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ESTIMATING THE PREDICTORS OF MATERNAL MORTALITY IN A SOUTHERN STATE OF NIGERIA USING LOGISTIC REGRESSION MODEL

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ABSTRACT: *The maternal mortality ratio (MMR) for Nigeria is 512 deaths per 100,000 live births, suggesting one of the highest in the world. Furthermore, disparities still exist between northern and southern Nigeria, and across the states of the country with varying contributing factors. This study therefore aimed to identify the predictors of maternal mortality in Rivers State, Southern Nigeria using the technique of logistic regression. Diagnostic study design was utilized for the study and data for women of childbearing age (15–49 years) were extracted from the Rivers State Hospital Management Board, Port Harcourt from January to December 2019. The association between the maternal mortality and selected maternal and health care related factors were tested using chi-square, and multivariate logistic regression was used to identify the effects of maternal and health care related factors on maternal mortality at 5% level of significance. The study identified maternal age, educational level, place of residence, marital status, delivery outcome, baby weight, ANC attendance and parity as the risk factors of maternal mortality in Rivers State. With the risks factors identified, policy makers will be better informed to plan intervention programmes to reduce maternal mortality in Rivers State and fast track the achievement of SDG goals on maternal health.*

KEYWORDS: Maternal mortality, Risks factors, Rivers State, Nigeria, Logistic Regression.

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INTRODUCTION

Maternal mortality is the death of a woman while pregnant, during delivery or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by the pregnancy or its management (WHO, 2005). According to 2019 World Health Organization (WHO) reports, about 295,000 women died during and following pregnancy and childbirth in 2017 and 94% of these deaths occurred in low-resource settings (WHO, 2019). Approximately 86% of these deaths occurred in Sub-Saharan Africa and Southern Asia. Sub-Saharan Africa accounted for about two-thirds of the deaths, while Southern Asia accounted for almost one-fifth (WHO, 2019).

Improving maternal health was one of the priorities of the international community. Hence, the formation of the concluded Millennium Development Goals (MDG) and the new Sustainable Development Goals (SDG). The Millennium Development Goal 5 (MDG5) was to improve maternal health by reducing the maternal mortality ratio (MMR) by three quarters by 2015 (Manyeh et al., 2018), while the SDG 3 is to reduce the global maternal mortality ratio (MMR) to fewer than 70 maternal deaths per 100,000 live births by 2030 (MHTF). Despite a global reduction in MMR by 44% (from 385 to 216 maternal deaths per 100,000 live births) between 1990 and 2015, the target of 75% was not achieved (MHTF). This necessitated the adoption of the SDG in 2015.

Nigeria, like most countries in sub-Saharan Africa, did not achieve the MDG 5 at the end of 2015. The maternal mortality ratio (MMR) for Nigeria is 512 deaths per 100,000 live births (NPC & ICF, 2019). The maternal mortality ratio in Nigeria was considered the highest in the world (Ujah et al., 2005). This statistic also suggests that Nigeria is still far from achieving the SDG 3.1. Furthermore, disparities still exist between northern and southern Nigeria, across the states of Nigeria with varying contributing factors (Meth et al., 2019). This study therefore aimed to identify the predictors of maternal mortality in Rivers State, southern Nigeria using the technique of logistic regression.

METHODS

The study was conducted in Rivers State, a southern part of Nigeria. The state is one of the thirty-six states in Nigeria and is rich in oil and gas. The state has 23 local government areas and 319 political wards in 3 senatorial zones, with Port Harcourt as the state capital. (RSMOH, 2020). There are 618 health facilities in Rivers State: 384 primary health facilities, 18 secondary health facilities, 5 tertiary health facilities, and 211 registered private health facilities (RSMOH, 2020).

The data involves the maternal data of the state from January to December 2019, extracted from the Rivers State Hospital Management Board, Port Harcourt. Diagnostic design was used in the study. In diagnostic design, the researcher tends to evaluate the cause of a phenomenon. It describes the factors responsible for the problematic situation and helps to identify the factors associated with a phenomenon. The study involves all women that visit the antenatal clinics, maternity wards, and postnatal clinics in Rivers State.

The outcome variable for this study was maternal mortality (i.e., whether a woman who visits the facility died while pregnant, during childbirth, or within two months of delivery). Maternal

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mortality was coded as a binary variable. It was coded as 0 if the woman was alive and coded as 1 if the woman was dead. The explanatory variables are divided into maternal and health-related variables. The maternal factors include mother's educational level defined as "below secondary" and "secondary and above", mother's occupation grouped as "not working" and "working", place of residence grouped as "rural" and "urban", mother's age grouped as "below 30 years" and "30 years and above", marital status grouped as "married" and "not married", religion grouped as "Christian" and "others" and sex of baby grouped as "male" and "female". The health-related factors include antenatal attendance defined as "less than 4 visits" and "4 visits and above", parity grouped as "less than 2" and "2 or more", mode of delivery defined as "SVD/AD" and "C/S", delivery outcomes grouped as "live birth" and "still birth", and weight of baby grouped as "<2.5kg" and "≥2.5kg".

Statistical analysis was done at the level of univariate, bivariate and multivariate analyses. Descriptive statistics of frequency and percentage were carried out at the univariate level to describe the respondents. Chi-square test was used at the bivariate level to test association between the explanatory variables and the outcome variable, while binary logistic regression was fitted to identify the significant impact of explanatory variables on maternal mortality.

The binary logistic regression model is expressed as:

$$Log\left[\frac{\rho}{1-\rho}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_n + \mu \qquad 1$$

The model shows the odds of maternal mortality. In this study, ρ is the probability of maternal mortality occurring, and $(1-\rho)$ is the probability of maternal mortality not occurring, while $X_1 \ldots X_n$ represent the independent variables and $\beta_1 \ldots \beta_k$ are the regression parameters. β_0 is a constant that gives the value of maternal mortality when all the independent variables are absent in the model, and μ is the residual or random error term. Log $\left[\frac{\rho}{1-\rho}\right]$ is referred to as the logistic transformation of probability of an event (i.e., maternal death) occurring.

All statistical analyses were performed using Stata 15. We estimated the odd ratio and their 95% confidence interval (CI). Statistical significance was set at P<0.05 and 95% CI not including unity.

RESULTS

Table 1 shows the percent distribution of respondents by the maternal factors used in the study. The result shows that 1.8% of the mothers were below 20 years, while 43%, 43.3%, and 11.8% were between 20–29 years, 30–39 years and 40 years and above respectively. Also, 85.8% lives in the urban area of the state while 14.2% lives in the rural areas of the state.

Of their religious affiliations, 91.8% were Christians and 8.2% were of other religious faith. On marital status, 94.8% of the women were currently married while 5.2% were not married.

A proportion (97.7%) of the mothers were working, while 2.3% were not working; others and not working at all were 13.9% and 2.3% respectively. A significant number of the women had a minimum of secondary education (82.3%), while 17.7% had below secondary education.

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From the table, all the variables were significantly related to maternal death (P<0.05) except maternal occupation.

Table 2 also shows the distribution of healthcare related factors used in the study. From the table, most of the women attended ANC at least 4 times (82%), delivered their baby alive (91%), and delivered a baby that weighed below 2.5kg at birth (88.1%). Regarding mode of delivery, 52.9% delivered through C/S, while 47.1% delivered through SVD/AD. Also, 68.8% of the women had two children or more, while 31.2% had less than two children, and all the variables were statistically significant (P<0.05), except baby weight at birth.

Table 1: Percentage Distribution of Respondents by Maternal Factors

Maternal Factors	Frequency (2021)	Percentage (100%)	Chi-square value	P-value
Mother's age				
< 30 years	906	44.80	1.010	0.001
≥ 30 years	1115	55.20		
Place of Residence				
Urban	1734	85.80		
Rural	287	14.20	0.008	0.033
Religion				
Christian	1856	91.80		
Others	165	8.20		
Educational level			0.071	0.008
< Secondary	358	17.70		
≥ Secondary	1663	82.30		
Occupation				
Not working	47	2.30	0.065	0.799
Working	1974	97.70		
Marital status				
Married	1916	94.80		
Others	105	5.20	7.929	0.005

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Table 2: Percentage Distribution of Respondents by Health-related Factors

Health-related factors	Frequency (2021)	Percentage (100%)	Chi-square value	P-value
No. of ANC attended				
< 4 visits	363	18.00	0.850	0.000
≥ 4 visits	1658	82.00		
Delivery Outcome				
Live birth	1840	91.00		
Stillbirth	181	9.00	0.050	0.000
Mode of delivery				
SVD/AD	952	47.10		
C/S	1069	52.90		
Parity			0.950	0.001
< 2	631	31.20		
≥ 2	1390	68.80		
Baby's weight				
< 2.5kg	1781	88.10	1.807	0.179
≥ 2.5kg	240	11.90		

The result in Table 3 shows the effects of maternal and healthcare related factors on maternal mortality in Rivers State, Nigeria. From the result, women aged thirty years and above were more likely to die than women of less than thirty years (Odds Ratio = 1.22; 95% C.I = 1.580–2.569). In the same way, unmarried women were more likely to die than the married ones (Odds Ratio = 1.27; 95% C.I = 1.274–3.133). Also, women who had at least secondary education were less likely to die than those with below secondary qualification (Odds Ratio = 0.79; 95% C.I = 0.280–0.691). Those who reside in rural areas were more likely to die than those in urban areas (Odds Ratio = 2.26; 95% C.I = 1.209–4.202).

Women who had stillbirth as delivery outcome were more likely to die than women who had live births (Odds Ratio = 1.31; 95% C.I = 1.230–2.634). Also, women with two or more parities were more likely to die during, within or weeks after delivery than women that had less than two parities (Odds Ratio = 1.30; 95% C.I = 1.701–2.4057). Women who attended ANC below four times before delivery were likely to die more than those who attended more than four times (Odds Ratio = 0.68; 95% C.I = 0.282–0.890). Also, women whose baby weighed 2.5kg or more were less likely to die than those whose babies weighed less than 2.5kg (Odds Ratio = 0.93; 95% C.I = 0.391–2.193).

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Table 3: Effects of Maternal and Healthcare-related Factors on Maternal Mortality in Rivers State, Southern Nigeria

MATERNAL FACTORS	EXP (B)	P-VALUE	95% CI FOR EXP (B)	
			LOWER	UPPER
Mother's age				
< 30 years	1.00			
≥ 30 years	1.22	0.040	1.580	2.569
Marital status				
Married	1.00			
Unmarried	1.27	0.020	1.274	3.133
Educational level				
< secondary	1.00			
≥ secondary	0.79	0.049	0.280	0.691
Religion				
Christian	1.00			
Others	1.28	0.633	0.465	3.516
Place of Residence				
Urban	1.00			
Rural	2.26	0.010	1.209	4.202
Occupation				
Not working	1.00			
Working	0.80	0.516	0.402	1.580
Delivery outcome				
Live birth	1.00			
Stillbirth	1.31	0.001	1.230	2.634
Baby's weight				
< 2.5kg	1.00			
≥ 2.5kg	0.93	0.000	0.391	0.930
No. of ANC attended				
< 4 visit	1.00			
≥ 4 visits	0.68	0.003	0.282	0.890
Mode of delivery				
SVD/AD	1.00			
C/S	1.45	0.356	0.892	1.760
Parity				
< 2	1.00			
≥ 2	1.30	0.006	1.701	2.406

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DISCUSSION

The aim of this study was to identify the factors associated with maternal mortality in Rivers State, with emphasis on maternal and health care related factors. The study revealed that maternal age, educational level, place of residence and marital status are significantly associated with maternal mortality in Rivers State. Studies had revealed similar results in the past. For instance, the odds of maternal death were lower in older mothers compared to younger mothers in some studies (Chowdhury et al., 2007; Karlsen et al., 2011; Illah et al., 2013; Kassebaum et al., 2014), while other studies (Adamu et al., 2003; Meh et al., 2019) showed lower maternal deaths in younger mothers than older mothers. The disparities in age and maternal deaths between this study and other studies may be attributed to religious and cultural practices, depending on the area of study (Meh et al., 2019).

Women with better education were identified as protected from maternal mortality compared to those that were less educated. This result agreed with some studies in the past (Adamu et al., 2003; Chowdhury et al., 2007; Karlsen et al., 2011; Meh et al., 2019). The risk of maternal death may be higher in women with less education because of factors such as non-use of maternal health services (Fagbamigbe & Idemudia, 2015), early marriage, and cultural practices that restrict their access and participation in the labor force (Meh et al., 2019).

Education is also one of the major components of social autonomy in women. As stated in Meh (2017), lack of autonomy/decision making among women is strongly correlated with pregnancy outcomes and maternal survival (Rogo et al., 2006). According to Amzat (2015), while women's rights are affected at the political level, they are also affected at the household and community level were lack of autonomy limits social status. This is seen in women's lack of control on their reproductive health, inequalities in decision making, domestic confinements and no participation in their health care, in cases where partners and husbands unilaterally make decisions (Amzat, 2015). Lack of autonomy translates into a woman having minimal control over her own affairs in health care. This problem is widespread in many cultures in Africa where women are subject to patriarchal dominance, requiring permission to exercise any activity (Amzat, 2015). Lack of autonomy plays an important role in maternal health outcomes, predisposing women to frequent births especially when male children are preferred over female children, and risk of complications due to frequent and poorly spaced pregnancies (Amzat, 2015).

Increasing levels of educational attainment is likely to enhance the capacity of women to obtain, process and understand basic health information about the benefits of good prenatal care and the reproductive health services needed to make appropriate health decisions. For instance, more educated women may be less likely to accept traditional explanations for life and death and instead take on broad information about birth spacing, the signs of pregnancy complications and the need to improve their nutritional status to reduce the risk of iron deficiency anaemia, all of which are of key importance in the drive to reduce maternal deaths. Also, more educated women are likely to be more confident about asking questions about their health care needs and are more likely to be listened to by health care professionals (Karlsen et al., 2011).

Resident in the rural area significantly increase the risk of maternal mortality in of Rivers State This is consistent with other studies in Nigeria and abroad (Adamu et al., 2003; Banda et al., 2015). A possible explanation for this could be that access to health care is usually better in

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urban than rural areas. Practices like unsafe abortions among women and a high prevalence of disease like HIV that are linked with maternal mortality might also be responsible for high maternal mortality in the rural areas compared to urban areas.

The study also showed marital status as a risk factor of maternal mortality. Unmarried women had a higher risk of maternal death compared to their married counterparts. This agrees with other findings which show that unmarried women were at risk of maternal deaths compared to married women (Evance et al., 2013; Manyeh et al., 2018). This could be attributed to lack of social and financial support. Marriage generally has a beneficial effect on health because it provides social support and social security, and married persons are likely to experience less distress and to have a healthier lifestyle (Ikeda et al., 2007).

In terms of health care related factors, the study revealed that delivery outcome, baby weight, and ANC attendance parity were the proximate factors significantly associated with maternal mortality in Rivers State. The finding was consistent with previous studies such as Karlsen et al. (2011), Mbassi et al. (2011), Hoj et al. (2002), Nafiu et al. (2016), Ntoimo et al. (2018), and Amoo and Ajayi (2019).

Parity, like other significant factors, affects the outcome of a pregnancy (Mbassi et al., 2011) and according to Hoj et al. (2012), age and parity together are the most vital risk factors of maternal death (Hoj et al., 2002). Risk of maternal death increases as the number of pregnancies increases (Meh et al., 2019). This is because of obstetric complications like postpartum hemorrhage in first pregnancies and in women with five or more past births. Second and third pregnancies are usually the most trouble free, with increasing risks in subsequent pregnancies (Meh et al., 2019). Similarly, multiple pregnancies increase the risk of maternal death (Hoj et al., 2002).

The impact of parity on maternal mortality is a worry for women in Africa where the fertility level is high (Amzat, 2015; Buor & Bream, 2004). Limited reach of family planning, the pressure for large families, the fear of childlessness and the fear of husbands bringing in new wives serve to promote this issue (Weinger & Akuri, 2007). There is a penchant for large family sizes in Africa for which a woman may not necessarily have a say in the decision (Amzat, 2015). This makes women bear many children often with poor spacing, predisposing them to pregnancy related complications (Amzat, 2015).

CONCLUSION AND RECOMMENDATIONS

This study has demonstrated the effects of some maternal and health care related factors on maternal mortality. This study unraveled maternal age, educational level, place of residence, marital status, delivery outcome, baby weight, ANC attendance and parity as the risk factors of maternal mortality in Rivers State.

With the risks factors identified, policy makers will be better informed to plan intervention programmes to reduce maternal mortality in Rivers State and fast track the achievement of SDG goals on maternal health. We suggest that risk of maternal death in Rivers State should also be x-rayed in terms of time to event data analysis. Furthermore, public health programs should focus more on ensuring that mothers have less pregnancies and better ANC practices, which are much quicker and less expensive.

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