T.R.N.C

NEAR EAST UNIVERSITY

INSTITUTE OF HEALTH SCIENCES

APPLICATION OF MULTIVARIATE STATISTICAL METHODS ON DETERMINANTS OF THE CAUSES OF MATERNAL MORTALITY IN KANO STATE, NIGERIA

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Master of Science in Biostatistics

Advisor:

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APPROVAL

Thesis submitted to the Institute of Health Sciences of Near East University in partial fulfillment of the requirement for the degree of Master of Science in Biostatistics.

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DEDICATION

This research work is dedicated to my Beloved Parents Late AlhajiAbubakar Musa, Hajiya Aisha Salisuand the entire members of my family. I also dedicated this work to the Kano State Government and the former Governor of the State Engr. Dr. Rabi'u Musa Kwankwaso who have given me the opportunity to undergo the master degree program at the prestigious university (Near East University).

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ABSTRACT

APPLICATION OF MULTIVARIATE STATISTICAL METHODS ON DETERMINANTS OF THE CAUSES OF MATERNAL MORTALITY IN KANO STATE, NIGERIA

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Large number of women dies every day in Kano state because of pregnancy and childbirth related causes. Most of these deaths occurred as a result of failure of pregnant women to attend health facilities for antenatal and postnatal care, and this attributed to the lack of education and awareness. Haemorrhages (both ante partum and postpartum) are considered as the major causes of this death. The other causes include abortions, sepsis, obstructed labor, eclampsia, anemia, among others. Programs and policies are being put in place by the governments of Kano state and Nigeria in general to tackle this problem, likewise a lot of Non-Governmental Organizations are helping the state to reduce and/or alleviate the maternal mortality in the state. The maternal mortality causes were evaluated with respect to these variables: age, parity, type of client, year, area, gender of the baby, status of the baby, birth condition, weight of the baby and education. A six-year data of Murtala Muhammad Specialist Hospital, Kano was used. The analyses of 1,197 Hospital maternal deaths were evaluated using multinomial logistic regression, Kruskal Wallis test, Mann Whitney U test, percentage and frequency tables, as well as the Chi-Square test and cross tables. 2011 is the year with the highest number of maternal mortality in Kano state which represents 23.5%, the deaths reduced to 7.9% in 2016. Most of women that died from haemorrhage, infectious diseases, non-infectious diseases and miscellaneous were un-booked (those who do not used to go to the health facilities for antenatal care). Women aged 20-24 has the highest number of deaths and most of these women are from urban areas. Haemorrhage, infectious diseases and other miscellaneous causes are mostly occurred in 2011 while abortion and non-infectious diseases are mostly occurred in 2012 and 2013, respectively.

Key Words: Maternal mortality, univariate statistics, multivariate statistics, Kano State, Nigeria

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LIST OF ABBREVIATIONS

S/No:	ABBREVIATIONS	EXPLANATION
1	MCH	Maternal and Child Health
2	UNFPA	United Nations Population Fund, (formally United Nations Funds for Population Activities)
3	UNICEF	United Nations Children's Fund
4	WHO	World Health Organization
5	MMR	Maternal Mortality Ratio
6	MDG	Millennium Development Goals
7	APH	Ante Partum Haemorrhage
8	PPH	Postpartum Haemorrhage
9	HIV	Human Immunodeficiency Virus
10	ANOVA	Analysis of Variance
11	OR	Odds Ratio
12	NGOs	Non-Governmental Organizations

CHAPTER ONE

INTRODUCTION

Maternal mortality is one of the critical areas that attract more attention of stakeholders. Several measures are put in place to overcome the problems associated with maternal mortality. Even though, all the necessary efforts have been put in place over the years to improve maternal and child survival, through various improvements in the field of technology, medicine, and governmental policies; up to now, it is clear from the present statistics that significant number of children and women suffer or die each year from some severe problems in pregnancy, childbirth, and during postpartum, unfortunately, most of these causes can be prevented (UNFPA, 2002: Van Lerberghe et al., 2005).

Mostly females aged between 15 and 49 years died from pregnancy related courses in all over the world. About 1,500 pregnant women die each day which resulted to the death of about 550,000 women each year (UN General Assembly, 2009). A good consideration into the efforts from the medical perspective to look into matters concerning MCH indicates that progresses in pediatrics, obstetrics and gynecology have long ago played the vital roles. Therefore, the positive influences they have on maternal and child survival have been obvious through the quick treatments of several abnormalities, problems and complications during and after the period of pregnancy. However, despite the fact that the focus of these developments has originally been a response, mainly, to maternal and child complications (Novick, 2004), needs on the avoidance of numerous irregularities and to support women to be aware and correct or accept positive changes during and after pregnancy is very crucial in the first quarter of the 20^{th} century.

UNFPA, UNICEF, WHO, and the World Bank (UNICEF, 2014) developed estimates in 2010 which state that about 260 women die per 100,000 live births worldwide and mostly sub-Saharan Africa has the highest number of these deaths. Africa has the Maternal Mortality Ratio of 620 per 100,000 live births according to these estimates. Europe has the lowest MMR of 21 maternal deaths per 100,000 live births and Greece has the lowest maternal death by country with 2 per 100,000 live births (UNICEF, 2014).

This problem is mostly experienced by developing countries like Nigeria. Nigeria is one of the developing countries that have the highest mortality rate. It is beinglisted as one of the six countries that account for 50% of global estimates of maternal deaths. India has been ranked as the number one country with the highest number of maternal mortality in the world followed by Nigeria. Nigeria is among the worst in Africa regarding the issue of maternal health and the situation is still worsening in some part of the country (Yar'zever, 2014). The maternal mortality rate ranges between 800 and 1,800 per 100,000 live births in Nigeria (Dragonas& Christodoulou, 1998), with marked variation between geo-political zones, 1,749 in the North- East compared with 165 in South West and between rural and urban areas (Carroli, et al., (2001) while total fertility rate is 5.7 births per woman. It is said that 60,000 of maternal mortalities occur annually in Nigeria due to pregnancy and delivery as well as post- delivery complications (Stanton et al., 2000). Nigeria, despite its abundant resources is second to India in terms of complete number of maternal deaths and it contributes more than 10% of all global maternal deaths. The worse indicators are in the northern part of the county (Van Lerberghe et al., 2005: National Population Commission, 2008). Maternal death continues to rise in some Nigerian regions despite the availability of services of maternal health. This is attributed to the poor implementation and management of health policies and services compounded with the cultural and socio-economic factors. The Nigerian government introduced some programs in its effort to curb the problems associated with maternal death like free antenatal care for all pregnant women, skilled care delivery during childbirth, postpartum family planning counseling and services and training of community midwives (WHO, 2008).

Numerous programs and conferences have been conducted by the international community to tackle the issues related to maternal death; those programs and conferences include the Beijing Conference for Women in 1995, the United Nations Millennium Development Goals (MDG'S) in 2000, the one conducted in Cairo in 1994 which is the United Nations Conference on population and development, the one conducted in Nairobi Kenya in 1987 which is the safe motherhood initiative and United Nations decades for women population conference held in Mexico City in 1984. These programs were all carried out to overcome the problems associated with maternal death and attract attention to gender equity and equality and rights as well as reproductive health. Furthermore, the Maputo declaration and action plan also demand for effort to reduce maternal death, promote maternal health and empower women with knowledge so that they are more useful to themselves, their families and communities (WHO, 2008). By considering these aims, prenatal care is in this time regarded as a pathway to best maternal survival in pregnancy and child birth (Ejembi et al., 2004: Audu and Ekele, 2001). Despite the integrity conferred on womanhood and the appreciation of the birth of a new born baby, pregnancy and child birth still regarded a terrifying journey (WHO, 2008).

It is for these reasons that this study uses some statistical methods in examining the determinants of maternal deaths and proffer solutions that may be recommended towards improving the health of mothers and newborn in both the urban and rural areas.

1.1 Statement of the problem

Maternal death is one of the major causes of deaths among women aged between 15 and 49 years, especially in developing countries like Nigeria. Nigeria is among the countries with the highest number of maternal mortality ratio (Yar'zever, 2014). Between the two parts of the country, the northern part recorded high number of these deaths. Therefore, the need arises to examine the causes of maternal mortality in Kano state, apply some multivariate as well as univariate statistical methods and use the findings to proffer solutions of overcoming the problems associated with the causes of the maternal deaths.

1.2 Objective of the research

Main goal of the study is to utilize the application of univariate and multivariate statistical methods to understand the nature of such a critical health problem.

1.3 Hypothesis

Multivariate statistical models can be effectively used for understanding the factors which might affect the causes of maternal mortality in Kano State, Nigeria.

1.4 Significance of the study

The study will contribute to the use of statistical techniques in health sciences. The factors which might affect the causes of maternal mortality in Kano State, Nigeria will be investigated and outcomes will have clinical significance for focusing on these factors thus, contribute to the prevention efforts.

1.5 Limitations of the research

The researcher has limited time to conduct and submit the research; the research was financed by the meager resources of the researcher. This has caused the researcher have access to only one health facility center which might affect the conclusion.

CHAPTER TWO. LITERATURE REVIEW

About 800 women die every day from pregnancy and newborn related preventable causes in the world. 99% of these deaths occur in developing countries such as Nigeria and India. A better way for further advances in minimizing the maternal death is to have a good knowledge about the causes of deaths for a sound health program policy and decisions (WHO, 2014). Complications develop during and after pregnancy, as well as childbirth, lead to the deaths of women. These complications are mostly experienced during pregnancy. The complications are deteriorated during pregnancy but others may occur before pregnancy. Preeclampsia and eclampsia, severe bleeding (usually after childbirth), unsafe abortion and infections (mostly after childbirth) are the major complications that account for about 80% of all maternal mortalities (WHO, 2014). The World Health Organization (WHO) states that in every 8 minutes, complications arising from an unsafe abortion lead to the death of a woman in a developing country (Haddad and Nour, 2009). Most of maternal complications and mortalities in the developing nations are due to poor management and diagnosis of preeclampsia-eclampsia patients (Ghulmiyyah and Sibai, 2012, February).The causes of maternal death are normally categorized into direct causes and indirect causes. Direct causes include ante partum haemorrhage, postpartum haemorrhage, sepsis, obstructed labor, embolism, abortion, pre-eclampsia and eclampsia (Asamoah et al., 2011). Hypertensive disorders, sepsis and haemorrhage are the main causes of maternal deaths that account for more than half worldwide from 2003 to 2009. The indirect causes are ascribed to more than a quarter of maternal mortality (Say et al, 2014). The indirect causes of maternal death are mostly infectious and non-infectious diseases and other miscellaneous causes (Asamoah et al., 2011).

In the Second Report on Confidential Enquiries into Maternal Deaths in South Africa 1999–2001, 3.7% of all deaths are caused by ruptured uterus and 6.2% of deaths because of direct causes and (1.8% as a result to rupture of a scarred uterus and 1.9% as result of rupture of an unscarred uterus). Obstructed labor is an important factor of uterine rupture (Gülmezoglu et al., 2004). In developing countries, sepsis is also one of the leading causes of maternal death. It is estimated that every year at least 75,000 maternal deaths are caused by puerperal sepsis, mostly in less developed nations (Van Dillen et al., 2010). Obstructed labor, preeclampsia-eclampsia, haemorrhage, infections, and anemia of pregnancy are also regarded as the major causes of maternal mortality. In most developing countries, anemia in pregnancy is a major cause of mortality and morbidity, as well as a common problem especially in malaria endemic places. In pregnancy, there is a significant impact of anemia on the health of both the mother and the fetus. Anemia contributed to 20% of maternal deaths in Africa (Idowu, et al., 2005). Pregnancy related hypertensive disorders (including Eclampsia) are in most cases, over-diagnosed while maternal mortalities related infectious diseases are often under-diagnosed (Asamoah et al., 2011). A study which was conducted in 12 maternities in Ivory Coast, Senegal and Benin revealed that post-partum haemorrhage and hypertensive disorder caused 15% and 29 % respectively of maternal death in three countries and they were the highest causes of maternal death among the group (Asamoah et al., 2011). In developed world, Antepartum haemorrhage (APH) is a leading cause of maternal morbidity and perinatal death (Giordano et al., 2010). In sub Saharan Africa, postpartum haemorrhage also remains a major cause of maternal death (Tort et al., 2015). Africa with about 10.5% has the highest prevalence rate (Carroli et al, 2008). More than

30% of all maternal deaths are attributing to PPH in Africa and Asia, where maternal deaths mostly occur (Khan et al., 2006).

Teenage girls under 15 years old have the highest risk of maternal death (Conde-Agudelo et al., 2005: Patton et al., 2009). Adolescents, aged from 15 to 19 and those under 15 are twice and five times as likely to die from pregnancy and childbirth, respectively as women in their twenties, that is the most common assertion (World Health Organization, 2001: United Nations, 2001). At older ages, the Maternal Mortality Ratios (MMRs) rise dramatically due to the fact that older women who get pregnant are chosen for some features related to higher death, including low education levels and poverty, both of which are associated with greater numbers of children (Blanc et al., 2013). Some descriptive analyses have revealed that women aged over 35 or 40 are less likely to attend antenatal care (AbouZahr and Wardlaw, 2003), have skilled attendance at birth (Stanton et al., 2006), and postnatal care (Fort et al., 2005) compared to those in their twenties and early thirties (Blanc et al., 2013). Good antennal and postnatal cares reduce the risks of women and newborn babies (Haddad and Nour, 2009). The effect of antenatal screening on reducing maternal death will depend on how well they manage and screen for malaria, HIV and pre-eclampsia/eclampsia (Oyerinde, 2013). Poor women in rural areas are the ones who are less likely to get satisfactory health care, especially in regions with low numbers of skilled health personnel, such as sub-Saharan Africa and South Asia. In many parts of the world, the levels of antenatal care have been increased during the past decade while in developing countries, only 46% of women benefited from skilled care during pregnancy and childbirth. This means that millions of births are not assisted by skilled birth attendants. Lack of information, poverty, cultural practices, inadequate services and distance are the factors which impede women from seeking care during pregnancy and childbirth (Haddad and Nour, 2009). Social networks health care systems serve as the most important sources of information for prenatal mothers (Nwaru, 2007).

The MMR in developed countries is 16 per 100,000 versus 240 per 100,000 births in developing countries. There are large discrepancies between countries, with few countries having extremely high MMRs of 1,000 or more per 100,000 live births. There are also large discrepancies within countries, between people with low and high income and between people living in urban and rural areas (Haddad and Nour, 2009).

In Nigeria, a woman's chance of dying from pregnancy and childbirth is 1 in 13. Although many of these deaths are preventable, the coverage and quality of health care services in Nigeria continue to fail for women and children. Presently, less than 20 per cent of health facilities offer emergency obstetric care and only 35 percent of deliveries are attended by doctors, nurses and midwives (UNICEF, 2010).

The maternal mortality rate in Kano State has remained high but the trend is gradually decreasing. The difference between urban and rural areas is distinct because of several factors that play in the lives of this sub-group. The highest cause of death is found to be bleeding disorders and eclampsia generally, but the difference was observed within the groups. For example, in urban areas bleeding and eclampsia disorders were the main causes of death, whereas, in rural areas eclampsia, obstructed labor and bleeding causes future prominently as causes of death. There is the disparity in age at marriage between urban and rural settings (Yar'zever, 2014).

Inferential and descriptive statistics are the important aspects of multivariate analysis. Optimal linear combination is usually derived in the descriptive field. The optimality standard or principle differs from one method to another. This depends on the aim in each case. In the inferential aspect, a lot of multivariate methods are additions of univariate techniques. In that aspect, the univariate techniques are applied before offering the corresponding multivariate methods. Multivariate inference is mainly important in controlling the researcher's pure focus to concentrate more in to the data. Proper care is maintained for experimental wise error rate, that is to say, the significance level (α value) maintains at the point design by the researcher. It has been cautioned by some authors against using similar multivariate methods to data for which the ratio or interval is not the scale of measurement. Nevertheless, it has been discovered that a lot of multivariate methods bring accurate result when used in the ordinal data (Rencher, 2003).

The multivariate methods include logistic regression analysis, structural equation modeling, multivariate analysis of variance, multiple regression analysis, cluster analysis, canonical correlation, conjoint analysis, discriminant analysis, factor analysis, among others.

Each of the aforementioned multivariate methods has a particular form of suitable research question. Each method has specific strengths and weaknesses. This should be unambiguously comprehended by the analyst before making any attempt to interpret the findings/results (Richarme, 2002).

CHAPTER TRHEE. METHODOLOGY

3.1 Logistic Regression

In a situation where dependent variable is not continuous in nature but rather categorical with two or more categories, an appropriate model for analyzing such kind of data is multinomial regression in logistic regression. The dependent variable has two levels. Maximum likelihood estimation is used to estimate the parameters of the model. This model is a probabilistic in nature since it is used to compute the probability of having a particular category.

3.2 Probability

When $P(B) > 0$, then $P(A|B) = \frac{P(A \cap B)}{P(B)}$, this happens in a situation where we have information about the occurrence or nonoccurrence of B. Also, if your knowledge of occurrence or nonoccurrence of B is independent of A, then A and B are said to be independent. Two events (A and B) are independents if $P(AB) = P(A)P(B)$. By implication, $P(A|B) = P(A)$ and also $P(B|A) = P(B)$. This idea can be extended to more than two events, for example if $A_1, A_2, A_3 \dots A_n$ are independent, then $P(A_1, A_2, A_3 \dots A_n) = P(A_1)P(A_2)P(A_3) \dots P(A_n)$. Events are said to be independent if information about occurrence or nonoccurrence of any event has no influence on occurrence or nonoccurrence of any other event (Ross, 2010).

3.3 Random Variable

A random variable is a variable whose outcome is not precisely known, but probabilities can be assigned to the probable values of its outcome. A random variable can either be discrete or continuous. A discrete random variable is one which assumes values in a counting process, that is when the outcome of the possible values is obtained in a finite manner or using countable numbers. While on the hand continuous random variable occurs when the outcome of the random variable takes on possible values in a continuum (Ross, 2010).

3.3.1 Binomial Distribution

If one wants to model the outcome of identical trials which are counting in nature, binomial distribution is the most appropriate. In binomial distribution, there are only two outcomes of an event, that is of either success or failure, occurrence or nonoccurrence, defective or non-defective, dead or alive, head or tail and the rest. When there is a single trial in an experiment, the process is said to follow Bernoulli distribution. In Binomial distribution, the trial happens in sequence to determine the probability of having defective or non-defective product. In this type of distribution, we have n independent and identically distributed trials and each having two probable results. The independent trials imply that the result of one trial does not influence the result of any other outcome.

Agresti (2007), If p signifies the probability of success and Y signifies the number of successes in n trials, and with n follows the assumption of independent and identically distributed, then Y follows binomial distribution with parameters n and p. Consequently, binomial distribution of having the probability of y outcome of Y is given as:

$$P(Y = y) = \binom{n}{y} p^y (1 - p)^{n-y}$$

$$P(Y = y) = \frac{n!}{y!(n-y)!} p^y (1 - p)^{n-y}$$

For the mean and variance of binomial distribution of n trials with parameter p are given respectively as:

$$E(Y) = \sum_{y=0}^{n} y \binom{n}{y} p^y (1-p)^{n-y}$$

$$= \mu$$

$$= np$$

and

$$\sigma^2 = \sum_{y=0}^{n} (y - np)^2 \binom{n}{y} p^y (1-p)^{n-y}$$

$$\sigma^2 = np(1-p)$$

With p of 0.5, binomial distribution is symmetric. With constant n, it becomes skewed as p proceed towards 0 or 1. Also, when p is constant, it becomes bell-shaped as n increases. Binomial distribution can be approximated to normal distribution if n becomes so large.

3.3.2 Multinomial Distribution

In some cases, categorical variables can have more than two outcomes. For example, causes of death can be categorized in to haemorrhage, abortion, infectious diseases and non-infectious diseases; in such a trial, Multinomial distribution is used to compute the probabilities of outcome that fall within each group. If k signifies the number of outcome categories, their probabilities by $(p_1, p_2, p_3, \ldots, p_k)$, and $\sum_j p_j = 1$. To compute the probabilities that n_1 is in category 1, n_2 is in category 2, ..., n_k is in category k, the formula is given as:

$$P(n_1, n_2, \ldots, n_k) = \left(\frac{n!}{n_1!, n_2!, \ldots, n_k!}\right) p_1^{n_1} p_2^{n_2} \ldots p_k^{n_k}$$

$$= \frac{n!}{\prod_{i=1}^{k} n_i!} \prod_{i=1}^{k} p_i^{n_i}$$

when $k = 2$, binomial distribution is used. Hence binomial distribution is a special case of multinomial distribution with $k = 2$(Agresti, 2007).

In statistics, it is not uncommon to use multivariate models. In this context, multinomial is referred to as multivariate distribution. For group j, the count n_j has expectation of np_j and σ of $\sqrt{[np_j(1 - p_j)]}$(Agresti, 2007).

3.3.3 Poisson Distribution

In binomial and multinomial distribution, it is assumed that the number of trial is small and that the probability of success is relatively large. But, if the number of trials is too large and hence the probability of having any particular outcome is too small, Poisson distribution is the most appropriate (Christensen, 1990).

(Christensen, 1990), pointed that the limiting distribution of binomial $Bin{\sim}(n,p)$ results in Poisson distribution and in such a case $n \to \infty$ and $p \to 0$. However, the convergence of the parameters should be in such a way that $np \to \lambda$. Consequentl, λ is the value of the parameter of the Poisson distribution. Poisson distribution is given as:

$$P(n = y) = \frac{\lambda^y e^{-\lambda}}{y!}$$

and that

$$n{\sim}Pois(\lambda)$$

He also derived an Expected value and Variance of Poisson distribution respectively as:

$$E(n) = \lambda$$

and

$$\sigma^2 = \lambda$$

this shows that in Poisson distribution, mean and variance are equal in value.

3.4 General Logistic Regression Model

The general logistic regression model is given as:

$$\log(\frac{p_i}{1 - p_i}) = y_i^T \theta$$

Where θ is the vector of parameters to be estimated, and y_i is the vector of dummy variables and continuous measurement. Logistic regression model is extensively used in data analysis with binary or binomial dependent variable. The model accommodates a technique like ANOVA and multiple regression involving continuous dependent variables. For estimation of the parameters θ and hence the probabilities $p_i = g(y_i^T \theta)$, Maximum likelihood estimates are achieved through maximizing the log-likelihood functions (Dobson, 2002).

3.5 Maximum Likelihood Estimation

Estimation of $K + 1$ (θ) unknown parameters is the main objective of logistic regression. Probability of distribution of the regressor is used to form the maximum likelihood equation.

In case of binomial distribution where each y_i signifies binomial count, the following equation gives the probability density function of Y as:

$$f(y|\theta) = \prod_{i=1}^{N} \frac{n_i!}{y_i!\,(n_i - y_i)!} p_i^{y_i} (1 - p_i)^{n_i - y_i}$$

From the above equation, it is clear that p_i is the probability of any one of the n_i trials, $P_i^{y_i}$ is the probability of y_i successes and$(1 - p_i)^{n_i - y_i}$ is the probability of $(n_i - y_i)$ failures. The likelihood function is given as:

$$L(\theta|y) = \prod_{i=1}^{N} \frac{n_i!}{y_i!\,(n_i - y_i)!} p_i^{y_i}(1 - p_i)^{n_i - y_i}$$

To estimate the parameters using maximum likelihood function, computing the first and second order derivative is required. But to differentiate the equation withrespect to θ is very hard, hence simplifying the likelihood equation will make iteasier. As part of the simplification, $(1 - p_i)^{n_i - y_i} = \frac{(1-p_i)^{n_i}}{(1-p_i)^{y_i}}$, and after careful rearrangement the following equation can be maximized:

$$L(\theta|y) = \prod_{i=1}^{N} (\frac{p_i}{1 - p_i})^{y_i}(1 - p_i)^{n_i}$$

Please also note that if e is taken from both sides of the general logistic regression model described in the previous section, we have:

$$(\frac{p_i}{1 - p_i}) = e^{\sum_{k=0}^{K} x_{ik}\theta_k}$$

making p_i the subject of the formula, we have:

$$p_i = (\frac{e^{\sum_{k=0}^{K} x_{ik}\theta_k}}{1 + e^{\sum_{k=0}^{K} x_{ik}\theta_k}})$$

After some substitutions,to maximize the equation:

$$L(\theta|y) = \prod_{i=1}^{N} (e^{\sum_{k=0}^{K} x_{ik}\theta_k})^{y_i}(1 - \frac{e^{\sum_{k=0}^{K} x_{ik}\theta_k}}{1+e^{\sum_{k=0}^{K} x_{ik}\theta_k}})^{n_i}$$

$$= \prod_{i=1}^{N} (e^{y_i \sum_{k=0}^{K} x_{ik}\theta_k})(1 + e^{\sum_{k=0}^{K} x_{ik}\theta_k})^{-n_i}$$

we now take the log of the likelihood function and thus:

$$l(\theta) = \sum_{i=1}^{N} y_i (\sum_{k=0}^{K} x_{ik}\theta_k) - n_i \log(1 + e^{\sum_{k=0}^{K} x_{ik}\theta_k})$$

To compute the estimated value of each θ, we differentiate the log likelihood function partially with respect to each θ and set it equal to zero.

$$\frac{\partial l(\theta)}{\partial \theta_k} = \sum_{i=1}^{N} y_i x_{ik} - n_i \frac{1}{1+e^{\sum_{k=0}^{K} x_{ik}\theta_k}} \frac{\partial}{\partial \theta_k} (1 + e^{\sum_{k=0}^{K} x_{ik}\theta_k})$$

$$= \sum_{i=1}^{N} y_i x_{ik} - n_i \frac{1}{1+e^{\sum_{k=0}^{K} x_{ik}\theta_k}} e^{\sum_{k=0}^{K} x_{ik}\theta_k} \frac{\partial}{\partial \theta_k} \sum_{k=0}^{K} x_{ik}\theta_k$$

$$= \sum_{i=1}^{N} y_i x_{ik} - n_i \frac{1}{1+e^{\sum_{k=0}^{K} x_{ik}\theta_k}} e^{\sum_{k=0}^{K} x_{ik}\theta_k} x_{ik}$$

$$= \sum_{i=1}^{N} y_i x_{ik} - n_i p_i x_{ik}$$

Also in case of multinomial regression, the model is given as:

$$\log(\frac{p_{ij}}{p_{iJ}}) = \log(\frac{p_{ij}}{1 - \sum_{j=1}^{J-1} p_{ij}}) = \sum_{k=0}^{K} x_{ik}\theta_{kj} \quad \begin{matrix} i = 1,2, \dots, N \\ j = 1,2, \dots, J-1 \end{matrix}$$

where p_{ij} is computed as:

$$p_{ij} = (\frac{e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}}{1 + e^{\sum_{j=1}^{J-1} x_{ik}\theta_{kj}}})$$

$$p_{iJ} = (\frac{1}{1 + e^{\sum_{j=1}^{J-1} x_{ik}\theta_{kj}}})$$

In this case, Y~ multinomial distribution with J levels for each given population. Hence, the probability density function is given as:

$$f(y|\theta) = \prod_{i=1}^{N} \left(\frac{n_i}{\prod_{j=1}^{J} y_{ij}!} \prod_{j=1}^{J} p_{ij}^{y_{ij}}\right)$$

The log likelihood function for the multinomial regression is given as:

$$L(\theta|y) \,\square\, \prod_{i=1}^{N} \prod_{j=1}^{J} p_{ij}^{\;\; y_{ij}}$$

$$= \prod_{i=1}^{N} \prod_{j=1}^{J-1} p_{ij}^{\;\; y_{ij}} . p_{ij}^{\;\; n_i - \sum_{j=1}^{J-1} y_{ij}}$$

$$= \prod_{i=1}^{N} \prod_{j=1}^{J-1} p_{ij}^{\;\; y_{ij}} \frac{p_{ij}^{\;\; n_i}}{p_{ij}^{\;\; \sum_{j=1}^{J-1} y_{ij}}}$$

$$= \prod_{i=1}^{N} \prod_{j=1}^{J-1} p_{ij}^{\;\; y_{ij}} \frac{p_{ij}^{\;\; n_i}}{\prod_{j=1}^{J-1} p_{ij}^{\;\; y_{ij}}}$$

$$= \prod_{i=1}^{N} \prod_{j=1}^{J-1} \left(\frac{p_{ij}}{p_{ij}}\right)^{y_{ij}} p_{ij}^{\;\; n_i}$$

also, remember the definition of p_{ij} and p_{ij} and hence;

$$L(\theta|y) = \prod_{i=1}^{N} \prod_{j=1}^{J-1} \left(e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}\right)^{y_{ij}} \left(\frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}}\right)^{n_i}$$

$$= \prod_{i=1}^{N} \prod_{j=1}^{J-1} e^{y_{ij} \sum_{k=0}^{K} x_{ik}\theta_{kj}} \left(1 + \sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}\right)^{-n_i}$$

If one takes natural log, the log likelihood function of the model becomes:

$$l(\theta) = \sum_{i=1}^{N} \sum_{j=1}^{J-1} (y_{ij} \sum_{k=0}^{K} x_{ik}\theta_{kj}) - n_i \log(1 + \sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}})$$

The aim here is to compute the values of θ for which the equation is maximum. This is done by taking first derivative with respect to each θ and equate it to zero just as was done in binomial model. Thus, the solution goes as:

$$\frac{\partial l(\theta)}{\partial \theta_{kj}} =$$

$$\sum_{i=1}^{N} y_{ij}x_{ik} - n_i \frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}} \cdot \frac{\partial}{\partial \theta_{kj}} (1 + \sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}})$$

$$= \sum_{i=1}^{N} y_{ij}x_{ik} - n_i \frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}} \cdot \frac{\partial}{\partial \theta_{kj}} (\sum_{k=0}^{K} x_{ik}\theta_{kj})$$

$$= \sum_{i=1}^{N} y_{ij}x_{ik} - n_i \frac{1}{1+\sum_{j=1}^{J-1} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}}} e^{\sum_{k=0}^{K} x_{ik}\theta_{kj}} \cdot x_{ik}$$

$$\frac{\partial l(\theta)}{\partial \theta_{kj}} = \sum_{i=1}^{N} y_{ij}x_{ik} - n_i p_{ij} x_{ik}$$

It is worth of notice that to compute each θ_{kj}, we need to set$(J - 1)(K + 1)$ equations equal to zero.

3.6 Odds

The odds of an event is defined as odds $=\frac{P}{1-P}$ where p is the probability of occurrence of that event and $1 - p$ is the probability of nonoccurrence of the events. Odds might be greater than one which indicates that the probability of the occurrence of an event is greater than half, while odds of less than one indicates that the probability of occurrence of that events is less than half (Christensen, 1990). Odds inspections lead to resizing the level of uncertainty. Odds appraises the likelihood that an event might occur.

3.6.1 Odds Ratio

In count data analysis, evaluation of odds ratio is not uncommon practice. (Powers andXie, 2000),Odds ratio is the ratio of the association between the events of two odds. It evaluates the odds of the outcome of an event of first category relative to the outcome of the other. Odds-ratio is defined as:

$$\alpha = \frac{p_1/(1-p_1)}{p_2/(1-p_2)} = \frac{exp(\theta+\gamma)}{exp\theta} = exp(\theta)$$

The odds-ratio (OR) is equal to 1 when the outcome of both categories is the same, this means that there is no difference in the outcome of both categories, that is the probability of success and that of failure are the same. When odds-ratio is greater than 1, this means that the outcome of the first odds are more likely to happen. Whereas if the odds-ratio is less than 1 the outcome of the second event is more likely to happen.Inregard to odds ratio, an odds ratio of 1.0 indicates that there is no difference between the two groups being compared,1.0 is the null value or no-effect. If both ends of the CI are less than 1.0 then it suggests an inverse association, likewise ifboth ends of a CI are greater than 1.0 this suggeststhat there is a positive association between the exposure and outcome.

3.7 The Research Model

In the conduct of this research, two kinds of logistic regression models have basically been analyzed, Binary logistic regression model and multinomial logistic regression model. In the case of binomial, the regressor (cause of death) has been categorized as direct and indirect causes. And, in the case of the multinomial logistic regression, the categories were Haemorrhage, Abortions, Infectious diseases, Non-infectious diseases and Miscellaneous.

In general, the researcher had 11 variables for the conduct of the research. The variables were Cause of death (which is the dependent variable and is categorical in nature), age (continuous), parity (continuous), type of client (categorical), year (categorical), area (categorical), gender of the baby (categorical), status of the baby (categorical), birth condition (categorical), weight of the baby (continuous) and education (categorical).

The multinomial logistic regression model was specified as:

$$\log\left(\frac{p_i^{(H)}}{p_i^{(M)}}\right) = \theta_0^H + \theta_1^H X_{1i} + \theta_2^H X_{2i} + \theta_3^H X_{3i} + \theta_4^H X_{4i} + \theta_5^H X_{5i} + \theta_6^H X_{6i} + \theta_7^H X_{7i} +$$

$$\theta_8^H X_{8i} + \theta_9^H X_{9i} + \theta_{10}^H X_{10i} + \theta_{11}^H X_{11i} + \theta_{12}^H X_{12i} + \theta_{13}^H X_{13i} + \theta_{14}^H X_{14i} + \theta_{15}^H X_{15i} +$$

$$\theta_{16}^H X_{16i} + \theta_{17}^H X_{17i} + \theta_{18}^H X_{18i} + \theta_{19}^H X_{19i} + \theta_{20}^H X_{20i} + \theta_{21}^H X_{21i} + \theta_{22}^H X_{22i} + \theta_{23}^H X_{23i}$$

$$\log\left(\frac{p_i^{(A)}}{p_i^{(M)}}\right) = \theta_0^A + \theta_1^A X_{1i} + \theta_2^A X_{2i} + \theta_3^A X_{3i} + \theta_4^A X_{4i} + \theta_5^A X_{5i} + \theta_6^A X_{6i} + \theta_7^A X_{7i} +$$

$$\theta_8^A X_{8i} + \theta_9^A X_{9i} + \theta_{10}^A X_{10i} + \theta_{11}^A X_{11i} + \theta_{12}^A X_{12i} + \theta_{13}^A X_{13i} + \theta_{14}^A X_{14i} + \theta_{15}^A X_{15i} +$$

$$\theta_{16}^A X_{16i} + \theta_{17}^A X_{17i} \theta_{18}^A X_{18i} + \theta_{19}^A X_{19i} + \theta_{20}^A X_{20i} + \theta_{21}^A X_{21i} + + \theta_{22}^A X_{22i} + \theta_{23}^A X_{23i}$$

$$\log\left(\frac{p_i^{(I)}}{p_i^{(M)}}\right) = \theta_0^I + \theta_1^I X_{1i} + \theta_2^I X_{2i} + \theta_3^I X_{3i} + \theta_4^I X_{4i} + \theta_5^I X_{5i} + \theta_6^I X_{6i} + \theta_7^I X_{7i} +$$

$$\theta_8^I X_{8i} + \theta_9^I X_{9i} + \theta_{10}^I X_{10i} + \theta_{11}^I X_{11i} + \theta_{12}^I X_{12i} + \theta_{13}^I X_{13i} + \theta_{14}^I X_{14i} + \theta_{15}^I X_{15i} +$$

$$\theta_{16}^I X_{16i} + \theta_{17}^I X_{17i} + \theta_{18}^I X_{18i} + \theta_{19}^I X_{19i} + \theta_{20}^I X_{20i} + \theta_{21}^I X_{21i} + \theta_{22}^I X_{22i} + \theta_{23}^I X_{23i}$$

$$\log \frac{p_i^{\ N}}{p_i^{\ M}} = \theta_0^N + \theta_1^N X_{1i} + \theta_2^N X_{2i} + \theta_3^N X_{3i} + \theta_4^N X_{4i} + \theta_5^N X_{5i} + \theta_6^N X_{6i} + \theta_7^N X_{7i}$$
$$+ \theta_8^N X_{8i} + \theta_9^N X_{9i} + \theta_{10}^N X_{10i} + \theta_{11}^N X_{11i} + \theta_{12}^N X_{12i} + \theta_{13}^N X_{13i}$$
$$+ \theta_{14}^N X_{14i} + \theta_{15}^N X_{15i} + \theta_{16}^N X_{16i} + \theta_{17}^N X_{17i} + \theta_{18}^N X_{18i} + \theta_{19}^N X_{19i}$$
$$+ \theta_{20}^N X_{20i} + \theta_{21}^N X_{21i} + \theta_{22}^N X_{22i} + \theta_{23}^N X_{23i}$$

Where $X_{1,2,\ldots,23}$ are defined as:

X_1 represents Age

X_2 represents Parity

X_3 represents Type of client (Booked)

X_4 represents Type of client (Un-booked)

X_5 represents Year (2011)

X_6 represents Year (2012)

X_7 represents Year (2013)

X_8 represents Year (2014)

X_9 represents Year (2015)

X_{10} represents Year (2016)

X_{11} represents Area(Urban)

X_{12} represents Area (Rural)

X_{13} represents Gender of the Baby (Male)

X_{14} represents Gender of the Baby(Female)

X_{15} represents Status of the Baby(Alive)

X_{16} represents Status of the Baby(Dead)

X_{17} represents Birth Condition(Normal)

X_{18} represents Birth Condition(Pre-Mature)

X_{19} represents Weight of the Baby

X_{20} represents Education (Illiterate)

X_{21} represents Education (Primary)

X_{22} represents Education (Secondary)

X_{23} represents Education (Tertiary)

H represents Haemorrhage

A represents Abortion category

I represents Infectious Disease category

N represents Non-Infectious Disease category

M represents Miscellaneous causes of death category

and $\theta_{0,1,2,\ldots,23}$ are the parameters to be estimated.

3.7.1 Hypothesis Test

To know whether a particular variable hadsignificant effect on odds of any response variable's category, a null hypothesis using Wald Test that its parameters were jointly equal to zero was tested. The hypothesis is stated as:

$$H_0: \theta_1^H = \theta_1^A = \theta_1^I = \theta_1^N = 0$$

versus

H_1: At least one of the $\theta_1^j \neq 0$

$$H_0: \theta_2^H = \theta_2^A = \theta_2^I = \theta_2^N = \theta_3^H = \theta_3^A = \theta_3^I = \theta_3^N = 0$$

versus

H_1: At least one of the $\theta_2^j \neq 0$

$$H_0: \theta_4^A = \theta_4^I = \theta_4^N = \theta_4^M = 0$$

versus

H_1: At least one of the $\theta_4^j \neq 0$

The same kind of test would be conducted for the other variables. In each case, if the $p < 0.05$, H_0 was rejected in favor of H_1 and the conclusion was to keep that particular variable in the model, otherwise the variable was dropped.

3.8 The Study Area

Kano city is an ancient city with over 1,500 years of history (Dan yaro, 2010). It remains one of the oldest Hausa city-states that enjoy the eminent position of being a foremost center of commerce, Islamic thought and culture. It is currently the most populous state in Nigeria according to the 2006 census with 10,810,340 peoples of which 51% (5,958,736) were male and 49% (5,851,734) were females (National population Commission, 2008). The culture of people is Hausa-Islamic culture, in that ethnicity and religion are so interwoven that a distinction is hardly discernable. The practice of polygamy is very common, so are large families and majority of women prefer home delivery. The metropolis is where majority of people with western education resides also where most of the tertiary hospitals are located and a center of commerce also the site of government.

3.8.1 Participants/Subjects

The participants of this study will include 1,197 women who died because of maternity at Murtala Muhammad Specialist Hospital in Kano State, Nigeria.

CHAPTER FOUR. RESULTS

Application of univariate and multivariate statistical analysis methods for understanding the reasons of maternal mortality requires step by step progress starting from describing the available data to the application of more advanced approaches.

Table 4.1: Socio-demographic characteristics of the cases (N=1,197)

Variables	No. of dead pregnant women	Percentage (%)
Age Group (years)		
<15	3	0.3
15-19	174	14.5
20-24	269	22.5
25-29	213	17.8
30-34	242	20.2
35-39	171	14.3
40-44	99	8.3
45-49	18	1.5
50-54	8	0.7
Total	**1197**	**100%**
Education Level		
Illiterate	167	14.0
Primary	349	29.2
Secondary	617	51.5
Tertiary	64	5.3
Total	**1197**	**100%**
Area/ Residence		

Urban	668	55.8
Rural	529	44.2
Total	**1197**	**100%**
Type of Client		
Booked	579	48.4
Un-booked	618	51.6
Total	**1197**	**100%**
Year		
2011	281	23.5
2012	220	18.4
2013	234	19.5
2014	243	20.3
2015	125	10.4
2016	94	7.9
Total	**1197**	**100%**
Status of the Baby		
Alive	992	82.9
Dead	205	17.1
Total	**1197**	**100%**
Variables	**No. of dead pregnant women**	**Percentage (%)**
Birth Condition		
Normal	1033	86.3
Pre-mature	164	13.7
Total	**1197**	**100 %**
Weight of the Baby		
Normal weight	961	80.3
Underweight	236	19.7
Total	**1197**	**100%**
Causes of Deaths		
Haemorrhage	391	32.7
Abortion	104	8.7
Infectious diseases	293	24.5
Non-infectious diseases	206	17.2
Miscellaneous	203	17.0
Total	**1197**	**100%**

Note: Booked clients are those who use to go to the health facility for antenatal care

Women in 20s and 30s havethe highest number of pregnancy compared to those in 40s and above or below 20.Women in the urban area (with about 55.8%) have the higher percentage than their rural counterparts. The number of died women that were un-booked (those who do not come to health facility for antenatal care) was 618 representing 51.6%. Most of these deaths occurred in2011and 2014, the number of deaths reduced to 125 in 2015 from 243 in 2014, also reduce to 94 in 2016

(November).Despitethe death of the women, the resultindicated that 82.9% of the babies survived and most of the babies were born beyond 37 gestation week,80.3% of the babies have normal weight while only 19.8% were underweight.Secondary school students have the highest number of death while tertiary have the least. Most of these deaths were caused by haemorrhage as the result showed that 32.7% of the women died from haemorrhage followed by infectious diseases (Table 4.1). This, in nutshell, indicatedthat haemorrhage was the major cause of maternal death in Kano state.

Table 4.2: Characteristics of the cases with respect to five maternal mortality categories

Variables	Haemorrhage n (%)	Abortion n (%)	Infectious Diseases n (%)	Non-infectious Diseases n (%)	Miscellaneous n (%)
Age Group (years)					
<15	2(66.7)		1(33.3)		
15-19	40(23.0)	6(3.4)	49(28.2)	45(25.9)	34(19.5)
20-24	85(31.6)	27(10.0)	64(23.8)	50(18.6)	43(16.2)
25-29	71(33.3)	19(8.9)	51(23.9)	30(14.1)	42(19.7)
30-34	90(37.2)	29(12.0)	49(20.2)	33(13.6)	41(16.9)
35-39	61(35.7)	13(7.6)	47(27.5)	28(16.4)	22(12.9)
40-44	36(36.4)	8(8.1)	25(25.3)	16(16.2)	14(14.1)
45-49	4(22.2)	2(11.1)	5(27.8)	4(22.2)	3(16.7)
50-54	2(25.0)		2(25.0)		4(50.0)
Total	**391**	**104**	**293**	**206**	**203**
Education Level					
Illiterate	53(31.7)	20(12.0)	36(21.6)	31(18.6)	27(16.2)
Primary	110(31.5)	25(7.2)	89(25.5)	44(12.6)	81(23.2)
Secondary	211(34.2)	51(8.3)	150(24.3)	122(19.8)	83(13.5)
Tertiary	17(26.5)	8(12.5)	18(28.1)	9(14.1)	12(18.8)
Total	**391**	**104**	**293**	**206**	**203**
Type of Client					
Booked	192(33.2)	60(10.4)	128(22.1)	100(17.3)	99(17.1)
Un-booked	199(32.2)	44(7.1)	165(26.7)	106(17.2)	104(16.3)
Total	**391**	**104**	**293**	**206**	**203**
Year					
2011	93(33.1)	24(8.5)	67(23.8)	42(14.9)	55(19.6)
2012	68(30.9)	30(13.6)	54(24.5)	34(15.5)	34(15.5)

2013	77(32.9)	20(8.5)	51(21.8)	52(22.2)	34(14.5)
2014	88(36.2)	10(4.1)	64(26.3)	37(15.2)	44(18.1)
2015	41(32.8)	8(6.4)	28(22.4)	24(19.2)	24(19.2)
2016	24(25.5)	12(12.8)	29(30.9)	17(18.1)	12(12.8)
Total	**391**	**104**	**293**	**206**	**203**
Area					
Urban	242(36.2)	58(8.7)	171(25.6)	114(17.1)	83(12.4)
Rural	149(28.2)	46(8.7)	122(23.1)	92(17.4)	120(22.7)
Total	**391**	**104**	**293**	**206**	**203**

Table 4.2 showed that, most of the women that died from haemorrhage and abortion were in 30-34 age category while for infectious diseases, non-infectious diseases and miscellaneous, those aged 20-24 have the highest number of mortality. Mostof the illiterate as well as those with primary and secondary certificates died from haemorrhage, while most tertiary institution students died from infectious diseases. Except for abortions in which booked women have the highest number of death, the number of death in all the other causes was higher in un-booked clients. The year, 2011 had the highest frequency of mortality while 2016 had the least number.

Table 4.3: Univariate tests of quantitative variables between causes of death categories

Variables	Causes of Death	Median	Minimum	Maximum	P	χ^2
Age (years)	Haemorrhage	29.00	14.00	50.00	0.038	10.165
	Abortion	29.50	16.00	45.00		
	Infectious Diseases	27.00	13.00	52.00		
	Non-infectious Diseases	25.00 ϕ Ψ	15.00	49.00		
	Miscellaneous	25.00	15.00	54.00		
Parity (n)	Haemorrhage	4.00	0.00	17.00	<0.001	26.060
	Abortion	3.50 ϕ	0.00	10.00		
	Infectious Diseases	4.00 ϕ	0.00	13.00		
	Non-infectious Diseases	3.00 ϕ	1.00	13.00		
	Miscellaneous	4.00 ϕþ	0.00	12.00		
Weight of	Haemorrhage	2.56	2.10	2.90	0.596	

Baby (kg)	Abortion	2.56	2.10	2.90	2.778
	Infectious Diseases	2.56	2.10	2.90	
	Non-infectious Diseases	2.56	2.10	2.90	
	Miscellaneous	2.56	2.10	2.90	

ɸ different from Haemorrhage
Ψ different from Abortion
þ different from Non-infectious Diseases

The table above showed the age and parity with pof 0.038 and 0.001 respectively, and this indicated that they have a statistically significant effect on causes of death while the weight of baby with pof 0.596showed that the causes of death do not have effect on babies' weight.

The Man Whitney U test indicated that non-infectious diseases (p = 0.003) with median age of 25 was statistically different from haemorrhage with 29 as the median age. The test also showed that abortion (p = 0.026), infectious diseases (p = 0.001), non-infectious diseases (p< 0.001), as well as miscellaneous (p = 0.028), with median parities 3.5, 4.0, 3.0 and 4.0 respectively were statistically different from haemorrhage with 4 as the median parity. It is indicated by the Man Whitney U test that non-infectious diseases (p = 0.029) with median age of 25 was different from abortion with 29 as the median age. The test also showed that miscellaneous (p = 0.016) with median parity of 4 was different from non-infectious diseases with 3 as the median parity.

The table also indicated that the youngest woman died from infectious diseases while the oldest one died from miscellaneous diseases. 17 is the maximum parity and the woman died from haemorrhage. The minimum weight of babies who their mothers died was 2.56 and it was the same for all the causes of mortality while 2.90 was the maximum (Table 4.3).

Table 4.4: Univariate tests of categorical variables between causes of death categories

Variables		Counts (of Causes of Deaths)					p	χ^2
		Haemorrhage(%)	Abortion(%)	Infectious Diseases(%)	Non-infectious Diseases(%)	Miscellaneous(%)		
Type of Client	Booked	192(49.1)	60(57.7)	128(43.7)	100(48.5)	99(48.8)	0.017*	6.293
	Un-booked	199(50.9)	44(42.3)	165(56.3)	106(51.5)	104(51.3)		
Area	Urban	242(61.9)	58(55.8)	171(58.4)	114(55.3)	83(40.9)	<0.001*	24.988
	Rural	149(38.1)	46(44.2)	122(41.6)	92(44.7)	120(59.1)		
Gender of the Baby	Male	195(49.9)	51(49.0)	128(43.7)	104(50.5)	79(38.9)	0.061	8.996
	Female	196(50.1)	53(51.0)	165(56.3)	102(49.5)	124(61.1)		
Birth Condition	Normal	333(85.2)	90(86.5)	257(87.7)	181(87.9)	172(84.7)	0.777	1.775
	Pre-mature	58(14.8)	14(13.5)	36(12.3)	25(12.1)	31(15.3)		
Status of the Baby	Alive	325(83.1)	90(86.5)	239(81.6)	170(82.5)	168(82.8)	0.849	1.371
	Dead	66(16.9)	14(13.5)	54(18.4)	36(17.5)	35(17.2)		
Education Level	Illiterate	53(13.6)	20(19.2)	36(12.3)	31(15.0)	27(13.3)	0.009**	26.546
	Primary	110(28.1)	25(24.0)	89(30.4)	44(21.4)	81(39.9)		
	Secondary	211(54.0)	51(49.0)	150(51.2)	122(59.2)	83(40.)		
	Tertiary	17(4.3)	8(7.7)	18(6.1)	9(4.3)	12(5.9)		
Year	2011	93(23.8)	24(23.1)	67(22.9)	42(20.4)	55(27.1)	0.080	29.406
	2012	68(17.4)	30(28.8)	54(18.4)	34(16.5)	34(16.7)		
	2013	77(19.7)	20(19.2)	51(17.4)	52(25.2)	34(16.7)		
	2014	88(22.5)	10(9.6)	64(21.8)	37(18.0)	44(21.7)		
	2015	41(10.5)	8(7.7)	28(9.6)	24(11.7)	24(11.8)		
	2106	24(6.1)	12(11.5)	29(9.9)	17(8.3)	12(5.9)		

* p<0.001 **p<0.05

The study showed that the type of client, area and education with pof 0.017, <0.001and 0.009 respectively have a statistically significant effect on the causes of maternal death in Kano state while the gender of the baby, birth condition and status of the baby, all with p>0.05 have no statistically significant relationship with the causes of maternal death. This indicated that, the death of a mother does not mean that the baby will be premature or dead (Table 4.4).

Table 4.5: Multinomial logistics regression findings for each individual variable

Variables	Beta	OR	95% CI for OR		p
			Lower	Upper	
			Haemorrhage		
Age (years)	0.013	1.013	0.991	1.036	0.240
			Abortion		
	0.013	1.013	0.983	1.044	0.408
			Infectious Diseases		
	0.002	1.002	0.979	1.025	0.889
			Non-infectious diseases		
	-0.016	0.984	0.959	1.009	0.214
			Haemorrhage		
Parity (n)	0.061	1.063	1.008	1.120	0.025**
			Abortion		
	-0.024	0.976	0.904	1.053	0.531
			Infectious Diseases		
	-0.015	0.985	0.930	1.043	0.607
			Non-infectious Diseases		
	-0.070	0.933	0.875	0.995	0.034**
			Haemorrhage		
Weight of the Baby (kg)	-0.182	0.834	0.321	2.169	0.834
			Abortion		
	-0.062	0.940	0.248	3.563	0.940
			Infectious Diseases		
	0.562	1.753	0.636	4.838	1.753
			Non-infectious Diseases		
	0.156	1.169	0.391	3.496	1.169
			Haemorrhage		
Type of Client (Un-booked)					
Booked	0.013	1.014	0.772	1.423	0.938
			Abortion		
Type of Client (Ref. Un-booked					
Booked	0.359	1.433	0.890	2.307	0.139
			Infectious Diseases		
Type of Client (Ref. Un-booked)					
Booked	-0.205	0.815	0.569	1.167	0.264

Variables	Beta	OR	95% CI for OR Lower	Upper	p
			Non-infectious Diseases		
Type of Client (Ref. Un-booked)					
Booked	-0.009	0.991	0.672	1.461	0.964
			Haemorrhage		
Year (Ref. 2016)					
2011	-0.168	0.845	0.392	1.824	0.669
2012	0.000	1.000	0.447	2.239	1.000
2013	0.124	1.132	0.508	2.525	0.761
2014	0.000	1.000	0.458	2.185	1.000
2015	-0.158	0.854	0.363	2.012	0.718
			Abortion		
Year (Ref. 2016)					
2011	-0.829	0.436	0.172	1.109	0.081
2012	-0.125	0.882	0.345	2.256	0.794
2013	-0.531	0.588	0.222	1.555	0.285
2014	-1.482	0.227	0.079	0.652	0.006**
2015	-1.099	0.333	0.108	1.034	0.057
Year (Ref. 2016)					
2011	-0.685	0.504	0.235	1.079	0.078
2012	-0.420	0.657	0.296	1.460	0.303
2013	-0.477	0.621	0.279	1.382	0.243
2014	-0.508	0.602	0.277	1.306	0.199
2015	-0.728	0.483	0.203	1.148	0.099
			Non-infectious Diseases		
Year (Ref. 2016)					
2011	-0.618	0.539	0.232	1.250	0.150
2012	-0.348	0.706	0.293	1.700	0.437
2013	-0.077	1.080	0.459	2.541	0.861
2014	-0.522	0.594	0.252	1.401	0.234
2015	-0.348	0.706	0.278	1.790	0.463
			Haemorrhage		
Area (Ref. Rural)					
Urban	0.854	2.348	1.661	3.320	<0.001*
			Abortion		
Area (Ref. Rural)					
Urban	0.600	1.823	1.131	2.939	0.014**
			Infectious Diseases		
Area (Ref. Rural)					
Urban	0.706	2.026	1.409	2.915	<0.001*
			Non-infectious diseases		
Area (Ref. Rural)					
Urban	0.583	1.792	1.210	2.652	0.004**
			Haemorrhage		
Gender of the Baby (Ref. Female)					
Male	0.446	1.562	1.106	2.205	0.011**
			Abortion		
Gender of the Baby (Ref. Female)					

Variables	Beta	OR	95% CI for OR		p
			Lower	Upper	
Male	0.412	1.510	0.938	2.433	0.090
Infectious Diseases					
Gender of the Baby (Ref. Female)					
Male	0.197	1.218	0.846	1.753	0.290
Non-infectious Diseases					
Gender of the Baby (Ref. Female)					
Male	0.470	1.600	1.081	2.370	0.019**
Haemorrhage					
Status of the Baby (Ref. Dead)					
Alive	0.026	1.026	0.654	1.609	0.911
Abortion					
Status of the Baby (Ref. Dead)					
Alive	0.292	1.339	0.685	2.619	0.393
Infectious Diseases					
Status of the Baby (Ref. Dead)					
Alive	-0.081	0.922	0.577	1.474	0.734
Non-infectious Diseases					
Status of the Baby (Ref. Dead)					
Alive	-0.016	0.984	0.590	1.641	0.950
Haemorrhage					
Birth Condition (Pre-mature)					
Normal birth	0.034	1.035	0.645	1.661	0.887
Abortion					
Birth Condition (Pre-mature)					
Normal birth	0.147	1.159	0.587	2.289	0.672
Infectious Diseases					
Birth Condition (Pre-mature)					
Normal birth	0.252	1.287	0.767	2.159	0.340
Non-infectious Diseases					
Birth Condition (Pre-mature)					
Normal birth	0.266	1.305	0.740	2.300	0.357
Haemorrhage					
Education Level (Ref. Tertiary)					
Illiterate	0.326	1.386	0.579	3.315	0.464
Primary	-0.042	0.959	0.434	2.118	0.917
Secondary	0.585	1.794	0.821	3.920	0.142
Abortion					
Education Level (Ref. Tertiary)					
Illiterate	0.105	1.111	0.383	3.224	0.846
Primary	-0.770	0.463	0.170	1.259	0.131
Secondary	-0.82	0.922	0.353	2.408	0.868
Infectious Diseases					
Education Level (Ref. Tertiary)					
Illiterate	-0.118	0.889	0.367	2.153	0.794
Primary	-0.311	0.733	0.332	1.614	0.440
Secondary	0.186	1.205	0.553	2.623	0.639
Non-infectious Diseases					

Variables	Beta	OR	95% CI for OR		p
			Lower	Upper	
Education Level (Ref. Tertiary)					
Illiterate	0.426	1.531	0.559	4.189	0.407
Primary	-0.323	0.724	0.283	1.852	0.501
Secondary	0.673	1.960	0.790	4.860	0.146

* p<0.001 ** p<0.05

The result showed a statistically significant relationship between parity and haemorrhage (p = 0.025) as well as parity and non-infectious diseases (p = 0.034). A unit increase in parity increased the probability of realizing haemorrhage by 6.3% and decrease by 6.7% in the probability of realizing non-infectious diseasesas compared with miscellaneous. As 2014 compared with 2016, the odds of dying from abortion as compared with miscellaneous decreased by 77.3% (Table 4.5).

For women living in urban area compared to those in rural, the odds of dying from abortion and non-infectious diseases increased by 82.3% and 79.2 % respectively while two times will likely for those in urban as compared with rural counterpart in haemorrhage and infectious diseases as compared with miscellaneous. As male baby compared with female counterpart, the odds of dying from haemorrhage and non-infectious diseases increased by 10.6% and 8.1% respectively (Table 4.5).

Table 4.6: The multinomial logistic regression findings

Variables	Beta	OR	95% CI for OR		P
			Lower	Upper	
			Haemorrhage		
Age (years)	-0.008	0.992	0.963	1.022	0.589
Parity (n)	0.078	1.081	1.007	1.161	0.032**
Weight of baby (kg)	-0.087	0.917	0.341	2.462	0.863
Type of client (Ref. Un-booked)					
Booked	0.011	1.011	0.713	1.433	0.952
Year (Ref. 2016)					
2011	-0.175	0.840	0.379	1.859	0.667
2012	-0.125	0.882	0.385	2.020	0.767
2013	0.053	1.055	0.463	2.403	0.899
2014	-0.165	0.847	0.379	1.894	0.687
2015	-0.257	0.773	0.321	1.861	0.566
Area(Ref. Rural)					
Urban	0.817	2.264	1.528	3.355	<0.001*
Gender of the baby (Ref. Female)					
Male	0.432	1.541	1.084	2.190	0.016**
Status of the baby (Ref. Dead)					
Alive	0.145	1.156	0.723	1.849	0.545
Birth condition (Ref. Pre-mature)					
Normal birth	0.072	1.075	0.659	1.751	0.773
Education level (Ref. Tertiary)					
Illiterate	0.630	1.877	0.735	4.789	0.188
Primary	0.173	1.189	0.511	2.766	0.687
Secondary	0.480	1.616	0.712	3.670	0.251
			Abortion		
Age (years)	0.034	1.035	0.995	1.077	0.089
Parity (n)	-0.077	0.926	0.836	1.025	0.139
Weight of Baby (kg)	-0.068	0.934	0.238	3.671	0.922
Type of client (Ref. Un-booked)					
Booked	0.369	1.446	0.885	2.362	0.141
Year (Ref. 2016)					
2011	-0.801	0.449	0.171	1.180	0.104
2012	-0.139	0.870	0.331	2.290	0.778
2013	0.472	0.624	0.229	1.696	0.355
2014	-1.555	0.211	0.072	0.621	0.005**
2015	-1.062	0.346	0.109	1.100	0.072
Area (Ref. Rural)					
Urban	0.630	1.878	1.086	3.248	0.024**
Gender of the baby (Ref. Female)					
Male	0.393	0.481	0.911	2.408	0.113
Status of the baby (Ref. Dead)					
Alive	0.402	1.495	0.745	2.998	0.258
Birth condition (Ref. Pre-mature)					
Normal Birth	0.144	1.155	0.573	2.330	0.887

Variables	Beta	OR	95% CI for OR Lower	Upper	p
Education level (Ref. Tertiary)					
Illiterate	0.516	1.575	0.535	5.346	0.384
Primary	-0.435	0.648	0.221	1.894	0.427
Secondary	0.024	0.977	0.356	2.677	0.963
			Infectious Diseases		
Age (years)	0.006	1.007	0.976	1.038	0.679
Parity (n)	-0.023	0.977	0.906	1.054	0.552
Weight of Baby (kg)	0.599	1.821	0.643	5.157	0.259
Type of client (Ref. Un-booked)					
Booked	-0.238	0.788	0.546	1.138	0.203
Year (Ref. 2016)					
2011	0.724	0.485	0.222	1.060	0.070
2012	-0.480	0.619	0.274	1.398	0.248
2013	-0.475	0.622	0.274	1.408	0.255
2014	-0.585	0.577	0.252	1.230	0.148
2015	-0.718	0.488	0.202	1.178	0.111
Area(Ref. Rural)					
Urban	0.657	1.982	1.278	2.909	0.002**
Gender of the baby (Ref. Female)					
Male	0.197	1.218	0.841	1.763	0.296
Status of the baby (Ref. Dead)					
Alive	0.007	1.007	0.620	1.635	0.979
Birth condition (Pre-mature)					
Normal birth	0.283	1.327	0.782	2.253	0.294
Education level (Ref. Tertiary)					
Illiterate	0.029	0.971	0.376	2.507	0.952
Primary	-0.259	0.772	0.333	1.790	0.546
Secondary	-0.024	0.976	0.432	2.206	0.954
			Non-infectious diseases		
Age (years)	0.003	1.003	0.969	1.038	0.869
Parity (n)	-0.070	0.933	0.856	1.016	0.111
Weight of Baby (kg)	0.071	1.073	0.348	3.310	0.902
Type of client (Ref. Un-booked)					
Urban	-0.055	0.947	0.635	1.410	0.787
Year (Ref. 2016)					
2011	-0.665	0.514	0.216	1.226	0.133
2012	-0.388	0.678	0.276	1.670	0.399
2013	0.084	1.087	0.451	2.620	0.852
2014	-0.604	0.547	0.227	1.319	0.179
2015	-0.333	0.717	0.277	1.858	0.493
Area (Ref. Rural)					
Urban	0.371	1.448	0.925	2.269	0.106
Gender of the baby (Ref. Female)					
Male	0.433	1.541	1.033	2.299	0.034**
Status of the baby (Ref. Dead)					
Alive	-0.011	0.989	0.581	1.686	0.969

Variables	Beta	OR	95% CI for OR		p
			Lower	Upper	
Birth condition (Ref. Pre-mature)					
Normal birth	0.335	1.397	0.780	2.503	0.216
Education level (Ref. Tertiary)					
Illiterate	0.324	1.383	0.472	4.050	0.554
Primary	-0.451	0.637	0.236	1.718	0.373
Secondary	0.418	1.518	0.590	3.906	0.386

* p<0.001 ** p<0.05

For parity,the result showed a statistically significant relationship between parity and haemorrhage (p= 0.032).A unit increasein parity increasedthe probability of realizing haemorrhage as compared with miscellaneous by 8.1%.The result also indicated that it is two times likely for women in urban area as compared with rural counterpart to die from haemorrhage as compared with miscellaneous. For male baby as compared with female counterpart, the odds of dying from haemorrhage and non-infectious diseases as compared with miscellaneous increased by 54.1% and 54.1% respectively.

The result also indicated a statistically significant relationship between year 2014 and abortion (p = 0.005) and as that year (2014) compared with 2016, the odds of dying from abortions as compared with miscellaneous decreased by 78.9%.The result also showed a statistically significant relationship between area and haemorrhage (p<0.001), area and abortion (p = 0.024) as well as area and infectious diseases (p = 0.002). For women living in urban area as compared with those in the rural, the odds of dying from abortions and infectious diseases increased by 87.8% and98.2% respectivelyas compared with miscellaneous and also it is two times likely for a woman in urban area as compared with rural counterpart to die from haemorrhage as compared with miscellaneous (Table 4.6).

CHAPTER FIVE. DISCUSSION OF RESULTS

Kruskal Wallis test showed that age and parity have statistically significant effects on the causes of death. A Mann Whitney U test for pairwise comparison indicated that haemorrhage and abortion with median ages of 29 and 29 respectively were statistically different from non-infectious diseases with 25 as the median age. The test also indicated that abortion, infectious diseases, non-infectious diseases, as well as miscellaneous with median parities 3.5, 4.0, 3.0 and 4.0 respectively were statistically different from Haemorrhage with 4 as the median parity. It is indicated by the Man Whitney U test that miscellaneous with median parity of 4 was different from Non-infectious Diseases with 3 as the median parity.

2011 was the year with the highest number of maternal mortality in Kano state which represents 23.5%, the death reduced to 7.9% in 2016. Type of client (booked and un-booked) have a statistically significant relationship with causes of maternal death. Booked women (those who use to go to the health facilities for antennal care) have the least number of maternal deaths compared to un-booked women. Most of women who died from haemorrhage, infectious diseases, non-infectious diseases and miscellaneous such as uterine rupture and obstructed labor were un-booked and unfortunately most of those who died from abortion were booked. This signifies the importance of antenatal care which enable the pregnant women receive the necessary care during their pregnancy and this care is very important for their wellbeing during this period in which failure to receive it during the pregnancy leads to a lot of maternal deaths.

Womenaged 20-24 years had the highest number of death and most of these women were from urban areas.The study shows a significant relationship between area/residence and the causes of maternal mortality. The major cause of death in the state was haemorrhage and the women who died from haemorrhage were mostly those of 30-34 age category. The women in that category (30-34) also have the highest number of death from abortion while for infectious diseases, non-infectious diseases and other miscellaneous causes such as obstructed labor and uterine rupture, women of 20-24 years have the highest number of mortality.

There was statistically significant association between education and the causes of death, tertiary institutions students have the least number of deaths compared to others while those who finished secondary school have the highest number while Illiterate women has about only 14 percent, the number was not high because most of illiterate women were older people, and they do not have a large proportion in the number of pregnant women.

Haemorrhage, infectious diseases and miscellaneous were mostly occurred in 2011 while abortion and non-infectious diseases were mostly occurred in 2012 and 2013 respectively. In 2016 (November), the number of death reduced to 6.1% for haemorrhage, 11.5% for abortion, 9.9% for infectious diseases, 8.3% for non-infectious diseases and 5.9% for miscellaneous. This development is attributed to the efforts of Kano state and Nigerian governments as well as supports given by NGOs and other philanthropists. Despite the deaths of these women, most of their babies (about 82.9%) were born alive and 86.3% of them were normal, that is only 13.7% of the babies were pre-maturely born. The number of normal weight babies was greater than the number of underweight, underweight babies represent only 19.7% of the total births.Age and parity as the results indicated have a statistically significant effect on the causes of maternal death. 54 years is the age of the oldest woman that died from miscellaneous diseases while the youngest woman with 13 years as the age died from infectious diseases. The maximum ages of those who died from haemorrhage and abortion are 50 years and 45 years respectively while that of those who died from infectious diseases and non-infectious diseases are 52 years and 49 years respectively. The woman with the highest parity died from haemorrhage.

A unit increase in parity increasedthe probability of realizing haemorrhage as compared with miscellaneous by 8.1% with the presence of other independent variables, but when it is the only independent variable, the percentage reduced to 6.3and both the p (all < 0.005 of the multiple variables and that of the single) showedthat parity had a statistical significant effecton haemorrhage.It is two times likely for women in urban areaas compared with those in ruralto die from haemorrhage as compared with miscellaneous, and this remained the same even when the area was the only independent variable.For women living in urban areas as compared with those in the rural, the odds of dying from abortion as compared with miscellaneous increased by 87.8% with the presence of other independent variables, while it increased by 82.3% with the absence of other variables.Also, the odds of dying from infectious diseases as compared with miscellaneous increased by 98.2% with the presence of other independent variables, while it increased by 79.2% with the absence of other variables.The small p (all < 0.005) for haemorrhage, abortion and infectious diseases respectively indicateda statistically significant associations between area and haemorrhage, area and abortion as well as area and infectious diseases. This in nutshell, showed the important and effect of other independent variablesas theyaffect the outcome of the study.

CHAPTER SIX. CONCLUSION AND RECOMMENDATIONS

Women aged 20-24 has the highest number of deaths in Kano state and most of these women were from urban areas. Haemorrhage, infectious diseases and other miscellaneous causes were mostly occurred in 2011 while abortion and non-infectious diseases were mostly occurred in 2012 and 2013, respectively. Most of women that died from haemorrhage, infectious diseases, non-infectious diseases and miscellaneous were un-booked. 2011 was the year with the highest number of maternal death in the state which represents 23.5%, but fortunately the percentage reduced to 7.9% in 2016. Women who used to shun the health facilities for antenatal care suffer or die most because of pregnancy and this attributed to the lack of education, lack of sensitization. A lot of women especially in the rural areas have a culture of avoiding hospital during pregnancy, they mostly prefer to deliver at home without the care of health personnel and this cause a lot of problems, even if the woman survive, that attitude affect the health of the newborn baby. This attitude of avoiding health facilities for necessary antennal care causes a lot of maternal deaths such as haemorrhage, obstructed labor, infectious diseases, among others.

To overcome these problems, the governments (Federal and state), NGOs and the other stakeholders like traditional rulers, ward heads, village heads, among others, need to be sensitizing communities on the need and/or important of attending hospitals for both antennal and postnatal cares, educating women and children since it is the lack of education that makes a lot of people both male and female from accepting hospital. There are a lot of people (men) in the state who do not like their women to deliver at the health facility due to the fear that male health worker will attend to their wives and this is the reason why a lot of women choose to deliver at home rather than hospitals. These happen because of lack of education. There is also a need for the government to increase the number of hospitals, health centers as well as health personnel most importantly doctors, nurses and midwives across the state because most of the women prefer to stay at home during pregnancy due to fear of congestion at the hospitals.

REFERENCES

1. UNFPA (2002), Maternal Mortality Update: A Focus on Emergency Obstetric Care. http://www.unfpa.org/upload/lib_pub_file/201_filename_mmupdate-2002.pdf

2. Van Lerberghe, W., Manuel, A., Matthews, Z., & Cathy, W. (2005). The World Health Report 2005-make every mother and child count. World Health Organization.

3. UN General Assembly. Geneva: Human Rights Council; 2009. Preventable Maternal Mortality and Morbidity and Human Rights.

4. Novick Gina. (2004). CenteringPregnancy and the Current State of Prenatal Care. Journal of Midwifery & Women's Health. 49(5):405-411.

5. UNICEF (2014). Trends in maternal mortality: 1990 to 2013.

6. YAR'ZEVER, S. I. (2014). Temporal analysis of maternal mortality in kano state, northern Nigeria: a six-year review. American Journal of Public Health Research, 2(2), 62-67.

7. Dragonas T & Christodoulou GN. (1998). Prenatal Care. Clinical Psychology Review. 18(2):127-142.

8. Carroli, G., Rooney, C., &Villar, J. (2001). How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. Paediatric and perinatal Epidemiology, 15(s1), 1-42.

9. Stanton, C., Abderrahim, N., & Hill, K. (2000). An assessment of DHS maternal mortality indicators. Studies in family planning, 31(2), 111-123.

10. National Population Commission (NPC) [Nigeria] and ORC Macro. Nigeria Demographic and Health Survey 2008. Calverton, Maryland: National Population Commission and ORC Macro.

11. WHO, "Maternal Mortality in 2008: Estimates Developed by WHO/UNICEF/UNFPA." WHO, 2007; Geneva.

12. Ejembi, C. L., Alti-Muazu, M., Chirdan, O., Ezeh, H. O., Sheidu, S., &Dahiru, T. (2004). Utilization of maternal health services by rural Hausa women in

Zaria environs, northern Nigeria: has primary health care made a difference? Journal of Community Medicine and Primary health care, 16(2), 47-54.

13. Audu, L. R., &Ekele, B. A. (2001). A ten year review of maternal mortality in Sokoto, northern Nigeria. West African journal of medicine, 21(1), 74-76.

14. (n.d.). Retrieved 10 07, 2016, from http://apps.who.int/iris/bitstream/10665/112318/1/WHO_RHR_14.06_eng.pdf

15. Haddad, L. B., &Nour, N. M. (2009). Unsafe abortion: unnecessary maternal mortality. Reviews in obstetrics and gynecology, 2(2), 122.

16. Ghulmiyyah, L., &Sibai, B. (2012, February). Maternal mortality from preeclampsia/eclampsia. In Seminars in perinatology (Vol. 36, No. 1, pp. 56-59). WB Saunders.

17. Asamoah, B. O., Moussa, K. M., Stafström, M., &Musinguzi, G. (2011). Distribution of causes of maternal mortality among different socio-demographic groups in Ghana; a descriptive study. BMC Public Health, 11(1), 1.

18. Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., ... &Alkema, L. (2014). Global causes of maternal death: a WHO systematic analysis. The Lancet Global Health, 2(6), e323-e333.

19. Gülmezoglu, A. M., Say, L., Betrán, A. P., Villar, J., &Piaggio, G. (2004). WHO systematic review of maternal mortality and morbidity: methodological issues and challenges. BMC Medical Research Methodology, 4(1), 1.

20. Van Dillen, J., Zwart, J., Schutte, J., & van Roosmalen, J. (2010). Maternal sepsis: epidemiology, etiology and outcome. Current opinion in infectious diseases, 23(3), 249-254.

21. Idowu, O. A., Mafiana, C. F., &Dopu, S. (2005). Anaemia in pregnancy: a survey of pregnant women in Abeokuta, Nigeria. African health sciences, 5(4), 295-299.

22. Giordano, R., Cacciatore, A., Cignini, P., Vigna, R., & Romano, M. (2010). Antepartum haemorrhage. Journal of prenatal medicine, 4(1), 12-16.

23. Tort, J., Rozenberg, P., Traoré, M., Fournier, P., & Dumont, A. (2015). Factors associated with postpartum haemorrhage maternal death in referral hospitals in Senegal and Mali: a cross-sectional epidemiological survey. BMC pregnancy and childbirth, 15(1), 1.

24. Carroli, G., Cuesta, C., Abalos, E., &Gulmezoglu, A. M. (2008). Epidemiology of postpartum haemorrhage: a systematic review. Best practice & research Clinical obstetrics &gynaecology, 22(6), 999-1012.

25. Khan, K. S., Wojdyla, D., Say, L., Gülmezoglu, A. M., & Van Look, P. F. (2006). WHO analysis of causes of maternal death: a systematic review. The lancet, 367(9516), 1066-1074.

26. Onde-Agudelo, A., Belizán, J. M., &Lammers, C. (2005). Maternal-perinatal morbidity and mortality associated with adolescent pregnancy in Latin America: Cross-sectional study. American journal of obstetrics and gynecology, 192(2), 342-349.

27. Patton, G. C., Coffey, C., Sawyer, S. M., Viner, R. M., Haller, D. M., Bose, K., ... &Mathers, C. D. (2009). Global patterns of mortality in young people: a systematic analysis of population health data. The Lancet, 374(9693), 881-892.

28. World Health Organization (2001). Thesecond decade: improving adolescent health and development. Geneva: WHO. p.4.

29. United Nations (2001). We the children: End-decade review of the follow-up to the World Summit for Children. Report of the Secretary-General. New York: United Nations. p. 50.

30. Blanc, A. K., Winfrey, W., & Ross, J. (2013). New findings for maternal mortality age patterns: aggregated results for 38 countries. PloS one, 8(4), e59864.

31. AbouZahr C, Wardlaw T (2003) Antenatal care in developing countries: promises, achievements, and missed opportunities. Geneva: World Health Organization.

32. Stanton C, Blanc A, Croft T, Choi Y (2006) Skilled care at birth in the developing world: progress to date and strategies for expanding coverage. J biosocSci 39 (1):109–120.

33. Fort A, Kothari M, Abderrahim N (2006) Postpartum care: levels and trends in the developing world. DHS Comparative Reports 15. Calverton, Maryland: Macro International Inc.

34. Oyerinde, K. (2013). Can Antenatal Care Result in Significant Maternal Mortality Reduction in Developing Countries?. Journal of Community Medicine & Health Education, 2013.

35. NWARU, B.(2007). Impact of prenatal care on postpartum childcare.

36. (n.d.). Retrieved 11 09, 2016, from http://www.unicef.org/nigeria/children_1926.html

37. Rencher, A. C. (2003). Methods of multivariate analysis (Vol. 492). John Wiley & Sons.

38. Richarme, M. (2002). Eleven Multivariate Analysis Techniques: Key Tools in YourMarketing Research Survival Kit. White paper.

39. Ross, S. M. (2010). Introduction to Probability Models. Elsevier, Oxford UK.

40. Agresti, A. (2007). An Introduction to Categorical Data Analysis. Wiley, Oxford UK.

41. Christensen, R. (1990). Log-Linear Models and Logistic Regression. Springer, USA.

42. Dobson, A. J. (2002). Introduction to Generalized Linear Models. Chapman and Hal- l/CRC, New York

43. Powers, D. A. and Xie, Y. (2000). Statistical Methods for Categorical Data Analysis.Academic Press, United States.

44. Dan Yaro, M.M. Ministry of information, Youth and culture bulletine, Kano.2010; 22, 4-8.