

Poisson Regression Modeling For Incidence of Maternal Deaths In Ghana

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ABSTRACT

The death of a woman while performing her naturally mandated duty of childbirth remains sad and sensitive to every nation worldwide. This paper seeks to explore the application of Poisson models in the study of incidence of Maternal Deaths at Komfo Anokye Teaching Hospital – Kumasi, Ghana. Analyses were based on data available at the Obstetrics & Gynecology directorate of the Hospital for the period 2000-2010. We found that within the eleven (11) year period, a total of 1,223 maternal deaths occurred with the years 2008 and 2009 recording the highest deaths of 138 and 144 respectively. Also, the mean incidence of maternal deaths remained approximately the same over the period. The results also show that compared to year 2010, the incidence of maternal death was significantly high in 2004, 2005 as well as 2008. We conclude 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 eleven years (2000 - 2010) reference to this teaching hospital.

Key words: Poisson Regression Model, Bio-statistics, KATH

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1.0 INTRODUCTION

Global attention began to focus more seriously on maternal mortality when in 1985; Rosenfield and Maine (1985) published a thought-provoking article 'Maternal Mortality - a neglected tragedy - where is the M in MCH?' and alerted the world to the fact that many developing countries were neglecting this important problem. Another significant contribution to the crusade against maternal mortality was the WHO (1986) publication, 'Maternal Mortality: helping women off the road to death.' All these led to the Safe Motherhood Conference in Nairobi, Kenya in 1987 as well as subsequent conferences up to the millennium summit in 2000.

Globally, 529,000 women die each year from pregnancy-related complications, of which about 90% occur in developing countries, the worst affected being West Africa, including Ghana (UN Millennium Project, 2006).It is estimated that over half of these deaths are in sub-Saharan Africa, with maternal mortality ratio of 910 deaths per 100,000 live births (WHO, 2006).Ghana's maternal mortality ratio (MMR) declined from 560 deaths out of 100,000 live births in 2005, to

451 deaths in 2007 (WHO, 2005; Ghana DHS, 2007). Aikins L. (2010) found that with a ratio of one doctor is to 17,733 and the Nurse-Population ratio of 1: 1,510 with great disparities between urban and rural dwellers, the presence of skilled birth attendants at delivery as per pregnant woman ratio was quite poor and is not aiding reduction in maternal deaths. Yanqiu,et al. (2009) used Poisson regression to study Time trends and regional differences in maternal mortality in China from 2000 to 2005 and found that MMR declined by an average of 5% per year. Razum, et al (1998) also examined the impact of marital status on maternal mortality in Germany using Poisson regression models and found the overall maternal mortality ratio to be stable before, and declined after, reunification. Louise, et al, (1994) compared the use of Poisson Regression and Time Series Analysis for Detecting Changes over Time in Rates of Child Injury and concluded that, although time series analysis has been promoted as the method of choice in analysis of sequential observations over long periods of time, Poisson regression is an attractive and viable alternative.

In this study, Poisson Regression model is used to examine the incidence of maternal mortality at Komfo Anokye Teaching Hospital – Kumasi. 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 KATH as a facility. The study will also contribute to the existing literature on maternal health in Ghana. The rest of the paper is organized as follows: Section 2 describes the concept of methods and formulations employed in the research. The data, empirical analysis and results are presented in Section3. Section 4 provides the concluding remarks.

2.0 DATA AND METHODOLOGY

The analysis is based on maternal deaths data available at the Bio-Statistics Department of the Obstetrics & Gynecology directorate of the Okomfo Anokye Teaching Hospital in Kumasi (KATH). The Kumasi metropolis is the most populous district in the Ashanti Region. The city accounts for nearly one-third of the region's population and is divided, in turn, into 10 sub-metropolitan areas. The majority of maternal deaths in Kumasi (about 93%) occur at KATH (KMHD, 2009), most likely because this hospital is the referral hospital for complicated medical emergencies. The data covers all recorded deliveries and maternal deaths for the period January, 2000 to December, 2010. Since maternal deaths are considered a count data, a Poisson regression model was specified with the years considered as covariate. In all, 132 monthly observations were used in the 11 years period with maternal death cases as the response variable and time (in years) as the predictor variable.

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 (Nelder and Wedderburn1972, JRSSA) 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 (Agresti, 2007). The primary equation of the model is given as (Simeon-Denis Poisson 1781–1840)

$$\Pr(Y_i = y_i) = \frac{e^{\mu}\mu_i{}^{y_i}}{y_i!}, y_i = 0,1,2$$

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:

$$\log(\mu_i) = x_i'\beta$$

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

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

This model has equivalent representation

$\log\mu - logt = \alpha + \beta_i X_{ij}$. Where $i = 1,2,3,\ldots..i \ \ and \ j = 1,2,3,4.$

The adjustment term, $-logt$ 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

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

The mean $\mu$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.

3.0 RESULTS AND DISCUSSION

The incidence of maternal deaths reference to the selected background characteristics is shown in Table 1. Within the eleven (11) year period, a total of 1,223 maternal deaths were recorded at the

hospital with the years 2008 and 2009 recording the highest deaths of 138 and 144 respectively.

Table 1: Descriptive Characteristics of the maternal deaths (2000 – 2010)

Variable	Frequency	Percentage
Time Trend		
2000	**98**	**0.93**
2001	**106**	**0.99**
2002	**107**	**0.99**
2003	**100**	**0.97**
2004	**111**	**1.03**
2005	**115**	**1.07**
2006	**94**	**0.94**
2007	**99**	**0.8**
2008	**138**	**1.08**
2009	**144**	**1.18**
2010	**111**	**0.79**

3.1 Poisson Model Specifications for Incidence of Maternal Mortality

To determine the incidence of maternal deaths, the study fitted a Poisson regression model to the available data. The selection of the final model was based on the Akaike information criterion (AIC).

Table 3 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 (2010). For appropriateness of a Poisson model, the model mean and variance should be the same. An objective test for over-dispersion, which follows the Pearson's chi-square, was performed. From Table 2, dispersion parameter (DP) was 1.0328 indicating a clear absence of over dispersion in the data. Hence, Poisson model is an appropriate model.

The results of the estimated model as presented in Table 3, indicates that the mean incidence of maternal deaths was high for all years compared to the year 2010 which happens to be the referenced year. The results show that there was a statistically significant maternal mortality incidence between years 2004, 2005 and 2008 relative to year 2010. Their chi-square values were 3.95, 5.12 and 5.83 with p-values of 0.0469, 0.0236 and 0.0158 respectively. Hence compared to year 2010, incidence of maternal death was significantly high in 2004, 2005 as well as 2008.

In 2008, government showed much commitment to addressing the challenges of maternal health, specifically the problem of low coverage of supervised deliveries and high institutional maternal mortality rate among others. Maternal mortality was therefore declared a national emergency in 2008 (2008 Ghana Millennium Development Goals report. April, 2010) and the programme of free health care for pregnant women, including deliveries through the National Health insurance Scheme, was implemented since July 2008. Okomfo Anokye Teaching Hospital also experienced the nationwide increase in supervised deliveries rates hence the rise in maternal death rates. It is however obvious that on average maternal deaths at the facility has neither reduced nor increased over the period of time under study (see Table 3).

4.0 CONCLUSION

Maternal mortality is one of the most sensitive indicators of the health disparity between richer and poorer nations. The lifetime risk of dying due to maternal causes is about one in six in the poorest countries; compared to about one in 30,000 in Northern Europe (Ronsmans and Graham, 2006).This paper seeks to explore the application of Poisson models in the study of incidence of Maternal Deaths at Komfo Anokye Teaching Hospital – Kumasi, Ghana. Within the eleven (11) year period, a total of 1,223 maternal deaths were recorded at the hospital with the years 2008 and 2009 recording the highest deaths of 138 and 144 respectively.

From the estimated Poisson regression model positive parameters from 2000 to 2009 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 2010 which happens to be the referenced year. The results also show that there was a statistically significant maternal mortality incidence between years 2004, 2005 and 2008 relative to year 2010.Hence compared to year 2010, the incidence of maternal death was significantly high in 2004, 2005 as well as 2008.

Understanding the incidence of maternal deaths provides useful information to policy makers for the development of actionable plans to improve maternal health policies and its implementations. For instance, the mean incidence of maternal deaths at the Hospital was found to have remained approximately the same over the eleven (11) years period. Such revelations are critical for monitoring and evaluating the existing programs which aims at reducing maternal deaths. This paper therefore recommend to management and government to 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 eleven years (2000 - 2010)

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Table 2: Criteria for assessing goodness of fit for incidence of maternal mortality model

Criteria For Assessing Goodness Of Fit			
Criterion	**DF**	**Value**	**Value/DF**
Deviance	121	124.9686	1.0328
Scaled Deviance	121	124.9686	1.0328
Pearson Chi-Square	121	125.4037	1.0364
Scaled Pearson X2	121	125.4037	1.0364
Log Likelihood		1443.3651	

Table 3. Parameter estimates for incidence of maternal mortality

Parameter	Time	Df.	Estimate	Standard Error	Wald 95% C.I		Chi-Sqr	Pr>ChiSqr
Intercept		**1**	**-4.8383**	**0.0949**	**-5.0243**	**-4.6523**	**2598.4**	**<.0001**
Year	2000	1	0.1562	0.1386	-0.1155	0.4278	1.27	0.2599
Year	2001	1	0.2199	0.1358	-0.0463	0.4861	2.62	0.1054
Year	2002	1	0.2477	0.1345	-0.016	0.5114	3.39	0.0656
Year	2003	1	0.2021	0.1379	-0.0681	0.4723	2.15	0.1427
Year	**2004**	**1**	**0.2667**	**0.1342**	**0.0036**	**0.5298**	**3.95**	**0.0469**
Year	**2005**	**1**	**0.3012**	**0.1331**	**0.0404**	**0.562**	**5.12**	**0.0236**
Year	2006	1	0.1697	0.1402	-0.105	0.4445	1.47	0.2259
Year	2007	1	0.0146	0.1382	-0.2564	0.2855	0.01	0.916
Year	**2008**	**1**	**0.3078**	**0.1275**	**0.0579**	**0.5577**	**5.83**	**0.0158**
Year	2009	1	0.1681	0.1333	-0.0933	0.4294	1.59	0.2075
Year	2010	0	0	0	0	0		
Scale		0	1	0	1	1		

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