



Poisson Regression Modeling of Pregnancy Related Death in Oyo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author OM designed the study, managed the literature searches, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AMB and CN managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Worldwide, Over 600,000 maternal deaths are recorded annually. Many women die due to pregnancy associated complications in Nigeria. Thus, this paper seeks to explore the application of poisson models in the study of incidence of pregnancy related death in Oyo state, Nigeria. The paper explores the application of poisson models in the study of maternal deaths. Understanding the incidence of maternal deaths may provide useful information to policy makers for the development of actionable plan to improve maternal health policies and its implementations. The analysis was based on data sourced from the records unit of the hospital for the period of 2009-2018. Within the 10 year period, a total of 1121 maternal death was observed, with the years 2016 and 2017 recording the highest deaths of 136 and 148 respectively. Also, the mean incidence of maternal deaths remained approximately the same over the period. Based on the result from our

analysis, we recommend that management and government reevaluate all existing intervention programs for reducing maternal deaths since they seem not to have yielded the expected results over the past ten years (2009 - 2018) reference to this general hospital.

Keywords: Maternal health; pregnancy related death; poisson regression model; Oyo State.

1. INTRODUCTION

Improving maternal health is the fifth of the Millennium Development Goals. Motherhood is normally a positive and satisfying experience; yet many women suffer ill-health and even death in the process of attaining this fulfillment. Maternal health and mortality in particular, has devastating effect, not only on the mother, but also on the children left behind, her family, the society and nation as a whole [1]. Many studies in maternal mortality have been to provide up to date statistics of its state and also to see how close we are to achieving the millennium development goals. Some studies have also been to assess the impact of certain interventions in the reduction of these mortality levels. Some modeling have also been done in maternal survival, for the most part, to estimate Maternal Mortality Ratio (MMRatio) in the absence of data [2]. Most of these studies have used linear models, and have basically been done to determine the extent to which some factors explain or influence MMRatio. Special studies in developing countries in the 1980's, revealed a higher than anticipated number of maternal deaths; heightening interest in maternal mortality [3]. These studies highlighted the twofold problems of developing good and informative estimates of maternal mortality: The MDG 5 indicators for maternal health are the MMRatio and proportion of births attended by skilled health personnel [4]. These measures do not consider the time, after pregnancy, that the maternal deaths are occurring. Also, deaths in a particular period do not usually match the risk of that period: These overlaps obviously have effect on these measures. Generally, there is a distinction between a direct maternal death that is the result of a complication of the pregnancy, delivery, or management of the two, and an indirect maternal death that is a pregnancy-related death in a patient with a preexisting or newly developed health problem unrelated to pregnancy [5]. Fatalities during but unrelated to a pregnancy are termed accidental, incidental, or non-obstetrical maternal deaths. The most common cause of postpartum bleeding (15%), complications from unsafe abortion (15%), hypertensive disorders of pregnancy (10%), postpartum infections (8%),

and obstructed labour (6%). Other causes of maternal death include blood clot (3%) and pre-existing conditions (28%). Indirect causes are malaria, anemia, HIV/AIDS, and cardiovascular disease, all of which may complicate pregnancy or be aggravated by it. Socio-demographic factors such as age, access to resources and income level are significant indicators of maternal outcome [6-9]. Young mothers face higher risks of complications and death during pregnancy than older mothers, especially adolescents aged 15 years or younger. Adolescents have higher risks for postpartum hemorrhage, puerperal endometritis, operative vaginal delivery, episiotomy, low birth weight, preterm delivery, and small-for-gestational age infants, all of which can lead to maternal death. Surgical support and family support influences maternal outcomes [10-13]. Furthermore, social disadvantage and social isolation adversely affects maternal health which can lead to increase in maternal death. Additionally, lack of access to skilled medical care during childbirth, the travel distance to the nearest clinic to receive proper care, number of prior births, barriers to accessing prenatal medical care and poor infrastructure all increases maternal deaths. Unsafe abortion is another major cause of maternal death [14-16]. According to the World Health Organization, every eight minutes a woman dies from complications arising from unsafe abortions [17]. Complications include hemorrhage, infection, sepsis and genital trauma. Globally, preventable deaths from improperly performed procedure constitute 13% of maternal mortality, and 25% or more in some countries where maternal mortality from other causes is relatively low, making unsafe abortion the leading single cause of maternal mortality worldwide [18-21]. In this study, Poisson Regression model is used to examine the incidence of maternal mortality at General Hospital, Ibadan. The main aim of the study is to explore the application of Poisson models in the study of Maternal Deaths. Understanding the incidence of maternal deaths may provide useful information to policy makers for the development of actionable plan to improve maternal health policies and its implementations. Also the findings would help to determine whether there exists a year to year

variation in the occurrence of maternal deaths at General Hospital, Ibadan as a facility.

2. MATERIALS AND METHODS

The analysis is based on maternal deaths data available at General Hospital, Ibadan. The data covers all recorded deliveries and maternal deaths for the period January, 2009 to August, 2018. Since maternal deaths are considered a count data, a Poisson regression model was specified with the years considered as covariate.

2.1 Model Specification and Estimation

To explain the incidence of maternal mortality, this paper specifies a Poisson regression model for the data. Class of generalized linear models provides a unified framework to study various regression models such as the Poisson regression model. The Poisson model assumes that the variance of the count data is equal to the mean. Consider the model;

$$P_r(Y_i = y_i) = \frac{e^{-\mu_i} \mu_i^{y_i}}{y_i!}$$

The Poisson regression model assumes that the sample of n observations y_i are observations on independent Poisson variables Y_i with mean μ_i . Note that, if this model is correct, the equal variance assumption of classic linear regression is violated, since the Y_i have means equal to their variances. The most common formulation of this model is the log-linear specification:

$$\log(\mu_i) = x_i^T \beta$$

When a response count Y has index (such as population size) equal to t , the expected value of the rate is μ/t , where $\mu = E(Y)$. A log linear model for the expected rate has form

$$\log\left(\frac{\mu}{t}\right) = \alpha + \beta_i X_i \quad \text{where } i = 1, 2, 3, \dots, i$$

This model has equivalent representation

$$\log(u) - \log(t) = \alpha + \beta_i X_i \quad \text{where } i = 1, 2, 3, \dots, i \text{ and } j = 1, 2, 3, \dots$$

The adjustment term, $-\log(t)$ to the log of the mean is called an offset. Standard GLM software can fit a model having an offset term. For such log linear model, the expected number of outcomes satisfies

$$\mu = \exp(\alpha + \beta_i X_i)$$

The mean μ is proportional to the index t , with proportionality constant depending on the value of the explanatory variable. For a fixed value of X , for example, doubling the population size t also doubles the expected number of murders μ . Like any generalized linear model, the specification of the Poisson regression model can be done using an information criterion such as the AIC. The coefficients of the Poisson regression model are estimated using the maximum likelihood techniques. The deviance (likelihood ratio) test statistic, G^2 , is used to assess the adequacy of the fitted model. The evaluation of the model follows the same way as for other generalized linear models.

3. RESULTS AND DISCUSSION

Within the 10 year period, a total of 1121 maternal deaths were recorded at the hospital.

To determine the incidence of maternal deaths, the study fitted a Poisson regression model to the data. The selection of the final model was based on the Akaike information criterion (AIC). An objective test for over-dispersion, which follows the Pearson's chi-square was performed. From Table 1, dispersion parameter (DP) was 1.0421 indicating a clear absence of over dispersion in the data. Hence, Poisson model is an appropriate model.

Table 2 summarizes the maximum likelihood estimates of the parameters in the model. The coefficients for all the variables are estimated relative to a selected reference year (2018). The

Table 1. Criteria for assessing goodness of fit for incidence of maternal mortality model

Criteria for assessing goodness of fit			
Criterion	Df	Value	Value/Df
Deviance	150	153.9667	1.0421
Scaled Deviance	150	153.9667	1.0421
Pearson Chi-Square	150	154.3007	1.0461
Scaled Pearson X2	150	154.3007	1.0461
Log Likelihood	150	1472.5113	

Table 2. Parameter estimates for incidence of maternal mortality

Parameter	Time	Df	Estimate	Standard Error	Wald	95% C.I	Chi-Sqr	Pr>Chi Sqr.
Intercept		1	-4.8112	0.0910	-5.0204	-4.6472	2518.4	< 0.0001
Year	2009	1	0.1523	0.1347	-0.1116	0.4239	1.21	0.2542
Year	2010	1	0.2160	0.1319	-0.0424	0.4822	2.23	0.1015
Year	2011	1	0.2438	0.1306	-0.013	0.5101	3.03	0.0617
Year	2012	1	0.2001	0.1340	-0.0642	0.4701	2.02	0.1390
Year	2013	1	0.2628	0.1303	0.0031	0.5259	3.62	0.4030
Year	2014	1	0.3003	0.1301	0.0401	0.523	5.01	0.2004
Year	2015	1	0.1658	0.1402	-0.105	0.4406	1.08	0.2220
Year	2016	1	0.0142	0.1348	-0.2542	0.2821	0.01	0.0096
Year	2017	1	0.3039	0.1251	0.0563	0.5561	5.46	0.0119
Year	2018	0	0	0	0	0		
Scale		0	1	0	1	1		

result of the estimated model indicates that the mean incidence of maternal deaths was high for all years compared to the year 2018 which happens to be the reference year. The result shows that there was a statistically significant maternal mortality incidence between the years 2016, and 2017 relative to year 2018. The chi-square values were 1.01, and 5.46 with p-values of 0.0096, and 0.0119 respectively.

4. CONCLUSION AND RECOMMENDATION

This paper seeks to explore the application of Poisson models in the study of incidence of maternal deaths at General hospital, Ibadan, Nigeria. Within the 10 year period, a total of 1121 maternal deaths were recorded at the hospital within the years 2016 and 2017 recording the highest deaths of 136 and 148 respectively. From the estimated Poisson regression model, positive parameters from 2009 to 2017 indicates that the mean incidence of maternal deaths at the hospital has remained approximately the same over the period and were all greater than that of the mean of the year 2018 which happens to be the referenced year. The result also shows that there was a statistical significant maternal mortality incidence between years 2016, and 2017 relative to year 2018. Hence compared to the year 2018, the incidence of maternal death was significantly high in 2016, and 2017. The mean incidence of maternal death at the hospital was found to have remained approximately the same over the 10 year period. This paper therefore recommends that management and government as a matter of urgency review and evaluate all existing intervention programs for reducing maternal deaths since they seem not to have yielded the expected results over the past ten years (2009-2018).

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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