + \beta_p q_p) \tag{2}$$

The time between the birth of the woman and the birth of her first child, or the date of the interview, is the woman's survival time. If the first birth does not happen, the survival status is written as 0, and if it does, it is coded as 1.

Since the baseline hazard is unspecified, ordinary Maximum likelihood estimation (MLE) methods cannot be used to estimate the model's parameters. In Cox (1975) proposed a partial likelihood for the parameter β without involving the baseline hazard $\lambda_0(t)$.

The CPH model assumes that the hazard function remains constant over time and this is mostly violated by real life data. If this assumption is violated, using the CPH model may lead to inaccurate estimates of the parameters.

2.1. The AFT Model

Survival data is also analyzed using the AFT model. The model measures the effect of covariate on survival time acceleration or deceleration. The AFT model's log-linear form in Equation 3 depicts the mathematical relationship between the set of variables and log of time, which is written as:

$$\log_e T_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_p X_p + \sigma\varepsilon_i \tag{3}$$

where,

T_i is the survival time.

β_0 is the intercept.

$\beta_1, \beta_2, ..., \beta_p$ are the model's coefficients.

X_i are the explanatory variables.

σ is the scale parameter. ε_i is an error term that is assumed to follow a probability distribution.

There is a corresponding probability distribution for T_i for each ε_i.

The survival ratios (SR) are the quantities $\exp(b_i)$. A SR higher than one for a continuous variable shows that the survival time increases as the pth explanatory variable increases. A detailed explanation on how to interpret the SR was done in Obite, Bartholomew, Nwosu, Anyiam, and Aminu (2021). The first levels for all the categorical variables were used as the reference level.

The MLE approach is used to estimate the coefficients of the model. The likelihood function (L) of the survival times $t_1, t_2, ..., t_n$ is given in Equation 4

$$L = \prod_{i=1}^{n} [g_i(t_i)]^{\alpha i} [s_i(t_i)]^{1-\alpha i} \tag{4}$$

where

$g_i(t_i)$ is the density function for the ith individual at time t_i.

$s_i(t_i)$ is the survival function for the ith individual at time t_i.

α_i is the event indicator for the ith individual.

where

$$\alpha_i = \begin{cases} 1, & \text{if the ith observation is event} \\ 0, & \text{if the ith observation is censored} \end{cases}$$

The survival function of $\varepsilon_i \left(s_{\varepsilon i}(q_i)\right)$ can be used to express T_i $\left(s_i(t_i)\right)$ survival function. This will give us Equation 5:

$$s_i(t_i) = s_{\varepsilon i}(q_i) \tag{5}$$

where

$$q_i = \frac{\log T_i - \beta_0 - \beta_1 x_1 - ... - \beta_p x_p}{\sigma}$$

Substituting these values will change Equation 4 to Equation 6:

$$L = \prod_{i=1}^{n} [\sigma t_i]^{-\alpha i} [g_{\varepsilon i}(t_i)]^{\alpha i} [s_{\varepsilon i}(q_i)]^{1-\alpha i} \quad (6)$$

Taking the ln of Equation 6 gives us Equation 7:

$$\ln L = \sum_{i=1}^{n} [-\alpha_i \ln(\sigma t_i) + \delta_i \ln\{g_{\varepsilon i}(q_i)\} + (1-\alpha_i) \log\{s_{\varepsilon i}(q_i)\}] \quad (7)$$

The functions $g_{\varepsilon i}(q_i)$ and $s_{\varepsilon i}(q_i)$ depends on the distribution of T_i and the MLE using the Newton Raphson procedure is used to estimate parameter σ, b_0 and $b_1,...,b_n$ (Obite et al., 2021).

For the purpose of comparing and selecting the optimal AFT model, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are utilized. The best AFT model is the model with the lowest AIC and BIC.

3. RESULTS AND DISCUSSION

The women for this study are aged 15-49. The survival time is measured from the date of the woman's birth, till the day of exposure to first birth. For those who have not experienced the event of interest at the date of the interview, the survival time is their current age.

The following independent variables or factors were considered.

- Region:

Region of respondents is categorized into South-west (SW), SS, South-east (SE), NC, NW and North-east (NE), with the NC set as the reference category.

- Type of place of residence:

The respondent place of residence is classified into Rural and Urban with rural set as the reference category

- Education:

The respondent level of education is categorized into, no education, primary education, secondary education and higher education. No education was set as the reference category

- Religion:

They are classified into catholic, other Christian, Islam, traditionalist and others. Catholic was set as the reference category.

- Husbands desire for children.

This is classified into both want the same (BWS), husband wants more (HWM), husband wants fewer (HWF) and don't know. Both want same was used as the reference category.

- Age at first sex.
- Age at first marriage.

This is classified into none, folkloric, traditional and modern methods.

- Knowledge of ovulation cycle

This is classified into during period (DP), after period ended (APE), middle of the cycle (MC), before period begins (BPB), at any time (AT), other and don't know.

- Husbands' educational attainment

The respondent husband's level of education is categorized into, no education, primary education, secondary education and higher education. No education was set as the reference category.

The covariates listed above were selected based on literature (Hossain & Majumder, 2019; Mugarara et al., 2016; Nahar et al., 2013). The literature showed that age at first birth is affected by various factors, socio-

economical, demographical, cultural and social. The researcher added a biological factor, knowledge of ovulatory cycle to test its effect on the age at first birth.

Table 1. The Covariates, their levels (Categories) and frequency.

Factor	Level	Frequency
Region	NC	1445
	NE	1569
	NW	2094
	SE	943
	SS	792
	SW	1193
Residence	Urban	3003
	Rural	5033
Education	No education	3359
	Primary	1328
	Secondary	2607
	Higher	742
Religion	Catholic	752
	Other Christian	2764
	Islam	4461
	Traditionalist	26
	Other	33
Desire	BWS	3269
	HWM	3478
	HWF	427
	Don't know	862
Ovulatory Cycle	DP	52
	APE	4451
	MC	2039
	BPB	983
	AT	273
	Other	13
	Don't know	225
Husbands Education	No education	2497
	Primary	1215
	Secondary	2921
	Higher	1290
	Don't know	113

Table 1 shows the covariates, their level and their frequencies. For the independent variables the following levels had the highest frequencies: for the region, the women from the NE; the women who lived in the rural places for the type of place of residence; the women with no education for the educational attainment of the respondent; the women that practiced Islamic religion in religion; the women whose husband want more children for husband's desire for more children; the after period had ended for ovulatory cycle; and the women whose husbands had attained an education up to the secondary school level for husband's education. The graph of the age of respondents at first birth by frequency is given in Figure 1 while the cumulative survival graph of the age of respondent at first birth is given in Figure 2.

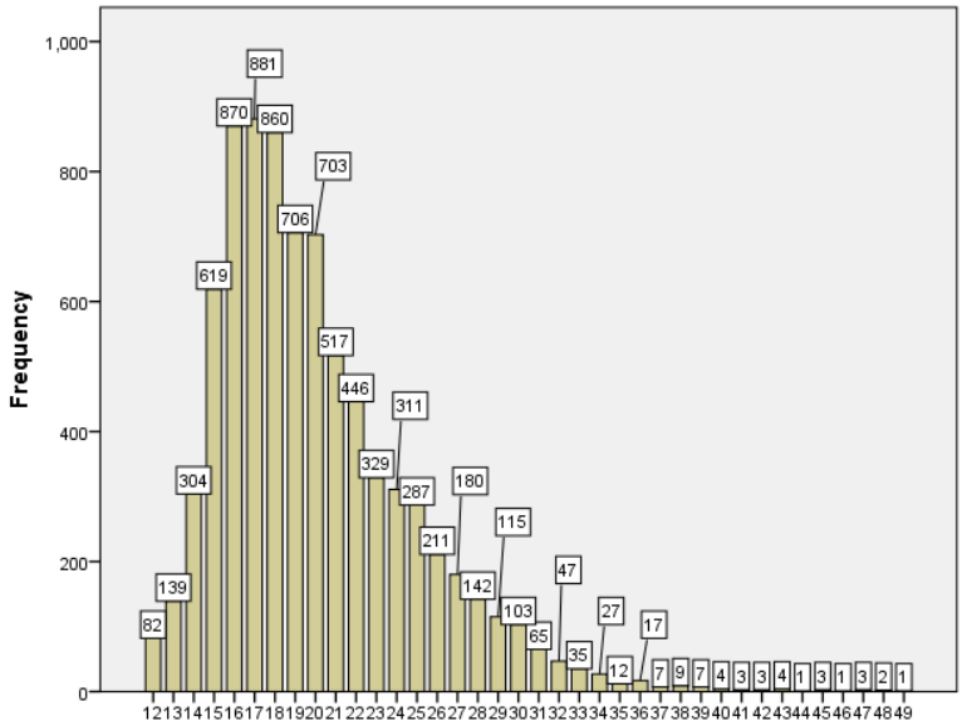

Figure 1. The frequency of age of the women at first birth.

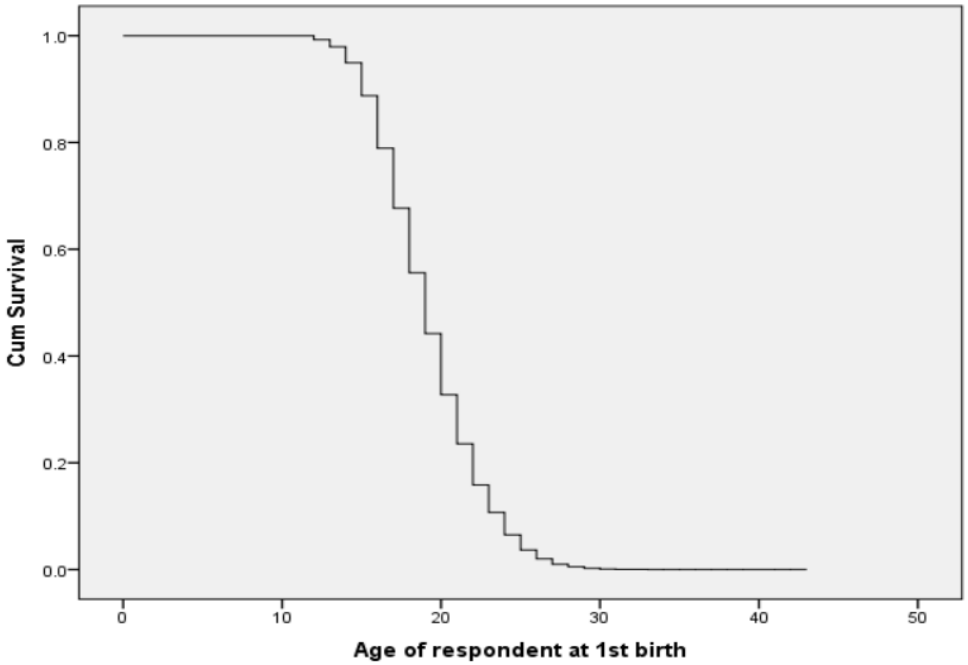

Figure 2. The cumulative survival graph of the age of respondent at first birth.

Figure 2 shows a substantial decline in survival from the ages of 13 to 30, which means that majority of first births occurred within this age interval.

The test for the proportional hazard assumption is not satisfied as the p-values < 0.05 for some of the variables and the global test which means a significant relationship between time and the residuals.

The CPH model can no longer be used for this work since the assumption is not met. We will proceed to using the AFT model to estimate how the different factors accelerate or decelerate the age at first birth as it is a viable alternative in the presence of non-proportional hazards. The Weibull AFT (WAFT), Lognormal AFT (LNAFT),

Exponential AFT (EAFT) and Log logistics AFT (LLAFT) were used to model the data and the best model was chosen using the least AIC and BIC as shown in Table 2.

Table 2. The different AFT models.

Model	Loglikelihood	K	Aic	Bic
WAFT Model	-20981.9	2	41967.8	41971.61
EAFT Model	-30521.5	1	61045	61046.91
LNAFT Model	-18639	2	37282	37285.81
LoLAFT Model	-17488	2	34980	34983.81

The LLAFT model has the least AIC and BIC and is chosen as the best fit AFT model for modeling the effect of all the factors on the age at first birth in Nigeria. The parameter estimates, survival ratios and the p-values of all the coefficients of the LLAFT model are given in Table 3.

Table 3. The parameter estimates, survival rates and p-values for the LLAFT model.

Factor	Levels	B	Exp(B)	P-Value
Intercept		2.164		0.000*
Religion	Other Christian	-0.006	0.994	0.220
	Islam	-0.003	0.997	0.627
	Traditionalist	0.001	1.001	0.979
	Other	-0.025	0.975	0.234
Region	NE	-0.002	0.998	0.614
	NW	0.010	1.010	0.013*
	SE	0.003	1.003	0.529
	SS	0.014	1.014	0.009*
	SW	-0.001	0.999	0.802
Residence	Rural	-0.002	0.998	0.540
Highest educational level	Primary	-0.011	0.989	0.010*
	Secondary	0.005	1.005	0.256
	Higher	0.015	1.015	0.015*
Age at first marriage		0.035	1.036	0.000*
Age at first sex		0.009	1.009	0.000*
Husband/partners educational level	Primary	-0.006	0.994	0.199
	Secondary	-0.003	0.997	0.386
	Higher	-0.002	0.998	0.620
	Don't know	0.011	1.011	0.297
Knowledge of ovulatory cycle	APE	-0.001	0.999	0.934
	MC	0.000	1.000	0.984
	BPB	-0.014	0.986	0.354
	AT	-0.007	0.993	0.663
	Other	-0.038	0.963	0.224
	Don't know	0.012	1.012	0.452
Husbands desire for children	HWM	0.000	1.000	0.897
	HWF	-0.002	0.998	0.644
	Don't know	-0.012	0.988	0.006*
Log(scale)		-2.758		0.000*

Note: * $p < 0.1$.

3.1. Religion

The age at first birth for other Christians, Islamists, Traditionalists and other religion did not differ significantly from Catholics since their p-values (0.22, 0.627, 0.979 and 0.234 respectively) > 0.05.

3.2. Region

The age at first birth for those in NW and SS differ significantly from those in NC since their p-values (0.013 and 0.009 respectively) < 0.05, while those in NE, SE, and SW did not differ significantly from the NC. The age at first birth for the women in the NW and SS accelerates by 1.01%and 1.41% respectively when compared to those in NC. This implies that the women in NC will give birth before those in NW and SS.

3.3. Residence

The survival time of age at first birth for women in rural and urban areas did not differ significantly since their p-value (0.54) > 0.05.

3.4. Woman's Education

The woman's highest educational level for primary, secondary and higher education were compared with the reference category, no education and it was discovered that the age at first birth for those with primary and higher education differ significantly from those with no education since the p-values (0.010 and 0.015 respectively) < 0.05 while there is no significant difference for those with primary and no education since the p-value (0.256) > 0.05. The age at first birth for the women with primary school education decelerates by 1.09% while it accelerates by 1.15% for those with higher education when compared to those with no education. This means that women with higher education will give birth later than those with no education while those with primary education will give birth before their counterparts with no education. While this is in line with the findings in Mugarara et al. (2016) that women with little or no education give birth significantly earlier than those with higher education, it contradicts (Hossain & Majumder, 2019).

3.5. Age at Marriage

A one-unit rise in a woman's age at first marriage causes her age at first birth to accelerate by 3.6% which means that the respondents with an earlier age at first marriage will have an earlier age at first birth than those with late age at first marriage.

3.6. Age at First Sex

A one-unit rise in a woman's age at first sex causes her age at first birth to accelerate by 0.9% which means that the respondents with an earlier age at first sex will have an earlier age at first birth than those with late age at first sex. This is in line with the findings in Nahar et al. (2013) and Mugarara et al. (2016).

3.7. Husband/Partners Educational Level

The age at first birth for women that the highest educational level of their husband is primary, secondary, higher or do not know, did not differ significantly from those with no education since all the p-values > 0.05.

3.8. Knowledge of Ovulatory Cycle

The age at first birth for women with ovulatory cycle APE, MC, BPB, AT, other and do not know, did not differ significantly from those with ovulatory cycle during their period since all the p-values > 0.05.

3.9. Husbands Desire for Children

The values of the categories of husband's desire for more children were compared with the reference category both want the same.

The age at first birth for women that their husband wanted more or fewer children do not differ significantly from those that have the same desire for the number of children since the p-values > 0.05 while those that did not

know their husband's desire for children differ significantly from those that have the same desire for the number of children since the p-value (0.006) < 0.05. The age at first birth for women who do not know their husband's desire for children decelerates by 1.2% when compared to those with similar desire for children. This means that the women who do not know their husband's status with respect to this will give birth earlier than those who want the same thing as their husbands.

4. CONCLUSION

Early age at first birth though has little positive effect on women and the economy, it has many negative effects on women and this study is determined to know the factors that influence the age at first birth so as to promote child and maternal health in Nigeria. The AFT model was used to establish the determinants of a woman's age at first birth in Nigeria. The AFT model was used after the dataset failed to satisfy the CPH model's assumption. The LLAFT model gave the best fit. The women that are more exposed to early first birth as discovered from this study should be empowered and educated so as to discourage early marriage. Policy makers should take decisions to help promote the health of the mother and her child. This will reduce the number of school dropout of women and more opportunities for women over the course of life.

A non-parametric variant of the AFT model could be used to further investigate this data, as it does not require the specification of the dataset's distribution.

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