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Factors affecting the duration of gestation among women taking prenatal care at Gondar referral hospital, Ethiopia

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Abstract

Background: Pregnant women taking prenatal care is vital for the health of the mother and the fetus. The duration of pregnancies provides a useful measure of a woman's natural length of pregnancy and may help in predicting an individual woman's due date. The objective of this study was to understand the factors affecting the duration of gestation among women taking prenatal care in Gondar referral hospital, Ethiopia.

Methods: A quantitative research design using secondary data available in the form of antenatal care (ANC) cards in the Gondar teaching referral hospital data set. Kaplan–Meier estimate was used to explain the median survival time of duration of gestation. A multivariate AFT model was performed to identify the factors related to the duration of gestation among women.

Results: The mean time of the length of pregnancy was 39.5 weeks. The factors such as, the age of women, number of children, number of doctor consultations, and the stage of gestation were found to be statistically significant ($p < 0.05$) for the survival time of time to birth of pregnant women in Ethiopia. Weibull AFT model was found to be the best model for predicting the time to birth of pregnant women in Ethiopia.

Conclusion: We did not see associations between length of gestation and blood pressure and bleeding during early pregnancy. We also did not find an association with the presence of disease, which has been associated with the length of pregnancy. The frequency of visiting a doctor during the gestation period enhances the length of the gestation period. The shorter gestation period from the due date is dangerous to the health of both mother and her fetus.

KEYWORDS

antenatal care, duration of gestation, parametric survival analysis, pregnant women

1 | INTRODUCTION

Prenatal care services give an opportunity to encourage healthy behaviors during gestation, recognize and treat health problems, and increase awareness of hazard signs that may occur during pregnancy.[1–3] During this serious prenatal period, women and the fetus face many risks that are life-threatening to them and could directly impact their survival.[4–6]

Despite the opportunity they have in terms of access to health services that give antenatal care (ANC) service, it is quite common that women residing in urban parts of Ethiopia do not use ANC facilities according to the World Health Organization (WHO) recommendation.[7] For instance, the number of pregnant women who had their first ANC engagement within the first trimester was found to be low.[8]

Even if prenatal care service handling is progressively available to women in low- and middle-income countries, the content, timing, and frequency of ANC services are insufficient.[9,10]

Gestation is the period of time between conception and birth. Throughout this time, the baby develops and progresses inside the mother's uterus. Gestational age is the common term used during pregnancy to know how far the pregnancy is. It is measured in weeks, from the first day of the women's last menstrual cycle to the due date.

The observed difference in the gestational extent may be due to errors in gestational age estimation. Natural conception is unobservable, and all estimates of the start of pregnancy are inexact. An alternative cause of variability and perhaps the least implicit is normal variation in the pace of fetal maturation and the timing of natural delivery. The possibility of natural variability is plausible.[11,12] Error and natural variability are vague without a careful measure of gestational age. Thus, in preceding studies, features that have been related to the length of gestation may have risen from mistakes in gestational age estimation or natural length of pregnancy or both.

Therefore, because of the limited scope of prenatal care outcomes as factors affecting the duration of gestation among women taking prenatal care considered in most studies, there have been calls to widen the outcomes in the evaluation of the factors that are affecting the duration of gestation among women taking prenatal care to establish the broad effectiveness of its impact.[13] These calls underlie the motivation for the present study and it is intended as a contribution to the efforts being made to provide the duration of gestation among women to take prenatal care before the time of delivery.

The study contributes to providing insightful and new knowledge that enriches an existing understanding of factors affecting the duration of gestation for women taking prenatal care. This study also provides information that would be helpful for decision-makers in formulating policies to mitigate the factors affecting the duration of gestation. Finally, it helps as a basis for further investigation in the study area and the results of the study can initiate and encourage various researchers to conduct further studies on a wider scale through the consideration of other dimensions of the problem.

No study has been conducted in our country that reports factors for duration of gestation among women taking prenatal care. Knowing factors that affect the duration of gestation will help in taking appropriate care of the problem. The objective of this study was to understand the potential factors affecting the duration of gestation among women taking prenatal care in Gondar referral hospital, Ethiopia.

2 | METHODOLOGY

2.1 | Research design

A quantitative research approach was used to conduct the study. The reason behind using these designs is that they will conveniently be found suitable in enabling the researcher to assess, describe, and determine the problem under study.

2.2 | Data source and research instrument

In this study, secondary data from the hospital's registry was used to retrieve data on prenatal care. Data were collected using structured and pretested questionnaires, which consists of sociodemographic characteristics, gestational information, and other related variables. A questionnaire was developed by authors after reviewing different kinds of literature on the topic and validated by professional experts. Two consecutive days of training to the data collectors and supervisors on the objectives, relevance of the study, ethical concern, and techniques of interviews were given before the actual data collection. Before data collection, the Research Ethics Committee approval was taken from the University of Gondar, College of Natural and Computational Science, and informed consent and confidentiality were assured by data collectors to the participants.

2.3 | Inclusion criteria

All pregnant mothers who visited ANC in the University of Gondar referral hospital from 2016 to 2018 were included in the study.

2.4 | Study variables

2.4.1 | Dependent variable

The dependent variable of this study was the duration of gestation among women taking prenatal care. It was measured in weeks. The response can be censored by the status of lost to follow-up or transfer to another hospital or clinic.

2.4.2 | Independent variables

Variables that are expected to affect the response or outcome are called independent variables or covariates or predictor variables. They can be either categorical or continuous. The descriptions of the independent variables are presented in Table 1.

2.5 | Methods for data analysis

In this study, we used four statistical approaches. First, we used descriptive statistical methods to see the nature of the data. Second, we used the Kaplan–Meier survival curves to estimate the survival probabilities for the duration of gestation. Third, we applied the log-rank test statistic to assess if there is a significant difference between proposed categorical factors or covariates on length of pregnancy. Finally, we used the accelerated failure time (AFT) model to establish the relationship between the survival probabilities and the explanatory variables.

The Kaplan–Meier estimator of the survivorship function (or survival probability) $S(t) = P(T \geq t)$ is defined as

$$\hat{S}_{(t)} = \prod_{t_{(i)} \leq t} \left(\frac{n_i - d_i}{n_i} \right)^{\delta_i} = \prod_{t(i) \leq t} \left(1 - \frac{d_i}{n_i} \right)^{\delta_i},$$

with the convention that $\hat{S}(t) = 1$ if $t \leq t$ (1), where $\delta_i = 1$ is uncensored observation, $\delta_i = 0$ is the censored observation, $t(1)$, ...,$t(m)$ is the set of m distinct death times observed in the sample, d_i is the number of death at t (i), and n_i is the number of individuals "at risk" right before $t(i)$.

TABLE 1 Description of the independent variables

Variables/factors	Description	Categories (if any)
Age	Age of women was measured in years	
Women education	Education level of women	Uneducated
		Had primary education
		Secondary education and above
Marital status	Marital status of women	Married
		Widowed
		Single
		Divorced
Place of residence	Place of residence of women	Urban
		Rural
Employment status	Employment status of women	Employed
		Unemployed
Number of children	Number of children	No children
		1–2 children
		More than 3 children
Number of times consulted a doctor	Number of times consulted a doctor in relation to the current pregnancy	
Blood pressure	Women's blood pressure	Normal
		High
Presence of other diseases	Presence of any other disease/health problem other than blood pressure	No disease
		Anemia
		Other
Stage of gestation	Stage of gestation women had attained	First trimester
		Second trimester
		Third trimester
Length of bleeding (in days)	Length of bleeding during the menstrual cycle (measured in days)	

2.5.1 | Parametric model

A link to parametric survival models derives through alternate functions for the baseline hazard. In this case, we can let the baseline hazard be a parametric form, such as exponential, log normal, and Weibull; for example, in exponential regression, the baseline survivorship function is as follows:

$$S = (t, X, \beta) = \exp\left[\frac{-t}{\exp(\beta_0 + \beta_{1X})}\right].$$

These parametric baseline hazards then undertake parametric survivorship, such as a flat downslope of the survival plot. Although the parametric models might be somewhat more efficient, they have more assumptions.

2.5.2 | Model selection criteria

The log-likelihood, Akaike information criteria (AIC), and the Bayesian information criteria (BIC) were used to assess the fit of the models. The AIC and the BIC are frequently calculated and compared distinctly among different models to determine the best-fitting model. In all cases, the lower the AIC and BIC, the better the model. Literature suggests that AIC will choose a more complex model irrespective of sample size, while BIC is more likely to choose a simpler model.

3 | RESULTS AND DISCUSSION

3.1 | Descriptive survival analysis

In our data, the average length of pregnancies was 39.5 weeks and the length of pregnancy for pregnant women varies from a minimum of 31 weeks to a maximum of 43 weeks. This average is not a traditional "predictor," in that we used the lengths of pregnancies occurring. In effect, the duration of other pregnancies provides information about a given woman's natural length of pregnancy.

Table 2 shows that the mean age of the pregnant women was 27.9 years, and the age of pregnant women varied from a minimum of 18 years to a maximum of 43 years. The number of times pregnant women consulted a doctor during their current pregnancy varied from 1 to 11, with an average mean of around 4.7 consultancies per woman. The length of bleeding during the menstrual period varied from 2 to 5 days among pregnant women, with a mean of 3.3 days per woman and a standard deviation of 0.8 days.

Table 3 shows that out of a total of 422 pregnant women considered in this study, 239 (56.64%) were living in the Gondar town and the rest 183 (43.36%) women were living in a rural area or out of the urban area. One hundred and twenty-nine (30.57%) pregnant women were uneducated, 125 (29.96%) had primary education, and the remaining 168 (39.47%) had secondary education or above. Two hundred and forty (56.87%) were employed and the rest of 182 (43.13%) were unemployed. Two hundred and ninety-eight (70.62%) of the pregnant women were currently married, 61 (14.45%) were currently widowed, 26 (6.16%) were single, and the remaining 37 (8.77%) were divorced at the time of their last visit to the doctor. Also, Table 2 shows that 266 (63.03%) of the pregnant women had normal blood pressure and the other 156 (36.97%) women had high blood pressure. One hundred and eight (25.6%) pregnant women had no children and 261 (61.85%) of the pregnant women already had 1–2 children, and the remaining 53 (12.55%) had three to four children.

3.2 | Nonparametric survival analysis

The estimates of the overall Kaplan–Meier survivor function presented in Figure 1 show a sharp decline after 30 weeks of follow-up. The estimated survival curve has its minimum of 0.5 at 43 weeks because the largest observed time was event observation.

3.3 | Parametric regression modeling of survival time of duration of gestation

3.3.1 | Univariate analysis

The log-rank test results presented in Table 4 show that age of women, number of children, marital status, stage of gestation, and doctor consultations had a significant effect on the duration of gestation among women taking prenatal care, while the length

TABLE 2 Summary statistics of sociodemographic variables for the duration of gestation (continuous variable)

Covariates	Number of observation	Mean	SD	Min	Max
Length of pregnancy	422	39.5	0.326	31	43
Age	422	27.82464	6.002182	18	43
Total number of doctor consultations during the gestation period	422	4.744076	1.927646	1	11
Length of bleeding (in days) during menstrual period	422	3.348341	0.7975524	2	5

TABLE 3 Summary statistics of sociodemographic variables for the duration of gestation (categorical variables)

Covariates	Categories	Number (%)	Number of events (%)	Censored (%)
Place of residence	Urban	239 (56.64%)	139 (58.16)	100 (41.84)
	Rural	183 (43.36%)	118 (64.48%)	65 (35.52)
Educational level	Uneducated	129 (30.57%)	73 (56.59%s)	56 (43.41)
	Primary	125 (29.96%)	79 (63.20)	46 (36.80)
	Secondary and above	168 (39.47%)	105 (62.50)	63 (37.50)
Employment status	Employed	240 (56.87%)	142 (59.17)	98 (40.83)
	Unemployed	182 (43.13%)	115 (63.19)	67 (36.81)
Stage of gestation	First trimester	15 (3.55%)	4 (26.67)	11 (73.33)
	Second trimester	119 (28.20%)	57 (47.90)	62 (52.10)
	Third trimester	288 (68.25%)	196 (68.06)	92 (31.94)
Number of children	No children	108 (25.6%)	73 (67.59)	35 (32.41)
	1–2 children	261 (61.85%)	148 (56.70)	113 (43.30)
	3–4 children	53 (12.55%)	36 (67.92)	17 (43.30)
Marital status	Married	298 (70.62%)	177 (59.40)	121 (40.60)
	Windowed	61 (14.45%)	37 (60.66)	24 (39.34)
	Single	26 (6.16%)	21 (80.77)	5 (19.23)
	Divorced	37 (8.77%)	22 (59.46)	15 (40.54)
Status of blood pressure	Normal	266 (63.03%)	164 (61.65)	102 (38.35)
	High	156 (36.97%)	93 (59.62)	63 (40.38)
Presence of disease	No disease	307 (72.74%)	186 (60.59)	121 (39.41)
	Anemia	54 (12.79%)	3 5(64.81)	19 (35.19)
	Other	61 (14.47%)	36 (59.02)	25 (40.98)

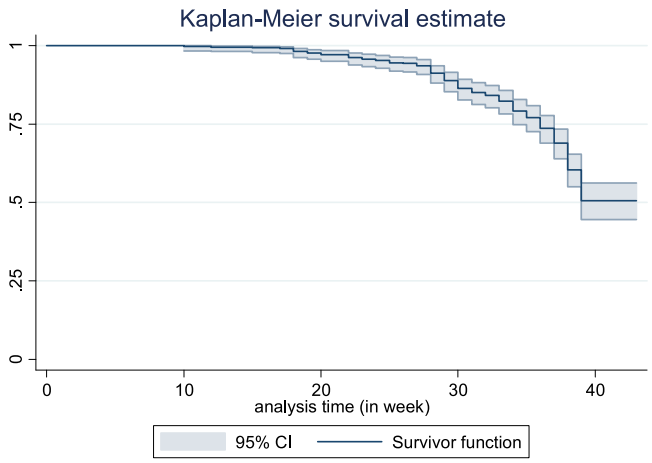

FIGURE 1 The plots of the overall estimate of Kaplan–Meier survival function for the duration of gestation

of bleeding during the menstrual period, place of residence, employment status, educational level, presence of disease, and blood pressure were not significant at 25% levels of significance

3.4 | Model selection for survival time of duration of gestation

Table 5 shows that the five commonly used parametric models in terms of log likelihood, AIC and BIC values. It is clear from the table below that the smallest values of AIC and BIC correspond to the Weibull regression fit. Indeed, the AIC and BIC values of the Weibull AFT distribution model are 258.9017 and 303.3967, respectively, and the value of the log-likelihood is −118.4508. Thus, we can conclude that, in this study, the Weibull regression model has provided the best fit among all considered models for the duration of gestation of pregnant women taking ANC in the Gondar referral hospital.

3.5 | Multivariable analysis for Weibull regression model

3.5.1 | Results

Table 6 shows the parameter estimates of coefficients for the predictors in the Weibull regression model along with their

TABLE 4 Log-rank test for categorical independent variables

Covariate/factors	χ^2	*df*	*p* Value
Place of residence			
Urban	1.19	1	0.2755
Rural			
Educational status of pregnant women			
Uneducated			
Primary	0.63	2	0.7289
Secondary and above			
Employment status			
Employed		1	
Unemployed	0.46		0.4968
Stage of gestation			
First trimester			
Second trimester	158.01	2	0.0000
Third trimester			
Number of children			
No children			
1–2 children	4.24	2	0.1198
3–4 children			
Marital status			
Married			
Windowed			
Single	4.83	2	0.1848
Divorced			
Status of blood pressure			
Normal			
High	1.01	1	0.3143
Presence of disease			
No disease			
Anemia	0.85	2	0.6552
Other			

corresponding significance level, *Tm*. Ratio with corresponding standard error and 95% confidence interval for the *Tm*.

3.5.2 | Ratio

Survival time of duration of gestation was significantly related to the age of the woman, the number of ANC visits, and the stage of gestation as shown in Table 5.

TABLE 5 Comparison of the parametric model by using Akaike's information criterion, Bayesian information criterion, and log-likelihood

Model	*df*	Log-likelihood	AIC value	BIC value
Exponential	10	−317.8077	655.6154	696.0654
Weibull	**11**	**−118.4508**	**258.9017**	**303.3967**
Log-normal	11	−122.1159	266.2319	310.7269
Log-logistic	11	−119.3229	259.6459	304.1409
Gamma	11	−196.0466	414.0932	458.5883

Abbreviations: AIC, Akaike information criteria; BIC, Bayesian information criteria.

4 | DISCUSSION

The study is primarily designed to examine the effect of various factors on the duration of gestation among pregnant women taking prenatal care. The results of this study would provide insightful and new knowledge that enriches an existing understanding of factors affecting the duration of gestation for women taking prenatal care for the community, researchers, and health sector. It also provides information that would be helpful for decision-makers in formulating policies. Finally, the study could provide baseline data for further studies in the future.

Based on the given data set, the number of children was the factor that affects the length of pregnancy. As it is indicated in Table 6, the *Tm* ratio indicates women who had no children have prolonged the duration of pregnancy than women who had children. The result of this study revealed that the age of pregnant women has a significant effect on the length of pregnancy. After adjusting for other covariates, the estimated *Tm* ratio was 1.006436, indicating that as the age of pregnant women increased by 1 year, the length of pregnancy increased by 0.6% weeks. This is consistent[14] with the finding that women who were older delivered later on average, with each year of age adding roughly 1 day to their pregnancy. In addition to the gestational length for other pregnancies, two other maternal characteristics were associated with a longer gestation: older maternal age (but not parity) and higher maternal birth weight. Older maternal age (greater than 35 years) has been associated with the length of pregnancy.

We did not see associations between length of gestation and blood pressure and bleeding during early pregnancy. We also did not find an association between the presence of disease and the length of pregnancy. This study found that stage of gestation that women attained at ANC was as significantly affect the length of pregnancy. Women who get ANC in the second and third trimesters in our data have a longer gestation, as compared with the first trimester. The frequency of visiting the doctor during the gestation period enhances the length of the gestation period from the due date. A shorter gestation period from the due date is dangerous to the health of both mother and her fetus.

TABLE 6 Weibull regression results in terms of parameter estimates and *Tm* ratio of the covariates

Covariates/factors	*Tm* ratio	SE	*p*>|*z*|	95% Confidence interval
Age of women (year)	1.006436	0.0023304	0.006	1.002–1.011
Number of doctor consultations	1.2678	0.0060599	0.000	0.965–0.989
Stage of gestation women				
Second trimester	1.390609	0.0712094	0.000	1.258–1.545
Third trimester	1.642301	0.0846369	0.000	1.485–1.817
First trimester (*)				
Number of children				
1–2 Children	0.9178705	0.0291432	0.007	0.862–0.977
3–4 Children				
No children (*)	0.9194395	0.0477979	0.106	0.830–1.0261
Marital status				
Widowed	1.00588	0.0340751		0.941–1.075
Single			0.863	
Divorced	1.197479	0.0835153	0.010	01.044–1.373
Married (*)	0.9822474	0.0408913	0.667	0.905–1.066

The reference categories were those indicated in asterisk (*).

5 | CONCLUSIONS

To identify the factors associated with the length of pregnancy, different AFT models were applied. Among these using AIC and BIC criteria, the Weibull AFT model was better fitted to the length of pregnancy data set than other AFT models. The length of human pregnancy varies significantly among healthy pregnancies, even when the onset of gestation is measured by an accurate marker of ovulation. This difference is better than suggested by the clinical assignment of a single due date. The length of gestation may give a suitable measure of a woman's normal length of pregnancy and may help in forecasting an individual woman's due date. In this study, the major factors for length of pregnancy identified were the age of the woman, number of children, stage of gestation, and number of doctor consultations at the time of pregnancy were statistically significant at a 5% level of significance. We also found that the age of pregnant women was strongly predictive of the total length of pregnancy, suggesting older maternal age prolongs the length of pregnancy.

6 | LIMITATIONS OF THE STUDY

As this is a cross-sectional study, the associations observed may not be causal enough. The study used data from prenatal care charts that have inherent gaps such as the absence of some variables that may affect the response variable and some variables are not included because of the unavailability of the variable in the prenatal care chart. No study has been conducted in our country that reports factors for duration of gestation among women taking prenatal care that make it was difficult to compare our study with similar previous studies.

AUTHOR CONTRIBUTIONS

Mequanent Wale Mekonen: Conceptualization; data curation; formal analysis; investigation; methodology; software; validation; writing—original draft; writing—review and editing. **Addisu Teka Bayew**: Conceptualization; data curation; formal analysis; investigation; methodology; software; validation; writing—original draft. **Tigist Jegnaw Lakew**: Formal analysis; investigation; methodology; supervision. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

TRANSPARENCY STATEMENT

The manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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