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Assessment of Effects of Maternal Age and Other Factors on Risk of Birth Defects in Zamfara State, Nigeria

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ABSTRACT: Birth defects have being a major public health challenge among the new born babies worldwide, particularly in developing countries including Nigeria and other Africa Countries. Consequently, the objective of this paper is to assess the Effects of Maternal Age and Other Factors on the Risk of Birth Defects in Zamfara State, Nigeria. The study examined the data collected for the presence of birth defects amongst the maternal age categories as following < 20, $20-29$ and ≥ 30 year. The study used logistic regression analysis to analyze the data and the study found that in the reviewed the highest prevalence of birth defect is malnutrition which stood at 34 - 45% of pregnant women in Zamfara State which the highest among the birth defects in zamfara state. More so, the results from the data showed that the chance of birth defect is higher among age less than 20 year compared to maternal age between 20-29 year old and maternal age of more than 30 year (>30 year). It was also observed that maternal mother less than 20 years (<20 year) old have a 14 times greater odds of a birth defect than maternal more than 30 year (<30 year) old and maternal age between 20-29 year old have a 6 times greater odds of a birth defect than maternal age of more than 30 year (>30 year).

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Birth defects are a major public health challenge worldwide and the leading cause of infant mortality, especially in developing countries including Nigeria, birth defects are the number five leading cause of years of potential life lost and contribute substantially to childhood morbidity and long-term disability (Yang, Wen, Leader, Chen, Lipson and Walker, 2006). Although the association between paternal age and the risks of birth defects has been well studied, the role of maternal age has received relatively little attention (Yang *et al.*, 2006). Recently, interest has been developed in exploring the effect of maternal age on birth defects. Age of mother is a known risk factor for chromosomal aberrations (Yang *et al*., 2006).

There is a lack of specific research available on the effects of maternal age on birth defects in Zamfara State of Nigeria. However, maternal age is known to be a significant threat issue for birth defects in general and this could also be applied in Zamfara State. Studies from other countries and regions have found a higher incidence of birth defects in babies born to older mothers (Hagen, Entezami, Gasiorek-Wiens *et al.*, 2011; Yogen, Melamed, Bardin *et al*., 2010). This is because as women age, their eggs are more likely to

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have chromosomal abnormalities, which can lead to birth defects in the baby. In Zamfara State, as in many other regions in Nigeria, the average maternal age at first birth is relatively low. However, there are still some women who give birth at an older age, particularly in urban areas (Venter, Christianson, Hutamo, Makhura and Gericke, 1995). This could potentially lead to an increased risk of birth defects in their babies (Venter *et al*., 1995). It is also important to note that maternal age is not the only factor that can lead to birth defects, other factors like maternal health, nutrition, and environmental factors also play a role (Tinker, Gilboa, Reefhuis, Jenkins, Schaeffer and Moore, 2015). Therefore, it is crucial for women of all ages to receive adequate prenatal care, nutrition, and education on maternal health to reduce the risk of birth defects (Tinker *et al.*, 2015).

On the other hand, in older mothers, the risk of chromosomal abnormalities such as Down syndrome and other genetic conditions increases. The risk of having a baby with Down syndrome, for example, is about 1 in 1,000 for a 30-year-old mother but increases to 1 in 100 for a 40-year-old mother (Chen, Wen, Fleming *et al*., 2007). In addition to maternal age, environmental factors and lifestyle choices during pregnancy can also affect the incidence of birth defects (Khasten, Baker, Kenny, 2010). For example, smoking during pregnancy can increase the risk of cleft lip and palate, heart defects, and other conditions (Sokal, Tata, Fleming, 2014). In younger mothers, the risk of some types of birth defects such as neural tube defects (NTDs) can be higher (Hematyar and Khajoi, 2005). This is because younger mothers may have lower levels of folic acid, which is essential for fetal brain and spinal development (Chandra, Schiavello, Ravi *et al.*, 2002).

In Zamfara State, several types of birth defects have been identified, often associated with lead poisoning and compounded by malnutrition. This study shows an overview of the different birth defects and their approximate prevalence rate: Types of Birth Defects and the prevalence rate according to Ajayi and Afolabi (2019), Centers for Disease Control and Prevention (2010), and Desyibelew and Dadi (2019), namely; Neural Tube Defects with Prevalence Estimated to affect 2-5% of newborns in affected areas, Musculoskeletal Defects with Prevalence Estimated at 3-4%, Cardiovascular Defects with Prevalence estimated at 1-2% of live births, Cleft Lip and Palate with Prevalence roughly 1% of cases in affected areas, Impact of Malnutrition on Birth Defects with Prevalence of Malnutrition affects 34-45% of pregnant women in Zamfara State which the highest among the birth defects in zamfara state. However, the association between maternal age and the risks of birth defects has not been well studied in Zamfara State, Nigeria. Therefore, the objective of this paper is to assess the Effects of Maternal Age and Other Factors on the Risk of Birth Defects in Zamfara State, Nigeria

MATERIAL AND METHODS

Sources of the Data: The data of this research work was based on data retrieved from unit of maternity, Federal Medical Centre Gusau, Zamfara State, Nigeria. For the birth defects among the age maternal mothers, the data extracted from the available records of the Hospital, for the associated risk factors for birth defects.

Statistical analysis: Logistic Regression analysis is a statistical method used to determine the relationships between a dependent variable and one or more independent variables. It is commonly used in epidemiology and medical research to study risk factors for diseases. To evaluate the effects of maternal age in modeling the risks of birth defects in Zamfara State, Nigeria, we categories the maternal age as less than 20; greater than 20 and < 30; and ≥ 30 years. The study used a logistic regression model and expressed the effect estimates as odds ratios (OR) and corresponding 95% confidence intervals (CI). The study used logistic regressions model and analysis to adjust for the most common known risk factors for maternal birth defects. Firstly, the study adjusted for possible maternal birth age by categorized the age of the mother into three classes; we adjusted the data by including maternal age (less than 20, between 20 and 29 years and ≥ 30 years). The essential data were collected by means of Microsoft Excel format and analyzed by using R Software.

Logistic Regressions Model: The equation for logistic regression is:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n \qquad (1)$$

Where, p = Probability of the event occurring like birth defect

Where $\beta_0 =$ Intercept, $\beta_1, \beta_2, \ldots, \beta_n =$ Regression coefficients for the predictor variables $x_1, x_2, \ldots, x_n$; $x_1, x_2, \ldots, x_n =$ Independent variables (Maternal age)

Equation (1) implies,

$$\frac{p}{1-p} = e^{(\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n)} \qquad (2)$$

$$\mathrm{p} = \frac{1}{1-e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n)}} \qquad (3)$$

Additionally, the logit model is a statistical method that models the log odds of a binary outcome based on one or more predictor variables. It is a special case of logistic regression. Therefore, the logit model is generally used to model binary outcomes in study of epidemiology and is especially valuable in cases of uncommon diseases (Long, 1997). The logit function is the natural log of the odds:

$$logit(p) = \log(\frac{p}{1-p}) \quad (4)$$

Odds Ratios (OR): We can use the odds ratio (ORs) to measure how the fitted probability changes between different values of the explanatory variable, OR =1 indicate a zero effect, OR >1 indicate an increase in odds and OR < 1 indicate a decrease in odds

$$OR = e^{\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n} \quad (5)$$

RESULTS AND DISCUSSIONS

Fitting Regression Model to Birth Defects data: The study categorized maternal age into three categories in order to have better and easier interpretation of logistic regression output, see the following table 1

Table 1: Data for categorized maternal age

	Maternal Age		
Birth Defect	< 20 year	20 - 29 year	≥ 30 year
Yes	109	106	37
No	1384	3758	6516

To estimate the effects of maternal age in modeling the risks of birth defects in Zamfara State, Nigeria, we categories the maternal age as less than 20, between 20 and 29 year, and ≥ 30 years. The study used a logistic regression model and expressed the effect estimates as odds ratios (OR) and corresponding 95% confidence intervals (CI)

Table 2: Fitting Regression Model to Birth Defect data

Deviance Residuals				
Min	1Q	Median	3Q	Max
-0.4652	-0.3049	-0.2150	-0.2150	3.3158
Coefficients	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-5.4277	0.2461	-25.411	<2e-18 ***
Age1	2.6773	0.3783	12.338	<2e-18 ***
Age2	1.8009	0.2632	7.265	<2e-18 ***

The model

$$Birth\ Defects\ Model = \log\left(\frac{p}{1-p}\right)$$
$$= -5.4277 + 2.6773Age1 + 1.8009Age2 \quad (6)$$

Represent the regression of Birth defects as a function of Age (x) variables are categorical, which is maternal age and cauterized into 3 categories.

The predicted model for women less than 20 years is given by:

$$Birth\ Defects\ Model$$
$$= -5.4277 + 2.6773(1) + 1.8009(0) \quad (7)$$

The predicted model for women between 20 - 29 years is given by:

$$Birth\ Defects\ Model =$$
$$-5.4277 + 2.6773(0) + 1.8009(1) \quad (8)$$

The predicted model for women more than 30 years is given by:

$$Birth\ Defects\ Model = -5.4277 +$$
$$2.6773(0) + 1.8009(0) \quad (9)$$

The p-values (2e-18) < α (0.05) for the intercept, maternal age less than 20 year old and maternal age between 20 – 29 year old is statistically significant but those parameter are not statistically stable, see table 1. From the system equation of (7), the research work obtained that p = 0.060 and found that less than 20 year (<20 year) old maternal group has an average of 6% chance of a birth defect. Also, from model system (8), since p = 0.036, this implies that the chance of 20–29 year old having birth defect is 0.036 which approximately 0.04. More so, from equation (9) with p = 0.0044, the maternal age of above 30 year old has an average of 0.4% birth defect. This result is in line with the reviewed part of this work about maternal age of birth defect. In Zamfara State, the chance of birth defect is higher among age less than 20 year and from the reviewed studied it was observed that malnutrition is the highest among the birth defect which it was 34 – 45% and is common among the young maternal age or pregnant mother.

Table 3: Odds Ratios for the Birth Defect

	OR	2.5 %	97.5 %
(Intercept)	0.006539115	0.4820743	0.008243534
Age1	14.189135633	8.0775318871	9.622868925
Age2	6.058487954	3.362376716	8.485620831

The maternal age of less than 20 year (<20 year) has a significant effect on birth defect outcome, the study used the Odds Ratios to measured how the fitted probability chance between the age group and from table 3, it was observed that maternal group less than 20 years (<20 year) old has a 14 times greater odds of a birth defect than maternal more than 30 year (≥30 year) old. Also, it is observed that, maternal age between 20-29 year old has a 6 times greater odds of a birth defect than maternal age of more than 30 year (≥30 year).

Conclusion: The study concluded that the chance of birth defect is higher among age < 20 year and it was observed that malnutrition is the highest caused of birth defect which it was 34 – 45 % in Zamfara state which is common among the young maternal age. The study observed that maternal mother < 20 year old has 14 times greater odds of birth defect than maternal age ≥ 30 year old and maternal age between 20-29 year old has 6 times greater odds of birth defect than maternal age of ≥ 30 year. The malnutrition during pregnancy, particularly deficiencies in folic acid, iron, and vitamins, significantly increases the risk of birth defects, including low birth weight. Efforts are underway to reduce the incidence of these birth defects, including environmental remediation, chelation therapy, and better nutritional interventions for pregnant women. The persistence of unsafe mining practices remains a challenge in mitigating these health issues

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Data Availability Statement: Data are available upon request from the corresponding author

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