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Prevalence and Predictors of Cesarean Delivery in a Tertiary Hospital in Taraba State, Nigeria

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Abstract

A cesarean section (CS) is a surgical technique in which a baby is delivered through an abdomen and uterine incision following fetal viability. It is imperative to identify the factors that influence the use of CS to reduce the needless use of this life-saving procedure and increase its availability for those who need it most. Therefore, this study assesses the prevalence and predictors of cesarean delivery in a tertiary hospital in Taraba state, Nigeria. Information of pregnant women who came for delivery to Federal Medical Center, Jalingo, Taraba state Nigeria from August 2021 to August 2023 was collected. Binary Logistic Regression using the probit model was used to analyse the data. $p<0.05$ was considered to be statistically significant. During the study period, there were 747 deliveries 115 by caesarean section (15.4%). The results show that maternal age, location, occupation, maternal education, maternal weight, birth weight, and number of antenatal care (ANC) visits significantly predict cesarean delivery. The results of this research will help to make policies and decisions related to health issues and intensify efforts to make provisions and precautionary steps on managing and controlling cesarean birth.

Keywords: Cesarean delivery; Prevalence; Parturition; Binary logistic regression

Introduction

A cesarean section (CS) is a surgical technique in which a baby is delivered through an abdomen and uterine incision following fetal viability (Bamigbala et al. 2022a). A cesarean section is recommended as a surgical intervention for pregnant women with medical or obstetric reasons (Flint 2015). Typically, a caesarean section is carried out when the mother's and the unborn child's life are in danger during a vaginal delivery. Sometime, though, mothers request for a CS even in the absence of any such risk.

The maximum CS rate for all deliveries has been set by the World Health Organization (WHO) at 15% (Betran et al. 2016). On the other hand, a cesarean rate of less than 5% suggests a lack of surgical obstetric treatment. Cesarean deliveries are often frequently associated with difficulties in breastfeeding, higher rates of pain, and problems in subsequent pregnancies (Lowe 2013). Therefore, it is crucial to weigh the advantages of a cesarean delivery against any potential risks while choosing this delivery method.

Many variables have been found to influence the chance of a cesarean section delivery globally. These variables include issues like fetal distress, a premature rupture of the amniotic sac, multiple pregnancies, healthcare facility choice, baby's birth weight, maternal height, the number of previous pregnancies, and the quality of antenatal care (Omotayo et al. 2022).

The currently available information on the prevalence of CS in Nigerians points to a number that is lower than the 10% WHO-

recommended threshold. In 2008, only 2% of births in Nigeria were by CS (Adewuyi et al. 2019), and the rate remained stable in 2013 and 2018 (Adewuyi et al. 2019). This figure is significantly lower compared to certain African nations [Ghana (12.80% in 2014), Lesotho (9.70% in 2014) and Uganda (5.22% in 2011)] (Cavallaro et al. 2013). It is imperative to identify the factors that influence the use of CS in order to reduce the needless use of this life-saving procedure and increase its availability for those who need it most. Therefore, the current study assesses the prevalence and predictors of cesarean delivery in a tertiary hospital in Taraba state, Nigeria.

Materials and Methods

Study Area

The study was carried out in Federal Medical Centre (FMC) Jalingo, Taraba State. To operationalize its policy of having/establishing at least a tertiary health facility in each State of the Nigerian Federation, the Federal Government of Nigeria established the Federal Medical Centre Jalingo, Taraba State, in November 1999. The hospital is a specialist consultation healthcare institution that offers sophisticated medical investigation and treatment capabilities, typically for inpatients and on referrals from primary or secondary health professionals (Margu and Everest 2023).

Source of Data

In this study, secondary data was collected. Information of pregnant women who came for delivery in Federal Medical Center, Jalingo, Taraba state Nigeria from August 2021 to August 2023 was collected. The above hospital was considered and selected because it is a hospital designed for the care of women before and during childbirth and for the care of newborn babies in Jalingo Taraba State.

Study Variables

The target variables were: mode of delivery of pregnant women (Normal or vaginal delivery and Caesarean Section), Age of mother, Maternal Educational Qualification, Occupation, Number of Antenatal Care (ANC) Visits, Locations (Rural and Urban), Maternal Weight, and Weight of Baby at Birth.

Method of Data Analysis

Logistic Regression

Logistic regression is a statistical analysis model used to predict a binary outcome, such as yes or no, success or failure based on prior observation of a data set. In statistics, the logistic model is a statistical model that models the probability of an event taking place by having the log odds for the event to be a linear combination of one or more independent variables. In regression analysis, logistic regression is estimating the parameters of a logistic model.

Let Y_i be a binary response variable (that is Women delivery) in which $Y_i = 1$ (women deliver with caesarean) and $Y_i = 0$ (women with normal delivery) for $i = 1, 2, 3, \ldots, n$ individuals, depending on the two explanatory variables in the study that is women with normal mode of delivery and caesarean. If the probability of success p_i means probability of $Y_i = 1$ given an i^{th} individual. Hence probability of failure is $q_i = 1 - p_i$

$$q_i = 1 - p_r\left(y = 1/i\right)$$

Let Y_1 and Y_2 represent caesarean and normal mode of delivery among the pregnancy women.

From logistic regression model:

The logistic regression function is the logit transformation of p_i

$$Logit\left(p_i\right) = In\left(\frac{p_i}{1 - p_i}\right) = \beta_0 + \beta_{1i}A + \beta_{2i}L + \beta_{3i}O + \beta_{4i}ME + \beta_{5i}MW + \beta_{6i}BW + \beta_{7i}ANC$$

where

$\beta_0 = Intercept$

$\beta_{1-9} = Slope\ (Coefficient\ of\ the\ Explanatory\ Variables)$

A=Mother's Age Groups
L=Locations
O=Occupations
ME=Mother's Education
MW=Mother's Weight
BW=Baby Weight at Birth
ANC=Antenatal Care Visit
Y=Delivery Type (Normal (0) or CS (1))

Where β_0 is the constant of the equation and β_j is the coefficient of the predicted variable *j*. Using the transformation in the way to overcome the problem that may arise if p was modelled directly as a linear function of the explanatory variables. In particular, it avoids fitted probabilities outside the range (0,1). The parameters in the model can be estimated by maximum likelihood estimation.

Probit Regression

In statistics, a probit regression model is a type of regression where the response variable can take only two values, for example, yes or no, success or failure, successful or unsuccessful, presence or absence, married or not married etc. This model was used to identify factors contributing to the mode of delivery (normal or Cesarean delivery). A probit model is a popular specification for a binary response model that employs a probit link function. This model is most often estimated using standard maximum likelihood procedure, such an estimation is called a probit regression.

In this study our response variable Y is binary, that is it can have only two possible outcomes which will be denoted as 0 or 1. It is presented in a yes or no format hence suitable for modelling binary dependent variables like in the case of this study, whether one had normal delivery (0) or by caesarean section (1). What the probit model does is to estimate the probability that the dependent variable is 1 ($Y = 1$). This is the probability that the event occurs. In this study, the event is taken as the choice to deliver by caesarean section in a health facility. The model uses maximum likelihood estimation method.

Probit regression model is characterized by the probit link function defined as the inverse of the standard cumulative normal distribution. The standard cumulative normal distribution is the area to the left of the value Z on a standard normal distribution. This function maps the interval (0, 1) to the real line.

Mathematically, the probit regression is defined as:

$$\phi(P_i) = Z_i = \frac{X - \mu}{\sigma} = \beta_0 + \beta_1 X_{i1} + ... + \beta_k X_{ik}$$

Where

$$P_i = \Pr ob(Y_i = 1 / X) = \phi(Z_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{X_i'\beta} (2\pi)^{-1/2} \exp\left(-\frac{z^2}{2}\right) dz$$

$\phi(Z)$ is the standard cumulative normal distribution and the area under the curve is between $-\infty$ and $X'\beta$ and the standard normal variate Z is defined as $Z = \frac{X-\mu}{\sigma}$.

In this study, the probit regression model is given by:

$$\Pr obit(Y=1) = \beta_0 + \beta_{1i}A + \beta_{2i}L + \beta_{3i}O + \beta_{4i}ME + \beta_{5i}MW + \beta_{6i}BW + \beta_{7i}ANC$$

Complementary Log Log (cloglog) Model

Cloglog regression is a statistical modeling technique used to analyze binary response variables. Complementary log-log models are frequently used when the probability of an event is very small or very large. Unlike logit and probit, the complementary log-log function is asymmetrical.

The cloglog model is described as follows:

$$Log(-\log(1-P(Y=1))) = \beta_0 + \beta_{1i}A + \beta_{2i}L + \beta_{3i}O + \beta_{4i}ME + \beta_{5i}MW + \beta_{6i}BW + \beta_{7i}ANC$$

In this study, SPSS version 26 and R – programming version 4.1.3 were used to analyze the data. $p<0.05$ was considered to be statistically significant.

Results

Socio-Demographic Characteristics of the Patients

Regarding the age distribution of mothers, a significant majority, accounting for 51.5% of the total, falls into the age group above 30 years. Those aged 25-30 years and less than 25 years make up 22.9% and 25.6%, respectively. In terms of the location of the mother, patients in urban areas have a predominant representation, constituting 71.1% of the total, while patients in rural areas make up 28.9%. On occupation of mothers, the majority were identified as housewives (56.2%), followed by those engaged in business (36.9%), with civil servants representing a smaller proportion at 6.8%.

Examining the educational qualifications of mothers, the two largest groups consist of those with tertiary education (29.2%) and those without formal education (30.6%). Primary and secondary education categories were 17.7% and 22.5%, respectively. Concerning parity, at 60.0%, the majority of mothers has two children and above, while those with 0-1 children make up 40.0%. Analyzing maternal weight, the majority weigh 65 kg and above, representing 66.1%, whereas those weighing less than 65 kg constitute 33.9%.

In terms of birth weight, at 59.7%, a significant portion falls within the range of less than 2.5 kg, followed by 2.5-3.5 kg (21.0%) and above 3.5 kg (19.3%). The data on the number of Antenatal Care (ANC) visits indicates that 46.1% of individuals have had 4 or more ANC visits, while 53.9% have had less than 4 ANC visits. Finally, examining the mode of delivery reveals that the majority of deliveries, at 84.6%, are normal, while caesarean deliveries account for 15.4% of the total.

Table 1: Socio-demographic characteristics of the patients

Factors	Categories	Frequency	Percentage (%)
Age of Mother	Less than 25 years	191	25.6
	25-30 years	385	51.5
	Above 30 years	171	22.9
	Total	**747**	**100.0**
Location of the Mother	Rural	216	28.9
	Urban	531	71.1
	Total	**747**	**100.0**
Occupation of the Mother	Business	276	36.9
	Civil Servant	51	6.8
	Housewife	420	56.2
	Total	**747**	**100.0**
Maternal Educational Qualification	No Education	229	30.6
	Primary Education	132	17.7
	Secondary Education	168	22.5
	Tertiary Education	218	29.2
	Total	**747**	**100.0**
Parity	0-1 Child	299	40.0
	2 Children and Above	448	60.0
	Total	**747**	**100.0**
Maternal Weight	65 kg and above	494	66.1
	Less than 65 kg	253	33.9
	Total	**747**	**100.0**
Birth Weight	Less than 2.5 kg	446	59.7
	2.5-3.5 kg	157	21.0
	Above 3.5 kg	144	19.3
	Total	**747**	**100.0**
Number of Antenatal care Visit	4 Visits and above	344	46.1
	Less than 4 ANC Visits	403	53.9
	Total	**747**	**100.0**
Mode of Delivery	Normal Delivery	632	84.6
	Caesarean Delivery	115	15.4
	Total	**747**	**100.0**

Table 2: Model selection (AIC and BIC values for the three models)

Binary Logistic Regression Link Function	AIC	BIC
Logit	576.70	641.33
Probit	575.38*	640.00*
Complementary Log-Log	577.36	641.99

**** Best Fit Model***

Table 2 shows the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values for three different models in binary logistic regression: Logit, Probit, and Complementary Log-Log. These information criteria are statistical measures used for model selection, with lower values indicating better-fitting models. The AIC and BIC values serve as indicators of the goodness of fit of each model, considering both model complexity and performance. In this study, the Probit model stands out as the best-fit model among the three, as it has the

lowest AIC and BIC values of 575.38 and 640.00.

In summary, based on AIC and BIC values, the Probit model is identified as the best fit among the Logit, Probit, and Complementary Log-Log models for the binary logistic regression analysis.

Table 3: Estimating parameters in binary logistic regression: Analyzing the impact of covariates on delivery models with a probit link function

Factors	Coefficients	Standard Error	Z-Value	P-Value	Odd Ratio
Constant	-2.105	0.331	-6.36	0.000*	0.1218
Age: 25-30 years (Ref)					1.000
Above 30 years	0.430	0.183	2.35	0.019*	1.5373
Less than 25 years	0.082	0.187	0.44	0.661	1.0855
Location: Rural (Ref)					1.000
Urban	0.471	0.160	2.94	0.003*	1.6016
Occupation: Business (Ref)					1.000
Civil Servant	-1.097	0.361	-3.04	0.002*	0.3339
Housewife	-0.375	0.133	-2.83	0.005*	0.6873
Educational Qualifications No Education (Ref)					1.000
Primary Education	-0.261	0.184	-1.42	0.156	0.7703
Secondary Education	-0.315	0.170	-1.85	0.064	0.7298
Tertiary Education	-0.573	0.173	-3.31	0.001*	0.5638
Parity: 0-1 Child (Ref)					1.000
2 Children and Above	0.104	0.148	0.71	0.479	1.1096
Maternal Weight: 65 kg and above (Ref)					1.000
Less than 65 kg	-0.306	0.146	-2.10	0.035*	0.7400
Birth Weight: 2.5-3.5 kg (Ref)					1.000
Above 3.5 kg	0.670	0.194	3.45	0.001*	1.9542
Less than 2.5kg	0.489	0.186	2.64	0.008*	1.6307
ANC Visit: 4 Visits and above (Ref)					1.000
Less than 4 ANC Visits	0.966	0.139	6.96	0.000*	2.6274

*Statistically significant at $p < 0.05$

Table 3 shows the outcomes of a binary logistic regression utilizing a probit link function, exploring the influences of different covariates on delivery models. The constant term represents the estimated log-odds of caesarean delivery when all other predictors are set to zero, and a statistically significant negative coefficient of -2.105 (p-value < 0.05) signifies a reduction in the log-odds of caesarean delivery.

With the reference age group set at 25-30 years, a statistically significant positive coefficient of 0.430 (p-value = 0.019) indicates an increase in the log-odds of caesarean delivery for mothers above 30 years. The odds of caesarean delivery increase by approximately 1.54 times for mothers above 30 years compared to the reference age group (25-30 years).

Concerning location, a statistically significant positive coefficient of 0.471 (p-

value = 0.003) suggests an upturn in the log-odds of caesarean delivery for urban locations compared to rural ones. The odds of caesarean delivery are approximately 1.60 times higher for urban locations compared to rural areas.

On the maternal occupation, a statistically significant negative coefficient of -1.097 (p-value = 0.002) indicates a decline in the log-odds of caesarean delivery for civil servants. The odds of caesarean delivery are approximately 0.33 times lower for civil servants compared to those in business. Additionally, a statistically significant negative coefficient of -0.375 (p-value = 0.005) suggests a decrease in the log-odds of caesarean delivery for housewives. The odds of caesarean delivery are approximately 0.69 times lower for housewives compared to those in business.

Regarding educational qualifications, a statistically significant negative coefficient of -0.573 (p-value = 0.001) indicates a decrease in the log-odds of caesarean delivery for mothers with tertiary education. The odds of caesarean delivery are approximately 0.56 times lower for mothers with tertiary education compared to those with no formal education.

Regarding the maternal weight, a statistically significant negative coefficient of -0.306 (p-value = 0.035) suggests a decrease in the log-odds of caesarean delivery for mothers weighing less than 65 kg. The odds of caesarean delivery are approximately 0.74 times lower for mothers with a weight less than 65 kg compared to those with 65 kg and above.

Considering the birth weight, a statistically significant positive coefficient of 0.670 (p-value = 0.001) indicates an increase in the log-odds of caesarean delivery for babies above 3.5 kg. The odds of caesarean delivery are approximately 1.95 times higher for babies with a weight above 3.5 kg compared to the reference range (2.5-3.5 kg). Additionally, a statistically significant positive coefficient of 0.489 (p-value = 0.008) implies an increase in the log-odds of caesarean delivery for babies less than 2.5 kg. The odds of caesarean delivery are approximately 1.63 times higher for babies with a weight less than 2.5 kg compared to the reference range (2.5-3.5 kg).

Finally, concerning ANC visits, a statistically significant positive coefficient of 0.966 (p-value = 0.000) indicates a rise in the log-odds of caesarean delivery for women with less than 4 ANC visits.

Discussion

This study examined the prevalence and predictors of cesarean delivery in a tertiary hospital in Taraba state, Nigeria. In this study, caesarean deliveries account for 15.4% (115) of the total deliveries of 747 in Federal Medical Center, Jalingo, Taraba state Nigeria from August 2021 to August 2023. This is marginally above the 5-15% recommendation of the World Health Organization (Bamigbala et al. 2022a). However, this is less than the rates of 22% (Arowojolu et al. 2003), 34.7% (Akinwuntan et al. 2006), and 40.1% (Akinola et al. 2014) found in previous studies conducted in tertiary hospitals in Nigeria.

According to the probit model, maternal age, location, maternal occupation, maternal education, maternal weight, birth weight, and number of antenatal care (ANC) visits significantly predict cesarean delivery.

In this study, age was a significant predictor of CS. The odds/likelihood of a caesarean delivery increased for women over 30 compared to those between the ages of 25 and 30. This finding aligns with previous studies (Nwoga et al. 2021, Bamigbala et al. 2022a, Ajayi et al. 2023) and implies that older women may be more susceptible than younger women to maternal complications and other comorbidities that may necessitate CS (Sauer 2015). It should be mentioned that there is a correlation between higher maternal age and risk of developing complications like multiple gestation, placental abruption, pregnancy-induced hypertension, breech presentation, placenta previa, and fetal macrosomia (Halil et al. 2020). Furthermore, older pregnant women have higher rates of diabetes and hypertension during pregnancy; this could result in increased CS delivery (Rydahl et al. 2019, Wang et al. 2021).

This study also showed that the odds of caesarean delivery were higher for mothers who reside in urban locations compared to rural areas. This agrees with the findings of Gunn et al. (2017). According to other studies, living in an urban area increases the chances of having a CS (de Loenzien et al. 2019, Bhandari et al. 2020, Mezemir et al. 2023). This result may be the result of cultural norms that discourage hospital deliveries, financial constraints, or gender disparities in household decision-making preventing pregnant women in rural areas from using healthcare facilities (Babalola and Fatusi 2009). This might also be the result of urban residents having greater exposure and access to information than their rural counterparts. Also, women from urban residents were more likely to be educated and to favour cesarean delivery over vaginal delivery.

In this study, the odds of caesarean delivery were lower for civil servants and housewives compared to those in business. Involvement in business may mean increased wealth and increased wealth index has been associated with an increase in CS delivery (Ahmmed et al. 2021).

Furthermore, in this study, the odds of caesarean delivery were lower for mothers with tertiary education compared to those with no formal education. It should be noted that education can influence people's behaviour and health knowledge (Bamigbala et al. 2022b, Okoro et al. 2022, Bamigbala and Ojetunde 2023). Non-educated pregnant women may have a higher risk of having a CS because they may not be aware of their health risks and often report late to health facilities with complications, which increases their risk of undergoing a CS (Apanga and Awoonor-Williams 2018). This, however, contradicts another finding that indicated that pregnant women with secondary or higher education had higher odds of having a CS compared to pregnant women with no or primary education (Rajabi et al. 2015).

This study observed that the odds of caesarean delivery were lower for mothers with a weight less than 65 kg compared to those with 65 kg and above. This may be because the increase in maternal weight and body mass index are linked to an increased risk of fetal macrosomia, which increases the risk of cephalopelvic disproportion and necessitates caesarean delivery (Ballesta-Castillejos et al. 2020).

This study also showed that the odds of caesarean delivery were higher for babies with a weight above 3.5 kg compared to 2.5-3.5 kg. This agrees with the research of Apanga and Awoonor-Williams (2018). Fetal macrosomia, defined as fetal weight $\geq$ 4000 grams, has been linked to a higher risk of cephalopelvic disproportion, which may require delivery by caesarean section (Brabin et al. 2002). Additionally, in this study, the odds of caesarean delivery were also higher for babies with a weight less than 2.5 kg compared to 2.5-3.5 kg. Akinola et al. (2014) also discovered that a higher risk of cesarean section is linked to birth weights between 1.6 and 2.5 kg. This could be because low birth weight (less than 2500 grams) tends to be associated with preterm labour (Georgiou et al. 2015), and preterm labour is an indication for CS (Mamah et al. 2020, Bamigbala et al. 2022a).

Antenatal care (ANC) visit was found to be a significant predictor of cesarean delivery in this study. The odds for caesarean delivery for women with less than 4 ANC visits were higher than for women with 4 ANC visits and above. This may be because women receive more information at each ANC visit regarding birth preparation, early detection of pregnancy issues, and difficulties. Hence, fewer ANC visits will mean less information about the early detection of complications during pregnancy, which could lead to more severe complications, resulting in an increased risk of CS.

Conclusion

This study has demonstrated that maternal age, location, maternal occupation, maternal education, maternal weight, birth weight, and number of antenatal care visits significantly predict cesarean delivery. Therefore, targeted health education programs should be developed, focusing on mothers in rural areas, to create awareness about delivery

options. Also, the importance of adequate ANC visits, aiming to reduce the likelihood of caesarean deliveries should be encouraged and emphasized. Furthermore, interventions for weight management during pregnancy, considering both maternal and birth weight, to potentially reduce the incidence of caesarean deliveries should be implemented. The results of this research will help the state government in making policies and decisions that relate to health issues and how to intensify efforts in making provisions and precautionary steps on how to manage and control cesarean birth.

Conflicts of Interest

No conflict of interest was declared by the authors.

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