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A Time Series Analysis of Maternal Mortality Rate in Anambra State. A Case Study of Nnamdi Azikiwe Teaching Hospital (NAUTH), Nnewi-Anambra State

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Abstract

Despite recent focus on maternal mortality in Nigeria, its rates remain unacceptably high in Nigeria. The study examines the maternal mortality rate at Nnamdi Azikiwe University Teaching Hospital Nnewi, Anambra State-Nigeria for the period of 2004-2013. The case files of all maternal deaths that occurred in the teaching hospital for the period of study were retrieved and data extracted into a study proforma. The time series analysis was applied and the method of least square used to determine the trend equation, $Y_t = 19.52 + 0.178t$. In the analysis, the causes of maternal deaths and factors associated within these deaths were identified. Some of these causes and factors leading to maternal mortality were homorrhage (22.2%), commonly observed with the age group (25-29) years; sepsis (33.3%) eclampsia (27.5%) and ruptured uterus (28.6%). The autocorrelation coefficients (ACF) for different lags were also determined. It is necessary to improve the quality of emergency obstetric service as well as reduce cost and educate women of reproductive age the importance of booking for antenatal care and family planning.

Keywords: Maternal Mortality, Millennium Development Goals, least square method, Trend, Time series Analysis, Autocorrelation function (ACF), Autocorrelations Coefficients.

1.0 Introduction

Maternal Mortality Rate (MMR) is the number of maternal deaths related to pregnancy, child birth and post natal (Peuperium) complications per 1000 live birth. It is a sensitive indicator of health status of a population. It reflects the socio-economic status of the community [1]. Maternal Mortality (MM) is a part of indicators for assessing; overall heath conditions, reproductive health programs, and development status of a nation. However, few countries have been able to establish a comprehensive demographic reporting needed for its estimation. Maternal Mortality (MM) remain a very big challenge to health system worldwide. For the assessment of progress towards millennium development, reliable information about the rates and trends of Maternal Mortality (MM) is needed.

The effort to lower Maternal Mortality Rate (MMR) in Nigeria has become the priority of the government. This informed the launching of the National Programme for the Prevention of Maternal Mortality (NPPMM). The aim of the programme was the advocacy for safe motherhoods integrated and adopted in the fifth millennium development goals [2].

In most developing countries, including Nigeria, the Maternal Mortality (MM) estimates are unreliable, imperfect, misleading and biased [3]. The reasons for these problems cannot be far fetched; some private hospitals in developing countries including Nigeria do not have demographic records of women who put to bed in their maternity wards and also women who died in the facility are not representative of the population. Based on these problems the population – based survey have to be used for the estimate of Maternal Mortality Rate (MMR) [4].

One such method of estimating Maternal Mortality Rate (MMR) is the use of sisterhood method which was originally designed to curtail the problem of large data requirements and cost [5]. It is an indirect method which based its analysis on four simple questions that ask adult respondents about how many of their relations have died and whether those who died were pregnant at the time of death. This method produces estimates of demographic indices based on data or information that is indirectly related to its value [6]. The reliability and validity trial of the sisterhood method was first carried out in Gambia in 1987 and it yielded results and he been used in many studies [7, 8, 9].

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In Nigeria, most births do not take place in government hospitals; therefore the reported statistics do not accurately reflect the number of deaths during pregnancy and childbirths. Hospital demographic records or statistics suffer serious biases due to the selectivity syndrome of the health ministries, and these often lead to over or under estimate of the level of Maternal Mortality Rate (MMR). Maternal Mortality Rate (MMR)in Nigeria is high and can be traced to numerous causes classified as direct obstetrics or indirect obstetrics. The direct obstetrics causes are related to complications of pregnancy and labour such as: homorrhage, sepsis, eclampsia, and obstructed labour and unsafe abortion. The indirect obstetrics causes are those emanating from diseases such as malaria, anaemia, diabetes, hepatitis, cardio vascular diseases. The human factors are not left out among the causes. Studies have shown that flaws in the health system such as hostilities between midwives and traditional birth attendants (TBA) could result to maternal mortality. Although different studies on maternal mortality have been carried out at different parts of the country among which are the result of the research from hospital records such as [10, 11]. We shall demonstrate the technique of time series analysis to model the maternal mortality rate and contributory factors to causes; since the emphasis on time series analysis is on model building.

2.0 Materials and Methods

Data for the study were collected on monthly basis from the medical record department of Nnamdi Azikiwe University Teaching Hospital (NAUTH). Nnewi – Anambra State for the period of 2004 – 2013. Though a secondary data, the data were classified into the number of death cases, by age of mothers parity and causes of deaths. Considering that the data is a time – sequence data collected at regular interval (monthly) we would adopt the technique of time series analysis in analyzing the data. Descriptive statistics would also be used to summarize the data. Time series analysis refer to the body of principles and technique which deals with the analysis of the observed data X_t, t = 1, 2, ….n. usually the data are analyzed in order to gain understanding of the underlying mechanism of the process X_t, tεz [12].

Since the emphasis on time series is on model building, the following models are always considered;

Additive model: $X_t = T_t + S_t + C_t + I_t$ …….. [1]

Multiplicative model: $X_t = T_t * S_t * C_t * I_t$ …… [2]

Mixed model: $X_t = T_t * S_t * C_t + I_t$…… [3]

Where X_t denotes the observed value of the series, T_t is the trend, S_t, the seasonal component, C_t the cyclic component and I_t, the irregular component [13].

The data on monthly maternal mortality (MM) is presented in a two dimensional table in table 1. A time series plot of the data is shown in Fig. 1. From fig 1, the series is seen to have a downward trend (0.20%) between the year 2004-2005 then increased by (0.26%) from 2005-2007, declined again by (0.21%) from 2007-2009, increased again by (0.24%) from 2011-2012. By the year 2013, a downward trend was observed.

From table 2, we determine the trend line to the time series:

$Y_t = a + bt$ ……. [4]

Where Y_t = the estimated trend value for a given period (t).

a = the trend line when t = 0

b = the gradient or slop of the trend line

The parameter estimates are

$$a = \frac{\Sigma y}{n} - b\frac{\Sigma t}{n} = \bar{y} - b\bar{t} \text{ ……} \quad [5]$$

$$b = \frac{n\Sigma ty - \Sigma t\Sigma y}{n\Sigma t^2 - (\Sigma t)^2} = \text{…….} \quad [6]$$

Trend equation, $Y_t = 19.52 + 0.178t$ …… [7]

The trend equation $Y_t = 19.53 + 0.176t$ was determined from the data.

For model adequacy at 5% level of significance, the autocorrelation coefficients are all expected to lie in the interval

$$\frac{\pm 1.96}{\sqrt{n}} = 0.16$$

Where n is the number of observations. The ACF plot of the residual series with autocorrelation coefficients at various lags are shown in Fig. 2 it is clear from Fig. 2 that all the coefficients lie within the interval. For detailed discussion of residual analysis [see 14]. Table 4 shows the causes of maternal mortality by direct obstetrics and age parity of the group. The table highlights that hemorrhage, sepsis, eclampsia and obstructed labour are some of the causes of maternal mortality (MM) within the age group of women exposed to child bearing risk.

Table 5 shows causes of maternal mortality (MM) by indirect obstetrics, anaemia, malaria, diabetes and hepatitis have been identified as some of the major causes of maternal mortality. From the analysis, the persistent high rate of maternal mortality in the country negates the achievement of the 4th and 5th Millennium Development Goals (MDG).

Table 1: Number of deaths of mothers monthly

Months	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Jan	3	1	3	4	1	2	3	4	3	1	25
Feb	2	0	0	1	1	2	2	3	3	1	15
Mar	4	0	3	2	1	1	1	2	3	1	18
Apr	1	1	1	2	2	1	1	2	1	2	14
May	1	2	2	3	2	1	2	2	2	2	19
Jun	2	1	1	1	2	1	1	2	1	2	14
Jul	2	2	2	1	3	3	2	1	3	3	22
Aug	1	1	2	2	1	3	1	1	0	2	14
Sept Oct	3	0	2	2	2	2	1	2	1	2	17
Nov	3	3	1	2	3	2	1	3	3	1	22
Dec	2	2	0	1	1	1	2	1	2	0	12
	2	1	0	1	1	1	2	2	2	1	13
Total	26	14	17	22	20	20	19	25	24	18	GT=205
Mean	2.17	1.20	1.40	1.80	1.70	1.70	1.60	2.10	2.0	1.50	GM=1.71
SD	0.94	0.99	0.94	0.94	0.78	0.78	0.65	0.90	1.04	1.80	

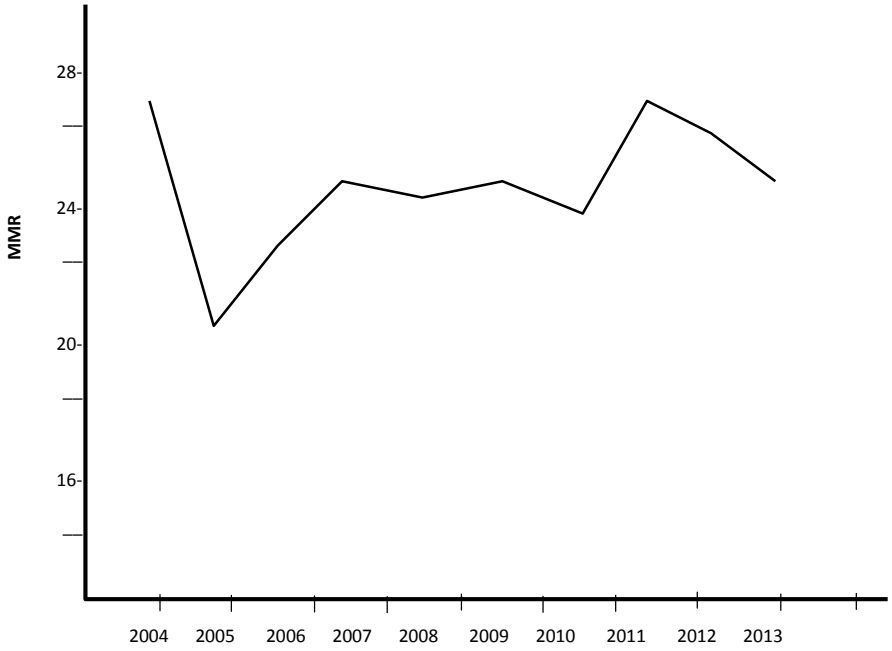

Figure 1: Trend in MMR
A time series plot of MMR data (X_t)

Table 2: Least Square Trend (Serial Time)

YEAR	**t**	$\mathbf{y_t}$	**ty**	$\mathbf{t^2}$
2004	1	26	26	1
2005	2	14	28	4
2006	3	17	51	9
2007	4	22	88	16
2008	5	20	100	25
2009	6	20	120	36
2010	7	19	133	48
2011	8	25	200	64
2012	9	24	216	81
2013	10	18	180	100
TOTAL	55	205	1142	384

Table 3: Autocorrelation Coefficients at Different LAGS

Lag	Corr.	Lag	Corr.
1	0.04	6	-0.004
2	0.03	7	0.003
3	0.01	8	0.017
4	0.004	9	0.018
5	0.004	10	-0.017

Table 4: Causes of Maternal Mortality by Direct Obstetrics

Age – Group	Hemorrhage %	Sepsis %	Eclampsia %	Ruptured Uterus %	Unsafe Abortion %	Total
15 – 19	2. 22.2	0 0.00	2 5.0	0 0.00	1 20.0	5
20 – 24	1 11.1	1 16.6	10 25.0	5 14.3	2 40.0	20
25 – 29	2 22.2	2 33.3	6 15.0	7 20.0	1 20.0	17
30 – 34	2 22.2	1 16.6	11 27.5	10 28.6	0 0.00	24
35 – 39	1 11.1	1 16.6	5 12.5	10 28.6	1 20.0	18
40 - 44	1 11.1	1 16.6	6 15.5	3 8.6	0 0.00	11
Total	**9**	**6**	**40**	**35**	**5**	**95**

Table 5: Causes of Maternal Mortality by Direct Obstetrics

Age – Group	Anaemia %	Malaria %	Diabetes %	Hepatitis %	Total
15 – 19	8 20.0	8 19.0	0 0.0	1 14.2	17
20 – 24	7 17.5	10 23.8	1 16.6	0 00.0	18
25 – 29	10 25.0	10 23.8	1 16.6	2 28.6	23
30 – 34	9 22.5	7 16.7	2 33.3	2 28.6	20
35 – 39	5 12.5	3 7.1	1 16.6	1 14.2	10
40 - 44	1 2.5	4 9.5	1 16.6	1 14.2	7
Total	**40**	**42**	**6**	**7**	**95**

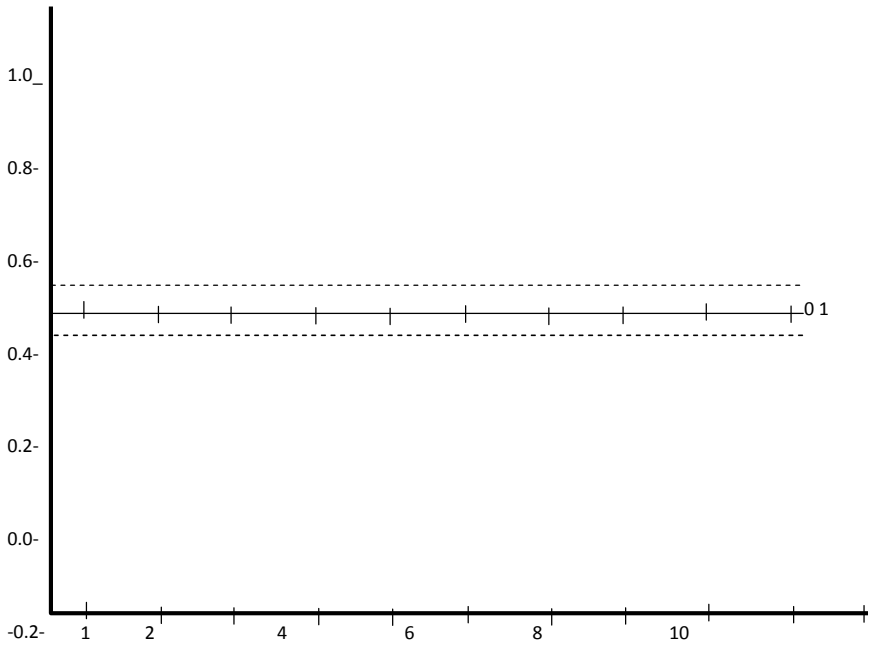

Fig. 2: ACF plot of the residual series.

3.0 Discussion and Conclusion

Table 1, shows the number of deaths of mothers per month from the referral centre, and a time series plot of the data shown in Fig 1.

Fig 2 shows he autocorrelation function & (ACF.) plot of the residual series with the (ACF) coefficient at various lags. From the results, we observed that maternal mortality rate is on the increase in Nigeria and some other developing countries. Table 4 shows some of the causes of maternal mortality rate by direct obstetrics. Hemorrhage and sepsis accounted for 55.7% of maternal deaths, followed by eclampsia and obstructed labour within the period of study. Eclampsia and unsafe abortion were observed to be a major health problem for mothers within the age brackets of 20 24yr, and 30 – 34yr. This reflects an inadequacy of the emergency obstetric response in Nigeria and some other developing countries [15].

Table 5, shows some of the causes of maternal mortality by indirect obstetrics. Anaemia, malaria, and diabetes were observed.

Some major health (indirect obstetrics) problems pregnant women are exposed to while being pregnant. They constitute about 80% of maternal death, and this can be attributed to non-attendance of antenatal clinics by these mothers. They only attendant antenatal clinics only when there are life threatening complications [16].

The health of women, especially mothers is fundamental to development as reflected in the Millenium Development Goals (MDG). Significant additional investments are needed to achieve these millennium development goals (MDG) and to improve women's health beyond the MDG target date of 2015. In order to achieve some of these millennium goals, obstetric-care should be provided free or at affordable rate for all pregnant women using some of these health facilities. All referral centres where these women put to bed should have a blood bank within the premises so as to be able to check-mate problems resulting from blood-shortage.

Widespread education of women within the reproductive age (15 – 45) of age, as well as their spouses be exposed to the importance of regular antenatal care and family planning. These factors when implemented will help reduce the maternal mortality rate.

4.0 References

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