MODEL-BASED SUB-POPULATION ESTIMATES OF MATERNAL MORTALITY RATES AND RATIO FROM SIBLINGS' SURVIVORSHIP HISTORIES IN NIGERIA
(2008 -2018)

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CERTIFICATION

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DEDICATION

To every woman out there who is a life giver.

Your worth is immeasurable.

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ABSTRACT

Despite several interventions, Maternal Mortality (MM) remains high in Nigeria. This is further complicated by lack of reliable estimates of MM for subnational levels such as states and geopolitical regions. A plausible estimate of MM levels is essential to provide evidence-based national and state-level planning, resource allocation and monitoring of progress. It will reflect the population diversity in the country and assist in closing MM gaps. This study was designed to adapt sisterhood method and small area estimation techniques to derive plausible estimates of MM rates and ratios for subnational populations in Nigeria.

Survivorship history data of 293,769 female siblings provided by 114,154 women in the Nigeria Demographic and Health Surveys conducted in 2008, 2013 and 2018 were analysed. The dataset from each survey was reconstructed into a panel data structure such that each reported sibling was captured as an observation. The MM Rates (maternal deaths per women-years of exposure to childbearing) and Ratios (maternal deaths per 100,000 live births) were estimated using direct and indirect sisterhood methods. Empirical Bayesian technique for small area demographic estimates was used to obtain MM rates and ratios at state-levels. The James-Stein estimator was used to shrink the estimates closer to the population mean values at 95% Confidence Interval (CI). Zero-inflated Poisson regression model was fitted to investigate association between selected covariates and maternal death counts at the community levels. Incident Risk Ratio (IRR) was reported as measures of effect. All analyses were weighted to adjust for the effects of clustering.

MM rates in 2008 were high in rural areas and North-West region at 1.21 and 1.65 per 1,000 women-exposure years and lowest in South-West at 0.45 per 1,000 women-exposure years. Levels of MM Ratios were highest in the rural areas and South-South region at 624 and 679 respectively and lowest in South-West (281 per 100,000 live births). In 2013, the levels of MM Ratio were highest in North-Central (712) and lowest in South-West (367 per 100,000 livebirths) and for 2018, it was higher in rural areas (548) compared to urban (523); highest in North-West (901) and lowest in the South-East (268). MM Ratio was consistently lower in the South-West (2008=281; 2013=367; 2018=392) and higher among the Northern regions of the country, particularly the North-East (2008=654; 2013=612; 2018=901). Overall, Kebbi, Adamawa and Taraba states had high MM Ratio across the three surveys. From 2008 to 2018, MM Ratio declined by 18% in the North-West and 54.2% in the South-East region. However, there was a 4.8% increase in MM Ratio for South-West from 2008 to 2018. At the community levels, geopolitical zone, knowledge (IRR=1.33, CI=0.98-6.1) and actual use of family planning (IRR=1.92, CI=1.1-9.1) were associated with maternal death counts.

This study has derived and shown differentials in subnational estimates of maternal mortality in Nigeria and has identified geopolitical region, the knowledge and use of family planning as major covariates of maternal mortality. This has produced a baseline upon which improvements in maternal mortality in states and geopolitical zones in Nigeria can be based.

Keywords: Maternal mortality, Sisterhood method, Small area estimation, Nigeria Demographic and Health Surveys

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AD	Age at Death
AFDR	Adult Female Death Rate
ASFR	Age Specific Fertility Rate
CEB	Children ever born
COD	Cause of Death
CEMoC	Comprehensive Emergency Obstetric Care
CVRS	Complete Vital Registration System
DHS	Demographic and Health Survey
EAs	Enumeration Areas
EBLUP	Empirical Bayesian Unbiased Predictor
FCT	Federal Capital Territory
GFR	General Fertility Rate
HDSS	Health and Demographic Surveillance Systems
IR	Individual recode
LMIC	Low- and Middle-Income countries
LTR	Lifetime Risk
LTRMD	Lifetime risks of maternal deaths
MM	Maternal Mortality
MD	Maternal Deaths
MDG	Millennium Development Goal
MMEIG	Maternal Mortality Estimation Inter-Agency Group
MMRate	Maternal Mortality Rate
MMR / MMRatio	Maternal Morality Ratio
MDSR	Maternal Death Surveillance and Response systems
NPC	National Population Commission
NDHS	Nigeria Demographic and Health Survey
P/F Ratio	Parity/Fertility Ratio
PRMR	Pregnancy Related Mortality Rate
RAMOS	Reproductive Age Mortality Survey
SDG	Sustainable Development Goal
SMI	Safe Motherhood Initiative

SAE	Small Area Estimation
SSA	Sub-Saharan Africa
SSH	Siblings Survival History
TFR	Total Fertility Rate
UN	United Nations
UNICEF	United Nations Children's Emergency Fund
UNFPA	United Nations Population Fund
VRS	Vital Statistics Registration Systems
WHO	World Health Organization
YSD	Years Since Death

CHAPTER ONE

INTRODUCTION

1.1 Maternal Mortality as a Global Health issue

Maternal mortality (MM) also referred to as "maternal death" , according to WHO is defined as " the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes" (WHO,1996). Elevated level of maternal mortality is a challenge in global population health and an essential indicator in population health and development studies. Its level can be used to monitor the developmental status of a population.

Maternal mortality is a vital measure for women's health, and it can be a pointer to the performance of health care systems in a population. (AbouZahr & Wardlaw, 2001; Abouzahr, 2010). According to the WHO, approximately 830 women die from preventable causes related to pregnancy and childbirth every day (WHO, 2018). During pregnancy and childbirth, a woman may experience some complications which may result in death. Such complications include severe bleeding which occurs mostly after childbirth, infections, high blood pressure (pre-eclampsia and eclampsia), and complications during delivery, unsafe abortions, malaria and AIDS during pregnancy. Most of these above-mentioned complications can be prevented or treated. According to the World Health Organization, 99% of all maternal mortality occurs in LMIC, and it is endemic in rural areas and poor communities (WHO, 2018).

In 1987, the United Nations launched the Safe Motherhood Initiative (SMI) in Kenya. This initiative was established to reduce death during pregnancy and after child birth. MM has since then been flagged a world health concern. The SMI targeted at reducing the MM figure yearly by 50 percent by the year 2000 was later launched in Nigeria in 1990. The fifth Millennium Development Goal (MDG), then, required all member states to improve maternal health and launched similar initiatives. These initiatives include: Beijing conference held at the instance of women activists in 1995 across the globe; the world summit for children (1990); the International Conference on Women (1994); the fourth conference on women (1995) and the United Nations Millennium Summit in 2000. In spite of these efforts, evidence suggest only a modest reduction in maternal mortality in developing countries (Ahmed and Hill, 2011; WHO,2019), but there are measurement concerns about the rates as accuracy cannot be verified as there are still inconsistencies in the published estimates from time to time. Measurement challenges stem primarily from non-existing or incomplete vital registration systems issues in Nigeria, as well as in other low and middle-income countries (LMIC). However, for more-developed countries where such vital registration systems exist and are complete, there are still challenges to ensure that all maternal deaths are correctly classified to avoid under-reporting and over-reporting due to misclassification for pregnancy-related deaths (Hill *et al*., 2007) .

In the same vein, monitoring health disparities has gained attention in the agenda of the post-2015 sustainable goals. The World Health Organization (WHO) has, from inception in 1948, been known for encouraging health inequality monitoring. The basics of the health monitoring systems make use of disaggregated data to identify underprivileged subgroups within populations and inform health policy makers make equity-oriented programmes and practices. Inequalities in maternal health exist worldwide, within and across sub-populations (WHO, 2019). Current deliberations on best practices to monitor and propose ways to curb maternal health inequity suggests collecting and analysing data that reveal patterns and trends of maternal health inequality across subgroups in a population (Reza & Bergen, 2016). Most times, measuring maternal health inequality/disparity across different subgroups in a population has not been a common practice. More attention has been on getting the population estimate right. However, ensuring there are no disparities in the access to maternal health care in different subpopulations can assist in getting disaggregated estimates that can enhance decentralization of policies and interventions. There is an emphasis on a need to disaggregate data by variables such as socio-economic status, geographical area or even sex in the aim to reinforce data monitoring and accountability (Reza & Bergen, 2016). However, there is still weakness in the health information systems of most LMIC and maternal death surveillances are non-existent. The long-term solution to this would be to have substantial investments in the health information and surveillance infrastructures of countries. However, in the interim, existing data can be innovatively analysed to provide sub-population estimates useful for monitoring purposes.

1.2 Maternal Mortality in Nigeria

Globally, Nigeria ranks second to India on the list of countries with the highest estimated number of maternal deaths according to WHO, MM estimation guideline, with an estimate of 58,000 maternal deaths (19%) in 2015. The estimated MMR was 814 per 100,000 live births. This estimate was jointly published by the World Health Organization (WHO), United Nation Population Fund (UNFPA), World Bank Group and the United Nations Children Funds. This body came together to form the Maternal Mortality Estimation Inter-Agency Group (MMEIG) in a bid to accurately produce estimates and standardized direct measures of maternal mortality. Their primary objective is to be able to provide internationally MMR estimates for comparison purposes across countries. (World Health Organization, United Children Emergency fund, United Nations Population Fund and The World Bank, 2008 and 2013). While several analysis of MM trends show that Nigeria is making progress in reducing the maternal mortality rate, the pace still remains slow as a woman's chance of dying from pregnancy and childbirth is 1 in 13 and more startling is that most of these deaths are preventable. (WHO & Unicef, 1997 & UNICEF, 2017).

Maternal deaths in Nigeria does not only contribute enormously to the high maternal mortality rate in the world but also there are still challenges in the measurement of the specific estimates. Several doubts have risen about the numbers that have been published as the rates of Maternal Mortality in Nigeria, considering the fluctuation and inconsistency of the figures and the uncertainty of their sources. The difficulty in measurement can be attributed to the inadequate recording of adult deaths, misclassification of maternal death and the relatively rare nature of maternal deaths. Nigeria, as a country, has an inefficient vital/civil registration system, a challenge several developing countries are battling. In the absence of a complete vital registration system which should have been the accurate source of number and causes of deaths, these concerns about the estimates are not outrageous in themselves since estimates are generated by alternate methods based on several assumptions or from health facilities neglecting events that occurred out of the hospitals. Therefore, it is critical and necessary to review the published estimates and also attempt refining them, as well as disaggregate the data for maternal mortality estimates across subpopulations in Nigeria.

An accurate country estimate of maternal mortality is essential to assess the real magnitude of the problem. Unlike developed countries where there are functioning national data sources on maternal deaths which would provide more accurate estimate of the mortality ratio and could serve as reference points for health advocates, professional advice and law/policy makers, Nigeria's vital registration of deaths are grossly incomplete like other less-developed countries, (Hill *et al*., 2006). Similar to any intervention programme, the various approaches and attempts to reduce the maternal deaths and consequently maternal mortality rates cannot be appreciated neither can impact be properly measured, if there are no adequate data and reliable estimates to measure the various performance indicators. The available sources of data on maternal deaths have been some community-based studies, hospital-based studies, and there has been a wide margin between these estimates and those derived from statistical models by WHO and sister agencies. As a matter of fact, hospital-based estimates are only related to that of women who managed to get to the hospital or choose the orthodox means of giving birth, which is most unlikely for women residing in the rural area of Nigeria, who only visit the hospital at critical and life-threatening stages of labour (World Health Organization, 2017).

1.3 Statement of the problem

According to Maternal Mortality Estimation Inter-Agency Group (MMEIG) report, about 295,000 women died annually during and following pregnancy and childbirth in 2017 (WHO, 2018). Only a minimal fraction of 1% occurs in developed countries while over half takes place in Africa, 42% in Asia and 4% in Latin America and the Caribbean. This suffices to say, that over 94% of maternal deaths take place in the developing countries of the world. It has been reported that the sub-Saharan Africa region alone accounts for about 62% of the global maternal deaths of 289000 with MMRatio of 510 per 100,000 live births, the second highest in the remaining Sustainable Development Goal (SDG) developing regions and Nigeria has a burden of 14% (40,000 maternal deaths) with India as the highest with 17% (50,000 maternal deaths) (WHO, 2018). It was also reported that the lifetime risk of maternal death in Nigeria is 1 in 31 and a MMRatio of 560 per 100,000 live births compared to 1 in 45,200 and a MMRatio of 1 in 100,000 live births in Belarus (World Health Organization, United Nations Children's funds, United Nations Population Fund and the World Bank, 2012; World Health Organization, 2013; World Health Organization 2014; World Health Organization, United Nations Children's funds, United Nations Population Fund, 2015).

There is increasing demand for accurate estimates of maternal mortality at the national and subnational level. This United Nations (UN) Interagency estimates of maternal mortality has indicated that between 2000 and 2017, there has been a global decline of maternal mortality by 38%, although, Nigeria has been shown not to have change much. Not only are these figures displaying wide variation and disparity, but it concealed the differentials of these estimates within the different regions, states and socio-economic groups in respective countries. Similar to most LMIC, there are relative inadequacies observed in the information on maternal death (MM) in Nigeria. The base population size of the country, which is a required parameter, is yet to be established among other issues, hence, the difficulty in obtaining data on mortality through a functional vital registration system. Mortality estimation requires that the population should be under observation over some time, and this is a challenge as routine vital data collection is not habitual in Nigeria’s context. This has made the vital registration system incomplete or totally non-existent.

Since there is no clear means of validating the estimates of MMRatio in Nigeria, this has made it difficult to assess the progress of programmes and interventions that have been initiated in the country. Furthermore, without valid estimates for the national and subnational subpopulations, the interventions cannot be targeted accurately to the groups of individuals who need it the most. Experts have suggested that to reduce the rate of maternal mortality in Nigeria, there need to be a strong political will in deploying enough resources in strengthening maternal surveillance systems to monitor and invariably reduce MM in Nigeria successfully. The question therefore remains, what is the magnitude of maternal mortality and how is this burden distributed across different states, ages, and socio-economic groups to ensure the government appropriates the intervention successfully? There are no generally accepted consistent estimates of maternal mortality rate in Nigeria. There seems to be differences in the estimates produced in various studies and used for various purposes. Several estimates that were issued in the past have met with several critiques of either how low they were or how high they still are despite several interventions that were put in place.

An obvious inadequacy of the existing estimate for Nigeria is that it refers to the country as a whole: there are no differentials such as urban/rural, geopolitical zones and administrative entities such as states that are necessary for disaggregated planning purposes. In the light of this, there is a need to explore other methods of monitoring maternal health within Nigeria, especially since policies can be decentralized for various regions and states. Documenting the evidence of the disparity, especially in the various sub-division, will provide alternate solutions than arguing over inconsistencies in the national estimates.

1.4 Justification of the study

There is a need for improved measurements and estimation of maternal mortality data (World Health Organization, 2015). Apparently, with inconsistent and contradictory estimates for maternal mortality, there is a need for a complete civil vital registration system (CVRS) which might be a long-term project of investing in the health information systems. However, there is a need to make use of the existing and available datasets and to improve methods of estimation. The NDHS have provided data opportunity for estimating national estimates of MM, but there are no estimates across sub-population groups. A small area estimation of maternal mortality in Nigeria’s subpopulation will ensure that planning for services are done with sub-population specific estimates of MM as opposed to, for example, making individual state intervention with the national estimates of MM. This approach will then ensure that comparison can be drawn in the trends and occurrences of MM among the different sub-population and programmes and interventions can be designed to close the maternal health gaps at the subpopulation level.

At the moment, very little is known about the magnitude of MM among the sub-population of Nigeria. There is a necessity to explore approaches in which within-country monitoring and policies for maternal health can be more evidence-based. Secondly, in attempt to bridge gaps of health inequities and differential, interventions will be implemented at sub-divisional i.e. state levels. Disaggregation of population data to capture the estimates for benchmarking these indicators is paramount in the face of reduced allocation and scarce funding as sub-population disaggregation of estimate provide more intuition in understanding the most disadvantaged region. Hence, this study was designed to provide plausible refined estimates of maternal mortality with small area estimation procedures using the direct and indirect sisterhood method applied to the NDHS 2008, 2013 and 2018 dataset. This effort which would be generating estimates for some sub-populations of Nigeria, would assist to improve the planning and the monitoring efforts of stakeholders and governing agencies.

1.5 Research Questions

This study seeks to provide answers to the following questions:

- What are the levels and observed differentials in maternal mortality in Nigeria between ten-year period 2008-2018?
- How does MM levels vary over time in Nigeria sub-populations?
- Are there country-specific correlates contributing to the magnitude of MM in Nigeria.
- What are the magnitudes of variation in estimates obtained using various methods in estimating MM?

1.6 Objectives of the study

General Objective

The general objective of this study is to derive refined estimates of MM rates and ratio for major subpopulations of Nigeria and to identify possible covariates contributing to MM, at community levels in Nigeria between 2008 and 2018.

The specific objectives are to:

1. derive refined plausible small area estimates of MM in various sub-population of Nigeria.
2. compare refined estimates with the baseline provided by the Nigerian Demographic and Health survey reports and UN Interagency groups.
3. describe pattern and trends of MM between 2008 and 2018 in all the major sub-populations in Nigeria.
4. investigate correlates of MM in Nigeria at the community levels

1.7 Operational Definition

- **Maternal Mortality:** The World Health Organization (WHO) defines maternal mortality as the death of a woman while pregnant or within 42 days of termination of pregnancy, from any cause related to or aggravated by the pregnancy but not from accidental or incidental causes. The maternal mortality ratio is measured per 100, 000 live-births (WHO, 2018).
- **Pregnancy-related death:** this is the death of a woman while pregnant or within forty-two days of termination of pregnancy, irrespective of cause. Theoretically, DHS data provide pregnancy-related deaths, not maternal deaths. While deaths related to pregnancy deaths are defined by the timing of death concerning the woman's pregnancy and delivery, irrespective of the relationship between the cause of death and the pregnancy, a true maternal death requires a specific cause of death information. Therefore, unintentional deaths or deaths due to violence that may or may not have occurred because of the state of being pregnant will be included in the pregnancy-related death categories but not as maternal deaths.
- **Pregnancy-related mortality ratio:** Pregnancy-related mortality ratio is an estimate of the number of pregnancy-related deaths for every 100,000 live births.

- **Live births** refers to the complete ejection or extraction from its mother of a product of conception, irrespective of the period of the pregnancy, which after such separation, breathes or shows any evidence of life such as; beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles whether or not the umbilical cord has been cut, or the placenta is attached. Each product of such birth is considered live born (WHO, 2018).

In this thesis, the term "maternal mortality" and "pregnancy related mortality" are used interchangeably. This agrees with the definition as adopted by the Demographic and Health Survey in Nigeria, where maternal mortality was actually measured with pregnancy-related deaths.

CHAPTER TWO

LITERATURE REVIEW

This review focuses on the estimates obtained from different data sources of maternal mortality as well as the methods used to obtain these estimates in Nigeria.

2.1 Data Sources and Estimation of maternal mortality.

Data sources of MM include Vital registration, Health service records, Household survey, Siblings survival history, and Reproductive age mortality studies and the newly adopted demographic health surveys.

(i) Civil Vital Registration Systems (CVRS): According to the UN, vital registration is the system by which a government records the vital events of its citizens and residents (WHO, 2010). Generally, the vital events in population studies include: births, death, marriages, divorces, foetal death (still-births), and induced terminations of pregnancy (abortions). The continuous registration of births and deaths is potentially the richest source of data about adult mortality. In most countries, vital registration helps create a permanent record of vital events. Vital registration creates legal documents which may be used to establish and protect the civil rights of individuals as well as providing a source of data which may be compiled to give vital statistics. Hence, they form the origin of fundamental demographic and epidemiologic measures and are used in planning and operating health programmes, commercial enterprises ranging from life insurance to the marketing of products for infants and a wide range of government activities. Data for MM can be sourced from vital registrations and MMRate and MMRatio can be calculated for each year in the conventional direct manner of dividing all maternal deaths occurring in one year by the number of live births occurring in the same year. This will provide accurate levels of MM; it will also give allowance for monitoring trends of MM as well ensure that small area demographic estimates can be generated for sub-populations. Issues in measuring MM have been attributed mostly to weak health information systems birthing defective data. Accurately measuring the maternal mortality is difficult except where Complete Vital registration Systems (CVRS) and ascertainment of cause of death (COD) exists. This provides complete registration of deaths and causes of deaths in the population as well as registrations of live-births, continuously. In some cases where this is done, maternal deaths are still sometimes found to be under-recorded in the official statistics as a result of the cause of death misclassification, how much more in countries with less statistically developed measures of measuring incomplete to non-existing CVRS. This challenge has birthed other methods of measuring the burden of maternal mortality through household surveys. In some places, census and models have to be used to estimate levels of MM. This is discussed in details in this work.

(ii) Facility Health Service Records: This involves a retrospective method of collecting information on recorded maternal deaths over a period. This would be used together with the number of live births in the facilities in the same period to generate the MMR of the facility. This approach might have succeeded in producing accurate MM ratio if a substantial number of women visit the health facilities to give birth. In the Nigerian context, this would have been further strengthened with the centralized system in the health sector, which mandates that in-depth facility based maternal and prenatal death reviews should be done and reported. This is to ensure a robust aggregated data at the facility, local governments, states and national levels. However, a large proportion of births in Nigeria still occur outside of the hospital facilities, especially in rural settings.

(iii) Reproductive Age Mortality Studies (RAMOS): The first alternate method for estimating maternal mortality that is also referred to as the *"gold standard"* is through the use of Reproductive Age Mortality Survey (RAMOS). This is generally known as the investigation of a group of deaths of women of reproductive age and in-depth study of those identified as maternal deaths (Ghebrehiwet and Morrow, 2010). RAMOS gives a comprehensive detail of maternal deaths among women of reproductive ages in a population. It involves recognizing and investigating the causes of all maternal deaths among the women through verbal autopsy. This has been done successfully in the few countries like Egypt, Honduras and Jamaica (World Bank and Koblinsky, 2003). A similar study was done by Professor Harrison in the Zaria Maternal Survey Harrision(1985). RAMOS uses triangulation of different sources and information that is gathered from registration systems, census, death registers, burial records, midwives' report, hospital records and surveys. This is used to compile a complete count on deaths of women of reproductive age coupled with record review and verbal autopsy to identify maternal deaths. This is then accompanied by the respondent's interviews and the analysis of medical records to ensure that the event was not just pregnancy related, but a true maternal death. Based on its use of multiple sources of information, RAMOS is considered the best way to estimate levels of maternal mortality next to the CVRS. RAMOS approach to estimating MM is not feasible where there is no available complete CVRS to ascertain the deaths of women of reproductive age in a population (Prata *et al*., 2012). In the study mentioned earlier, Harrision (1985) collected data in the Ahmadu Bello University Zaria. Data on 22,774 consecutive hospital births was collected over a 3.5 years period (January 1976 to July 1979). The report was an extensive documentation of varying causes of maternal deaths during the study period in the hospital and laid a foundation for what can be replicated at community levels in across Nigeria.

(iv) Maternal Death Surveillance and Response (MDSR) systems: This is the process of routine identification and timely notification of maternal deaths with interpretation of the aggregated information. The process builds on existing programmes for maternal death reviews (MDR) where each maternal death is reviewed locally by a committee that examines the medical and non-medical factors contributing to a maternal death. This is a real-time information system that thrive on instant notification of maternal deaths in a community or/ and facility within 24-28 hours. The MM of a country can be estimated in real-time and trends can be monitored. A similar one of the first attempts at the surveillance system was also done at the Ibarapa Community Health Programme of the College of Medicine, University of Ibadan in Igbo Ora, in South Western part of Nigeria in the 1970s (Ayeni, 1979). This approach also involved putting a geographical area in a defined population under detailed study for a period of time as seen in Zamfara state's Nahuche Health and Demographic Surveillance system (HDSS) (Alabi *et al*., 2014), where data collection on births, migration, pregnancies, marriages and marriage termination was routinely collected. Verbal autopsies were also collected for all deaths reported during the routine data collection. Similarly, a UNFPA country assisted periodic state-wide Maternal and Peri-Natal Deaths Surveillance and Response (MPDSR) was done in Ogun State (Sageer *et al*., 2019)(Sageer *et al*., 2019). This is similar to what was also carried out in selected referral hospitals in Lagos Island (Okonofua *et al*., 2017). The MDSR system helps strengthen the civil and vital registration systems in a country. In the absence of CVRS, surveillance systems in communities and sub-national populations will be a source of data that will help in estimating the magnitude of MM in Nigeria, especially in rural communities, where maternal deaths are likely to go unreported. This can then augment information from facility health records in most urban centres to provide a plausible picture of cases of maternal deaths among women of reproductive ages in the country.

(v) Population Censuses: Another valid approach to estimating MM indices is through the population census data. The census is about the most adequate survey large enough to support the measurement of spatial and socio-economic differentials in maternal mortality. According to the UN, it is the total process of collecting, compiling, analysing and publishing or otherwise disseminating demographic, economic and social data about all persons in a country or a well-delineated part of a country at a specified (UNFPA, 2017). This can also serve as a source of MM. The census dataset supports the standard methods and traditional demographic methods that exist for evaluating and if need be adjusting the data on overall deaths. For countries that also lack a civil vital registration system (CVRS) and ascertainment of cause of death (COD), the use of population census has been adopted. The questions about the household deaths in a defined period before the census is included in the census module and used to evaluate the adult mortality in the specific country. A good number of countries attempted this method in the 2000 census (Stanton *et al*., 2001; Hill *et al*., 2009; Hill *et al*., 2011; Fauveau, 2011). Several even added more questions for deaths of women of reproductive age as to whether they were pregnant or within two months of delivery at the time of death (Hill *et al*., 2006; Hill *et al*., 2011).

(vi) Siblings Survival History

This is most widely used substitute for the CVRS in generating MM estimates (Merdad *et al*, 2013). The sibling's survival history is used in a single round survey, where interviewers ask women about the survival of their siblings that are women of reproductive ages. Further questions are asked about their survival status and the interviewer then probes further about the causes of death to know if it were pregnancy related. The timing of death is also sometimes captured to allow for calculation of the women exposure-years. This can be included in national population census as well as in demographic health surveys. More on this method is described in the following chapter.

MM indices can also be measured indirectly from the age and sex-specific death rates especially where data on causes of death are not available. In their study, Blum *et al* (1990) assumed that in the absence of maternal mortality, the age schedule of adult female mortality would follow the Gompertz law. Furthermore, it was affirmed that while estimates from the first approach gave a good approximation of MM levels from direct obstetric causes and that estimates of the latter are closer to the overall maternal mortality ratio, including deaths due to indirect obstetric causes (Blum and Fargues, 1990). In another derivative of the method, Bhat *et al*. (1995) applied methods of relating sex differentials in mortality for people of reproductive age to the age schedule of fertility to a sample registration system of India. In this method, it is assumed that in the absence of maternal deaths, the ratio of women's to men's death would change linearly between ages 10 and 45 and this deviation of the observed ratio from this norm could be attributed to maternal causes. This approach is basically to study the deviations from the regular pattern of ratios of female to male mortality by age (Bhat *et al*., 1995).

2.2 Review of estimates based on various methods and approaches to estimating Maternal Mortality in Nigeria

2.2.1 Facility-based estimates

Commonly used approach in Nigeria is facility-based studies. This takes on a retrospective approach where cases of maternal deaths are investigated against the number of live births for a given period in a facility. This approach measures maternal death counts from actual occurrences and not those reported by families or siblings as other methods. The following reviews were aimed to demonstrate the inconsistencies observed in level of MM in various facilities in various state.

In 1975, Oduntan *et al*. carried out a study on MM in Western Nigeria. Data on maternal death counts were collected from preselected medical institutions in the Western states in Nigeria from 1972 to 1973. The medical institutions included 4 specialist hospitals and 19 general hospitals in various districts of the region. The aim was to identify the major causes of maternal deaths in the region. From the study, an overall MMRatio of 3.8/1000 total births in 1972 and 4.7/1000 total births in 1973 was obtained. The MMRatio obtained from this study is equivalent to 380 per 100,000 live births in 1972 and 470 per 100,000 live births in 1973 (Oduntan and Odunlami, 1975).

In 1987, a twelve-year survey on the MM at the University of Ilorin Teaching Hospital (U.I.T.H), Ilorin, Nigeria was done. The study aimed at determining the maternal death at the U.I.T.H. Ilorin over 12 years (1972-1983). From the study, there were 138,577 births and 624 deaths making a MM rate of 4.50 per 1000 births. This study indicates an equivalent MMRatio of 450 births per 100,000 live births. (Adetoro, 1987). The primary direct obstetric causes of death include: haemorrhage, ruptured uterus and obstructed labour. The most important indirect causes of death were cerebrospinal meningitis, pulmonary infection and fulminating hepatitis. The avoidable causes were ineffective and cumbersome blood transfusion services, poor management of the third stage labour, large number of un-booked patients and poor delivery room structure which encouraged sepsis. Also, from the study, it was stated that a more integrated type of maternity services, health education to the public especially expectant women and availability of blood bank service within maternity hospitals for prompt treatment of patient requiring emergency blood transfusion would reduce maternal mortality rate.

A comparative retrospective analysis of maternal deaths at the University of Nigeria Teaching Hospital, Enugu, Nigeria was carried out for two ten-year periods; 1976-1985 and 1991-2000. The study was done to determine the effect of the Safe Motherhood Initiative on MM in the hospital. Variables for the two periods were compared employing the T-test at 95% confidence level. From the study, the MMRatio obtained in period 2 was significantly higher than in period 1 with values of 1406 per 100, 000 live births and 270 per 100, 000 live births respectively. The leading cause of death was uterine rupture for period 1 and septicaemia for period 2, (Okaro *et al*., 2001).

In 2001, Olatunji, *et al*. carried out a retrospective hospital-based ten-year review (1988-1997) on the maternal deaths at the Ogun State University Teaching Hospital. During the period, there were 92 maternal deaths including those from abortion and ectopic pregnancy. The total deliveries were 5,423 giving a maternal mortality ratio of 1,700 per 100,000 live births. The leading causes of death include: ruptured uterus, eclampsia, postpartum haemorrhage and complications of abortion. From the study, it was suggested that easy access to affordable antenatal care, good blood transfusion services and more widespread use of contraceptives as well as training of traditional birth attendants would help reduce the risk of maternal death (Olatunji and Sule-odu, 2001).

A retrospective analysis of maternal deaths for the years 1999-2003 was carried out to estimate the MMRatios in health institutions with comprehensive emergency obstetric care in Enugu State. This was done to assess the current level of MM in eligible health institutions. Each maternal death was studied in details to ascertain the socio-demographic characteristics of women who died. Within the five years (1999-2003), there were 141 maternal deaths and 18, 257 live births, giving a maternal mortality ratio of 772 maternal deaths per 100,000 live births. The leading causes of maternal deaths among the women were obstetric haemorrhage (19.1%), sepsis (18.0%), prolonged obstructed labour/ruptured uterus (16.9%) and pre-eclampsia/eclampsia (16.9%) (Okaro *et al*., 2001).

A ten-year review of MM in Sokoto, Northern Nigeria was carried out to determine the institutional MMRatio, risk factors, causes and preventive measures to prevent or reduce the maternal deaths. The study was based on hospital case records of all maternal deaths at the Usman Dan Fodiyo University Teaching Hospital, Sokoto, between January 1990 and December 1999. From the study, there were 9,158 live births during the study period, 197 maternal deaths. The maternal mortality ratio was 2,151 per 100,000 live births. The mean age at death was 27 years. Risk factors obtained from the study were nulliparity, poverty, illiteracy and lack of prenatal care. Ruptured uterus, eclampsia, infection, and haemorrhage were reported to be the leading causes of death (Bukar, Audu, and Tkai 2010; Audu *et al*., 2002).

A study on the MM in the University of Port-Harcourt Teaching Hospital, Port-Harcourt in the last year before the new millennium was carried out in 2004. From the study, a total of 1645 mothers delivered, 1472 (89.5%) were booked while 173 (10.5%) were un-booked with the hospital. Forty-five maternal deaths; 40 (88.9%) among the un-booked and 5 (11%) among the booked mothers constituting a maternal mortality ratio of 121.4 and 339.7 per 100, 000 deliveries respectively were obtained. The combined maternal mortality ratio was 2735.6 per 100,000 deliveries. The significant causes of death include; severe pre-eclampsia/eclampsia, haemorrhage and sepsis (Uzoigwe & John 2004).

In a study on the maternal deaths in the Lagos University Teaching Hospital, a 10 year review (1989-1998) was carried out in 2004which aimed at determining the roots and rates of maternal death in the Lagos University Teaching Hospital as seen at autopsy; to find their associated age frequencies and to compare these findings with previous studies done in this hospital as well as those from other parts of the world. The study involved cases for which autopsies were requested and performed between January 1989 and December 1998. Patients who died on arrival, as well as badly autolyzed cases, were excluded from the study. The result obtained from the study showed a MMRatio of 2,920 per 100,000 live births. The leading causes of maternal death include; obstetric haemorrhage (25.6%), genital sepsis (19.68%) and pregnancy-induced hypertension (16.7%). The most common indirect cause of death was anaemia (7.01%). From the study, 70% of death occurred between 11 and 30 years. It was concluded from this study that; though MM figures hospital-based studies are usually

over-estimated of the actual picture in the community, they tend to provide a more thorough assessment of the underlying causes of death and their contributing factors, hence providing useful data for planning interventions (Daramola *et al*., 2004).
A review of all the records of deliveries and case files of women who died during pregnancy and child-birth between January 1, 1985, and December 31, 2001, in the maternity unit of Jos University Teaching Hospital, Jos, North-central region, Nigeria was reviewed. A total of 267 maternal deaths occurred among 36,768 deliveries over the 17 years, making the MMR 740/100000 total deliveries. The trend fluctuates between 450 in 1960 and 1010/100000 deliveries in 1994 (Ujah *et al*., 2005).

In Abakaliki, Eastern Nigeria, all maternal deaths were recorded at Ebonyi State University Teaching Hospital (EBSUTH); from January 2000 to December 2003. It was observed that 4,192 live births were recorded, out of which 79 maternal deaths were obtained. It implies a maternal mortality ratio of 1,884 per 100,000 live births. The case records of only 49 (62%) of these maternal deaths were complete and included in this review. The above scenario shows one of the insufficiencies of hospital data in estimating maternal mortality (Umeora *et al*., 2005).

A study conducted in Shagamu, Western Nigeria in 2006 to investigate MM observed all maternal deaths recorded at Olabisi Onabanjo University Teaching Hospital, Sagamu Nigeria in 2005. The retrospective study revealed 63 (84.0%) of the deaths were direct maternal deaths while 12 (16.0%) were indirect maternal deaths. Major causes of deaths were eclampsia (28.0%), haemorrhage (21.3%) and sepsis (20.0%). The research further showed that the MMRatio of 2989.2 per 100 000 live births was much higher than that reported for 1988–1997 in the same institution (Oladapo *et al*., 2006).

A retrospective hospital survey on MM in a Nigeria teaching hospital was carried out for six years from 1997 to 2002. The survey was aimed at determining the MMR in a Nigerian tertiary health institution (University of Ilorin Teaching Hospital, Ilorin, Nigeria). From the survey, the MMR obtained for the six years was 825 per 100,000 live births. It was stated that the common causes of maternal death were severe pre-eclampsia/eclampsia 30(27.8%), haemorrhage 22(20.4%) and complications of unsafe abortion 16(14.8%). Also, Grand multiparous and patients aged above 40 years were at the highest risk. This hospital-based MMR was very high when compared with previous reports showed a 150% increase (Aboyeji *et al*., 2007).

Onakewhoru *et al*. (2008) carried out a hospital-based study on the changing trends in MM in a developing country. The objective of the study was to have a five-year review (January 1, 1996, to December 31, 2000) of the MMRatio in the largest centrally located Mission hospital (Saint Philomena Catholic Hospital) in Benin-city where a large proportion of women deliver yearly. The study also reviewed the causes of MM in the hospital. From the study, 7,055 women delivered during the five-year review. Thirty-two maternal deaths occurred with a MMR of 454 per 100,000 live births. Un-booked emergencies accounted for 68.7% of all deaths which doubled that of booked women. It was also stated that as the number of deliveries decreased progressively from 1,530 to 1,247 in 1996 to 2000 respectively, the MMR increased from 327 to 675 in 1996 to 1999. The four leading cause of death were Eclampsia, Haemorrhage, Infections, and Abortions. From this study, the MMR obtained was still high as a sub-section of the country relative to the Nation average for MMR (Onakewhor and Gharoro, 2008).

Furthermore, the case notes of all maternal deaths at the University of Uyo Teaching Hospital, Uyo over six years were reviewed. About 26.0% of the women booked for antenatal care, while 74.0% were un-booked. Most of the antenatal clinic defaulters (52.6%) and the un-booked women (81.5%) were brought from traditional birth attendants homes. Majority of the deaths occurred postpartum (72.6%) and within 24 hours of admission in the hospital (63.0%). The most common causes of maternal deaths were eclampsia (28.8%), puerperal sepsis (17.8%) and obstetric haemorrhage (11.0%). Results showed there were 3,531 live-births and 91 maternal deaths resulting in a MMR of 2,577 per 100,000 live-births. The MMRate is one of the highest in the country (Abasiattai and Umoiyoho, 2008).

Olapade *et al*. (2008) carried out a retrospective case-control study at the Adeoyo Maternity Hospital, Ibadan between January 2003 and December 2004. The study was done to determine the MMR in a secondary health facility, to identify the causes of death and review factors associated with these deaths. From the study, there were 8,724 live births and 84 maternal giving a MMRatio of 963/100,000 live births.

Haemorrhage, sepsis, and eclampsia were the leading causes of death (Olapade and Lawoyin, 2008).

A ten-year review of MM was conducted at Central Hospital, Benin City Nigeria. The study was conducted to document the number and pattern of obstetric deaths at the Central Hospital, Benin City over a ten-year period and identify the common causes of maternal deaths and proffer relevant interventions. From the result, the MMR was 518 per 100,000 live births. The MMR was 30 times higher in un-booked as compared to the booked patients, while 60% of maternal death occurred within 24 hours of admission. The major direct causes of maternal deaths were found to be sepsis, haemorrhage, obstructed labour and pre-eclampsia/eclampsia while the indirect causes are institutional difficulties and anaemia. Also, low literacy, high poverty level, extremes of parity and non-utilization of maternity services were associated with MM. According to the study, it was proffered that female education, poverty alleviation, public enlightenment campaign and advocacy activities aimed at mobilizing resources for reducing maternal mortality will contribute to the reduction of the burden of maternal mortality (Abe, 2008).

A study on the maternal mortality at the State Specialist Hospital, Bauchi, North-eastern Nigeria was carried out to analyse and document experiences with MM over seven years. Common causes and attributing socio-demographic factors of MM were also investigated. From the study, the MMR for the period under review was 1,732 per 100, 000 live births. 621 deaths (81%) occurred in 12,067 un-booked deliveries giving a MMR of 5,146 per 100, 000 un-booked mothers. This ratio is approximately eleven times than obtained in booked live deliveries (Mairiga & Saleh, 2009).

A retrospective review of MM in a transitional hospital, Enugu State University Teaching Hospital located in the South-Eastern part of Nigeria, was done to determine the trends of MMR in the hospital as it transit from a General through a Specialist to a Teaching hospital. The review was done over a five year transition period (January 2004 to December 2008). There were 7,146 live births and 60 maternal deaths giving an overall MMR of 840 per 100,000 live births. There was an increase in the MMR from 411 to 1,137 per 100,000 live births as a specialist hospital, with a decline to 625 per 100,000 live-births as a teaching hospital. Eclampsia/Pre-eclampsia (29.63%) was the principal cause of maternal death. The MMR obtained at a specialist hospital was higher than that of the teaching hospital due to inadequate facilities to properly manage the rising number of referred obstetric emergencies as well as the limited workforce in the hospital (Ezugwu *et al*., 2009).

A retrospective study was carried out in two tertiary and two secondary healthcare institutions in Ebonyi state, Southeastern Nigeria over the 3-year period January 2003 to December 2005. The study was done to determine the MM trend in South East Nigeria, less than a decade to the millennium developmental goals. This study aimed at determining the ratios, causes and key factors of MM in institutions located at different socio-economic settings. In this study, all the facilities had emergency obstetric services. Also, the socio-demographic characteristics, causes of maternal death as well as factors that contributed to the deaths were noted. From the study, the MMRatio was 902.7 per 100,000 live births, the ratio increased from 756.8 to 897.6 in 2003 to 2004 respectively and then to 1052.2 in 2005. The significant risk includes: grand multi-parity, maternal age ≥ 35 years, low socioeconomic status and unscheduled emergencies. The primary cause of maternal death was sepsis (25.8%), followed by obstetric haemorrhage (23.7%). Pre-eclampsia/eclampsia and anaemia accounted for 12.4% each. The MMRatio worsened, and the study concluded that Nigeria might not meet the Millennium Developmental Goal number 5 (MDG 5) if the trend continues (Nwagha *et al*., 2010).

A ten-year review of MM in the University College Hospital, Ibadan Nigeria 1974, showed that 820/100,000 maternal deaths occurred in the hospital from January 1, 1962, and December 31, 1971. However, the number of maternal deaths recorded are not representative of what happens in the community since number of that take place outside of the health facilities are unknown (NPC and ORC, 2003).

Bukar *et al*.(2010) carried out a retrospective hospital-based study to determine trends in MM at the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria from 2001- 2005. The study was also done to identify the background socio-cultural factors, significant causes of death and determine avoidable factors. From the study, the MMR for the period under review was 430 per 100,000 live births. There were annual fluctuations in MMR. However, there was a consistently rising trend in MMR from

2002 to 2004 with the highest ratio of 545 per 100,000 live births recorded in the year 2004 with a decline in 2005. Eclampsia, sepsis, prolonged-obstructed labour/ruptured uterus were the direct causes of maternal death (Bukar, Audu, and Takai, 2010).

A facility-based study was carried out by Ujah *et al*., (2005) to determine the estimate, trends and causes of maternal death in North-central Nigeria. The data was collected between January 1, 1985 and December 21 2001 at the maternity Unit of Jos University Teaching Hospital. There was a total delivery of 38,768 and 267 maternal deaths during the reviewed period. This gave a MMR of 740 per100,000 live-births. In a similar study, a facility-based prospective study was designed to determine the MMR at the Jos University Teaching Hospital (JUTH) and ascertain the causes of maternal death. The study was done for the period between 1st June 2006 and 31st May 2008. During the study period, there were 56 maternal deaths and 4,443 live births at JUTH giving a MMR of 1,260 per 100,000 live-births. Of these, there were 15 deaths among 81 un-booked patients giving a MMR of 18,518 per 100,000 live births. 25 deaths occurred among those who booked elsewhere (2,969 per 100,000 live births) and 9 deaths among women who booked in JUTH with a MMR of 256 per 100,000 live births. 39 (69.6%) of the deaths were direct maternal deaths while 17 (30.4%) were indirect maternal deaths. The leading causes of direct maternal deaths were eclampsia (28.6%), haemorrhage (23.1%), unsafe abortion (8.9%) and pulmonary embolism (5.4%). Of the indirect causes of MM, HIV/AIDS accounted for 14.3% while anaemia, aesthetic complications, and thyrotoxicosis accounted for 8.9%, 3.6% and 1.8% respectively. From the study, it was observed that the MMR is still high in JUTH. It was found to be lower in those that had tertiary education and in booked patients. HIV/AIDS appears to be emerging as one of the leading causes of MM in this study (Ngwan and Swende, 2011).

A study was carried out to observe trend and causes of MM in an upgraded tertiary facility in North Central Nigeria (Federal Medical Centre, Lokoja) from January 1, 2005, to December 2009 suggested ways of improving Safe Motherhood services at the centre and in Nigeria. From the study, 44 maternal deaths occurred and 9,496 live births were recorded, giving an MMR of 463 per 100,000 live births. The annual MMR decreased from 779 per 100,000 live births to 392 per 100,000 live births in 2005 to 2009 respectively. Hypertension disorders, abortion complications, obstructed labour/

uterine rupture, and haemorrhage were the leading causes of maternal death (Alabi *et al*., 2012).

A retrospective study of all maternal deaths recorded at the Federal Medical Centre Yola (FMCY), Adamawa State, in the North Eastern region of Nigeria, from January 2007 to December 2011 was carried out to review and document the MMR. From the study, there were 54 maternal deaths among the 8,497 deliveries, giving an overall MMR of 636 per 100,000 live births. The fact that most deaths occurred within 24 hours of admission implies that many of the patients delayed reaching the referring centre for variety of reasons (Bukar *et al*., 2013).

This extensive review has shown the individual attempts of various teaching hospitals and community surveillances in estimating MM at localize levels. There is observed inconsistency in the estimates of MM despite similar methods of estimation. The livebirths as denominators might be one of the challenges, as research has shown that women-person years is a better denominator of MM. Also, for the hospital-based estimates, this only accounts for women that chose to give birth in the hospital or emergencies or high risk pregnancies. It is difficult to assume this is true representative of the various states they represent as many women are left out of the sample.

2.2.2 Estimates from Health and Demographic Surveillance Systems.

A population-based study of MM was done in Kano, Northern Nigeria to determine the incidence and causes of MM as well as its temporal distribution from 1990-1999. This was a retrospective study using information contained in the vital statistics register maintained by the Research and Statistics Department of the Ministry of Health in Kano State. This is one of the few data collections systems on deliveries and MM in Nigeria. The data were computed and analysed using the Poisson assumption to derive confidence intervals around the estimates. A non-linear regression model was fitted to obtain the best temporal trajectory for the MMR across the decade of study with a total of 4,154 maternal deaths occurring among 171, 621 live births, therefore yielding an MMR of 2,420 deaths per 100, 000 live births. Eclampsia, ruptured uterus and anaemia were responsible for about 50% of maternal deaths which were found to be one of the highest MMR in the world (Adamu *et al*., 2003).

Using the indirect sisterhood method, a pilot community-based study was carried in South-West, Nigeria to determine the incidence of MM in Ibadan, and there is exploration of the applicability of this method in a community where MM is not a rare event. Respondents between the ages of 15-49 were selected from randomly pre-selected Local Government Area of Oyo State, Nigeria. Structured instruments were used to collect data about the respondent's sister using the principles of the sisterhood method. From the study, there was a high incidence of MM; 1,324/6519 (20.3%) sisters of respondents had died with 1,139 deaths reportedly related to pregnancy, childbirth or puerperium. The MMR obtained from the study was 7,778 per 100,000 live births (95% CI 6144 – 6909) (Adegoke,*et al*, 2013).

A study of MM in 2012 was carried out in Zamfara state, Northern Nigeria, to determine the lifetime risk (LTR) of maternal death and the MMR in Zamfara state. In this study, data from Nahuche Health and Demographic Surveillance System were utilized using the 'sisterhood method' for estimating MM. Female respondents from six (6) districts in the surveillance area were interviewed, creating a retrospective cohort of their sisters who had reached reproductive age of 15 years. Based on population and fertility estimates, they calculated the LTR of maternal death and MMR. A total of 17,087 respondents reported 38,761 maternal sisters of whom 3,592 had died and of whom 1261 were maternal related deaths. This corresponded to an LTR of maternal death of 8% (referring to a period of about 10.5 years prior to the survey) and an MMR of 1,049 deaths per 100,000 live births (95% confidence interval, 1021-1136). The study provides documented evidence of high MM in the study area as well as the state as a whole. Thus there is a need to improve the health system by provisions of skilled birth attendants, emergency obstetric care, promotion of facility delivery and antenatal care attendance (Doctor *et al*, 2012; Alabi *et al*., 2014).

2.2.3 Estimates derived from indirect sisterhood approach and its variants

Other methods and approaches for measuring the Maternal Mortality rate/ratio include the "sisterhood" method, and its variant of full sibling’s report. This is the approach used in the demographic and health surveys (DHS). In this approach, the questionnaire consists of questions tagged as “the maternal module”, this asked about the survival of the respondents' sisters, and for sisters who died during the reproductive ages, additional questions are asked about the sister if she was pregnant or within two months of the delivery at the time of death. In the last two decades, the Sisterhood method commonly used in the household survey for estimating MM has been widely accepted for it is time-effective and cost-effective, and reduces sample size requirements compared to Censuses and RAMOS. In countries or areas with high levels of maternal death (i.e., over 500 maternal deaths per 100,000 live births), a sample size of 4,000 households or fewer is acceptable for this method. The sisterhood method provides a useful means of assessing MM.

In 2008, Oye-Adeniran *et al* obtained a population-based estimate of obtaining an estimate of MMR in Lagos state, Nigeria. The sisterhood method was used to obtain information from 4,315 respondents on the maternal experience of their sisters. 9910 ever married sisters were reported. The estimated MMR from the study was 450 deaths per 100,000 livebirths (Oye-Adeniran *et al*., 2011).

In a variant of the indirect sisterhood method approach, Adebowale *et al*. (2010) obtained the lifetime risk of maternal death of urban and rural women in reproductive ages from the 2008 Nigerian DHS. In their study, the adjusted TFR from the P/F ratio method was used in computing MMRatio from the LTR derived from the sisterhood method for Nigeria, and its Rural and Urban sub-population. Results revealed that the adjusted total fertility rates for urban and rural areas were 5.26 and 7.12 respectively. The LTRMD in urban was 0.0221 (1 in 45) whereas, in rural area it was 0.0309 (1 in 32). These results correspond to MMR of 424/100,000 and 440/100,000 live births in urban and rural areas respectfully (Adebowale, *et al*., 2010).

Zakari *et al*. (2013), carried out a community based cross-sectional descriptive study in estimation of MM using the indirect sisterhood method in Suleja, Niger state, Nigeria. The study was aimed at assessing MMR, lifetime risk of dying from maternal causes and the proportional l MMR in Suleja LGA of Niger State. From the study, there were a total of 1,094 deaths out of which 174 were maternal deaths. The MMR was 400 per 100,000 live births and a life time risk of dying from maternal causes during reproductive life is 0.023 (1 in 43 women).

In 2013, Adegoke *et al* also carried out a study using the sisterhood method approach in estimating MMR with a community based dataset in the southwest state, Ibadan, Nigeria. A total of 3,028 households were interviewed and with 2,877 respondents. A high incidence of maternal mortality was observed in the community with 1,139 reported maternal deaths from, MMR was estimated to be 7,778 maternal deaths per 100,000.

A study carried out in the north-eastern part of Nigeria, applied the indirect sisterhood method to data collected from rural communities in some part of Kebbi State, across 6 randomly selected local government areas. A total of 8,233 female siblings were reported by the 2,917 respondents. Out of the female siblings reported, 206 maternal deaths were recorded summing to MMR of 890 deaths / 100,000 live births. This is higher than the value reported as the national estimates in the 2013 NDHS report (Gulumbe *et al*., 2018).

Similar to the local health surveys, Adebowale and Akinyemi(2016) estimated MMR in a cross sectional study done in selected communities in Ogun state, Nigeria. Respondents were interviewed on reproductive health, admist other questions bordering around fertility, mortality and environmental issues. A ‘multi-indirect’ approach was used that involved adjusting total fertility rate (adjTFR) using the Coale and Trussell P/F ratio model. The second step was to estimate the LTR of maternal death using the sisterhood method, which was then converted to MMR using the standard adjustment factors and the adjusted TFRs. With 864 sisters reporting on their 2,3888 sisters, who had 29 maternal pregnancy related deaths. The estimated MMR was 480 deaths per 100,000 livebirths (Adebowale & Akinyemi, 2016).

In a study examining the high mortality in Jigawa State Northern Nigeria using the sisterhood method, 7,069 women of reproductive ages reported 10,957 sisters who had reached reproductive age as well, out of which 1,026 had died. 300 (29.2%) occurred during pregnancy, childbirth or within 42 days after delivery. This gave MMR estimate of 1,012 maternal deaths per 100,000 births with the reference period of 2001 (Sharma, *et al*., 2017). In their attempt, the researchers had used randomly selected clusters of communities in various Local government areas (LGAs) across Jigawa state.

The widely accepted Nigerian Demographic and Health Survey (NDHS) also estimated maternal mortality indices using the direct sisterhood method. The first few surveys were NDHS was carried out without the maternal mortality module. However, the recent surveys of 2008, 2013 and 2018 added the sisterhood method's question. The additional questions collected the siblings' history of the respondent sisters. This was used to identify the maternal death counts from, if the sisters died from pregnancy related causes. The MM indices was projected for the whole of Nigeria. The MMRatio for 2008 was 545 per 100,000 livebirths, 576 and 512 per 100,000 livebirths for 2013 and 2018 respectively (NDHS 2008; NDHS 2013; NDHS 2018).

These reviewed studies have shown the magnitude of maternal mortality in various states and in a few subnational populations in Nigeria, using various approaches. While the evidence is clear that maternal mortality remains high in Nigeria, as most of the studies done in the 2000s revealed, the wide disparity in the estimates also shows that there exist margin and varying estimates. This has made it difficult to see a consensual picture of what the true rates of maternal mortality are in Nigeria as a whole and in various sub-population, as well. In addition, most of the estimates did not report any measure of "uncertainty" of the estimates to which some level of confidence can be base.

2.2.4 Estimates derived from Regression Model

Using a covariate-based multi-level regression model approach, the Interagency Group derived estimates and projections of maternal mortality with updated information on maternal mortality. This model represents the maternal deaths with direct obstetric causes or indirect causes aside from HIV/ADIS deaths. The three selected covariates used in the model are the gross domestic product per capita (GDP), the General Fertility rate (GFR) and if a skilled attendant were at the birth, a proportion of total live births (SAB). These variables was to ensure that the indications for socio-economic development, process variables and the risk of exposure as a function of fertility are taken into consideration in the estimation of the MM indices. The modelled estimate per 100,000 live births for maternal mortality ratio (MMR) in Nigeria was reported to be 1,100, 1,000, 840, 630, and 560 in 1990, 1995, 2008, 2010 and 2015 respectively. (WHO UNICEF UNFPA and The World Bank, 2008, 2010, 2013, 2017). This was conducted to observe trends from 1990 to 2015 and 2000 to 2017. The UN estimates were derived using multilevel regression models which included the elements of observations at random levels, countries and regions. The model took into account the nature of the underlying empirical data as well as the country and regional specifications. The Institute for Health Metrics and Evaluation (IHME) used a multistage approach of a linear model and spatial-temporal model in obtaining their own estimates. The intent was to capture the real systematic variations that are missing in the covariates.

2.3 Small Area Demographic Estimates

The population and demographic change of small areas is driven by regional demographic and economic influences, and small area demographic process which includes, birth, deaths and migration in a spatial-temporal context. Direct estimates from a survey based on area-specific sample data are known to yield large standard errors due to small sample sizes. Small area estimates provide the avenue for small areas to borrow strength from related areas to increase the effectiveness of the sample sizes. As the concept of various demographic units begins to grow in the light of various demographic transitions, it has become pertinent to have methods that assist in monitoring trends, inequalities and disparities among various sub-population in a larger population, especially in populations with heterogeneous sub-groups. This would ensure better understanding of unique traits of smaller demographic units.

A small area is defined as a population or sub-population for which a reliable estimate of interest cannot be obtained as a result of the limitations of the small sample size of the group or geographical region. Information from population censuses is collected at about 5-10- years' intervals to provide population counts for geographical areas and subpopulations of a country. The sub-populations can be disaggregated into age, sex, marital status, geopolitical zones and states among many other demographic groups. Due to the changes in size, composition, and migration, information from census becomes outdated and makes the estimation of population indices more difficult, especially in the dearth of population registers and complete vital registration systems.

This challenge then makes it necessary for demographic researchers to develop suitable methods of estimating demographic information and measure population changes in the non-censual years. Those, as mentioned earlier, were the initial reasons small area estimates were introduced into demography, however, in developing countries where these data collection methods are not efficient, basic traditional demographic methods become inefficient in the measurement of population indices without researcher's intervention. With the introduction of small area estimation techniques, sub-populations with less population and in remote areas would have the opportunities to be included in evaluation monitoring their progress against national estimates. Two prominent methods have been used in estimating small area mortality. One uses the Bayesian Poisson Model and the other uses a Bayesian model with a prior of local registration information (Data for Health Initiatives, 2018). These small area estimates are derived from stages of analysis and known as indirect estimators. They are derived based on mixed models and usually associated with empirical Bayes estimators in which random effects represent the area-specific effects as suitable (Pfeffermann, 2013).

In their study in Bangladesh, Ahmed *et al*. (2011) used the Empirical Bayesian method in estimating MM rates for sub-national districts in Bangladesh with the countries Demographic and health survey dataset. Also, Ndagurwa & Odimegwu, (2019) used the Poisson regression-based approach to generate refined small area estimates of fertility using the 2015 Zimbabwe Demographic and Health Survey datasets. There are no small area estimates of maternal mortality in Nigeria, as at the time of this study.

2.4 Summary and Research gaps

Every one of the approaches for measuring MMR have recorded commendations as they have given each country an alternative in the absence of the most efficient way of measuring MM through CVRS. However, there are some limitations to the approaches in practice. Although RAMOS has been said to be best approach at monitoring the estimates of maternal mortality, however it also comes with the burden of multiple sources, to be able to identify all deaths with its complication and is largely expensive. The level of the livebirths also used in the estimation of maternal mortality might not be accurate especially in settings where women deliver at home. For the CVRS, maternal deaths might be misclassified or underreported if there is an absence of active case findings. In cases of the population census might have been a better approach to handling the issue of reference period as it captures the maternal death in the household in a relatively shorter reference period of about 1-2 years, hence producing more recent maternal mortality estimates, but censuses are carried out about 10-years interval (or not at all in some settings) and that limits the monitoring of maternal mortality.

A few other estimates had been generated using the indirect sisterhood methods in various communities in the country. Additionally, model-based estimates and projections based on multiple sources of data has also be added to the list by bilateral agencies, involving the WHO, UN, and the World Bank. MM estimates variation raises a fundamental demographical concern on possible explanation of the inconsistencies. Different sources of data might be one of the bases of discrepancies in MM estimates generated in Nigeria. The sources vary firstly in the time of references considered for the studies. For example, the community-based studies that used sisterhood method (direct and indirect) referred to at least 0-6 years before the year of survey and some can be as much as 6-12 years preceding the time of the survey, while some facility-based studies were centred on a year preceding the study and some are even prospective studies whose data were collected over time. Different sources also come with the way the measured deaths are defined. Certainly, the facility-based deaths were mostly maternal deaths, however, most community-based studies and population surveys actually measured pregnancy-related mortality rather than MM because there is no information collected on the cause(s) of death (COD). This reason affects the precision and reliability for the estimates derived and might deprive policy makers of some kind of comparison. The interagency estimates, on the other hand, are mostly empirically generated for countries like Nigeria without usable data sources. They are based on statistical modelling and multilevel regression analysis datasets generated from various sources within the population/ country of interest. While they are good for forecasting and far-casting, it might be inappropriate to use as baseline on which progress are measured.

The interagency estimates, community and hospital-based studies as well as the various attempts with the NDHS dataset, are great addition to knowledge on the measurement of maternal mortality in Nigeria. The trend has shown from literature that various geographical regions and states within Nigeria have shown that there are no consensus on the pattern of maternal mortality observed in various settings. For example, in the study by Adebowale *et al*. (2010), the P/F ratio adjusted estimates for Nigeria, Rural and Urban residential areas were lower than the 545 per 100,000 live-births reported by the NDHS where both the urban and rural estimates were very close values. Additionally, most of the facility-based studies generated estimates that are way higher than was observed in the NDHS report.

In the review of the previous research done in Nigeria, with quite a number done between the years 2007-2012, there were several communities based, retrospective tertiary health facility-based studies and a very few prospective studies. From the studies, the estimate of MMRatio have ranged from 625 per 100,000 live-births to about 2,577 per 100,000 live-births across various states in Nigeria. Gulumbe et al. (2018) observed that MMRatio for Kebbi State is 890 per 100,000 live-births. These validate the claims of the extensive inconsistencies in the estimates for MMRatio and data available for maternal mortality and the current estimates generalized for the country at large. UN Interagency generated estimates are inconsistent for the different years that were reviewed. Nigeria was reported to have MMRatio of 840 per 100,000 live-births in the 2013 report (World Health Organization and United Nation Childrens' Emergency Fund 1997; World Health Organization, United Nation Childrens' Emergency Fund, United Nations Population Fund and The World Bank 2012; World Health Organization 2014). However, the most recent Nigerian Demographic Health Survey (NDHS) (2018) has reported a MMRatio of 512 per 100,000 live-birth as opposed to the 545 per 100,000 in the NDHS 2008 report. Also, Nigeria has MMRatio of 585 per 100, 000 live births according to the World Health Organization report of the 2008 estimates which makes the NDHS the slightly consistent estimates for Nigeria in the last 10-15 years. Similar variation has been observed in other developing countries where the UN estimates vary from the DHS derived estimates. The likely explanation for DHS estimates is that direct sisterhood method of data collection in the DHS assumes that the family knows if their sister was pregnant at the time of death which results in the likelihood of under-reporting pregnancy-related deaths that occurred many years before the survey (Bowie and Geubbels, 2013). Some experts explained that the variation observed in the UN estimates may be due to the difference in the underlying empirically available data. Some other factors established were the way the available data are adjusted to account for bias, the way the deaths among HIV-positive pregnant women are dealt with, the use of different estimates of total deaths in women of reproductive age and the specifications of the statistical models used to generate missing values (Abouzahr, 2011).

In summary, despite the various efforts, there are no consensus on the specific estimates of MM in Nigeria and the facility-based and community-based estimates have generated varying estimates at different times, without sufficient state representative sample. These estimates are currently the only source of MM indices for the various states in Nigeria. None exists for the six geopolitical regions. Additionally, the datasets used for the hospital-based studies are not adequate for disaggregation into various socio-demographic groups. The NDHS data is the best set of data source available till date to monitor the maternal mortality estimates in the country. Despite its robustness, and the fact that it is readily available, attempts at disaggregation are rare. Therefore, it is important to analyse the dataset disaggregated into various socio-demographic groups. The arguments for disaggregating NDHS dataset have been the rareness of the event and the small death counts in each disaggregated group.

In the Nigerian context, maternal death counts are still relatively high and sufficient for an attempt in the disaggregation into sub-national groups. Moreover, the small area estimation techniques are novel in handling rare counts in sub-national estimates. Hence, this approach was used in this study to generate maternal mortality rates and ratio estimates, disaggregating the data across the major sub-national groups within the Nigerian population.

2.5 Analytical Framework

In determining the covariates for the small area regression model, the framework as developed by McCarthy & Maine, (1992) was adopted. This framework that is organized in three general stages includes the processes that results in maternal disability or death. Pregnancy-related complications are the closest event to maternal deaths and are also considered. Maternal death as an outcome, is influenced by the following intermediate determinants (i) the health status of the woman, (ii) her reproductive status (iii) her access to health services (iv) her health care behaviour (including her use of health services) and (v) a set of other unknown factors. As much as the Nigerian Demographic and Health survey allows, the reproductive status, access to health services and some health behavioural indicators were used in the analysis of this research work.

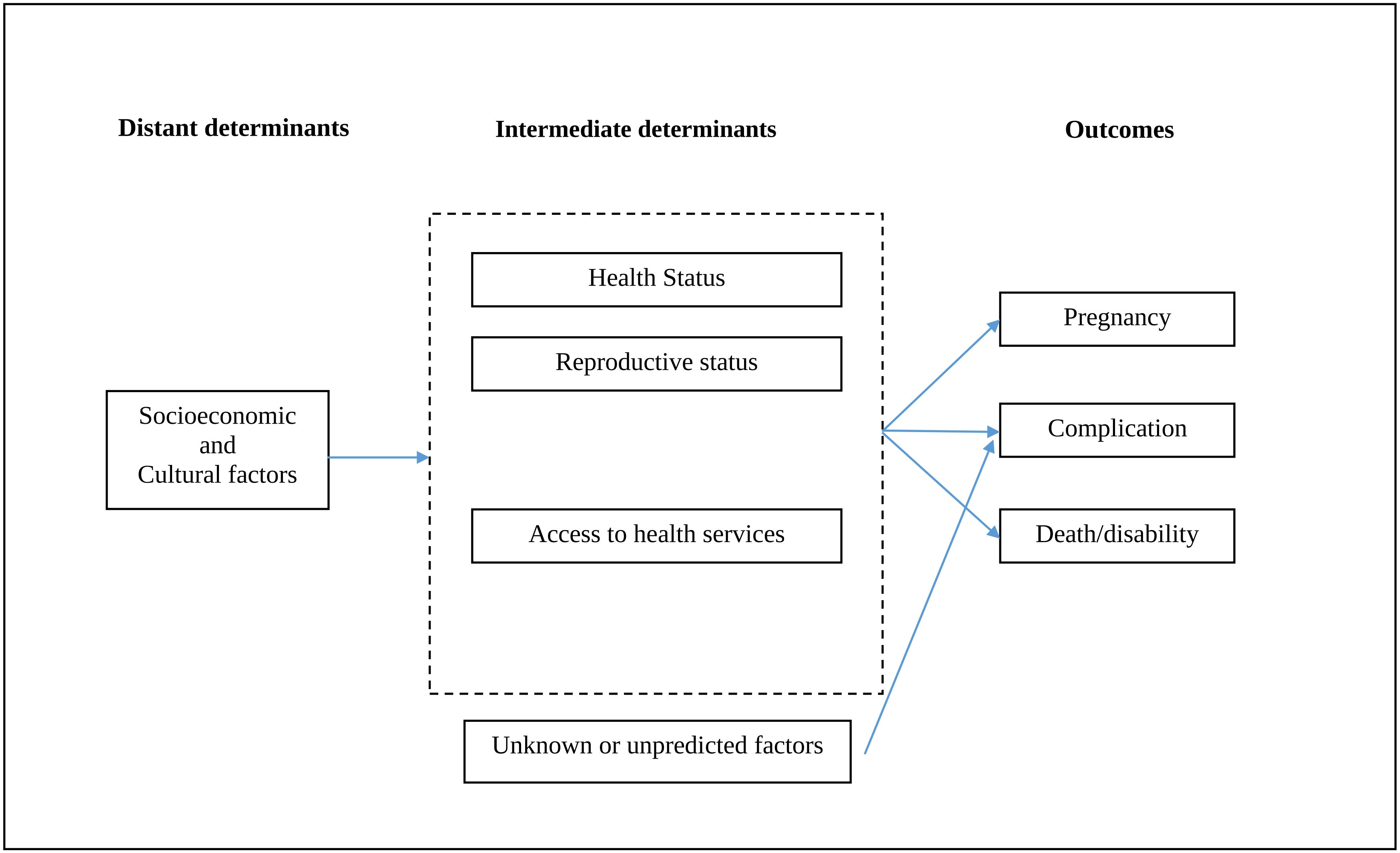


Figure1: Analytica Framework showing determinants of Maternal mortality (adapted from McCarty &Maine, 1992)

CHAPTER THREE

METHODOLOGY

3.1 Study Setting

Nigeria is the most populous country in Africa and the 14th largest in land mass. The country's 2006 Population and Housing Census placed the country's population at 140,431,790. It occupies approximately 923,768 square kilometres of land stretching from the Gulf of Guinea on the Atlantic coast in the south to the fringes of the Sahara Desert in the north sharing boarders with Republics of Niger, Chad, Cameroon, and Benin. Nigeria is made up of its Federal capital territory (FCT) and 36 states which amount to the initial 37 sub-population groups in this analysis. The states are further grouped into six geopolitical zones consisting of the North Central, the North East, the North West, the South East, the South-South and the South West part of the country. There are 774 constitutionally recognized local government areas (LGAs) in the country (NPC and ICF, 2014).

Over the years, Nigeria has collected data on demographic statistics through censuses, vital registration systems, and sample surveys. However, the first thorough and near-scientific census conducted in Nigeria was in 1952-1953. It has been evaluated to have lacked simultaneity and probably under enumerated the country's population. The same was experience in the 1963 censes which was reported to be suspicious and controversial. The next attempt took place in 1991 and counted a total of 88,992,220 Nigerians, and a subsequent one in 2006 by Population and Housing Census reported Nigeria's population to be 140,431,790, with a national growth rate estimated at 3.2 percent per annum. This has ranked Nigeria the most populated country in the African continent and the seventh most populous in the world (Population Reference Bureau, 2013). For this research, the sect of the population studies was the reported siblings of the respondents who were of reproductive age of 15-49 years and were dead by the time of the study due to maternal reasons.

3.2 Research Design

This study is a demographic and statistical analysis of cross-sectional population data obtained from the Nigerian Demographic and Health Surveys. The target population understudied was the siblings of respondents that were of reproductive age 15-49.

3.3 Data Source

The data used in the research came from the successive Nigeria Demographic and Health Surveys of 2008, 2013 and 2018 carried out by the ICF International. The individual women's recode and birth recode dataset were used to generate the maternal mortality data and the fertility data respectively. The DHS data, which was built and improved on the concept of the World fertility survey (WFS), offers a rich data set which has advantages of enabling comparative analyses due to the use of standardized instruments, training, data collection, and data processing. The sampling frame used was the list of enumeration areas (EAs) prepared for the 2006 Population Census of the Federal Republic of Nigeria, provided by the National Population Commission. The sample was designed to provide population and health indicator estimates at the national, zonal, and state levels. The sample design allowed for specific indicators to be calculated for each of the six zones, 36 states, and the Federal Capital Territory, Abuja.

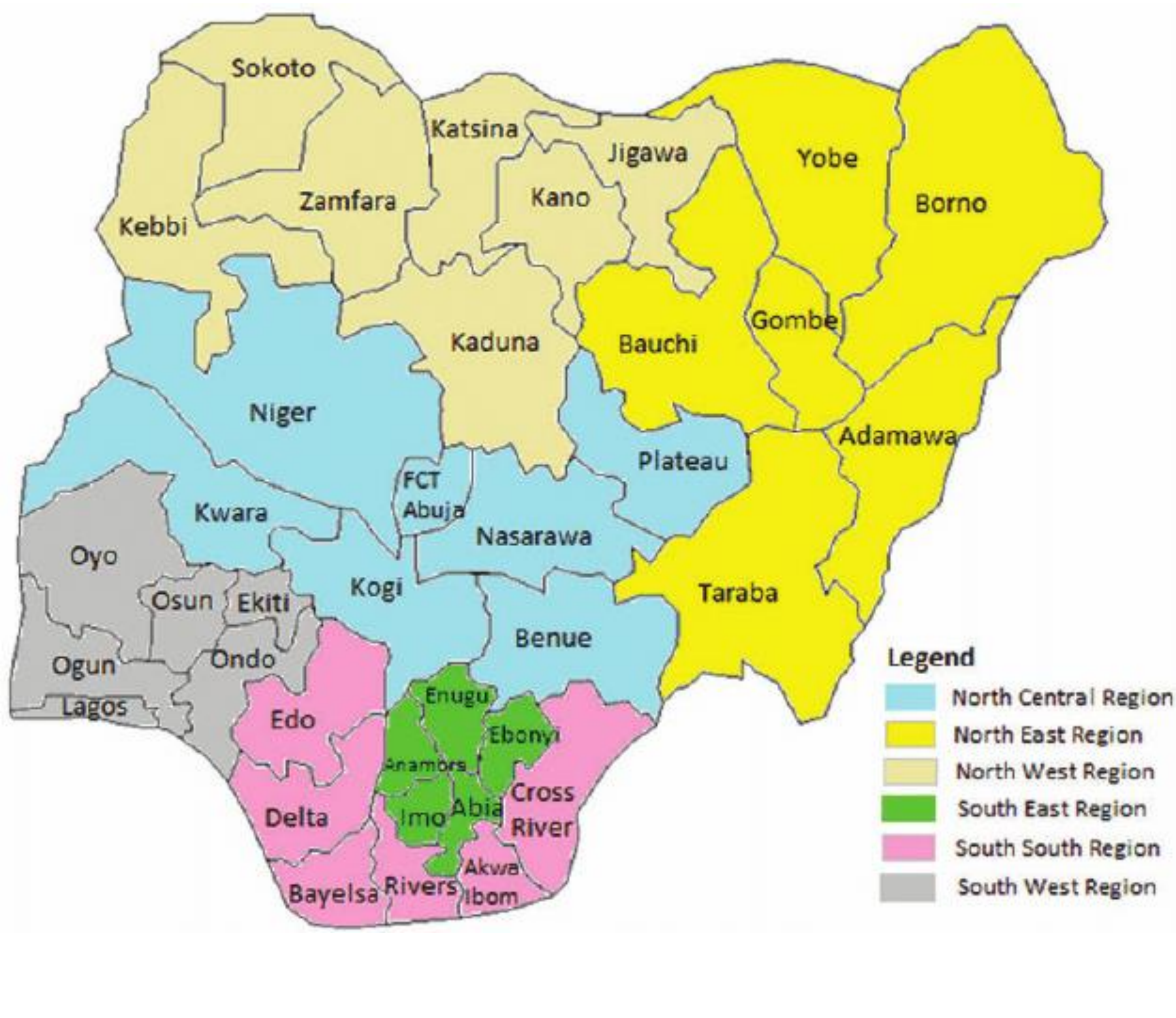


Figure 3.1: Map of Nigeria showing the states and geo-political zones

3.4 Sampling Design of the Nigeria DHS

Nigeria has 36 states and FCT grouped into six geo-political zones. Each state is sub-divided into local government areas (LGAs), and each LGA is divided into localities. In addition to these administrative units, during the 2006 Population Census, each locality was subdivided into convenient areas called census enumeration areas (EAs). The primary sampling unit (PSU), referred to as a cluster for the 2008 NDHS, is defined by EAs from the 2006 EA census frame. The 2008 NDHS sample was selected using a stratified two-stage cluster design consisting of 888 clusters, 286 in the urban and 602 in the rural areas while the 2013 NDHS sample was selected using a stratified three-stage cluster design consisting of 904 clusters, 372 in urban areas and 532 in rural areas. The 2018 NDHS sample was larger than the previous 2 surveys. A total of 1, 389 clusters were used and approximately 42,000 household for the 2018 NDHS. A representative sample of 36,800 and 40,680 households was selected for the 2008 and 2013 NDHS survey respectively, with a minimum target of 950 and 943 completed interviews per state for each respective year. In each state, the number of households was distributed proportionately among its urban and rural areas. All women age 15-49 who were either permanent residents of the households in the survey sample or visitors present in the households on the night before the survey were eligible to be interviewed. Three modules were used in each survey, namely: The Household Questionnaire, the Women's Questionnaire and the Men's Questionnaire. These questionnaires are further translated from English to major Nigerian languages which are Hausa, Igbo and Yoruba.

For the purpose of this study, the maternal and adult mortality module also known as the sibling survival module which was added to the 2008, 2013 and 2018 Women's Questionnaire was used. The respondents were asked questions about their siblings born to the same biological mother. The name of each of the siblings is provided from the oldest to the youngest, with which the interview proceeds to find our more details about each of the siblings. The current age of the siblings is required as well as the marital status, for living siblings. The age at death and year since death is asked for siblings that are reported to be dead. Female siblings who are above the age of 15 are further probed about. The interview asked if the sister died during pregnancy, childbirth or during the postpartum period.

3.5 Method of Analysis

3.5.1 Data Analysis

The demographic and statistical analyses of data for this study were done in stages: (1) completeness of reporting of events (deaths as a result of maternal causes) and assessment of data quality calculating sibship size and sex ratio among siblings (2) estimation of the direct estimates of Adult female mortality rate across subpopulation (3)estimation of the direct estimates of MM rate and ratio across sub-population – the direct estimation of MM requires the collection of a complete sibling history from each respondent in the survey (4) Application of the Graham indirect sisterhood method across the sub-populations (5) Empirical Bayesian Estimation of MM in states within the data set. Selected factors in line with the analytical framework were explored as covariates to get estimates that was be used in comparison of MM level across states in Nigeria.

In preparing the data for analysis, the period length is captured by computing reference period which is basically the seven-years periods prior the survey, excluding the month of the interview i.e. 0 - 6 years preceding the survey i.e.{ Date of interview (CMC) – 1} to {Date of interview (CMC) – 84 months} therefore, the period length is obtained first by calculating the variation in months between the date of the interview and the date of death of the siblings, both in century month code (CMC) format.

compute period = 7

To determine the limits of the time period and the total exposure time period, the zero to six years period is the date of the interview (v008) minus eighty-four months and the date of interview minus a month

Compute kmax = v008 -1

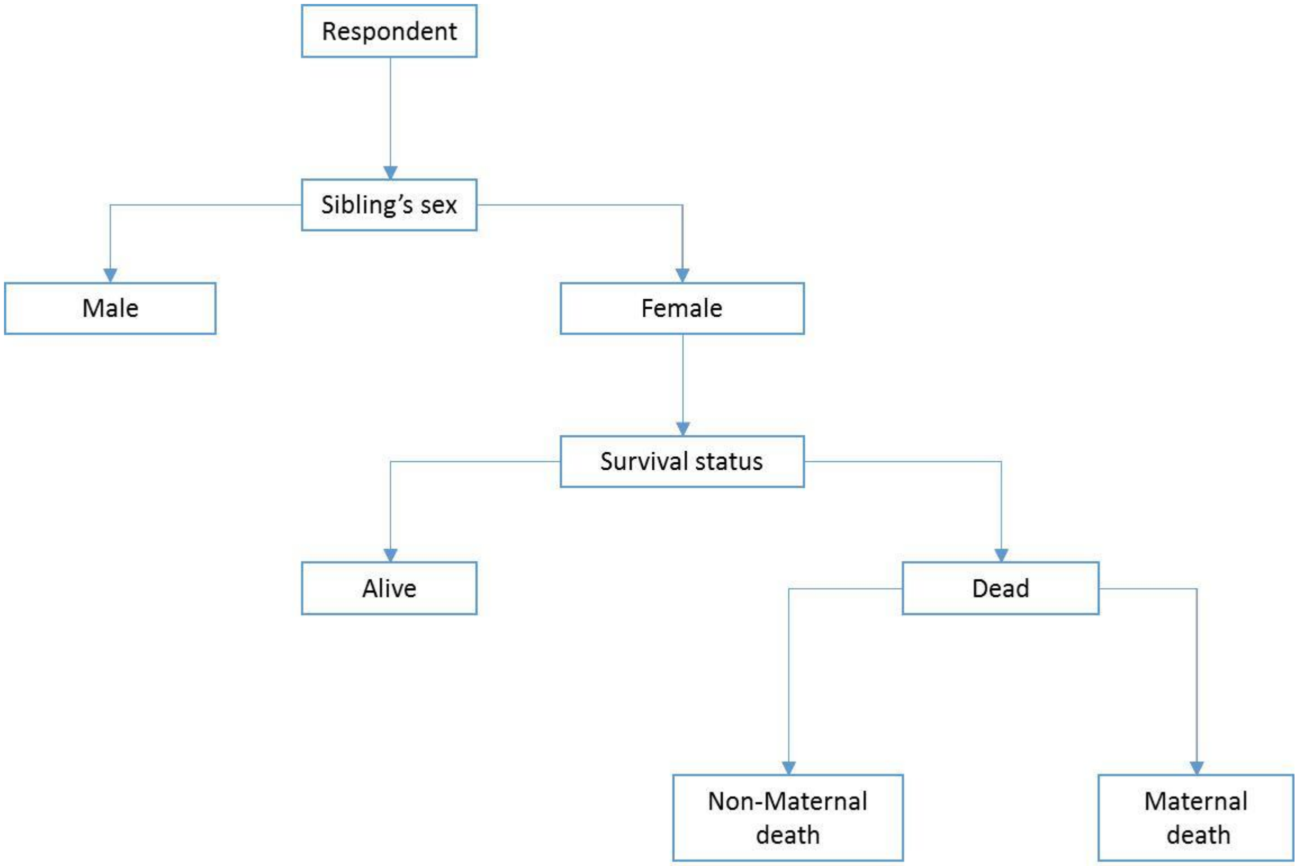
Compute kmin = v008 – 84 (12*period to covert the 7 years into months equaling 84)

The dead siblings were included if they died within the period of interest. The kmax (upper limit) is replaced with the date of death of the sibling if the sibling had died. The total exposure is the difference between the upper limit and the lower limit plus a month i.e.

totexp = kmin-kmax+1.

The Individual sibling respondent dataset was then reconstructed into panel data (person-years) using the *varstocases* command in SPSS and each reported sibling was counted as an observation and is the unit of analysis from the siblings' history. This reconstructed dataset is what is called the MM dataset. It has the records of all female siblings reported by the individual women. The data of female siblings who were dead from maternal causes were then used for further analysis. Female siblings who are reported to have died were assumed to be exposed to the risk of dying for 6 months in their year of death and this was considered in calculating the person-years of exposure. For entries with missing value on the survival of the siblings, it was excluded from the analysis. Age was adjusted for all the estimates generated and sampling weight was taken into consideration for all analyses. The dataset was then disaggregated to the various sub-population which includes; the 36 states and FCT, Urban/Rural subpopulation and the 6 Geopolitical zones. This was done using the IBM SPSS Statistics Version 21.0.

Figure 3.1: Flowchart for the identification of female sibling who died of maternal related causes



3.5.2 Completeness of reporting of events (deaths due to maternal causes) and assessment of data quality)

The valid estimation of maternal mortality requires accurate and complete reporting of the events (deaths due to maternal causes) among at-risk women (age 15-49) during a reference calendar period. MM is a subset of adult female deaths from all causes. The Demographic Health Surveys take into considerations the completeness of death reporting from any cause by the Brass growth balance method (Brass, 1975). A comparison was also made between the completeness of reporting between male (brothers) and female (sisters) populations to ascertain whether there were any systematic biases (underreporting) in the reporting of death from any cause for females (Stanton, Abderrahim and Hill 1997 ; Ahmed *et al.*, 2014). According to the DHS data quality and assessment report, a comparison of the age structure of sisters to that of respondents was conducted to assess any possibility of age coverage errors, age-displacement, and under-reporting of sisters by estimating the Whipple Index for assessing digit preference in age reporting (Stanton *et al.*, 2014). Also, there was an examination in the under-reporting (under-enumeration) of siblings by comparing the responses in the sibling history records with the parity distribution of respondents' mothers was examined. Studies suggest that maternal mortality risk is higher at younger and older ages than at mid-reproductive ages between twenty and forty years (Ahmed et al., 2014).

The reliability and validity of the estimate of the parameters used as demographic indicators of a population are largely dependent on the completeness and value of data used. Due to the retrospective nature of most of the data recorded from reported survivorship of siblings, there are factors that could affect the quality of the data generated. These factors include but are not limited to an inappropriate understanding of the reference period which would affect accurate capturing of the births or deaths, mis-reporting of the age of death.

As with DHS practices, the quality of the data used in deriving the MMR was examined for 1). The completeness of reporting the sibling history, 2). The pattern of the missing data and 3).The appropriate reporting of the event (deaths of the mother) and the status of pregnancy at the time of death (throughout pregnancy, at delivery, or in the postpartum period). The missing data on the timing of death about the pregnancy was represented in percentages and showed the quality of the data. The estimates of maternal MM can be affected and biased directly by the mis-reporting of the above phenomenon. This has been attributed to recall bias by respondents in the survey of the true picture of the situation around the female deaths being recorded. A decline in the degree of missing responses in the data in relations to pregnancy compare to previous DHS reports would mean the 2008 and 2013 are more valid reports than the controversial 1999 report that was widely critiqued (DHS report ,2000)

This was evaluated based on the frequencies of missing values which are a common problem in surveys. This may be due to non-response to some questions by respondents. Some subjects may refuse to provide values deliberately for fear of confidentiality or lack of appropriate knowledge. Missing data diminish the statistical power of the study and may bring in bias. Reports of vital events, age, calendar period of death, and timing of death about pregnancy (during pregnancy, during delivery, or during the postpartum period) were missing. . In statistical literature, missing data refers to the overall status of missing response or incomplete data/variables in the data set.

The proportion of responses categorized as "do not know and other" determines the quality of the general overview of the data set. The ages at death of the siblings and current ages of living siblings were examined in order to assess the quality of the data,.

In overall evaluation, there were few observations of missing data for the sibling survival status, and as expected there are reasonably lower levels of missing data for the living siblings than the dead ones. This might be attributed to recall issues. As required for the direct estimation of adult and MM, the birth and deaths were placed in calendar time. This was obtained by asking the respondents their sibling's age at death and year since the death occurred. This was a more productive approach than asking for the direct birth and death dates as it was discovered that the two questions asked regarding dead siblings, placing the death in time are considerably more difficult for the respondent that is declaring the siblings age at death (Stanton *et al*., 1997a).

3.5.3 Adjustment for missing data for pregnancy at time of deaths

A weighting method which corrects for mortality selectivity bias was proposed by Gakidou and King (2006) because of the lower selection likelihood of sibships with high mortality. A case similar to that would be that of women who have died with no surviving sister have zero probability of selection in the sisterhood sampling scheme which may also introduce under-estimation. Earlier, previous studies have shown that MM estimates obtained by the DHS method are fair because of the under-estimation bias that could occur due to the exclusion of zero surviving sisters is compensated for by the overestimation risk of excluding the surviving respondents, under the assumption that the mortality risks of the sisters are independent (Trussell and Rodriguez, 1990). This is termed as the compensation mechanism of the sisterhood method. However, subsequent reproduction work shows that the application of such weighting over-estimates mortality (Pison, Masquelier, and Kante 2014a; Masquelier 2013). A similar weighting scheme adopted by Ober Meyer *et al*. (2010) also increased the mortality estimates largely. Previous author believed that the adjustment with weighting is controversial and choose to use unweighted data (Pison, Masquelier, & Kante, 2014b).

The weight (w_j) is the number of elements in the population represented by the sample element j.

$$\hat{Y} = \sum w_j y_j \qquad (3.5)$$

There, every estimated y■ is a weighted estimated for this analysis.

3.5.4 Estimation of Maternal mortality with Direct Sisterhood Method.

Direct estimation of MM requires the collection of a complete sibling history from each respondent in the survey.

So the proportion of adult sisters dead from maternal causes is obtained in each age group by

$P(i) = \frac{D(i)}{n(i)}$ which becomes $P(i) = \frac{D(i)}{PY}$

Maternal Death divided by total exposure (Croft, Marshall, Aileen, & Allen, 2018)

Number of respondents' female siblings who died during the pregnancy, delivery or within two months of delivery in the period zero to six years prior to the interview by sub-national groups

Numbers of years of exposure of respondents' female siblings during the period zero to six years prior the survey

Numerator: Number of respondents' siblings who died in the period zero to six years prior to the interview by five-year age group at time of death.

Deaths are put into a table according to period of death and the age of sibling at the time of the death.

Period of death: The period of death is calculated as the difference in months between the date of interview and the date of death of the sibling, both in century month code (CMC) format. Deaths of siblings are included if they occurred within the period of interest (v008-84 <= mm8 <= v008-1).

Age of sibling at the time of the death: The difference in months between the date of death of the sibling and the date of birth of the sibling, both in CMC. The difference is then divided by 60 and truncated to whole numbers to form the age groups (int (m8 - m4) / 60) . Deaths are tabulated by age group.

Denominator: Number of person-years of exposure of siblings of respondents during the period 0-6 years prior to the survey by five-year age group, disaggregated by sex.

Person-years of exposure are calculated as the sum of the number of months exposed in the five-year age group during the time period divided by 12. A sibling can contribute exposure to two or three five-year age groups during an 84-month period. (3.6)

Where:

n(i) – the number of sisters surviving at age 15

D(i) – No of Maternal deaths among the sister reported dead

D'(i) – No of Non-maternal deaths among the sisters

PY- women-years exposure (person-years)

m(i) – mean/ average No. of births to women in age group (i), which would be obtained by dividing the number of live-births in the age group by the number of sisters in the age group.

b(i) – Total number of births to sisters

As in indirect methods, D(i) was also be obtained by summing the Number of respondents records as dead when pregnant, at childbirth and at two months after delivery

The direct method is based on little or no assumptions or model. As the name implies, the process of converting the collected data into estimates of MM is without ambiguity and quite direct. The method employs the individual-level data on the surviving status of sisters and deceased sisters. The method also collects data that allows for the deaths and births to be placed in calendar time and it also allows for the calculation of age-specific death rates for the reference periods. As an advantage, the direct estimation provides the opportunity to evaluate the estimate with the number of person-years of exposure to mortality and the number of maternal deaths by the period. The MM estimates can also be made for a series of periods and women by their different age groups and subpopulation. In summary, the direct method allows for comparisons across different socio-demographic variables and it also permits for a substantial number of data quality checks for completeness and plausibility that are not possible with counterpart approaches. However, it is limited in producing estimates for subpopulations with small counts or zero event.

3.5.5 Application of the Graham indirect sisterhood method across the sub-populations.

The sisterhood method is based on responses obtained from adults about the survival of their adult sisters. It is an indirect demographic method used in many developing countries to estimate the maternal mortality burden. Graham *et al*. (1989) proposed an indirect sisterhood method estimating MM in which the respondent is asked about the number of sisters of the same mother who survived till adulthood and the number of those who have died. Additionally, the respondents are further asked about the timing of the sisters' death, who has attained reproductive age and whose death is related to pregnancy. This is used to identify pregnancy-related deaths which in turns helps to calculate the maternal deaths (Graham, Brass, and Snow, 1989).

Sisterhood questions were included in the Nigerian DHS in what was termed the "maternity module". This is to help estimate the MMR. The data on the sibling's history as gathered from the respondents on the sisterhood question was disaggregated into 5- year age groups of the respondents. The number of sisters exposed to the risk of maternal death and the duration of their exposure was calculated by multiplying the number of sisters by an age-specific adjustment factor.

The Indirect method is guided by four basic questions (i) How many sisters (born to the same mother) have you ever had who were ever married (including those who are now dead)? (ii)How many of these ever-married sisters are alive now? (iii) How many of these ever-married sisters are dead? (iv). How many of these dead sisters died while they were pregnant, or during childbirth, or during the six weeks after the end of pregnancy?

$N_{(i)}$: number of sisters ever at risk of maternal death i.e. Number of sisters aged between 15-45years as reported in age group (i)

$D_{(i)}$: Number of maternal deaths among those $N_{(i)}$ sisters

So the proportion $P_{(i)}$ of adults sisters dead from maternal causes reported by respondents aged i equals:

$$P(i) = \frac{D(i)}{N(i)} \tag{3.18}$$

Where D(i) is calculated by summing the number of sisters who died when they were pregnant, during childbirth and two months afterward.

So, since the indirect sisterhood method is a cause-specific development of the technique for estimating general mortality based on the survivorship of sister, the proportion of the sisters who died from maternal cause would be used to provide estimates of the lifetime risk of maternal mortality, $q_{(w)}$. The lifetime risk (LTR) of maternal death was calculated by dividing the total number of maternal deaths by the estimated total number of sisters exposed in each age group. Using the Total fertility rate from the NDHS the MMR was calculated as follows:

$$MMR = 1 - \left[(1 - LTR)^{\frac{1}{TFR}}\right] \tag{3.19}$$

It is worthy to note that the indirect method is an extension of a demographic technique called the sibling survivorship method of estimating adult mortality as such this method can be used in terms of the overall experience of all their sisters, meaning no individual information is needed. This indicates that while the data collection procedure of the indirect approach is somewhat more straightforward compared to the additional questions involved with the direct method, the limitation accompanying the retrospective nature of the adult mortality experience being reported exists. This makes the estimate obtained from this method at its best reflect the weighted average of mortality conditions over a lengthy period (Merdad, Hill and Graham, 2013). The Indirect method itself only obtains the lifetime risk of MM by making use of the information on the proportion of sisters who had died from maternal causes. This first conversion is based on three underlying assumptions. The sisters of respondents are adequate representatives of women exposed to the risk of maternal death; that the age distribution of siblings of the respondents is known and the mean age of the sisters is the same as that of respondents, that the distribution of maternal deaths by age is known. These assumptions make it possible to calculate the set of adjustment factors that are used in getting the probabilities of the death of women from the proportion of women dying, as recommended by Graham *et al*. (1989).

3.5.5.1 Computation of Confidence Interval

A procedure to construct confidence interval for the sisterhood estimates was developed by Hanley *et al*. (1996) . In the procedure, standard error is calculated for quantifying the sampling variability. The standard error is then used to construct confidence intervals.

LTR – Lifetime risk of maternal deaths

P(i) – Proportion of dead adult sisters from maternal causes

N(i) – No of Sisters ever at risk of Maternal death.

So since $LTR = \frac{P_{(i)}}{N_i}$ ……………………..(3.20)

The lifetime probability of avoiding death from maternal causes is then denoted by

$\rho = 1 - LTR \; i.e. 1 - \frac{P_{(i)}}{N_i}$ ………………..(3.21)

Recall that MMratio is then approximated by

$$MMR = 1 - [\rho]^{\frac{1}{TFR}} \, x \, 100{,}000 \qquad (3.22)$$

It is assumed that when LTR and TFR are high, an excellent approximation of the MMR is simply

MMR=LTR/TFR (3.23)

According to Hanley *et al*., (1996) confidence interval for MMR is derived by

$$MMR \pm Z_{\frac{\alpha}{2}} S.E.(MMR) \quad (3.24)$$

Where $Z_{\alpha/2}$ is the regular statistical notation for the appropriate normal deviate corresponding to a two-sided confidence interval of 100(1-∝), and standard error S.E. (MMR) is calculated as

$$S.E\ (MMR) = \frac{1-LTR}{TFR}\sqrt{\frac{LTR}{Exposure(1-LTR)} + \frac{(\log(1-LTR))^2 Var(TFR)}{TFR^2}}$$

$$MMR_L = MMR - 1.96(\frac{1-LTR}{TFR}\sqrt{\frac{LTR}{Exposure(1-LTR)} + \frac{(\log(1-LTR))^2 Var(TFR)}{TFR^2}})$$

And

$$MMR_U = MMR + 1.96(\frac{1-LTR}{TFR}\sqrt{\frac{LTR}{Exposure(1-LTR)} + \frac{(\log(1-LTR))^2 Var(TFR)}{TFR^2}})$$

3.5.6 Brass's Parity/ Fertility Ratio Method of adjusting Total fertility rate

Total Fertility Rate (TFR) is required for converting LTR derived from indirect method to MMRatio. For plausible estimates, of TFR, the P/F ratio method was employed. The Original P/F ratio method also known as the Brass method is used in adjusting the level of observed age-specific fertility rates (Brass & Coale, 1968).This is done using the average number of children ever born to women in 5-year age groups and age specific fertility derived from births in the preceding year to the survey. This is based on the assumption that that the fertility rates are true representative of the age pattern which agrees with the level of fertility as indicated by the mean parities of women in age groups lower than 30 or 35 (this ages are assumed to be accurate). The P/F ratio method is a multi-step approach of first obtaining the average parity equivalents, F, comparable to reported average parities, P, which are obtained from period fertility rates and cumulating and interpolation. The data requirement for the P/F method includes the number of children ever born by mothers in the conventional five-year age groups, the number of children born during the year preceding the survey disaggregated by the five-year age groups. Finally, the total number of women in each five-year age group is required, as well as the total population to enable to calculate the birth rate. The actual computation is further explained as follows:

1. Calculation of reported average parities: The reported average parity of women in each age group is denoted by P_i . This is obtained by dividing the total number of children ever born (CEB) to the women in age group i. The next step is to calculate the preliminary fertility, f(i) schedule from the information on births in the past year. This value is calculated from each age group, I, by dividing the number of births in the past one year before the survey by the total number of women (childless or not, ever married or not) in each age group. The calculation of the cumulated fertility schedule for the period is obtained next. This is denoted by $\emptyset(i)$, and obtained as follows

$$\emptyset_{(i)} = 5\left[\sum_{j=0}^{i} f(j)\right] \qquad (3.25)$$

2. The average parity equivalents, *F(i)*, for the period is then estimated by interpolation using the fertility rates *f(i)* and the cumulated fertility values $\emptyset(i)$. Coale and Trussell 's second-degree polynomial method was used to calculate the relationship between average parity and cumulated fertility for successive age groups for a range of age locations of the fertility model. *F(i)* was obtained as

$$F(i) = \emptyset\,(i-1) + af(i) + bf(i+1) \qquad (3.26)$$

Which is then refined to be

$$F(i) = \emptyset\,(i-1) + a(i)f(i) + b(i)f(i+1) + c(i)\emptyset(7) \qquad (3.27)$$

For a more accurate estimation, Where a, b and c are constants whose values are shown in appendix.

3. The next stage is the calculation of fertility schedule for conventional five-year age groups, $f^{+}{}_{(i)}$. This can be estimated by weighing the rates on the age groups and

using the coefficients, x, y and z (as displayed in tables A4.22 –A4.39 in the appendix) ,

$$f_i^+ = \left(1 - w(i-1)\right)f(i) + w(i)f(i+1) \qquad (3.28)$$

Where w(i) is calculated as.

$$w(i) = \frac{x(i) + y(i)f(i)}{\emptyset(7)} + \frac{z(i)f(i+1)}{\emptyset(7)} \qquad (3.29)$$

4. The final step is adjusting the period fertility schedule with the ratio

$$\left(\frac{P(i)}{F(i)}\right) \qquad (3.30)$$

In an ideal situation, the P/F should be fairly similar for the different age groups i. If there is no similarity, a weighted average is obtained using the number of women in age groups 20-24 and 25-29 as a proportion of all women in ages 20-29. As a rule, P(1)/F(1) should be disregarded because of the intrinsic difficulty in estimating F(1) and the P/F ratio for age groups over 30 might be unreliable due to possible omission of children ever born (United Nations, 1983). If the ratio shows a consistent pattern, there is assurance in the adjustment factor that will be selected.

5. The adjustment factor can then be calculated as below, if it falls consistently between the age range of 20-34;

$$k = \frac{\frac{P(2)}{F(2)} + \frac{P(3)}{F(3)} + \frac{P(4)}{F(4)}}{3}$$

However, k will be calculated as

$$k = \frac{P(2)}{F(2)}\, X\, \frac{FP(2)}{FP(2) + FP(3)} + \frac{P(3)}{F(3)}\, X\, \frac{FP(3)}{FP(2) + FP(3)} \qquad (3.31)$$

If the ratios are not consistent, this will reflect the weights, being the number of women in each age group as a proportion of the women both age groups (i= 2 and 3).

The adjusted age specific fertility rates, f_i^*, are then obtained by multiplying the f_i^+ values by the adjustment factor k. The Total fertility rate is then estimated by multiplying the sum of the adjusted age-specific fertility rates f_i^* by five:

$$TFR = 5\sum f_i^* \qquad (3.32)$$

Also, the pattern of variation in the ratio with ages might reveal the dynamics of the challenges in the population.

The method is then completed by using the newly generated TFR to convert values of LTR from the indirect sisterhood method into, $MMR = 1 - [\rho]^{\frac{1}{TFR}}\ x\ 100{,}000$ and the 95% confidence interval is calculated as already described for the indirect sisterhood method.(Hill, Stanton and Gupta, 2001).

3.5.7 Empirical Bayesian Estimation of Maternal Mortality in all the states within the survey.

Differentials of MM across different states were assessed by employing Small Area Estimation (SAE) techniques. The approach is similar to that used for the estimation of maternal mortality for Bangladesh at the subnational level (Ahmed and Hill, 2011). This method is based on statistical inference of generalized linear models. Because small geographic areas might not have large sample sizes to perform a direct estimation of MM rate or MM ratio, moreover most of the samples from a small geographical area or small strata may not have samples large enough to provide a valid and stable estimate. Also, due to the nature of the siblings' history, data on the exact location of death of sister were not collected. Hence, it is impossible to make estimates for sub-population asides using the location of the reporting siblings as proxy. However, the SAE technique utilizes sub-population specific factors known as determinants associated with MM, to create a model in the prediction of MM estimates.

This method adjusts for a small area based on generalized linear models. The model produces the best linear unbiased predictor (BLUP) of the parameters. Using the Empirical Bayesian-based model on the BLUP due to its dependence on variance components being replaced with asymptotically consistent estimators from the fitted models would generate Empirical Best Linear Unbiased Estimator. This would require computationally intensive Markov chain Monte Carlo simulation algorithms. However, it gives a potential benefit of a clear framework that can handle different types of variables; continuous, dichotomous, categorical and different random effect structures; independent, spatially correlated. Bayesian methods are well suited to sparse data problems. As maternal deaths are rare events, the Bayesian-based method offers adequate posterior distribution that can capture the parameters needed for a small area estimate because of its exact inference (Modulo Conte Carlo simulation error associated with the estimation algorithm). This results in a more productive output than the traditional point and interval estimates from a corresponding likelihood-based model.

The generalized linear model appropriate for count data and was used for this work is the Poisson log link regression model (Rao, 2003).

3.5.7.1 Computation

A direct estimator of MMR was obtained based on sample weights the information of maternal deaths from the NDHS.

$$MMRate_{direct} = Y_{direct} = \sum \frac{d_i}{N_j} \qquad (3.7)$$

d_t = the number of deaths in each state/ type of place of residence/ geopolitical zones.

Nj = the number of woman in reproductive age in each state/type of place of residence/ geopolitical zones

This method is insufficient to obtain the desired parameter in a small area because there might be small areas not represented adequately in the sample size or not large enough to provide a stable and precise estimate.

A synthetic estimate also called an indirect estimate was obtained using the equation:

$$MMRate_{indirect} = Y_{indirect} = X'\beta + \epsilon \qquad (3.8)$$

ε = error term

X' = Vector of covariates, measured at aggregate/mean for every small area. X is a vector of auxiliary variables that are mortality predictors which would be measured as a mean of the values for the sub-national levels. So, the mixed model is optimally based on direct and indirect estimates of Y. This prediction is known as best linear unbiased prediction (BLUP) and is a weighted estimate of the direct and indirect estimators which "borrows strength/information" from related areas and groups. This information provided from other related areas increases the effectiveness of the sample size, and in return, the precision of the estimate derived.

However, the expected value of the $Y_{indirect}$ then ignores the error term

$$E(Y_{Indirect}) = X'\beta \qquad (3.9)$$

It ignores the diversity (heterogeneity) of all the small areas based on the assumptions of the areas having similar characteristics; it then assumes that the MMR is the same.

One of the techniques the small area estimation makes use of is the Random effect model also known as the mixed model. This is different from the generalized linear models as it includes all models in the variance components procedure. MIXED model handles correlated data, unequal variances and complicated situation in which units are nested in a hierarchy, for example, data obtained from a sample of respondents from a sample of states and political region in Nigeria, as in the NDHS data. Unlike the Generalized linear model (GLM) that makes use of the analysis of variance (ANOVA) methods, MIXED procedure makes use of the Maximum likelihood (ML) and Restricted Maximum likelihood (REML). The ML and REML that produces asymptotically efficient estimators for balanced and unbalanced design, which is what is more applicable in real life data. Conveniently, the asymptotic normality of the ML and REML estimators then makes it more convenient to make inferences on the variance and covariance parameter of the model, which would be difficult or most impossible to do in the GLM.

The mixed model combines the technique of the direct estimator and the indirect estimator to produce what is known as the BEST LINEAR UNBIASED PREDICTION. The Best Linear Unbiased Prediction estimators minimize the Mean Square Error among the other classes of linear unbiased estimators, and it generally does not depend on the normality of the random effects.

$$Y_{mixed} = \bar{X}'\beta + u_j + \varepsilon_{ij} \qquad (3.10)$$

where u_j is the heterogeneity/diversity across the small areas.

$$u_j \sim N(0, \sigma_u^2)$$

$\varepsilon_j \sim N(0, \sigma_\varepsilon^2)$

$Y_{mixed} = Y_{jBLUP} = \bar{X}'_j\beta + \gamma(\bar{y}_j - \bar{X}'_j\beta)$

$= \bar{X}'_j\beta + \gamma\bar{y}_j - \gamma\bar{X}'_j\beta$

$= (\bar{X}'_j\beta - \gamma\bar{X}'_j\beta) + \gamma\bar{y}_j$

$$= \bar{X}'_j\beta(1-\gamma) + \gamma\bar{y}_j \qquad (3.11)$$

$\bar{X}'_j\beta$=Indirect estimator

γ= Shrinkage factor (SF) for area j.

$$\gamma_j = \frac{\sigma^2}{\sigma_u^2 + \sigma_\varepsilon^2} \qquad (3.12)$$

Hence,

Y_{mixed} = *(SFj)* x *direct estimator* + **(1** — *SFj)* x *indirect estimator*

The BLUP too is not devoid of its limitation in that it depends on the shrinkage factor which is determined by the variance components which are unknown in practice, therefore EBLUP is obtained by the Empirical Bayesian Method. This is obtained by replacing the variance components with asymptotically consistent estimators, and then the BLUP becomes Empirical Best Linear Unbiased Prediction (EBLUP).

The empirical Bayesian method fits a random-effect Poisson regression model, under a generalized mixed model specification. The Empirical Bayesian method as adopted in this research is the Poisson-Gamma model. Poisson-Gamma is a two-staged model appropriate for count data. This resulted in a Generalized mixed model with Poisson response and link log i.e., the mean parameter of this model is linked to linear predictors through the log-link. The maternal death counts were treated as the response variable, and the states, region of residence, wealth index, religion and level of education were the covariates in the model.

So a random variable Y is defined to have a Poisson distribution with parameter μ with probability for μ>0, with the assumption that y_i has an independent Poisson distribution,

$y_i | \mu_i \sim Poisson(e_i \mu_i)$

$$\Pr\{Y = y\} = \frac{e^{-\mu}\mu^{y}}{y!} \qquad (3.13)$$

The mean and variance of this distribution are the same. Hence every factor that affects one affects the other and the usual homoscedasticity assumption is nullified.

$$E(Y) = Var(Y) = \mu$$

This model is based on the assumptions that Poisson distribution for the events (maternal death) and a gamma distribution for the distribution of the average.

The Bayesian method smooths the frequencies and yields a more reliable estimate for smaller groups by borrowing strength across areas.

$$\log(y_{ij}) = \beta_o + \beta_1 Religion_j + \beta_2 Region_j + \beta_3 WealthIndex_j + \beta_4 Education_j + \beta_5 Urban/Rural_j + v_j + \log(py)$$

Where βs are the model estimated coefficients and log(py) is the offset term-logarithm of maternal exposure measured in women persons-years.

At the second stage of estimation (Empirical Bayesian stage), we assumed that $y_i \sim Poisson(e_i\theta_i), i = 1, \ldots .m.$

A "conjugate" model linking the maternal mortality rate θ , $\theta_i \sim gamma(\beta,\alpha)$ where $gamma(\beta,\alpha)$ denotes the gamma distribution with parameter β>0, α>0.

$$f(\theta_i|\beta,\alpha) = \frac{\beta^{\alpha}}{(\alpha)} e^{-\beta\theta_i}\theta_i y_i^{\alpha-1} \qquad (3.14)$$

$$E(\theta_i) = \frac{\alpha}{\beta} = \mu \qquad (3.15)$$

$$V(\theta_i) = \frac{\alpha}{\beta^2} \qquad (3.16)$$

Note:$\theta_i|y_i,\beta,\alpha \sim gamma(y_i + \alpha_i e_i + \beta)$ the Bayes estimator of θ_i and posterior variance of θ_i are obtained from (2) and (3) by changing β to $e_i + \beta$ and v to $y_i + v_i$.

$$\therefore \hat{\theta}_i^{\beta}(\beta,\alpha) = E(\theta_i|y_i,\alpha,\beta) = \frac{(y_i+\alpha)}{e_i+\beta} \qquad (3.17)$$

Moreover, $V(\theta_i|y_i,\beta,\alpha) = g_{1i}(\beta,\alpha,y_i) = \frac{(y_i+\alpha)}{(e_i+\beta)^2}$

$\alpha = \left(\frac{\mu}{s}\right)^2$ and $\beta = \frac{s^2}{\mu}$ where s^2 is the weighted sample variance.

3.6 Ethical Consideration

Formal approval for the use of data was obtained from the MEASURE DHS in charge of Demographic and Health surveys worldwide.

CHAPTER FOUR

RESULTS

This chapter is arranged into various sections. Section one dealt with the findings from the assessment of the completeness of the siblings' history and the sibship size of the respondents' mother as reported by the respondents in the DHS report. The second section described the estimates of adult female mortality in the sub-populations in Nigeria. The section which follows described the sub-population estimates of MM rates and ratio using the direct and indirect sisterhood method, using the crude and adjusted fertility rates on the Nigeria DHS Dataset. The final section contains plausible estimates of MMRates and MMRatio, using a model-based and Poisson regression model showing the effects of correlates on MM.

4.1 Completeness of sibling' history

The result of completeness of survival status of sisters from respondents are presented in this section. Table 4.1 illustrates the percent of siblings with omitted data for the essential data quality variables for the sibling's history data. For the three surveys, vital status was recorded for at least 99% of the siblings. Only about 0.2% and 0.1% unknown survival status were recorded among the reported siblings for 2008 and 2013 respectively. The percentage of missing data for current ages of siblings reduced from 1.1% in NDHS 2008 to 0.6% in NDHS 2013 while the percentage of dead siblings with missing age at death (AD) and the year since death (YSD) declined from 1.7% in 2008 to 0.5% in 2013. In general, a total of 33,385, 38,948 and 41,821 respondents reported 86,302, 100,877 and 106,590 maternal sisters who survived the age of 15 years in 2008, 2013 and 2018 respectively.

Table 4.1: Completeness of information on survival status of sisters reported by Interviewed women, NDHS 2008 , 2013 and 2018.

	2008		2013		2018	
	Number of Sisters	%	Number of Sisters	%	Number of Sisters	%
All siblings	86,302	100.0	100,877	100.0	106,590	100.0
Living	72,113	83.6	86,065	85.3	94,068	88.3
Dead	13,993	16.2	14,746	14.6	12,514	11.7
Survival status unknown	196	0.2	66	0.1	8	.0
Living siblings	72,113	100.0	86,065	100.0	94,068	100.0
Age reported	71,308	98.9	85,526	99.4	94,068	100.0
Age missing	805	1.1	539	.6	0	0.0
Dead siblings	13,993	100.0	14,746	100.0	12,514	100.0
AD and YSD reported	13,344	95.4	14,509	98.4	12,514	100.0
Missing only AD	311	2.2	96	0.7	0	0.0
Missing only YSD	105	0.8	70	0.5	0	0.0
Missing AD and YSD	233	1.7	71	0.5	0	0.0

AD- Age at death

YSD- Year since death

4.2 Maternal and Non-maternal deaths

In 2008, of the 1,699 adult female deaths, 398 were maternal deaths. Likewise, for 2013 and 2018, there were 480 maternal deaths out of the 1,514 adult female deaths and 493 maternal deaths out of the 1,422 adult female deaths that were recorded from the siblings' history for the respective years. Out of the adult female deaths, 17.5% and 13.8% could not be classified as maternal deaths for 2008 and 2013 respectively (Table 4.2). Maternal causes increasingly accounted for 22.9%, 31.7% and 34.7% of all adult female deaths in 2008, 2013 and 2018 respectively. Proportion of maternal deaths out of all adult female deaths for both the urban-rural places of residence, the six geopolitical zones are presented in Table 4.3. Table 4.4 shows the data on respondents' mother's parity i.e. fertility of the previous generation as well as sex ratios for birth of five year preceding the survey. Taraba states recorded the highest mean sibship size (7), followed by Adamawa state (6.7) and Bauchi State (6.5) for 2008 and 2013 as well.

Table 4.2: Percentage of adult female deaths that are maternal deaths, Nigeria 2008, 2013 and 2018

	2008		2013		2018	
	N	**%**	**N**	**%**	**N**	**%**
Total number of sisters who died at ages 15-49	1699	100.0	1514	100.0	1,422	100.0
Deaths that are classified as maternal	398	22.9	480	31.7	493	34.7
Deaths that could not be classified as maternal or non-maternal	297	17.5	209	13.8	0	0

N.B.: Restricted to sisters who died during the seven years preceding the survey

Table 4.3: Percentage of female deaths that are maternal by type of place of residence and geo-political region in Nigeria, 2008, 2013 and 2018

Type of place of residence	**Percentage of female deaths that are maternal**		
	2008	**2013**	**2018**
Urban	20.2	26.7	30.4
Rural	25	35.4	36.8
North Central	13.8	33.8	18.9
North East	34.1	28.3	51.9
North West	38.3	53.4	46.5
South East	19.5	26.7	16.0
South South	22.0	14.7	20.6
South West	11.8	19.4	24.7
All Nigeria	**22.9**	**31.7**	**34.2**

Table 4.4: Mean sibship size and sex ratio of siblings at birth by different states for 2008, 2013 and 2018.

		2008 Mean sibship size[1]	Sex ratio of siblings [2]	2013 Mean sibship size[1]	Sex ratio of siblings [2]	2018 Mean sibship size[1]	Sex ratio of siblings [2]
North Central	Kogi	4.4	1.06	5.1	1.06	5.08	1.00
	Niger	5.6	1.15	4.6	1.15	5.64	1.07
	Abuja	5.5	1.08	4.9	1.04	4.72	1.01
	Nasarawa	5.3	1.09	5.3	1.05	5.21	1.02
	Benue	6	0.99	6	1.09	5.02	1.15
	Kwara	4.3	1.21	4.7	1.09	4.77	1.08
	Plateau	5.2	1.01	5.6	1.02	5.43	1.08
North East	Yobe	5.2	0.99	5.2	1.05	6.21	1.14
	Borno	5.5	1.04	4.5	1.17	5.04	1.02
	Adamawa	6.7	1.13	6.2	1.05	5.31	1.11
	Gombe	5.7	1.15	6.4	1.09	6.66	1.06
	Bauchi	6.5	1.06	6.7	1.06	6.48	1.08
	Taraba	7	1.12	6.4	1.05	5.76	1.01
North West	Katsina	3.9	1.05	6.1	1.01	6.06	1.03
	Jigawa	5	1.11	5.3	1.03	6.49	1.03
	Kano	5.4	1.01	5.9	1.06	6.13	1.04
	Kaduna	5.9	1.05	4.2	1.05	5.65	1.02
	Kebbi	4.1	1.15	5.6	1.04	6.17	1.05
	Sokoto	5.2	1.1	5.2	1.07	5.58	1.05
	Zamfara	5.2	1.04	5.7	1.04	5.92	1.05
South East	Anambra	6	1.05	4.7	1.02	4.6	1.06
	Enugu	4.8	1.05	5.5	1.03	4.68	1.04
	Ebonyi	5.2	1.08	6	1.12	5.02	1.05
	Abia	5.8	1.07	5.1	1.04	4.56	1.06
	Imo	6	1.1	5.8	1.17	5.55	1.02
South South	Edo	5.9	1.1	5.5	1.05	5.42	1.09
	Cross River	5.5	1.04	5.1	1.01	4.64	1.14
	Akwa Ibom	5.4	1.06	4.7	1.01	4.17	1.07
	Rivers	6	1.07	5	1.04	4.68	1.11
	Bayelsa	4.7	1.06	4.9	1.12	3.94	1.06
	Delta	5.8	1.08	4.8	1.11	4.97	1.1
South West	Oyo	4.6	1.12	5.1	1.08	5.02	1.09
	Osun	4.3	1.07	4.4	1.12	4	1.07
	Ekiti	5.2	1.13	4.9	1.05	4.84	1.09
	Ondo	5.1	1.06	5.4	1.01	4.36	1.02
	Lagos	5.5	1.14	4.7	0.98	3.84	1.06
	Ogun	5	1.03	4.6	1.12	3.83	1.16

[1] includes respondents[2] excludes respondent

4.3 Magnitude and Pattern of adult female death rates, 2008-2018

Data quality assessment included estimating for the adult female death rate to set a picture for the magnitude and pattern of MM estimates as a subset of same. Tables 4.6a shows the observed Adult female death rates (Afdr) in the urban-rural places of residence for 2008. The Afdr was higher (4.83 deaths per 1,000 female adults) in the rural area than the urban place of resident (3.97 deaths per 1,000 female adults). Table 4.6b and 4.6c show the observed Afdr in the Northern and Southern states and their geopolitical zones for 2008. The North Central region has the highest Afdr , 5.47 deaths per 1,000 female adult and the South Western region has the lowest at 3.58 deaths per 1,000 adult female. Zamfara state has the highest Afdr 8.65 deaths per 1,000 adult female in 2008 (Table 4.6b). Table 4.7a shows the observed Afdr in the urban-rural places of residence for 2013. Tables 4.7b and 4.7c show the observed Afdr for the Northern and Southern states and their geopolitical zones for 2013. The North East region has the highest Afdr, 4.95 deaths per 1,000 and Borno state had the highest Afdr of all the 36 states (7.26 deaths per 1,000 adult female while Bayelsa state had the lowest Afdr (0.97 deaths per 1,000 adult female) of all the 36 states for 2013. Tables 4.8a, 4.8b and 4.8c shows the observed Afdr for urban-rural places of residence, Northern and Southern states and their respective geopolitical zones for 2018. Similar patterns of Adfr was observed across all the states and geopolitical zones except for Gombe state which stood out at 7.35 deaths per 1,000 adult female (Table 4.8b).

There is not much significant variation between the female adult mortality experience across the geopolitical zones, aside the North central rate that stood out at 5.47 deaths per 1,000 female adult in 2008 (Table 4.6b) and declined to 3.91 deaths per 1,000 women of reproductive age and with Benue State with the highest in the region with 8.2 deaths per 1,000 female adult in 2008 (table 4.6c) and Nasarawa with 7.35 deaths per 1,000 female which decreased to 5.25 deaths per 1,000 female adult in 2013 (Table 4.7c). The lowest in 2008 is South West at 3.58 deaths per 1,000 female adults in 2008 (Table 4.6c) and declined to 2.94 deaths per 1,000 female adults in 2013. (Table 4.7c). Further decrease was observed in 2018. In the South Western geopolitical zone, Osun state had lower adult female death rate with 1.37 deaths per 1,000 female adult (Table 4.8c) and 1.09 deaths per 1,000 female adult in Nasarawa (Table 4.8b)

Table 4.5a: Adult Female Death Rate for Urban/Rural Place of Residence 2008

Type of Place of Residence	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
Urban	568	143326	3.97
Rural	1130	234136	4.83
All Nigeria	**1699**	**377463**	**4.50**

[1] Expressed per 1,000 women age 15-49

Table 4.5b: Adult Female Death Rate for Northern States, Nigeria DHS 2008

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
North Central	Kogi	31	8561	3.59
	Niger	51	9278	5.49
	Abuja	20	4398	4.65
	Nasarawa	38	5133	7.43
	Benue	103	12547	8.24
	Kwara	11	5356	1.97
	Plateau	48	10044	4.81
All North Central		**302**	**55317**	**5.47**
North East	Yobe	22	5703	3.88
	Borno	30	9240	3.25
	Adamawa	58	8806	6.56
	Gombe	22	5135	4.37
	Bauchi	57	10977	5.17
	Taraba	35	6888	5.10
All North East		**224**	**46749**	**4.80**
North West	Katsina	34	12074	2.79
	Jigawa	37	8724	4.24
	Kano	60	21732	2.78
	Kaduna	78	16342	4.77
	Kebbi	45	6184	7.23
	Sokoto	25	7051	3.58
	Zamfara	63	7244	8.65
All North West		**342**	**79352**	**4.31**

[1] Expressed per 1,000 women age 15-49

Table 4.5c: Adult Female Death Rate for Southern States, Nigeria DHS 2008

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
South East	Anambra	61	14288	4.28
	Enugu	21	8568	2.46
	Ebonyi	33	6436	5.17
	Abia	59	9855	5.98
	Imo	63	12695	4.94
All South East		**237**	**51842**	**4.57**
South South	Edo	37	10109	3.68
	Cross River	53	9332	5.71
	Akwa Ibom	82	10782	7.58
	Rivers	107	18265	5.85
	Bayelsa	15	5167	2.90
	Delta	24	13684	1.78
All South South		**318**	**67339**	**4.73**
South West	Oyo	28	13406	2.11
	Osun	22	9642	2.26
	Ekiti	18	5896	3.03
	Ondo	25	9148	2.69
	Lagos	135	28844	4.68
	Ogun	48	9928	4.80
All South West		**276**	**76864**	**3.58**

[1] Expressed per 1,000 women age 15-49
a Age-adjusted rate

Table 4.6a. Adult Female Death Rate for Urban/Rural Place of Residence 2013

Type of Place of Residence	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
Urban	648	195616	3.31
Rural	865	247486	3.50
All Nigeria	**1514**	**443102**	**3.42**

[1] Expressed per 1,000 women age 15-49
a Age-adjusted rate

Table 4.6b: Adult Female Death Rate for Northern States, Nigeria DHS 2013

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
North Central	Kogi	25	8062	3.14
	Niger	59	16310	3.62
	Abuja	16	3843	4.12
	Nasarawa	26	7249	3.58
	Benue	80	15329	5.25
	Kwara	11	6376	1.78
	Plateau	40	8912	4.52
All North Central		**257**	**66081**	**3.91**
North East	Yobe	36	11023	3.30
	Borno	90	12372	7.26
	Adamawa	42	9701	4.35
	Gombe	29	6518	4.38
	Bauchi	51	13310	3.85
	Taraba	66	10567	6.25
All North East		**314**	**63491**	**4.95**
North West	Katsina	37	16724	2.23
	Jigawa	66	12926	5.14
	Kano	73	35966	2.03
	Kaduna	69	20126	3.44
	Kebbi	58	13580	4.29
	Sokoto	24	11634	2.05
	Zamfara	24	14291	1.67
All North West		**351**	**125247**	**2.81**

[1] Expressed per 1,000 women age 15-49
a Age-adjusted rate

Table 4.6c: Adult Female Death Rate for Southern States, Nigeria DHS 2013

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
South East	Anambra	21	12540	1.64
	Enugu	38	11954	3.21
	Ebonyi	63	12961	4.85
	Abia	10	7063	1.45
	Imo	25	10882	2.32
All South East		**157**	**55400**	**2.84**
South South	Edo	27	9149	2.91
	Cross River	36	8521	4.20
	Akwa Ibom	52	9800	5.31
	Rivers	69	15739	4.36
	Bayelsa	4	4109	0.97
	Delta	27	11588	2.34
All South South		**215**	**58906**	**3.64**
South West	Oyo	45	17962	2.52
	Osun	13	8039	1.66
	Ekiti	8	3799	2.05
	Ondo	33	10219	3.27
	Lagos	84	24358	3.44
	Ogun	34	9602	3.53
All South West		**217**	**73979**	**2.94**

[1] Expressed per 1,000 women age 15-49
a Age-adjusted rate

Table 4.7a: Adult Female Death Rate for Urban/Rural Place of Residence 2018

Type of Place of Residence	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
Urban	593	220507	2.69
Rural	849	259875	3.27
All Nigeria	**1422**	**480382**	**3.18[a]**

[1] Expressed per 1,000 women age 15-49
[a] age adjusted

Table 4.7b: Adult Female Death Rate for Northern States, Nigeria DHS 2018

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
North Central	Kogi	34	8168	4.22
	Niger	51	16383	3.10
	Abuja	8	3800	2.21
	Nasarawa	9	8260	1.09
	Benue	62	15701	3.93
	Kwara	20	7757	2.64
	Plateau	18	11171	1.59
All North Central		**202**	**71240**	**2.84**
North East	Yobe	42	14174	2.99
	Borno	44	15369	2.88
	Adamawa	35	10655	3.29
	Gombe	69	9343	7.35
	Bauchi	63	15455	4.09
	Taraba	50	11283	4.43
All North East		**304**	**76279**	**3.98**
North West	Katsina	53	27382	1.94
	Jigawa	38	14768	2.57
	Kano	84	32464	2.60
	Kaduna	103	29668	3.47
	Kebbi	48	14218	3.38
	Sokoto	26	9762	2.67
	Zamfara	48	16474	2.93
All North West		**401**	**144736**	**2.77**

[1] Expressed per 1,000 women age 15-49

Table 4.7c: Adult Female Death Rate for Southern States, Nigeria DHS 2018

Region	States	Adult Female Death	Exposure (Person-years)	Adult Female Death Rate[1]
South East	Anambra	32	18055	1.77
	Enugu	29	10747	2.72
	Ebonyi	27	12250	2.24
	Abia	22	7528	2.90
	Imo	41	13272	3.08
All South East		**151**	**61852**	**2.45**
South South	Edo	29	6987	4.20
	Cross River	32	6169	5.13
	Akwa Ibom	36	9538	3.83
	Rivers	77	16883	4.57
	Bayelsa	10	2691	3.80
	Delta	18	11164	1.65
All South South		**203**	**53433**	**3.80**
South West	Oyo	27	13520	1.98
	Osun	13	9181	1.37
	Ekiti	13	5218	2.58
	Ondo	13	7305	1.83
	Lagos	99	28610	3.44
	Ogun	15	9007	1.72
All South West		**180**	**72842**	**2.47**

[1] Expressed per 1,000 women age 15-49

4.4 Direct Sisterhood estimates of maternal mortality levels

Tables 4.8a, 4.8b and 4.8c show the MM rates and ratios from direct sisterhood method with 95% confidence interval for the urban-rural places of residence, for 2008, 2013 and 2018 respectively. In 2008, the MMRate (maternal deaths per 1,000 women exposure years) in rural area was 1.21 (95% CI: 1.17 – 1.48) while the urban has 0.80 (95% CI: 0.80 – 1.15) (Table 4.8a). This is similar to the MMRate for rural and urban area estimated in 2013 as well, higher MMRate of 1.24 (95% CI: 1.12 – 1.52) was observed in the rural area and 0.89 (95% CI: 0.91 – 1.23) (Table 4.8b) and also similar for 2018, higher MMate in the rural residence 1.20 (95% CI: 1.18 – 1.48) and 0.82 (95% CI: 0.84 – 1.16) for the urban residence (Table 4.8c). The urban-rural estimates of MM ratio (maternal deaths per 100,000 livebirths) reveals lower MMRatio 480 (95% CI: 480 – 691) for urban areas and higher MMRatio of 624 (95% CI: 606 – 765) for rural areas in 2008 (Table 4.8a). Pattern similar to this was also observed in 2018, where the urban residents had a lower MMratio of 523 (95% CI: 490-698) compared to 548 (95% CI: 520-788) for the rural place of residence (Table 4.8c).

Trends of MMRatio from the direct sisterhood method observed in the urban-rural places of residence were presented in Figure 4.1. Some form of decline in MM for the rural areas were observed between 2008 and 2018 (from MMRatio of 624 in 2008, to 565 in 2013 and then 548 in 2018. Contrarily, some form of increase was observed in the MMRatio of the urban places of residence during the same period. MMRatio increased from 480 in 2008 to 523 in 2018 (Figure 4.1).

Tables 4.9a, 4.9b and 4.9c shows the estimated MM rates and ratio from the direct sisterhood method with 95% confidence interval for the six different geopolitical zones, for 2008, 2013 and 2018 respectively. Estimates observed at the geopolitical zone level in 2008 ranged from 0.42 (95% CI: 0.34 – 0.67) at the South West region to 1.65 (95% CI: 1.37 – 1.94) at the North West region (Table 4.9a). Likewise for the MMRatio, North West Region has the highest MMRatio of 675 (95% CI: 548-771) maternal deaths per 100,000 live-births while MMRatio is lowest in the South West region, 281 (95% CI: 226-448) (Table 4.9a). The North central region had the highest MMRatio for 2013, 712 (95% CI: 684 -1040) (Table 4.9b) and also varied in 2018 with the highest MMRatio of

901(95% CI: 576-1011) observed at the North East while the lowest was South East Region 268 (95% CI: 201-543) (Table 4.9c).

Figure 4.2 shows the trends of MMRatio in the six geo-political zones in Nigeria. Overall, a consistent decline in the estimates of MMRatio was observed in the North Western region between 2008 and 2018, where MMRatio declined from 657 in 2008, to 628 in 2013 and further to 539 by 2018. A similar pattern was observed in the South Eastern region within the same period, from MMRatio of 586 in 2008 to 520 in 2013 and further to 268 in 2018 (Figure 4.2) This pattern is also mirrored for the MMRate of both regions. An opposite pattern was observed in the South Western region where MMRatio steadily increased from 2008 to 2018.

Table 4.8a: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Rural and Urban areas, Nigeria 2008.

Type of residence	Maternal Deaths	Women person-years	Mmrate[1] 95% C.I	Mmratio[2] 95% C.I
Urban	115	143326	0.80 (0.80-1.15)	480 (480-691)
Rural	283	234136	1.21 (1.17-1.48)	624 (606-765)
All Nigeria	**398**	**377463**	**1.05 (1.05-1.31)**	**545 (475-615)**

[1] Expressed per 1,000 woman-years of exposure
[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

Table 4.8b: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Rural and Urban areas, Nigeria 2013

Type of residence	Maternal deaths	Women person-years	MMrate 95% C.I	MMratio 95% C.I
Urban	173	195616	0.89 (0.91- 1.23)	565 (581-782)
Rural	307	247486	1.24 (1.22 -1.52)	565 (555-693)
All Nigeria	**480**	**443102**	**1.05 (1.05-1.31)**	**576 (500-652)**

[1] Expressed per 1,000 woman-years of exposure

[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

Table 4.8c: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Rural and Urban areas, Nigeria 2018

Type of residence	Maternal deaths	Women person-years	Mmrate 95% C.I	Mmratio 95% C.I
Urban	180	220507	0.82 (0.84- 1.16)	523 (490-698)
Rural	313	259875	1.20 (1.18 -1.48)	548 (520-788)
All Nigeria	**493**	**480,381**	**1.03(1.00 -1.21)**	**573 (497-649)**

[1] Expressed per 1,000 woman-years of exposure
[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

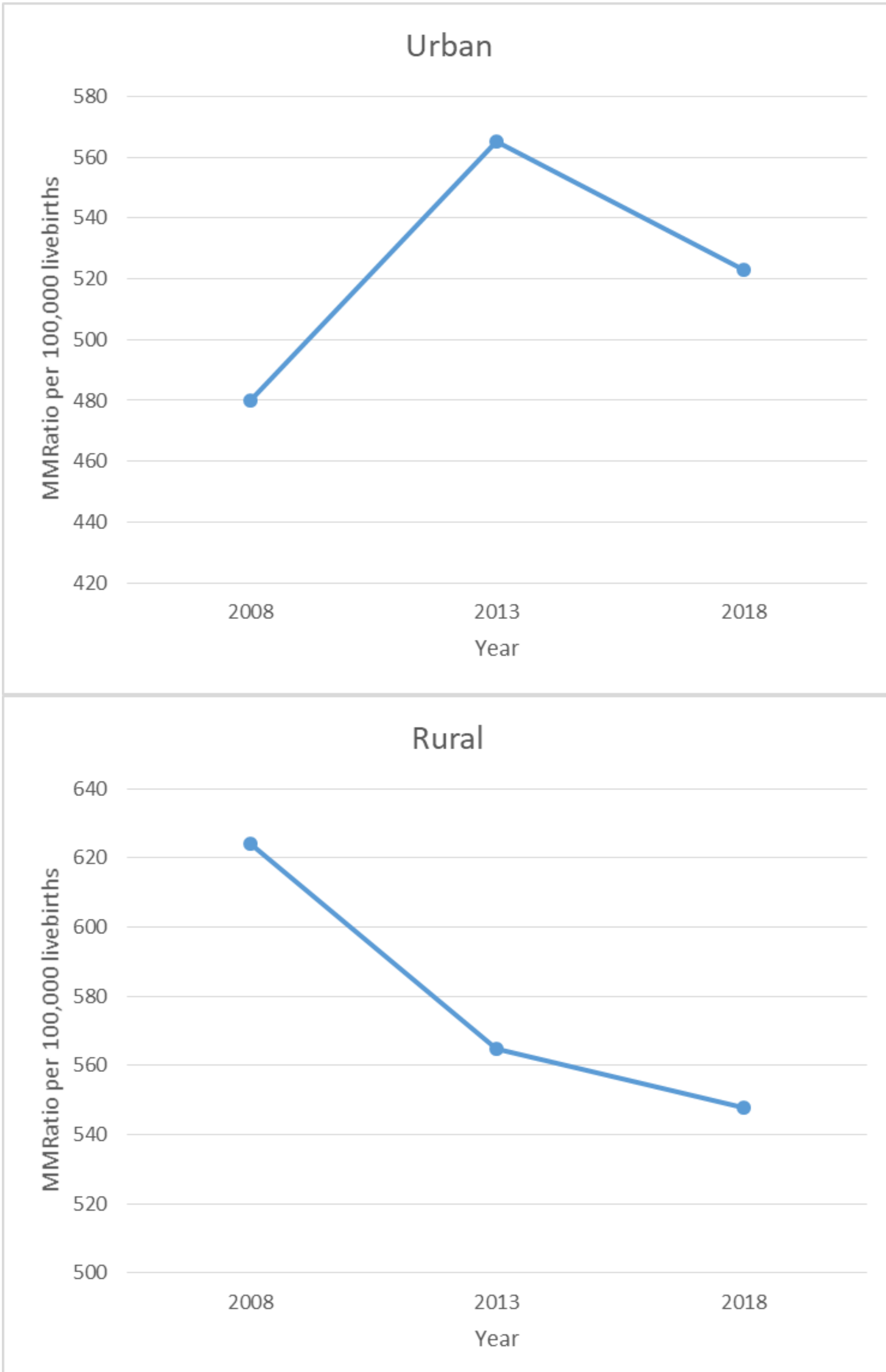


Figure 4.1: Trends in direct sisterhood estimates of maternal mortality in Urban-rural places of residence in Nigeria.

Table 4.9a: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Geopolitical Region, Nigeria 2008

Region	Maternal deaths	Women person-years	Mmrate[1] 95% C.I	Mmratio[2] 95% C.I
North Central	41.83	55317	0.75(0.65-1.19)	399(343-628)
North East	76.5	46749	1.64(1.43-2.24)	654(573-896)
North West	130.89	79351	1.65(1.37-1.94)	657(548-771)
South East	46.22	51842	0.89(0.85-1.50)	586(557-989)
South South	70	67339	1.04(1.01-1.61)	679(661-1055)
South West	32.4	76864	0.42(0.34-0.67)	281(226-448)
All Nigeria	**398**	**377463**	1.05(1.05-1.31)	**545 (475-615)**

[1] Expressed per 1,000 woman-years of exposure
[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

Table 4.9b: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Geopolitical Region, Nigeria 2013

Region	Maternal deaths	Women person-years	Mmrate[1] 95% C.I	Mmratio[2] 95% C.I
North Central	87.2	66081	1.32 (1.27-1.93)	712 (684 -1040)
North East	88.93	63491	1.40 (1.25 – 1.90)	612 (547 -828)
North West	188.02	125247	1.50 (1.37 -1.83)	628 (574 -763)
South East	42.09	55400	0.76 (0.70 – 1.27)	520 (476 – 869)
South South	31.45	58904	0.53 (0.45 – 0.90)	380 (319 -640)
South West	42.2	73979	0.57 (0.49 -0.90)	367 (318 – 581)
All Nigeria	**479.94**	**443101**	**1.05 (1.05-1.31)**	**576 (500-652)**

[1] Expressed per 1,000 woman-years of exposure
[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

Table 4.9c: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for Geopolitical Region, Nigeria 2018

Region	Maternal deaths	Women person-years	Mmrate[1] 95% C.I	Mmratio[2] 95% C.I
North Central	38.35	71240	0.54(0.45-1.19)	290(261-697)
North East	157.47	76279	2.06(1.43-2.24)	901(576-1011)
North West	186.61	144736	1.29(1.37-1.94)	539(349-854)
South East	24.24	61852	0.39(0.85-1.50)	268(201-543)
South South	41.80	53433	0.78(1.01-1.61)	556(480-640)
South West	44.41	72842	0.61(0.34-0.67)	392(290-494)
All Nigeria	**493**	**480382**	**1.03(1.00-1.21)**	**573 (497-649)**

[1] Expressed per 1,000 woman-years of exposure
[2] Expressed per 100,000 live births; calculated as the maternal mortality rate divided by the general fertility rate

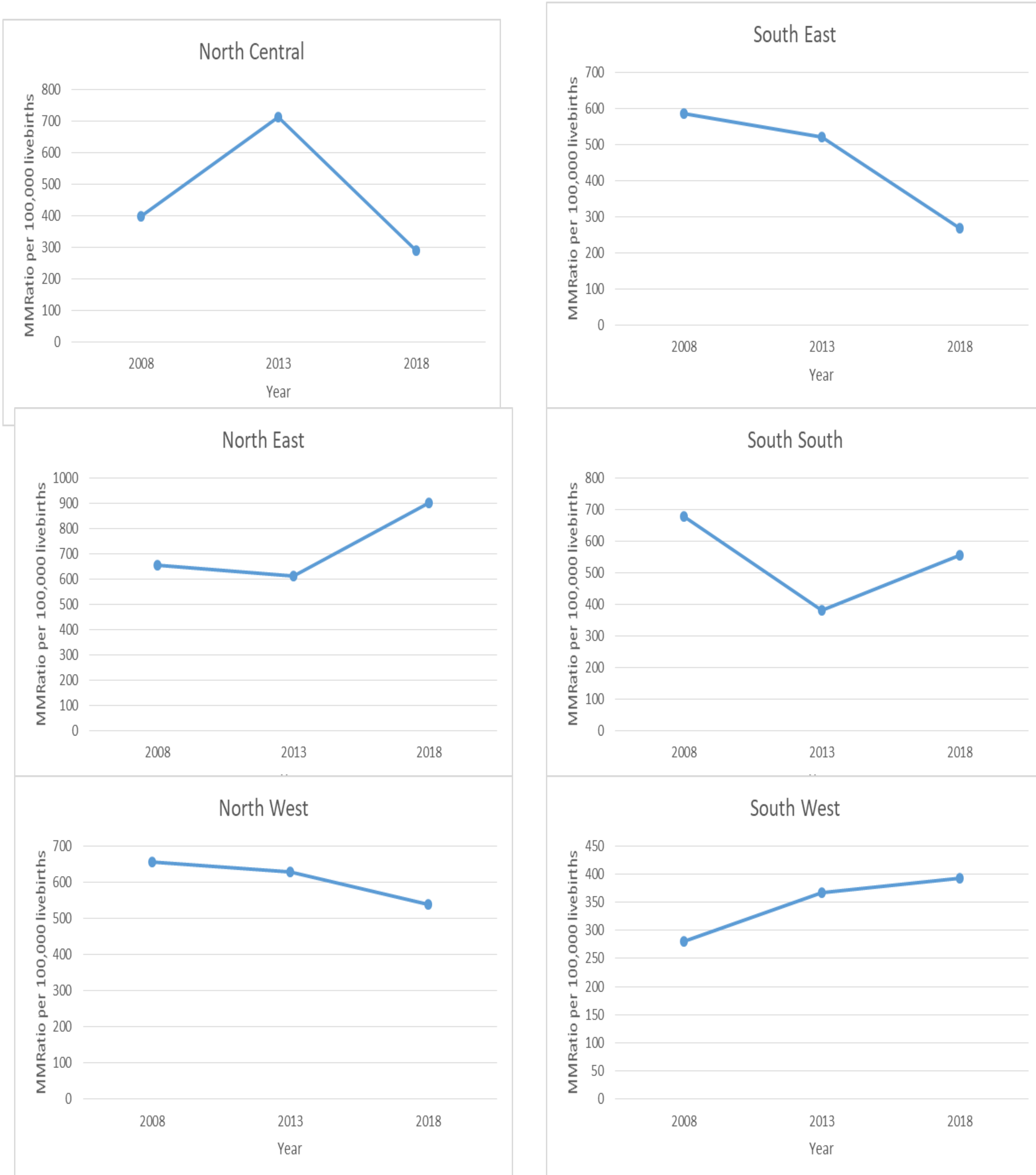


Figure 4.2: Trends in direct sisterhood estimates of maternal mortality in the six geo-political zones in Nigeria.

Tables 4.10a and 4.10b show direct sisterhood estimates of MM for individual states in Northern and Southern Nigeria respectively in 2008. Tables 4.11a and 4.11b show for 2013, while tables 4.12a and 4.12b show for 2018. In 2008 (tables 4.10a and 4.10b) the MMrate ranged from 0.12 (95% CI: 0.04-0.63) in Delta state to 4.51 (95% CI: 3.41-6.58) in Zamfara state. Oyo and Ondo State has one of the lowest MMRate at 0.26 (95% CI: 0.10 – 0.78) and 0.33 (95% CI: 0.13 – 1.11) respectively (Table 4.10b). For 2013 (tables 4.11a and 4.11b), the MMRate ranged from 0.13 (95% CI: 0.02-1.33) in Bayelsa to 2.64 (95% CI: 2.07-3.97) in Kebbi state (Tables 12a &12b). Similar patterns were observed in 2018 where Gombe State had the highest MMRate 5.45 (95% CI: 0.59-2.55), and the lowest estimate of MMRate was in Plateau 0.13 (95% CI: 0.08-2.74) (Table 12a).

In 2008, the MMRatio varied from 85 (95% CI: 27-442) in Delta to 1873 (95% CI: 1325-2561) in Zamfara State. Four(4) states had relatively high MMRatio, namely: Zamfara (1873, 95% CI: 1325-2561)), Kebbi (1464, 95% CI: 795-1905), Taraba (996, 95% CI: 686-1966) and Adamawa (927, 95% CI: 673-1681) (Table 4.10a). Among the Southern states, Abia and, Rivers states reported the highest MMRatio for 2008 at 1,448 (95% CI: 1173-2864) and 1,009 (95% CI: 1838-1816) respectively (Table 4.10b). For 2013, Borno ranked highest with MMRatio 1350 (95% CI: 834-1670) while Bayelsa state had the lowest of 81 (95% CI: 10-808) (Tables 4.11a & 4.11b). However in 2018, Bayelsa experienced a rapid increase in MMRatio and ranked the highest (1133, 95% CI: 1004-1673) and Oyo had the overall lowest for same year with estimated MMRatio of 67 (95% CI: 47-532) (Table 4.12b).

Figures 4.1, 4.2 and 4.3 gives vivid pictorial dispersion of the magnitude of MM across the various geopolitical regions in the country for 2008, 2013 and 2018 respectively. The levels of MM was seen to be spatially clustered around the various geopolitical zone. Relatively similar levels of MMR were obtained according to the geographical location of each states on the map of Nigeria. This pattern is comparable for all 2008, 2013 and 2018.

Table 4.10a: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in North Central, North East and North West, Nigeria 2008

States	Maternal deaths	Women person-years	Mmrate 95% C.I (per 1,000 woman-years of exposure)	Mmratio 95% C.I (per 100,000 live births)
North Central				
Kogi	2.72	8561	0.32 (0.11-1.05)	203 (71-674)
Niger	8.83	9278	0.95 (0.56-2.03)	373 (218-796)
Abuja	1.6	4398	0.36 (0.10-1.78)	235 (67-1150)
Nasarawa	3.42	5133	0.67 (0.27-2.04)	404 (163-1239)
Benue	19.84	12547	1.58 (1.32-3.15)	787 (654-1565)
Kwara	1.6	5356	0.29 (0.06-1.18)	166 (37-679)
Plateau	3.82	10044	0.38 (0.19-1.28)	213 (105-720)
All North Central	**41.83**	**55317**	**0.75(0.65-1.19)**	**399(343-628)**
North East				
Yobe	7.76	5703	1.36 (0.72-2.86)	521 (276-1094)
Borno	15.51	9240	1.68 (1.04-2.77)	612 (377-1010)
Adamawa	18.01	8806	2.04 (1.49-3.71)	927 (673-1681)
Gombe	7.72	5135	1.50 (0.83-3.29)	577 (317-1262)
Bauchi	13.98	10977	1.27 (0.83-2.34)	470 (307-864)
Taraba	13.52	6888	1.96 (1.35-3.87)	996 (686-1966)
All North East	**76.5**	**46749**	**1.64(1.43-2.24)**	**654(573-896)**
North West				
Katsina	12.77	12074	1.06 (0.54-1.60)	407 (208-613)
Jigawa	4.76	8724	0.55 (0.21-1.18)	218 (83-472)
Kano	26.85	21732	1.24 (0.89-1.89)	463 (333-707)
Kaduna	25.84	16342	1.58 (1.32-2.83)	741 (617-1328)
Kebbi	19.7	6184	3.19 (1.73-4.15)	1464 (795-1905)
Sokoto	6.09	7051	0.86 (0.34-1.60)	306 (121-567)
Zamfara	34.88	7244	4.81 (3.41-6.58)	1873 (1325-2561)
All North West	**130.89**	**79351**	**1.65(1.37-1.94)**	**657(548-771)**

Table 4.10b: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in the South East, South South and South West, Nigeria 2008

States	**Maternal deaths**	**Women person-years**	**Mmrate 95% C.I (**per 1,000 woman-years of exposure)	**Mmratio 95% C.I (**per 100,000 live births)
South East				
Anambra	8.05	14288	0.56 (0.39-1.52)	334 (232-898)
Enugu	3.4	8568	0.40 (0.16-1.20)	293 (116-887)
Ebonyi	7.3	6436	1.13 (0.61-2.52)	640 (343-1418)
Abia	18.91	9855	1.92 (1.55-3.80)	1448 (1173-2864)
Imo	8.56	12695	0.67 (0.49-1.81)	456 (329-1228)
All South East	**46.22**	**51842**	**0.89(0.85-1.50)**	**586(557-989)**
South South				
Edo	7.23	10109	0.72 (0.46-1.91)	423 (271-1128)
Cross River	16.19	9332	1.73 (1.35-3.55)	991 (773-2026)
Akwa Ibom	14.6	10782	1.35 (0.93-2.58)	925 (638-1758)
Rivers	25.32	18265	1.39 (1.15-2.50)	1009 (838-1816)
Bayelsa	4.99	5167	0.97 (0.45-2.48)	532 (249-1364)
Delta	1.67	13684	0.12 (0.04-0.63)	85 (27-442)
All South South	**70**	**67339**	**1.04(1.01-1.61)**	**679(661-1055)**
South West				
Oyo	3.42	13406	0.26 (0.10-0.78)	143 (58-438)
Osun	4.96	9642	0.51(0.23-1.26)	402 (178-982)
Ekiti	3.72	5896	0.63 (0.25-1.77)	408 (162-1142)
Ondo	2.98	9148	0.33(0.13-1.11)	202 (79-686)
Lagos	11.76	28844	0.41(0.27-0.84)	317 (213-657)
Ogun	5.56	9928	0.56 (0.28-1.43)	312 (158-797)
All South West	**32.4**	**76864**	**0.42(0.34-0.67)**	**281(226-448)**

Table 4.11a: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in North Central, North East and North West, Nigeria 2013

States	Maternal deaths	Women person-years	Mmrate 95% C.I (per 1,000 woman-years of exposure)	Mmratio 95% C.I (per 100,000 live births)
North Central				
Kogi	3.15	8062	0.39 (0.16-1.28)	278 (111-910)
Niger	38.72	16310	2.37 (1.93-3.61)	1065 (867-1622)
Abuja	2.93	3843	0.76 (0.31-2.73)	527 (214-1889)
Nasarawa	5.01	7249	0.69 (0.36-1.96)	379 (197-1074)
Benue	26.15	15329	1.71 (1.44-3.08)	869 (732-1567)
Kwara	1.4	6376	0.22 (0.05-1.06)	137 (32-659)
Plateau	9.88	8912	1.11 (0.80-2.74)	638 (463-1578)
All North Central	**87.2**	**66081**	**1.32 (1.27-1.93)**	**712 (684 -1040)**
North East				
Yobe	16.7	11023	1.52 (1.07-2.76)	627 (441-1141)
Borno	31.44	12372	2.54 (1.57-3.14)	1350 (834-1670)
Adamawa	10.86	9701	1.12 (0.73-2.35)	549 (356-1151)
Gombe	6.78	6518	1.04 (0.59-2.55)	413 (233-1015)
Bauchi	7.04	13310	0.53 (0.29-1.25)	184 (102-434)
Taraba	16.11	10567	1.52 (1.17-3.08)	723 (556-1462)
All North East	**88.93**	**63491**	**1.40 (1.25 – 1.90)**	**612 (547 -828)**
North West				
Katsina	20.15	16724	1.21 (0.86-2.03)	454 (322-765)
Jigawa	27.83	12926	2.15 (1.42-2.97)	785 (517-1082)
Kano	43.21	35966	1.20 (1.01-1.82)	525 (439-796)
Kaduna	37.41	20126	1.86 (1.27-2.41)	1094 (749-1416)
Kebbi	35.78	13580	2.64 (2.07-3.97)	1072 (843-1617)
Sokoto	15.57	11634	1.34 (0.86-2.31)	532 (344-918))
Zamfara	8.07	14291	0.56 (0.31-1.19)	194(106-409)
All North West	**188.02**	**125247**	**1.50 (1.37 -1.83)**	**628 (574 -763)**

Table 4.11b: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in the South East, South South and South West, Nigeria 2013

States	**Maternal deaths**	**Women person-years**	**Mmrate 95% C.I** (per 1,000 woman-years of exposure)	**Mmratio 95% C.I** (per 100,000 live births)
South East				
Anambra	2.62	12540	0.21 (0.08-0.78)	151 (57-566)
Enugu	10.38	11954	0.87 (0.60-1.98)	646 (444-1472)
Ebonyi	20.28	12961	1.56 (1.17-2.77)	965 (721-1710)
Abia	3.11	7063	0.44 (0.21-1.72)	313 (147-1225)
Imo	5.7	10882	0.52 (0.31-1.51)	345 (201-996)
All South East	**42.09**	**55400**	**0.76 (0.70 – 1.27)**	**520 (476 – 869)**
South South				
Edo	1.64	9149	0.18 (0.05-0.90)	127 (38-641)
Cross River	3.21	8521	0.38 (0.16-1.29)	222 (94-763)
Akwa Ibom	7.5	9800	0.77 (0.43-1.74	626 (351-1424)
Rivers	12.04	15739	0.76 (0.54-1.64)	580 (408-1245)
Bayelsa	0.55	4109	0.13 (0.02-1.33)	81 (10-808)
Delta	6.51	11588	0.56 (0.31-1.38	407 (223-1002)
All South South	**31.45**	**58904**	**0.53 (0.45 – 0.90)**	**380 (319 -640)**
South West				
Oyo	12.3	17962	0.68 (0.45-1.36)	418 (275-830)
Osun	1.4	8039	0.17 (0.04-0.82)	129 (30-609)
Ekiti	1.91	3799	0.50 (0.15-2.17)	366 (113-1576)
Ondo	4.31	10219	0.42 (0.21-1.32)	262 (132-821)
Lagos	16.25	24358	0.67 (0.51-1.34)	463 (354-927)
Ogun	6.03	9602	0.63 (0.31-1.48)	343 (170-808)
All South West	**42.2**	**73979**	**0.57 (0.49 -0.90)**	**367 (318 – 581)**

Table 4.12a: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in the North Central, North East and North West, Nigeria 2018

States	**Maternal deaths**	**Women person-years**	**Mmrate 95% C.I** (per 1,000 woman-years of exposure)	**Mmratio 95% C.I** (per 100,000 live births)
North Central				
Kogi	9.18	8168	1.12 (0.16-1.28)	951(638-2313)
Niger	13.44	16383	0.82 (0.73-3.61)	354(249-756)
Abuja	1.16	3800	0.31 (0.31-2.73)	695(498-1252)
Nasarawa	2.15	8260	0.26 (0.16-1.96)	242(105-940)
Benue	6.13	15701	0.39 (0.24-3.08)	233(65-864)
Kwara	4.86	7757	0.63 (0.05-1.06)	437(255-1133)
Plateau	1.44	11171	0.13 (0.08-2.74)	95(60-608)
All North Central	**38.35**	**71240**	**0.54 (0.27-1.93)**	**290(101-998)**
North East				
Yobe	16.61	14174	1.17 (1.07-2.76)	504(316-890)
Borno	28.23	15369	1.84 (1.57-3.14)	780(599-1391)
Adamawa	14.42	10655	1.35 (0.73-2.35)	806(290-1126)
Gombe	50.96	9343	5.45 (0.59-2.55)	4310(1977-4559)
Bauchi	37.53	15455	2.43 (0.29-1.25)	901(708-1502)
Taraba	9.72	11283	0.86 (1.17-3.08)	631(464-1370)
All North East	**157.47**	**76279**	**2.09 (1.25 – 1.90)**	**901(623-1670)**
North West				
Katsina	20.68	27382	0.76 (0.86-2.03)	185(100-456)
Jigawa	10.68	14768	0.76 (1.42-2.97)	278(189-493)
Kano	47.78	32464	1.47 (1.01-1.82)	453(185-750)
Kaduna	54.07	29668	1.82 (1.27-2.41)	527(395-838)
Kebbi	24.23	14218	1.70 (2.07-3.97)	779(433-1100)
Sokoto	8.28	9762	0.85 (0.76-2.31)	373(144-918)
Zamfara	20.89	16474	1.27 (0.31-1.19)	516(341-1456)
All North West	**186.61**	**144736**	**1.29 (1.37 -1.83)**	**539(303-898)**

Table 4.12b: Direct Sisterhood Estimates of Maternal Mortality Rate and Ratio for States in South East, South South and South West, Nigeria 2018

States	Maternal deaths	Women person-years	Mmrate 95% C.I (per 1,000 woman-years of exposure)	Mmratio 95% C.I (per 100,000 live births)
South East				
Anambra	4.04	18055	0.22 (0.10-1.44)	117(84-943)
Enugu	4.78	10747	0.44 (0.19-1.48)	400(234-1312)
Ebonyi	6.19	12250	0.51 (0.16-1.29)	340(97-1085)
Abia	2.52	7528	0.33 (0.14-1.18)	352(258-767)
Imo	6.72	13272	0.51 (0.06-1.22)	339(196-991)
All South East	24.24	61852	**0.39(0.21-1.02)**	**268(200-758)**
South South				
Edo	2.88	6987	0.41 (0.26-1.49))	285(213-1011)
Cross River	4.08	6169	0.66 (0.44-3.01)	673(398-1471)
Akwa Ibom	6.15	9538	0.65 (0.13 – 1.91)	535(446-1048)
Rivers	21.47	16883	1.27 (1.11-2.02)	735(551-1329)
Bayelsa	1.88	2691	0.70 (0.38-1.95)	1133(1004-1673)
Delta	5.34	11164	0.48 (0.09-0.65)	289(118-955)
All South South	41.80	53433	**0.78 (0.61-0.82)**	**556 (422-680)**
South West				
Oyo	2.11	13520	0.16 (0.13-0.79)	67(47-532)
Osun	2.69	9181	0.29 (0.09-0.91)	189(80-653)
Ekiti	4.19	5218	0.80 (0.25-1.49)	804(661-1216)
Ondo	3.47	7305	0.48 (0.22-1.12)	420(291-979)
Lagos	30.36	28610	1.06 (0.56-1.91)	433(344-913)
Ogun	1.60	9007	0.18 (0.03-0.76)	106(47-616)
All South West	44.41	72842	**0.67 (0.51-0.90)**	**392 (333-569)**

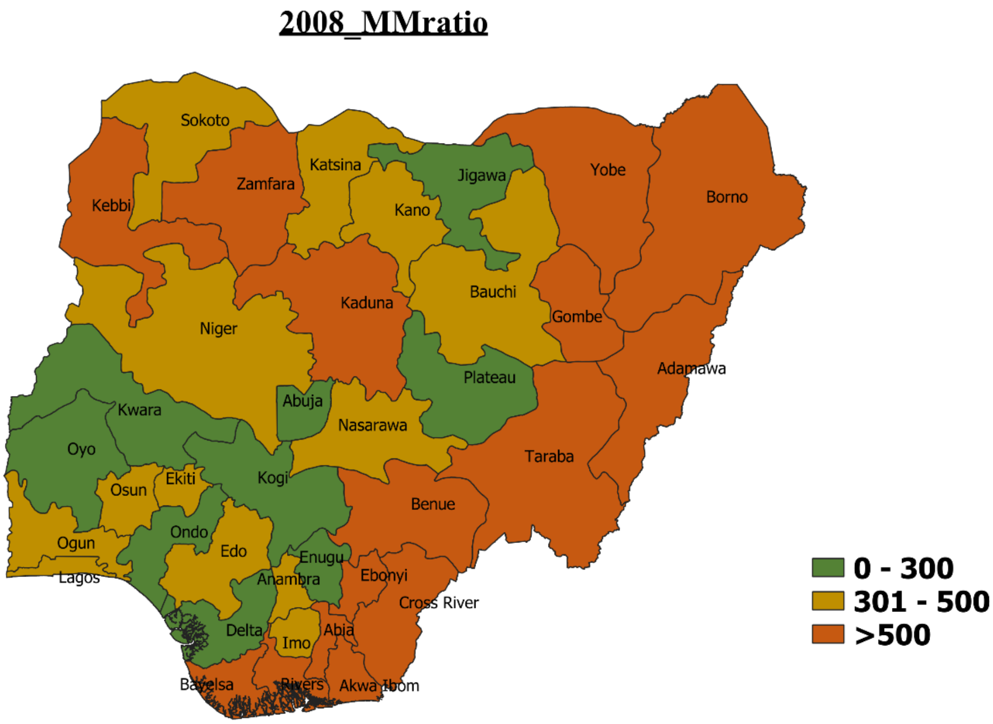


Figure 4.3: Map showing maternal mortality ratio (MMR) estimates from direct sisterhood method, for 36 states and FCT, Nigeria DHS 2008.

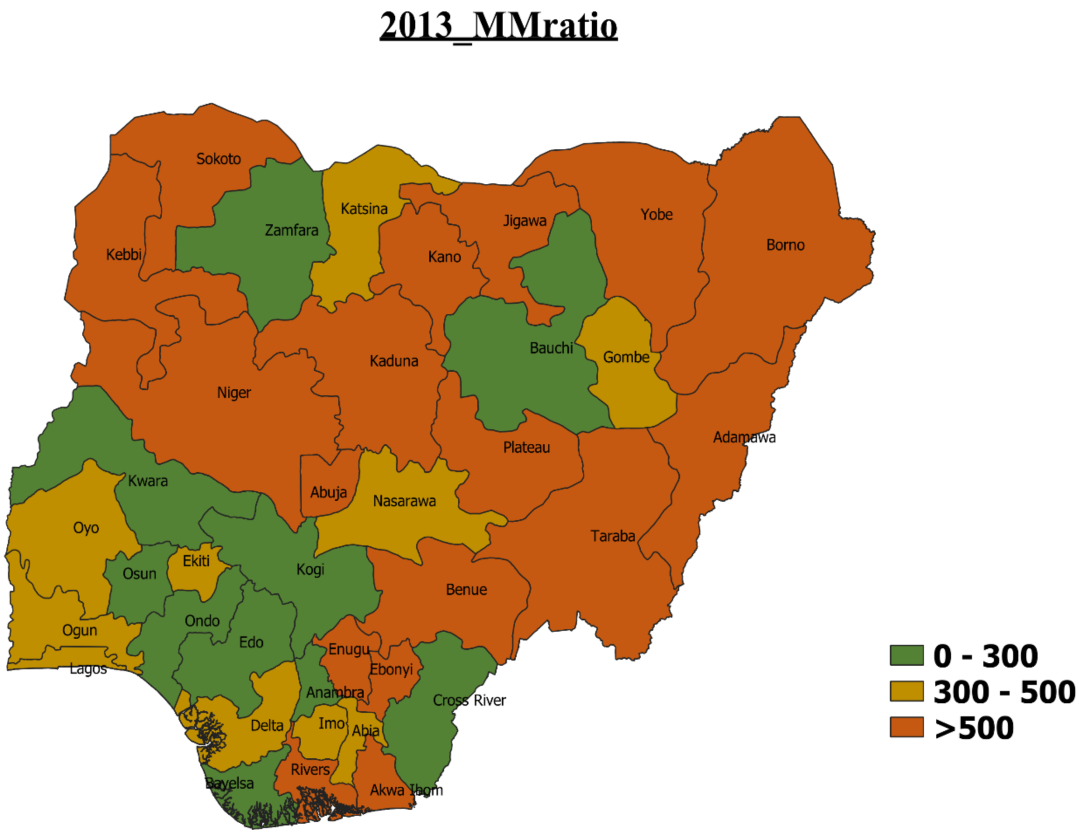


Figure 4.4: Map showing maternal mortality ratio (MMR) estimates from direct sisterhood method, for 36 states and FCT, Nigeria DHS 2013.

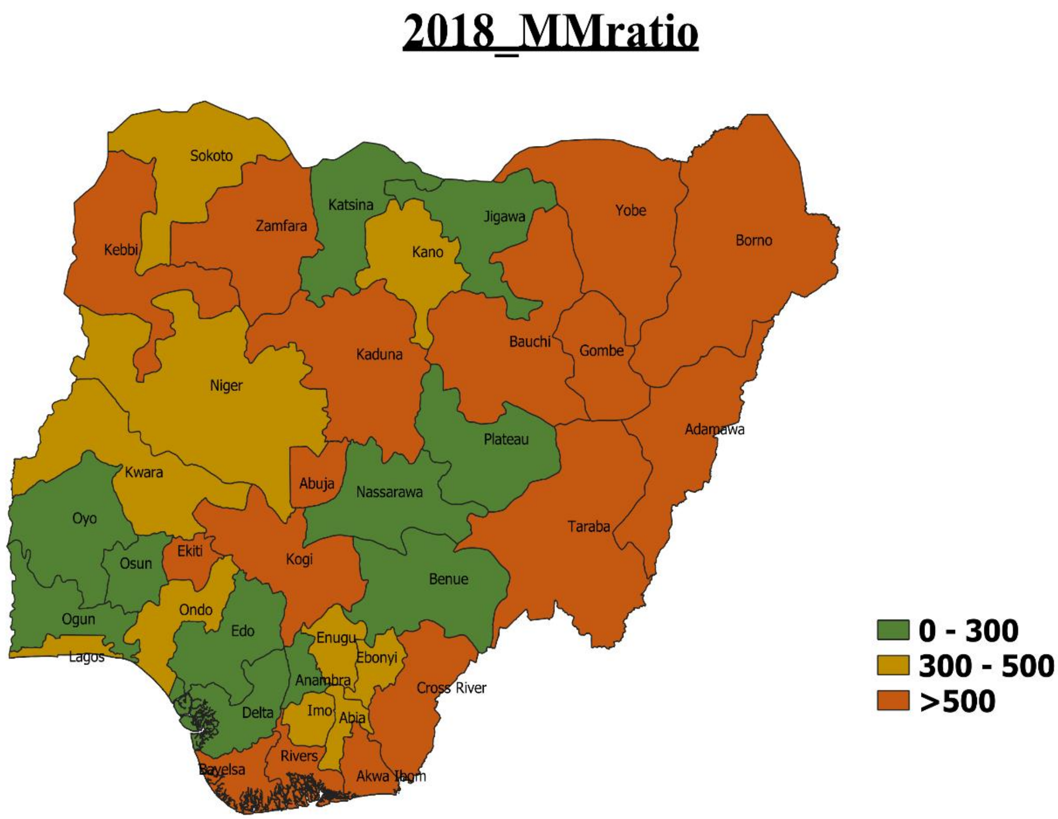


Figure 4.5: Map showing maternal mortality ratio (MMRatio) estimates from direct sisterhood method, for 36 states and FCT, Nigeria DHS 2018.

4.5 Estimates from Indirect Sisterhood method

The lifetime risk of dying from maternal causes and their respective , Maternal Mortality Ratio ,MMR, per 100, 000 live-births estimated from the crude and adjusted TFR for Urban-Rural and six geo-political zones in 2008,2013 and 2018 are presented in the appendix tables A4.15, A4.16 and A4.17 respectively. The summary of the rates for each survey year 2008, 2013, and 2018 are presented in Tables 4.15, 4.16 and 4.17 respectively. Using the indirect sisterhood method with the crude total fertility rates, In 2008 MMR was 575 (95% CI: 538 – 612) maternal deaths per 100,000 live-births for all Nigeria (Table 4.15), 534 (95% CI: 465 – 603) maternal deaths per 100,000 live-births for Urban (Table 4.15) and the MMR for Rural was 580 (95% CI: 537 - 623) (Table 4.15). In same 2008, of the six geo-political zones, levels of MMR was highest in the South East Region, 1,057(95% CI: 824 – 1293) maternal deaths per 100,000 live-births (Table 4.15) and the south west region had the lowest of 255 (95% CI: 183 – 326) maternal deaths per 100,000 live-births (Table 4.15). In 2013, using the crude TFR, The MMRatio for all Nigeria was 553 (95% CI:510-576) maternal deaths per 100,000 live-births (Table 4.16a), 551 (95% CI: 510 – 592) maternal deaths per 100,000 live-births (Table 4.16c) and 508 (95% CI: 454 – 562) maternal deaths per 100,000 live-births (Table 4.16b) for both rural and urban area respectively. At the geopolitical region levels, The North West Region had the highest estimates of MMR 689 (95% CI: 619-759) with the crude TFRs (Table 4.16f) and the lowest was observed at the South West region with MMR of 361 (95% CI: 287– 435) maternal deaths per 100,000 live-births (Table 4.16i).

After adjusting the total fertility rate for 2008 using the P/F ratio method, the MMR was 524 (95% CI: 427 -621) maternal deaths per 100,000 live-births for the South South region and 216 (95% CI: 156 – 277) maternal deaths per 100,000 live-births (Table 4.14a). Similar estimates were obtained in 2013 using the adjusted total fertility rate on the lifetime risk of dying (Table 4.14b). After adjustments were made to the TFR, the MMR estimated for the rural and urban areas were 509 (95% CI: 471 – 547) maternal deaths per 100,000 live-births and 477 (95% CI: 427 – 528) maternal deaths per 100,000 live-births respectively. North East had the highest MMR 625 (95% CI: 549 -701). However, the South South region had the lowest MMR of 227 (95% CI: 177 -277) maternal deaths per 100,000 live-births with the adjusted TFR. These results are similar to those observed from the crude.

Table 4.13a: Summary of Maternal Mortality Ratio Estimates Using Different Sisterhood Methods 2008

Sub-population	Direct sisterhood method	Indirect Sisterhood method with crude TFR	Indirect sisterhood method with adjusted P/F Ratio TFR
Rural	624 (606 -765)	580 (537 – 623)	362 (335 – 389)
Urban	480 (480-691)	534 (465 – 603)	483 (420 – 545)
North Central	399 (343-628)	366 (298 - 435)	330 (268 – 392)
North East	654 (573-896)	750 (664 -837)	643 (569 – 718)
North West	657 (548-771)	704 (623 – 786)	635 (562 -709)
South East	586 (557 -989)	1057 (824– 1293)	996 (775 – 1218)
South South	679 (661-1055)	580 (472 –687)	524 (427 – 621)
South West	281 (226-448)	255(183 – 326)	216 (156 – 277)
All Nigeria	545 (475 - 615)*	575 (538 -612)	512 (479 – 546)

*NDHS

Table 4.13b: Summary of Maternal Mortality Ratio Estimates Using Different Sisterhood Methods 2013

Sub-population	Direct sisterhood method	Indirect Sisterhood method with crude TFR	Indirect sisterhood method with adjusted P/F Ratio TFR
Rural	564 (555 -693)	551 (510 – 592)	509 (471 -547)
Urban	565(581-782)	508 (454 – 526)	477 (427 – 528)
North Central	712 (684-1040)	485 (406 – 565)	476 (398 – 554)
North East	612 (547-828)	685 (601 – 769)	625 (549 – 701)
North West	628 (574-763)	689 (619 – 759)	624 (561 – 687)
South East	520 (476 -867)	477 (382 – 572)	448 (359 – 538)
South South	380 (319-640)	343 (268 – 419)	227 (177 – 277)
South West	367 (318-581)	361 (287– 435)	332 (264 – 400)
All Nigeria	576 (500-652)*	543 (510 -576)	

*NDHS

Table 4.13c: Summary of Maternal Mortality Ratio Estimates Using Different Sisterhood Methods 2018

Sub-population	Direct sisterhood method	Indirect Sisterhood method with crude TFR	Indirect sisterhood method with adjusted P/F Ratio TFR
Rural	548 (515 - 706)	601 (560 – 642)	426 (397 -455)
Urban	523 (422 – 661)	502 (452 – 553)	410 (369-541)
North Central	290 (202 - 400)	264 (213 – 315)	256 (207 -305)
North East	901 (729 – 1011)	1119 (1019 – 1220)	1025 (934 -1117)
North West	539 (420 - 729)	615 (553 – 677)	476 (428-524)
South East	268 (201 – 499)	323 (255 – 392)	350 (276-425)
South South	556 (476 – 810)	583 (478 -689)	567(465-671)
South West	392 (310 - 543)	251 (186– 216)	310 (230 -391)
All Nigeria	556 (484-629)*	574 (542 – 606)	421 (397 – 444)

* NDHS measured as pregnancy-related ratio in 2018,
Maternal mortality ratio in 2008 and 2013.

4.6 Model-based estimates of maternal mortality rates and ratio

Tables 4.19, 4.20 and 4.21 shows the small area estimates of MM levels for the various states and Federal Capital Territory in Nigeria using the model-based approach respectively for 2008, 2013 and 2018. For 2008, the estimates for MMR ranged from 280 (95% CI: 172 – 457) maternal deaths per 100,000 live-births in Lagos to 879 (95% CI: 718 – 1075) maternal deaths per 100,000 in Nasarawa State for 2008 (Figures 4.6 and 4.7) and ranged from 95 (95% CI: 57 – 158) maternal deaths per 100,000 live-births in Lagos state to 1621 (95% CI:1295 – 2029) maternal deaths per 100,000 live-births in Kastina State for 2013 (Figure 4.6).

Table 4.19a shows the model-based estimates of MMR in the Northern states for 2008. Among all the Northern states, Nasarawa had highest MMR of 879 (95% CI: 718 – 1075) maternal deaths per 100,000 live-births. Adamawa state had the highest MMR of 709 (95% CI: 621 – 810) maternal deaths per 100,000 live-births among the North Eastern states and Kebbi state had the highest among the North Western states with MMR of 780 (95% CI; 633 – 962). Table 4.19b shows the model-based estimates of the Southern states. Among the states in the Southern geopolitical zones, Lagos recorded the lowest MMR of 280 (95% CI: 172 – 457) maternal deaths per 100,000 live-births and Bayelsa State had the highest MMR of 832 (95% CI: 671 – 1033) maternal deaths per 100,000. Akwa Ibom State in the South South and Enugu State in the South East also had closely high MMR of 762 (95% CI: 666 – 872) maternal deaths per 100,000 live-births and 768 (95% CI:683 – 865) maternal deaths per 100,000 live-births respectively.

Table 4.20a and Table 4.21a show the model-based estimates of maternal mortality ratio for the Northern and Southern states for 2013 respectively. Katsina State in North Western part and Benue State in the North Central part of Nigeria had the highest MMR of 1621 (95% CI: 1295 – 2029) and 1257 (95% CI: 973 -1625) maternal deaths per 100,000 live-births respectively followed by Bauchi State in the North East with MMR of 998 (95% CI: 845 – 1179) maternal deaths per 100,000 live-births . However, states like Kaduna in the North West and Taraba states in the North East had relatively lowered

MMR of 267 (95% CI: 213 – 334) and 317 (95% CI: 332 -414) maternal deaths per 100,000 live-births.

Figure 4.4 and 4.5 gives insight into how each state in the country fared compared to the national estimates of 545 maternal deaths per 100,000 live-births from the NDHS 2008 and 576 maternal deaths per 100,000 live-births. The observation for 2008 is that about half of the 36 states and the FCT falls below and borderline the estimates published by the Nigeria DHS, while the other half of the states have MMR estimates higher than the published national average. However, in 2013, half of the states have MMR below the published estimates by the Nigeria DHS and the other half have MMR higher than the national estimates by the Nigerian DHS. In figures 4.4 and 4.6, spatial geographical variations in the MMR from the model-based method for both 2008 and 2013 are presented respectively. Identical patterns, denoted by color-codes (see figure legend) are seen in the various geo-political zones. The MMR levels are similar in clusters in the North and this mirrors what is also observed towards the West and the East.

Table 4.14a: Model-Based Estimate of maternal mortality rates (MM rates) and Maternal mortality ratio (MMR) in Northern states in Nigeria DHS, 2008

Region	States	MMRate	MMRatio
North Central	Kogi	0.09 (0.07-0.12)	577 (440 – 756)
	Niger	0.13 (0.10 -0.17)	524 (411 – 668)
	Abuja	0.11(0.08 – 0.14)	704 (536 - 920)
	Nasarawa	0.14 (0.12 – 0.18)	879 (718 – 1075)
	Benue	0.09 (0.06 - 0.13)	448 (315 – 640)
	Kwara	0.12 (0.10 -0.16)	718 (575 – 898)
	Plateau	0.11 (0.09 -0.13)	629 (524 – 754)
North East	Yobe	0.15 (0.12-0.19)	583 (475 – 715)
	Borno	0.14 (0.12 -0.16)	520 (454 – 595)
	Adamawa	0.16 (0.14 -0.18)	709 (621 – 810)
	Gombe	0.15 (0.13 -0.17)	562 (483 – 653)
	Bauchi	0.14 (0.12-0.17)	533 (452 – 628)
	Taraba	0.14 (0.12 -0.16)	687 (599 – 788)
North West	Katsina	0.14 (0.12 -0.17)	551 (467 – 649)
	Jigawa	0.18 (0.15 – 0.22)	728 (595 – 892)
	Kano	0.16 (0.12 -0.21)	604 (459 – 794)
	Kaduna	0.12 (0.10 -0.14)	541 (453 – 646)
	Kebbi	0.17 (0.14 -021)	780 (633 – 962)
	Sokoto	0.19 (0.16 – 0.22)	662 (553 – 793)
	Zamfara	0.17 (0.14 – 0.20)	646 (540 – 773)

Table 4.14b: Model-Based Estimate of maternal mortality rates (MM rates) and maternal mortality ratio (MMR) in Southern states in Nigeria DHS, 2008

Region	States	MM rate	MMR
South East	Anambra	0.06 (0.04 -0.07)	331 (255 – 430)
	Enugu	0.10 (0.09 -0.12)	768 (683 – 865)
	Ebonyi	0.10 (0.08 – 0.13)	574 (467 – 705)
	Abia	0.08 (0.07 – 0.10)	602 (504 – 718)
	Imo	0.08 (0.07 -0.10)	564 (480 – 663)
South South	Edo	0.06 (0.05 -0.08)	374 (287 – 487)
	Cross River	0.09 (0.08 -0.11)	539 (452 – 643)
	Akwa Ibom	0.11 (0.10 -0.13)	762 (666 – 872)
	Rivers	0.10 (0.08 -0.12)	695 (568 – 850)
	Bayelsa	0.15 (0.12 – 0.19)	832 (671 – 1033)
	Delta	0.08 (0.07 – 0.10)	582 (503 – 674)
South West	Oyo	0.07 (0.05 – 0.08)	367 (288 – 468)
	Osun	0.06 (0.05 – 0.08)	502 (390 – 646)
	Ekiti	0.09 (0.07 – 0.11)	568 (434 – 742)
	Ondo	0.09 (0.07 0 11)	566 (460 – 697)
	Lagos	0.04 (0.02 – 0.06)	280 (172 – 457)
	Ogun	0.08 (0.06 – 0.09)	421 (336 – 528)

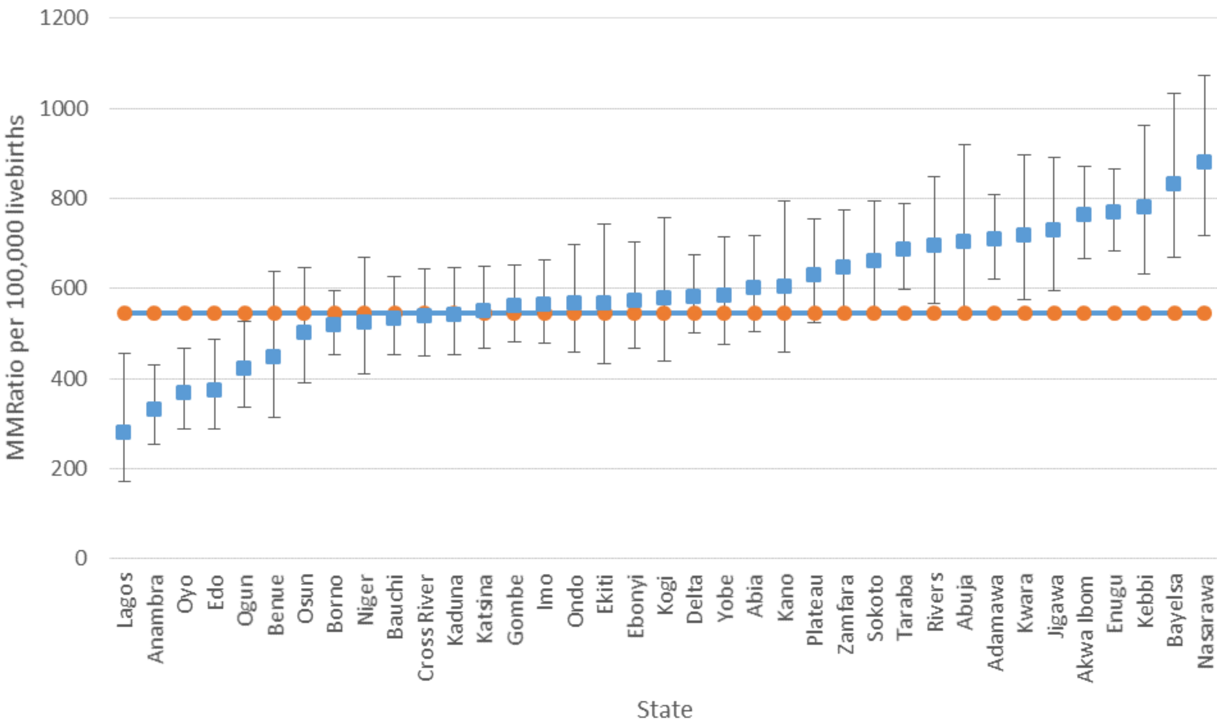


Figure 4.6: Model-based maternal mortality ratio estimates for all 36 States of Nigeria, 2008

Figure 4.7: Map showing Model-based subnational maternal mortality ratio (MMR) estimates, for 36 states and FCT, Nigerian DHS 2008

Table 4.15a: Model-based Estimate of maternal mortality rates (MM rates) and maternal mortality ratio (MMR) in Northern States Nigeria, 2013

Region	States	MM Rate	MMRatio
North Central	Kogi	0.14 (0.12 – 0.17)	572 (485 – 674)
	Niger	0.17 (0.13 – 021)	660 (525 -829)
	Abuja	0.13 (0.11 – 0.15)	439 (368 -525)
	Nasarawa	0.11 (0.10 – 0.13)	422 (358 – 497)
	Benue	0.21 (0.17 -0.28)	1257 (973 – 1625)
	Kwara	0.14 (0.12 – 0.17)	809 (667 – 982)
	Plateau	0.14 (0.12 – 0.16)	514 (466 -592)
North East	Yobe	0.12 (0.10 – 0.14)	591 (505 – 692)
	Borno	0.14 (0.11 – 0.17)	856 (689 – 1062)
	Adamawa	0.12 (0.10 – 0.14)	494 (415 – 587)
	Gombe	0.13 (0.11 – 0.15)	691 (607 – 788)
	Bauchi	0.20 (0.17 -0.24)	998 (845 – 1179)
	Taraba	0.08 (0.08 – 0.09)	371 (332 – 414)
North West	Katsina	0.23 (0.19 – 0.29)	1621 (1295 – 2029)
	Jigawa	0.18 (0.14 – 0.22)	960 (766 – 1204)
	Kano	0.08 (0.08 – 0.14)	325 (193 – 545)
	Kaduna	0.08 (0.06 – 0.10)	267 (213 -334)
	Kebbi	0.12 (0.10 – 0.15)	584 (490 -696)
	Sokoto	0.14 (0.11 – 0.16)	963 (810 – 1146)
	Zamfara	0.11 (0.09 – 0.13)	480 (385 – 599)

Table 4.15b: Model-based Estimate of maternal mortality rates (MM rates) and maternal mortality ratio (MMR) in Southern States Nigeria, 2013

Region	States	MM Rate	MMRatio
South East	Anambra	0.09 (0.07 – 0.11)	632 (517 774)
	Enugu	0.09 (0.07 - 0.10)	503 (430 -588)
	Ebonyi	0.08 (0.07 -0.09)	641 (541 -760)
	Abia	0.13 (0.11 – 0.15)	915 (784 – 1068)
	Imo	0.07 (0.06 – 0.08)	433 (375 -499)
South South	Edo	0.11 (0.08 – 0.13)	691 (554 – 862)
	Cross River	0.08 (0.07 – 0.09)	620 (542 – 710)
	Akwa Ibom	0.15 (0.14 – 0.17)	939 (826 – 1066)
	Rivers	0.07 (0.05 – 0.08)	483 (387 -603)
	Bayelsa	0.16 (0.13 – 0.20)	1169 (937 -1458)
	Delta	0.07 (0.06 – 0.09)	454 (388 – 532)
South West	Oyo	0.04 (0.03 -0.05)	262 (186 – 386)
	Osun	0.08 (0.07 -0.10)	620 (508 – 759)
	Ekiti	0.11 (0.09 – 0.14)	681 (552 – 842)
	Ondo	0.09 (0.07 – 0.10)	624 (523 – 743)
	Lagos	0.01 (0.01 – 0.02)	95 (57 – 158)
	Ogun	0.08 (0.07 – 0.10)	453 (378 -543)

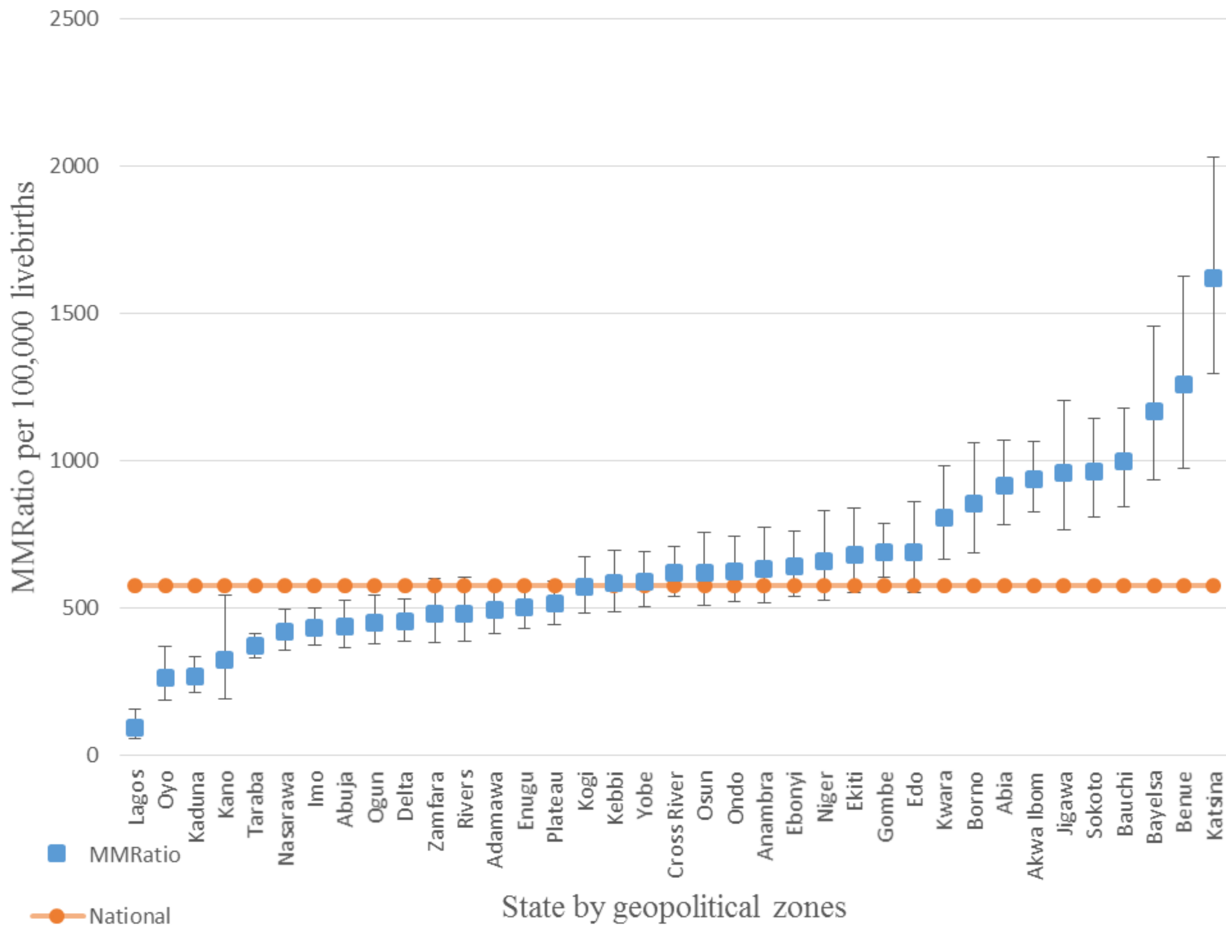


Figure 4.7: Model-based maternal mortality ratio estimates for all 36 States of Nigeria, 2013

Figure 4.8 : Map showing Model-based sub-national maternal mortality ratio (MMR) estimates, for 36 states and FCT, Nigerian DHS 2013.

Table 4.16a Model-based Estimate of maternal mortality rates (MM rates) and maternal mortality ratio (MMR) in Northern States Nigeria, 2018

Region	States	MM Rate	MMRatio
North Central	Kogi	0.14	2308 (2247 – 2314)
	Niger	0.09	2464 (2456 -2654)
	Abuja	0.21	1206 (1072 -1442)
	Nasarawa	0.14	949 (929 – 954)
	Benue	0.09	626 (617 – 628)
	Kwara	0.14	591 (540 – 614)
	Plateau	0.12	862 (844 -992)
North East	Yobe	0.10	480 (445 – 494)
	Borno	0.10	357 (291 -394)
	Adamawa	0.12	659 (614 – 687)
	Gombe	0.13	811 (743– 862)
	Bauchi	0.10	651 (601 – 788)
	Taraba	0.11	420 (377 – 536)
North West	Katsina	0.07	188 (150 – 199)
	Jigawa	0.10	173 (70 – 227)
	Kano	0.06	233 (149 – 281)
	Kaduna	0.07	326 (273 – 346)
	Kebbi	0.10	665 (617 -689)
	Sokoto	0.12	320 (294 -328)
	Zamfara	0.09	809 (761 – 830)

Table 4.16b: Model-based Estimate of maternal mortality rates (MM rates) and maternal mortality ratio (MMRatio) in Southern States Nigeria, 2018

Region	States	MM Rate	MMRatio
South East	Anambra	0.09	667 (645 – 799)
	Enugu	0.12	681 (649- 685)
	Ebonyi	0.11	831 (803 -937)
	Abia	0.14	886 (837 -971)
	Imo	0.10	969 (928 – 1068)
South South	Edo	0.15	3719 (3683 -3725)
	Cross River	0.16	1872 (1862 – 1974)
	Akwa Ibom	0.13	890 (859 – 1094)
	Rivers	0.09	1083 (1064 – 1188)
	Bayelsa	0.26	444 (414 -647)
	Delta	0.12	1735 (1658 -1857)
South West	Oyo	0.10	323 (309 – 423)
	Osun	0.13	895 (797 – 1025)
	Ekiti	0.18	943 (508 – 759)
	Ondo	0.15	1059 (1046 – 1163)
	Lagos	0.07	546 (503 – 644)
	Ogun	0.13	13 (12 – 15)

4.7 Effects of selected covariates associated with maternal mortality.

A Zero-inflated Poisson regression model was fitted to observe the effects of aggregated selected covariates on MM and provide an empirical evidence of the McCarthy framework as it applies to Nigeria at the state levels, using the 2008 and 2013 Nigerian DHS datasets. The results of the models fitted for the MM are presented in Tables 4.17a (2008), 4.17b (2013) and 4.17c (2018). The Zero-Inflated Poisson model for count variables used in this analysis showed that the knowledge of family planning and the region of residence are important covariates that contributes to the MM outcomes of women in Nigeria for the 2013 survey.

Table 4.17a: Effects of selected covariates associated with maternal mortality at the state level NDHS, 2008

Variables	RR	P-value
Proportion of women in various wealth index households		
Poor		
Rich	0.65(0.30 – 0.91)	0.54803
Type of Place Residence		
Rural(reference category)		
Urban	0.30(0.12-0.45)	0.05395*
Skilled Birth Attendant		
No(reference category)		
Yes	2.76(0.90-3.11)	0.01348
Knowledge of Family Planning		
No(reference category)		
Yes	0.75(0.44-0.81)	0.00551*
Use of Family Planning		
No (reference category)		
Yes	0.52(0.33-0.89)	0.22138
Attended Antenatal Clinic		
No (reference category)		
Yes	0.42(0.32-0.78)	0.06804
Geopolitical region		
North Central		0.06092
North East		0.53149
North West	1.84(0.92 -2.01)	0.74243
South East	1.26(0.98-1.41)	0.41746
South South	1.12(0.66-1.45)	0.00171*
South West (reference category)	0.71(0.46-1.01)	

Table 4.17b: Effects of selected covariates associated with maternal mortality at the state level NDHS, 2013

Variables	RR(95%C.I)	P-value
Proportion of women in various wealth index households		
Poor		
Rich	0.77(0.41-0.89)	0.80361
Type of Place Residence		
Rural(reference category)		
Urban	0.81(0.55-1.79)	0.03120*
Skilled Birth Attendant		
No(reference category)		
Yes	0.73(0.50-0.82)	0.6111
Knowledge of Family Planning		
No(reference category)		
Yes	0.55(0.30-0.67)	0.0400
Use of Family Planning		
No (reference category)		
Yes	1.23(1.01-1.60)	0.1821
Attended Antenatal Clinic		
No (reference category)		
Yes	0.90(0.77-.1.02)	0.0908
Geopolitical region		
North Central		0.1432
North East		0.9111
North West	0.34(0.11-0.56)	0.3012
South East	0.96(0.80-1.09)	0.4111
South South	1.01(0.81-1.90)	0.0009*
South West (reference category)	0.66(0.21-0.95)	

Table 4.17c: Effects of selected covariates associated with maternal mortality at the state level NDHS, 2018

Variables	IRR	P-value
Proportion of women in various wealth index households		
Poor		
Rich	0.66(0.34-0.90)	0.9098
Type of Place Residence		
Rural(reference category)		
Urban	0.51(0.13-0.75)	0.0034*
Skilled Birth Attendant		
No(reference category)		
Yes	1.27(1.00-1.50)	0.1230
Knowledge of Family Planning		
No(reference category)		
Yes	0.55(0.30-0.90)	0.0000*
Use of Family Planning		
No (reference category)		
Yes	0.43(0.20-0.61)	0.3123
Attended Antenatal Clinic		
No (reference category)		
Yes	0.94(0.45-1.55)	0.0600
Geopolitical region		
North Central		0.0700
North East		0.9087
North West	2.01(1.68-2.40)	0.7000
South East	1.34(1.11-1.87)	0.1476
South South	1.78(1.41-1.99)	0.0000*
South West (reference category)	0.81(0.50-.1.00)	

CHAPTER FIVE

DISCUSSION

Firstly, this study has main goals to do a comprehensive and critical review of the various published estimates of MM in Nigeria and the various methodological approaches. Secondly is to provide plausible direct and model- based estimates for adult female and MM for sub-populations in Nigeria. These sub-populations included the 36 States and the Federal Capital Territory, the 6 geo-political zones and the two types of residence, either urban or rural. The third was to compare the results from the direct and model with estimate using the indirect sisterhood method using the crude and adjusted total fertility rates, for the 6 geo-political zones and two types of places of residence. The fourth was to identify covariates contributing to high MM in Nigeria.

Prior to this research, attempts have not been made at using the widely accepted Nigerian Demographic Health Survey datasets to generate disaggregated rates for MM in Nigeria. There were arguments also on the magnitude of mortality among women of reproductive age in Nigeria. This challenge is similar to that observed in many other developing countries all over the world. Also, while studies have identified the various causes of MM, specific effect of the covariates has not been assessed in the Nigerian population. It can be widely agreed as a frame work that certain covariates are attributing to death in women of reproductive age in a population. However, there would be unique effects of specific ones in the Nigeria population. This study has ascertained the number of maternal deaths observed in each state, geo-political zones and also residential places in Nigeria. In the face of the rareness of maternal deaths and the proposed large standard error that comes with its use, model-based refined estimates with confidence intervals have been generated for these sub-populations and this would assist programme and intervention evaluation as well as policy making in the country. The limitations and strength of the study were also discussed.

5.1 Data quality and completeness of information on siblings from respondents.

In general, the assessment of the data showed the Nigerian DHS's siblings history record was excellently collected for both the 2008, 2013 and 2018 reports. The magnitude of missing data in sibling's history exposes the combine effort of the interviewers and the siblings recounting the maternal experiences of their sisters to provide high quality datasets required for reliable estimates of MM estimation. The age at death (AD) and year since death (YSD) (before the interview date) the sibling died are two variables necessary to correctly measure the women person-years of exposure for the women and hence the MM rates and MMR. Minimal data on survival status of sisters as well as the ages at death were missing. This depicts progress in the quality of data generated with the Nigerian DHS. It can then be inferred that the 2008 and 2013, 2018 are more valid reports than controversial 1999 report that was widely critiqued.

As expected, the percentage of siblings with missing data for the current age was lower than the percentages of missing vital status recorded for the dead siblings. Respondents generally had more information about their living sisters than recalling information about a dead sister, although sometimes, a huge age gap between a respondent and the reported sibling or migration from the family household by the respondent or her siblings can be reasons for leading to reporting of unknown vital status (Stanton, Abderrahim and Hill, 1997 ;Ahmed, Li, Scrafford and Pullum, 2014). It is can be conveniently assumed that events that occurred in distance past also contributes to the unreported vital status, due to recall issues of events occurring in the later years of zero to six years before the survey. The dependability of the MM estimates derived is directly related to the estimates of adult female mortality estimates from the Nigerian DHS dataset (Ahmed *et al*., 2014). The pattern shown in the generated result of the MM rates and ratio, resonates with the pattern observed in the adult female mortality estimate. The general levels and pattern of mortality is high in Nigeria; hence these are reflected in the mortality experiences of women of reproductive ages. This serves as some validation for the MMRates and MMR in the absence of other sources to compare the results with (Boerma, 1987). In Summary, due to the completeness of the respondents account of their siblings, valid estimates can be made with the dataset for MM levels, as there were minimal recall issues in the reporting of the events in their sibling's life. This is further strengthened by the assumption that sisters are likely to remain in contact and even possibly assist each other during pregnancy and childbirth.

5.2 Validating plausibility of estimates through Fertility of Previous Generation: Mothers' parity i.e. sibship size

Sibship size, also known as mother's parity, is important since the sisterhood method is based on proportional relationship between respondents and their sisters. It is a strong base for the plausibility of information obtained from siblings' history (Graham, Brass and Snow, 1989). Adequate sibship size which comes to play as smaller sibship indicates that there might be a zero-reporter and the smaller sibships population are more likely to be completely missed in the sampling for data collection (Masquelier and Dutreuilh, 2019). In conventional discourse, the sibship size is investigated across the age groups to view age heaping and investigate how much siblings the older women report compared to women in younger ages. This is because it is assumed that mothers of older women have completed their fertility and mothers of younger women might not. However, since disaggregation was done in this study across sub-population without further breaking it into age groups of respondents, this might not be possible. Howbeit, this is an attempt of validating the consistency and quality of the data set before using the siblings' history approach in generating MMR and MM rate. The sibship size gives the average family sizes in a high fertility society in a developing country like Nigeria. The sibship sizes were observed for inappropriate shoot or decline in any of the 36 States, in such a way that might reflect inconsistencies with the GFR of Nigeria. This also provides the adequacy of the number of households that were visited in each state to obtain the information on large number of women who has reached reproductive ages on which the MM estimates are based. It is assumed that in these populations, families especially sisters remain in close contact for a long time after leaving their natal homes. Since the circumstances of death of an adult sister remain a memorable event, the validity of the ages at death and causes of death reported by the siblings' remain plausible. In summary, the fertility of the previous generation, as reported by the respondent's mirrors acceptable trend on fertility in Nigeria as it is assumed that aside for a few countries, sub-Saharan Africa's fertility rate remained high and stable, or slightly decreased over the past 35 years. This validates the of accuracy and recall on information that has happened in the past. In addition, due to the recall and selection bias associated with siblings' history approach to estimating mortality, the fact that an individual respondent (usually a woman) is alive at the time of the survey data collection is capable of biasing the estimates of MM downwards (Gakidou and King, 2006). The suggestion was to exclude the respondent from the denominator in the calculation of the rates of MM. However, for this study, the approach for the validity of the rates and ratio was used, since the mortality did not significantly vary, in all the sub-populations, with the size of the family of the siblings i.e. sibship size (Trussell and Rodriguez, 1990). Hence, the estimates of MM generated are not biased. In total, the results on mother's parity shows the reported consistency in the fertility patterns compared with the total fertility rate observed in Nigeria; 5.7 for 2008 and 5.5 for 2013.

5.3 Sub-national variation and trend in maternal mortality Rates and Ratios

The study has successfully highlighted the critical areas where maternal mortality rates and ratios are highest in Nigeria. The general outlook of the percentage of adult female deaths that were maternal deaths was seen to increase with each year of the survey. The percentage of female deaths increased from 22.9% in 2008 to 34.2% in 2018. The observed differences in MM between urban and rural places of residence and the various states and geo-political zones mirrors inequalities that has been observed in other developed countries (Ronsmans and Graham, 2006). Both the direct sisterhood method and the model-based approach have produced plausible estimates of MMR for the various states in Nigeria. The direct sisterhood method further produced estimates that can be used for planning and policy formulation across the six geopolitical zones and the rural-urban places of residence. There were no significant gap in the estimates from the two approaches, however, highlighted difference exist between the confidence interval of levels of MMR estimated with the direct sisterhood method and the model-based approach. The model-based approach produced estimates with considerable narrower confidence interval. Both aforementioned approaches produced estimates that are similar to the estimates published by the international interagency group on maternal mortality and also the Nigerian DHS.

Another set of estimates were presented by the Institute for Health Metrics and Evaluation (IHME) of the University of Washington in Seattle. Their regression model differed from the Interagency with the use of more AIDS or AIDS-related deaths in to the regression model used in obtaining the MMRatio. The IHME estimated maternal deaths to be 342,900 compared to the UN estimates of 358,000 maternal deaths. This was used to obtain IHME estimates of 251 per 100,000 live-birth (range 221-289) and UN estimates was 260 (range 200-370). According to Abouzahr, the estimates differ in the statistical methods used in deriving the parameters and does not necessarily mean one is superior to the other (Abouzahr, 2011). While the UN estimates used Gross National Income (GNI) as a covariate in their analysis, as well as general fertility rate and proportion of deliveries attended to by skilled birth attendants, in addition to the IHME covariates included total fertility rate, HIV zero-prevalence, neonatal mortality, age-specific female education as well as age. Although still birth attendant was included in the IHME analysis, it was not an addition of the predictive validity of the estimates of MM. It is difficult to judge one method as superior to another as the statistical models are rather descriptive than explanatory in nature.

This study has shown that women of child-bearing ages in urban areas have fewer mortality experiences than their counter-parts in the rural area. Likely explanation for this pattern is that women in urban areas have better access to the take up of health services and other amenities that improves the survival of the women during and after pregnancy. This is consistent with studies done in some rural areas in the Northern part of Nigeria showing that women in rural areas are disadvantaged in the inequality of provision of health services. (Gulumbe *et al*., 2018). An overview of the plausible estimates of the levels of MMR from this study shows a spatial pattern in the magnitude of the MM, indicating higher levels in the Northern part of the country than the Western and Southern areas of the country. According to descriptive findings, the Northern states have higher sibship sizes meaning higher number of mother's parity for all respondents. In essence, there was high fertility experiences as well as high mortality experiences in those regions. The poor health outcomes for mothers in Northern Nigeria are linked to factors such as weak health infrastructure, low literacy and large distances from health facilities (Alabi *et al*., 2014). It is common knowledge that child marriages and early child bearing are common in the Northern parts of Nigeria, studies also confirmed that there is a richer culture of seeking medical attention and having hospital deliveries among the Southerners especially the Yoruba tribes (Lewis Wall, 1998). In a previous study, it was observed that women from the northern region were mostly uneducated and mainly unemployed, relatively poor and young mothers, who are younger than 18 years (Adedini and Odimegwu *et al*., 2015). Other researches show a proof of higher education, which is linked with less fertility rate, is observed at the Southern States, especially the South West zone of Nigeria (Olusegun *et al*., 2012).

Although the magnitude of MM is highest in the North, a few states contribute to the magnitude of the MM reported in the various geo-political regions. This is one of the advantages of this study; further investigation has been made to ensure that each state in the geo-political region is accounted for, to reveal the magnitude of burden they contribute to each region. For instance, in 2008, the North East and North West had the highest MMR, however, Taraba state in the North East and Kaduna and Zamfara states in the North West, contributed largely to the MMR of the region compared to other states in the region. Ebonyi state in the South East and Akwa Ibom State in the South South also had MMR that were as high as those observed in the Northern parts of the country. Similarly in 2013, Niger state in the North Central, Borno state in the North East and Kaduna and Kebbi states in the North West contributes largely to the high magnitude of MMR for the Northern states. Although the Southern states had lower level of MM compared to the states in the North, Ebonyi state in the South East and Akwa Ibom in the South South had relatively high MMR as well. These states estimates from these studies can be compared in magnitude to other MMR estimated from hospital-based studies in the various states in the country, which are relatively high. This resonates with a previous study in Malawi. (Beltman *et al*., 2011) (See Appendix Table 2.1a, 2.1b &2.1c). This highlights possible political will issue and administrative lag in commitment to the health services of individual states. This trickles to the allocation of resources from the central pool to address the healthcare needs of each state. If there are no small area sub-national estimates of mortality indices, in this case MM and resources are being allocated to each state equally, or based on other indicators other that the burden of mortality and monitored and evaluated healthcare needs, then, the real high risk areas will be neglected. This might in turn cause the heavy inequality in the MM experience of women in neighboring states within the same geographical locations.

5.4 Observed limitations from estimates obtained from indirect sisterhood method

On the other hand, unlike the direct sisterhood and model-based approach of estimating levels of MMR, the indirect method generated slightly questionable estimates of MMR for the rural-urban places of residence and the six geo-political zones, using the crude and adjusted total fertility rate for Nigeria. In general, the estimates derived from the indirect method were lower compared to that of the direct method. Subsequently, the indirect method produced estimates that were lower than the average produced by the NDHS report for both 2008 and 2013. Apparent differences in the indicators of mortality generated by the two methods starts from the numerators and denominators, while the indirect method estimates the lifetime risk of maternal deaths and the proportion of adult female deaths, the direct methods allows for the estimation of exposure time by the additional questions at the time of the survey about the calendar time of the deaths of the siblings reported. With the DHS as well, the births are also calculated from the survey therefore this allows for sex and age specific death rates for the reference period of seven years preceding the survey. The MMR results obtained from the lifetime risk of dying for women of reproductive ages, were ridiculously lower than what is plausible possible. An observed reason for this might be the inherent mathematical relationship in the theory of multiplying total number on ever married sisters in each age group across varying sub-national groups with the same multiplying factor (adjustment factor, A). This poses a challenge of not considering the various heterogeneity of the groups, location and even varying exposure of women in their reproductive ages in the subgroups in question.

5.5 Covariates of Maternal Mortality in Nigeria.

Region of residence and knowledge of family planning were significant covariates of MM using the Nigerian DHS 2008 and 2013. This agrees with other researches attributing the mortality experience of mothers to socio-economic disparities , regional distribution of awareness and utilization of family planning (Fabamwo, Akinola and Akpan, 2009;

Olatunji and Sule-odu, 2001). This might be due to the huge differences in cultural affiliations, population densities, diversities in religious believers and traditional practices, as well as the political fluctuations.

5.5.1 Contribution to the body of knowledge and suggestions for further studies

First, this is the first known attempt at deriving plausible estimate of maternal mortality rates and ratio for sub-national levels in Nigeria. The estimates of maternal mortality as an important indicator of development and population health in Nigeria's major sub-population (especially the 36 states and the FCT) has been added to the body of evidences available to policy and decision makers. This has the potential of enhancing the quality of health investments in the various under represented areas in the population. Second, this study has been able to provide the measures of uncertainty for MM rates an ratios in the Nigeria's sub-populations. Lastly, it provides an empirical assessment of direct, indirect sisterhood and small area estimation methods of maternal mortality estimation.

In summary, the disaggregation of population data in generating demographic estimates has also been introduced as a plausible means of handling the issues of health disparities across varying sociodemographic groups in the Nigerian population. This is a novel area in demographic research as attention becomes draw to precision public health to enhance health outcomes through equitable, data-driven policies in population health. This same methods can be applied the under-five mortality and fertility patterns of the various states and geo-political zones in Nigeria. Small area estimation has shown promising possibilities of handling the data inadequacies in some demographic or geopolitical groups that might have insufficient sample sizes for direct estimations of demographic indicators. In addition, further studies involving qualitative data collection might be required to further provide empirical evidence on the inequity experienced by woman of reproductive ages across subpopulation in Nigeria.

5.6 Strength and Limitation of Study

This study has provided estimates that allow for spatial mapping of small area MM experience in Nigeria. This helps for understanding geographical variation and allocating decentralized resources, and policies to curb MM in sub-national areas with high level of MM. This can also assist social demographers in assessing etiological hypotheses in researching the high-risk areas of MM in Nigeria per state.

While the dataset allows for direct estimation of MMRates and MMR using the sisterhood method, in the line of thoughts of previous researchers of such disaggregation yielding wider confidence intervals and high relative errors, the model-based approach takes care of this patterns in the estimates for the various states. This approach centres the estimates around an average by borrowing information within the population to generate a refined estimates with assumptions suitable for small area estimations. This is a major strength for the small area estimation technique utilizing the empirical Bayesian method. Furthermore, the estimates from this method yielded a narrower 95% confidence intervals for generated estimates.

In the interpretation of this study, some limitations should be considered for effective approbation. The maternal deaths captured by the Nigerian DHS is, in fact, pregnancy-related death by definition and the datasets are not appropriate for tracking development in maternal health over a short period of time. Also, the sisterhood method used in the DHS surveys assumes that the reported sisters by each respondent are a representative sample of the population in which the survey took place. It is then believed that it is possible to make unbiased estimations of MM indicators with the dataset comfortably. However, the respondents answered question about their dead siblings which might have migrated from their places of birth or the respondent might have migrated due to reason bordering from marriage and places of work. Therefore, we had no information on direct residence of the reported sisters; the location of the responding siblings was used as proxy for the dead siblings' location. The assumption that in African settings sisters are known to keep in touch after marriage then became the bedrock for the disaggregation to sub-national groups.

One other limitation of the study is that disaggregation does not allow for the conventional age structure disaggregation that is well known in generating demographic estimates. Historically, demographers have used methods that break data in five-year age intervals, further disaggregation of the sub-population into conventional age structures would have allow to make deduction that are age specific and also identify age heaping in the sub-national groups that are otherwise impossible. However, the number of maternal death counts will be too low in the further disaggregation, hence, making this aspect of analysis impossible. Finally, in an ideal situation, siblings-based mortality estimates can be validated by comparing it to the estimates from some other valid sources which includes census, vital registration systems, etc. Unfortunately, in Nigeria, the DHS sibling's history is the only source available to estimate both adult and MM estimates.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Maternal Mortality is an indicator of socio-economic development of a country. Its adoption into the sustainable development goals (SDG goal 3.1) as one of the indices for delivering a demographic dividend in the wake of demographic transition, necessitates a need to obtain reliable estimates to track the progress toward the attainment of the goal. In a bid to narrow down interventions to as much micro levels as possible, the estimates required also engender a need to have sub-population versions. These are some of the reasons why population-based surveys are carried out regularly. A few community and facility-based studies have attempted to show the magnitude of MM in various local segment of the population, however, the inconsistencies in the estimated rates has made it difficult to draw trends in the burden of MM in Nigeria, and its sub-population. Similarly, identification of covariates that contributes to the burden of MM in Nigeria in particular has not been investigated to reveal the pattern of adjustments that needs to be made in interventions and programme designs to curb the mortality menace, explicitly for each sub-population.

This study was therefore conducted to address these essential research gaps. Plausible estimates of MM have been derived for all 36 States and FCT, Six geopolitical zones and urban/rural places of residence, from using the available MM datasets from the Nigeria Demographic and health Surveys of 2008, 2013 and 2018. Adequate interpretation of the result has been discussed with regards to the evidences generated. Additionally, an in-depth explanation of the strengths and limitations of the study was briefly discussed. The next sections make conclusions, some recommendations and possible policy implications.

6.2 Conclusion

The findings show that MMR in Nigeria has not decreased significantly, and this also showed in the estimates from 2008, 2013 and 2018. It was in fact noticed that there was a slight spike in the estimates of MMR from the 2013 datasets as compared to the 2008 datasets and the percentage of maternal deaths increased across the three surveys. MM was relatively lower in the Southern part of Nigeria compared to the Northern regions. Although this is so, the South West experienced a slight increase in MMRatio of about 4.8% from 2008 to 2018. However, the Mortality trends declined about 18% in the North West and 54.2% in the South east from 2008 to 2018.

In comparison with sub-national MM estimates, findings from this study suggests that facility-based estimation of MMR, are not substantive representative of these states in which they were carried out. These studies might have over reported the phenomenon, in that it is concentrated for women that were able to access health care at the clinics where the study was carried out. This leaves out other deaths that occur at home, that could not reach the health care centres or hospitals, and in fact the deaths that were measured might just be emergencies that were rushed into the clinics. Hospital based MMR is rather influenced by a delay in the health seeking behaviour of the women, It can be concluded that facility-based estimates are unacceptably high. MM was observed to be higher in states and region with high fertility, especially northern part of the country. This means that women of reproductive years are more exposed to the risk of child-bearing in these regions. It is also known that these regions are socially conservative and have practices of early girl-marriages most especially in their rural regions (Gulumbe 2018). At the communities levels, High maternal death counts were associated with geopolitical zones and the knowledge and the actual use of family planning.

This study has successfully provided patterns of MM in Nigeria and as such produced a baseline on which improvements on MM can be based in the three major sub-population categories in Nigeria; *States, Geopolitical zones and Urban/Rural places of residence*. This has fulfilled one of the basic tenants of public health in understanding spatial patterns of health-related problems (Atkinson, Crowson, Pedersen and Therneau, 2008) in essence also crossing the hurdles of unreliable estimates due to unavailability of CVRS and the rareness of maternal deaths in a statistical sense.

6.3 Recommendations /Policy Implications

With the desire to reduce the global maternal mortality ratio(MMR) to less than 70 maternal deaths per 100,000 live-births between 2016 and 2030, the international agreement for low and high risks of maternal deaths that is a lifetime risk of 1 in 3,300 and 1 in 100 women of reproductive years, respectively. This makes Nigeria still fall into the category of regions with women of high risk in pregnancy.

In order to curb high MM in Nigeria, sub-national disparities need to be addressed. This can be urban-rural, geo-political region and even the various states' context. This is beside the concentrated effort made at the central government level. Socio-economic and health development imbalances impede the progress of a country's global or public health improvement. If there are left behind groups in a population, achieving any of the sustainable goals will be sabotaged by huge spatial inequalities. The disaggregation of the data into the sub-population as adopted in this study has provided plausible estimates with which MM in Nigeria's sub-population can be described, monitored and curbed. At this stage, in Nigeria, level of MM produced in this study for each sub-population might not precise estimates, but it is sufficient to raise the consciousness of the government and policy makers to the magnitude in various types of places of residence, geo-political zones and states. For instance, estimates bordering between 300-700 per 100,000 might be given same policy responses, however, sub-population with estimates higher than that are definitely red flagged areas. Evidence-based decisions clearly require reliable estimates, in the absence of which resources will be wasted undetected. This has provided researched evidence for a need to target intervention programmes to the high risks areas like the North Central, North West and some part of the South-South, where MM is highest and most likely to occur.

Reliable sub-population data and estimates on mortality are essential for policy and for planning to monitor the progress and development of a country against set goals. In Nigeria, since Vital Statistics Registration System (CVRS) is unavailable, small area demographic estimation methods can be explored in the interim. This can be by disaggregating population-based data and exploring direct estimation or using model-based approaches (Hosseinpoor *et al*., 2016; Reza and Bergen, 2016). Within country comparison of demographic estimates, mortality will reveal the dimensions of inequalities in the population. Whiles the availability of the NDHS has brought a rich dataset for demographers to understand the dynamics of population and estimates indices in Nigeria, strengthening the complete CVRS should be a key priority in the country. The registering of births and deaths should be an integral part of the nation's health surveillance culture. In the meantime, more investments should be put in place into the NDHS in enhancing the data quality.

Small area datasets need to be collected in national surveys. It might be expensive to have a single survey capture all the information needed, however, data on both health and inequity might be gotten from different sources. For instance, if the data source captures studies for different purposes, it might decide to collect data not only at household level but also put into consideration disaggregation that allows for regional analysis and sub-national estimates which might include, race, ethnicity, economic status etc. Therefore it means sampling must always align with administrative stratification for uniformity. Also, since health intervention programmes are aimed to curb health menaces and also to reduce disparities, regional or state level monitoring of demographic indices will be a useful tool to provide benchmarking terms. This will ensure that there is appropriate resource allocation according to the magnitude of burden in each sub-national population. This is particularly more effective when the country's health system is decentralized and allows to capture the substantial differences that may occur in the various geographical areas.

It is no news that a population-wide intervention would costs more money and resources to implement, hence, focused sub-population-based interventions has been proven to bring about more reduction in MM (Kidney *et al*., 2009). Building a sustainable evaluation capacity at the country and state levels will help in the allocation of scarce resources. Evidence-based intervention, programmes and policies can be made to various states and geo-political zones. This enhances the cases of inclusiveness for rural residents and vulnerable people across the country. There is a need to improve and scale-up demographic estimates for mortality and fertility in different sub-populations in Nigeria exploring the robustness of the Bayesian method and more importantly to strengthening small area demographic estimates in Nigeria and Sub-Saharan Africa at large. The Bayesian method is a rich method that can utilize data from ranges of sources and measure uncertainty in resultant rates. It also has the capability of smoothing data across age, time and space as well as correct mortality data for its incompleteness. More investigation will be required, largely through qualitative researches and probably maternal surveillance audit and autopsies, to determine the factors contributing to high level of maternity mortality (MM) in the high-risk zones in Nigeria.

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APPENDICES

Appendix 1

Table Adapted from Manual X.

TABLE 7. COEFFICIENTS FOR INTERPOLATION BETWEEN CUMULATED FERTILITY RATES TO ESTIMATE PARITY EQUIVALENTS

Age group (1)	Index i (2)	Equation No. (3)	Coefficients $a(i)$ (4)	$b(i)$ (5)	$c(i)$ (6)
(a) *Fertility rates calculated from births in a 12-month period by age of mother at end of period*					
15-19-40-44	1-6	B.2	3.392	−0.392	-
45-49	7	B.3	0.392	2.608	-
15-19	1	B.4	2.531	−0.188	0.0024
20-24	2	B.4	3.321	−0.754	0.0161
25-29	3	B.4	3.265	−0.627	0.0145
30-34	4	B.4	3.442	−0.563	0.0029
35-39	5	B.4	3.518	−0.763	0.0006
40-44	6	B.4	3.862	−2.481	−0.0001
45-49	7	B.4	3.828	0.016[a]	−0.0002
(b) *Fertility rates calculated from births by age of mother at delivery*					
15-19-40-44	1-6	B.2	2.917	−0.417	-
45-49	7	B.3	0.417	2.083	-
15-19	1	B.4	2.147	−0.244	0.0034
20-24	2	B.4	2.838	−0.758	0.0162
25-29	3	B.4	2.760	−0.594	0.0133
30-34	4	B.4	2.949	−0.566	0.0025
35-39	5	B.4	3.029	−0.823	0.0006
40-44	6	B.4	3.419	−2.966	−0.0001
45-49	7	B.4	3.535	−0.007[a]	−0.0002

[a] This coefficient should be applied to $f(i-1)$, not $f(i+1)$, that is, to $f(6)$ instead of $f(8)$.

TABLE 8. COEFFICIENTS FOR CALCULATION OF WEIGHTING FACTORS TO ESTIMATE AGE-SPECIFIC FERTILITY RATES FOR CONVENTIONAL AGE GROUPS FROM AGE GROUPS SHIFTED BY SIX MONTHS

Age group (1)	Index i (2)	Coefficients $x(i)$ (3)	$y(i)$ (4)	$z(i)$ (5)
15-19	1	0.031	2.287	0.114
20-24	2	0.068	0.999	−0.233
25-29	3	0.094	1.219	−0.977
30-34	4	0.120	1.139	−1.531
35-39	5	0.162	1.739	−3.592
40-44	6	0.270	3.454	−21.497

Table A2.1a: Previous Estimates of Maternal Mortality in Nigeria

Author	**Sources**	**Reference Period**	**Method**	**Maternal deaths**	**MMRatio**
(Oduntan & Odunlami, 1975)	Medical institution in Western States	1972	Retrospective Hospital-based Study	Not available	380
Oduntan and Odunlami 1975	Medical institution in western states	1973	Retrospective Hospital-based Study	Not available	470
(Adetoro, 1987)	Maternal Death Review, University of Ilorin Teaching Hospital	1972-1983	Retrospective Hospital-based Study	624	450
Okaro *et al*., 2001	University of Nigeria Teaching Hospital, Nssukka, Enugu State	1991-2000	Retrospective Hospital based study	182	1406
Olatunji *et al*, 2001	Ogun State University Teaching Hospital	1988-1997	Retrospective Hospital based study	92	1700
Okaro *et al*., 2001	University of Nigeria Teaching Hospital, Nssukka, Enugu State	1976-1985	Retrospective Hospital based study	127	270
Audu *et al* 2002	Usmanu Danfodiyo Univeristy Teaching Hospital, Sokoto	1990-1999	Retrospective Hospital based study	197	2151
Adamu *et al*, 2003	Research and Statistics Department of the Ministry of Health; Retrospective study of information contained in the vital statistics register in Kano State	2003	A non-linear regression model was fitted to obtain the best temporal trajectory for the Maternal Mortality Ratio	4154	2420

Table A2.1b: Previous Estimates of Maternal Mortality in Nigeria

Author	**Sources**	**Reference Period**	**Method**	**Maternal deaths**	**MMRatio**
Uzoigwe *et al* 2004	University of Port-Harcourt Teaching Hospital; Retrospctive maternity histories	1999	Direct (Maternal deaths per total deliveries)	45	2735.6
Bukar *et al*., 2013	Maternal Death Review, Federal Medical Centre Yola, Adamawa State	2007-2011	Retrospective Hospital-based Study	54	636
Daramola, *et al*, 2004	Lagos University Teaching Hospital	1989- 1998	Retrospective Hospital based study	Not available	2920
Ujah *et al*., 2005	University Teaching Hospital, Jos	1985-2001	Retrospective Hospital-based Study	267	740
Oladapo *et al*, 2006	Olabisi Onobanjo University Teaching hospital, Ogun State	2000-2005	Retrospective Hospital based study-with autopsy record	75	2989.2
Aboyeji *et al*., 2007	University of Ilorin Teaching Hospital	1997-2002	Retrospective Hospital Survey	108	825
Onakewhoru *et al* 2008	Maternal Death Review, Saint Philomena Catholic Hospital	1996- 2000	Retrospective Hospital-based Study	32	454
Abe *et al* 2008	Maternal Death Review, Central Hospital, Benin City, Edo State	1994-2003	Retrospective Hospital based study	146	518

Table A2.1c: Previous Estimates of Maternal Mortality in Nigeria

Author	**Sources**	**Reference Period**	**Method**	**Maternal deaths**	**MMRatio**
Olapade *et al* 2008	Adeoyo Maternity Hospital, Ibadan	2003-2004	Retrospective Hospital Survey	84	963
Abasiattai *et al*, 2008	University of Uyo Teaching Hospital	2000-2005	Retrospective Hospital Survey	91	2577
Ezugwu *et al* 2009	University of Nigeria Teaching Hospital	2004-2008	Retrospective Hospital based study	60	840
Mairiga *et al*, 2009	State Specialists Hospital, Bauchi	2001-2008	Retrospective Hospital based study	Not available	1732
Bukar *et al* 2010	Maternal Death Review, University of Maiduguri Teaching Hospital	2001-2005	Retrospective Hospital-based Study	Not available	430
Anastasi *et al*., 2010	Retrospective Cross Sectional study, Bidia and Riverine Urban Slums in Lagos	2010 (but referring to years back)	Indirect Sisterhood method	Not available	1050

Table A2.1d: Previous Estimates of Maternal Mortality in Nigeria

Author	Sources	Reference Period	Method	Maternal deaths	MMRatio
Idris *et al*., 2010 (Idris,*et al*, 2010)	Retrospective Cross sectional study , 3 Rural Community in Zaria, Kaduna State	2010 (but referring to years back)	Indirect Sisterhood method	328	1400
Ngwan *et al* 2011	Jos University Teaching Hospital	2006-2008	Prospective Hospital Survey	56	1260
Alabi *et al* 2012	Maternal Death Review, Federal Medical Centre Lokoja	2005-2009	Retrospective Hospital-based Study	44	463
Doctor *et al*., 2012	Community; Jigawa, Kastina, Yobe and Zamfara	2011	Direct Sisterhood method	298	1271
Olamijulo *et al*, 2012	Lagos University Teaching Hospital	2007-2011	Retrospective Hospital based study	Not available	2096
Bukar *et al*., 2013	Maternal Death Review, Federal Medical Centre Yola, Adamawa State	2007-2011	Retrospective Hospital-based Study	54	636
Alobo *et al*., 2013	Maternal Death Review, Federal Medical Centre, Makurdi	2012	Retrospective Hospital-based Study	29	1381

World Health Organization, 2014	All Nigeria	2013	Multi-level Regression model	Not available	**560**
Sharma *et al*, 2017	Retrospective Cohort Study , 24 Local Governments in Jigawa State	2001	Indirect Sisterhood method	300	1012
Gulumbe *et al*, 2018	Retrospective Cohort Study, 6 Local Governments in Kebbi State	2001	Indirect Sisterhood method	204	890

Table A4.1: Crude and Adjusted total fertility rate for 2008 and 2013 in Nigeria

	2008		2013		2018	
	Crude TFR	**Adj TFR**	**Crude TFR**	**Adj TFR**	**Crude TFR**	**Adj TFR**
Urban	4.7	5.2	4.7	5.0	4.7	5.8
Rural	6.3	10.1	6.2	6.7	6.2	8.7
North Central	5.4	6.0	5.3	5.4	5.3	5.5
North East	7.2	8.4	6.3	6.9	6.3	6.9
North West	7.3	8.1	6.7	7.4	6.7	8.7
South East	4.8	5.1	4.7	5.0	4.7	4.3
South South	4.7	5.2	4.3	6.5	4.3	4.4
South West	4.5	5.3	4.6	5.0	4.6	3.7
All Nigeria	**5.7**	**6.4**	**5.5**	**6.0**	**5.5**	**7.5**

Table A4.2a: Fertility and Mortality indices Northern states, grouped by geopolitical zones, Nigeria DHS 2008

States	Birth	GFR	Total number of women of reproductive ages	Proportion maternal of the adult female deaths
North Central				
Kogi	707	0.16	792	8.85
Niger	1285	0.26	827	17.32
Abuja	349	0.16	369	7.83
Nasarawa	450	0.16	458	8.96
Benue	1140	0.2	972	19.18
Kwara	579	0.17	553	14.59
Plateau	834	0.18	777	7.91
North East				
Yobe	838	0.26	537	35.03
Borno	1485	0.27	912	51.58
Adamawa	996	0.22	764	31.17
Gombe	730	0.26	465	34.42
Bauchi	1597	0.27	998	24.65
Taraba	675	0.2	587	38.51
North West				
Katsina	2183	0.26	1372	37.93
Jigawa	1484	0.25	959	12.87
Kano	3316	0.27	2070	44.43
Kaduna	1700	0.21	1333	33.17
Kebbi	976	0.22	732	44.07
Sokoto	1372	0.28	822	24.14
Zamfara	1140	0.26	733	55.65

Table A4.2b: Fertility and Mortality indices for Southern States, grouped by geopolitical zones, Nigeria DHS 2008

States	Birth	GFR	Total number of women of reproductive ages	Proportion maternal of the adult female deaths
South East				
Anambra	1052	0.17	1042	13.18
Enugu	609	0.14	780	16.13
Ebonyi	615	0.18	586	21.95
Abia	618	0.13	775	32.11
Imo	795	0.15	908	13.65
South South				
Edo	772	0.17	770	19.41
Cross River	764	0.18	735	30.36
Akwa Ibom	828	0.15	938	17.87
Rivers	1224	0.14	1490	23.71
Bayelsa	469	0.18	468	33.33
Delta	917	0.14	1071	6.85
South West				
Oyo	1316	0.18	1205	12.11
Osun	665	0.13	922	22.8
Ekiti	497	0.15	556	20.85
Ondo	749	0.16	791	12.1
Lagos	1914	0.13	2446	8.72
Ogun	950	0.18	870	11.67

Table A4.3: Fertility and Mortality indices for Northern States, grouped by geopolitical zones, Nigeria DHS 2013

States	Birth	GFR	Total number of women of reproductive ages	proportion maternal of the adult female deaths
North Central				
Kogi	561	0.14	704	12.46
Niger	1939	0.22	1462	65.52
Abuja	283	0.14	315	18.52
Nasarawa	661	0.18	594	19.31
Benue	1413	0.2	1240	32.51
Kwara	554	0.16	596	12.33
Plateau	699	0.17	662	24.51
North East				
Yobe	1372	0.24	971	45.89
Borno	1549	0.19	1412	34.99
Adamawa	997	0.2	828	25.77
Gombe	824	0.25	550	23.74
Bauchi	1983	0.29	1161	13.75
Taraba	1060	0.21	844	24.39
North West				
Katsina	2438	0.27	1525	53.95
Jigawa	2231	0.27	1353	41.87
Kano	4219	0.23	3189	59.21
Kaduna	2125	0.17	2136	54
Kebbi	1816	0.25	1244	61.47
Sokoto	1623	0.25	1098	65.17
Zamfara	2286	0.29	1332	33.8

Table A4.4: Fertility and Mortality indices for Southern states, grouped by geopolitical zones, Nigeria DHS 2013

States	Birth	GFR	Total number of women of reproductive ages	Proportion maternal of the adult female deaths
South East				
Anambra	878	0.14	1052	12.72
Enugu	763	0.13	951	27.03
Ebonyi	1059	0.16	1122	32.25
Abia	455	0.14	518	30.28
Imo	765	0.15	833	22.53
South South				
Edo	593	0.14	742	6.16
Cross River	745	0.17	703	8.98
Akwa Ibom	615	0.12	864	14.41
Rivers	1030	0.13	1276	17.54
Bayelsa	336	0.16	364	13.82
Delta	785	0.14	993	23.98
South West				
Oyo	1549	0.16	1568	27.18
Osun	614	0.14	765	10.52
Ekiti	261	0.14	326	24.61
Ondo	769	0.16	808	12.88
Lagos	1756	0.14	1964	19.37
Ogun	1018	0.18	883	17.81

Table A4.5: Full Analysis of the Direct Sisterhood Method for Estimating Maternal Mortality Rate and Ratio, 2008 For Urban/Rural With 95% CI.

Place of Residence	Maternal Death	Women Exposure	Births	GFR	mrate	Lower limit	Upper limit	Mmratio	Lower limit	Upper limit
Urban	114.65	143326	11336	0.167	0.80	0.799	1.152	480	480	691
Rural	283.12	234136	272	0.194	1.21	1.174	1.482	624	606	765
TOTAL	397.77	377463			1.05	1.079	1.314			

Table A4.6: Full Analysis of The Direct Sisterhood Method for Estimating Maternal Mortality Rate and Ratio, 2008 , Geopolitical region with 95% CI.

Geopolitical Region	Maternal death	Women Exposure	Births	GFR	MMRate	Lower Limit	Upper limit	MMRatio	Lower limit	Upper limit
North Central	41.8	55316	5344	0.19	0.75	0.65	1.19	399	343	628
North East	76.5	46749	6320	0.25	1.64	1.43	2.24	654	573	896
North West	130.9	79352	12172	0.25	1.65	1.37	1.94	657	548	771
South East	46.2	51842	3688	0.15	0.89	0.85	1.50	586	557	989
South South	70.0	67339	4974	0.15	1.04	1.01	1.61	679	661	1055
South West	32.4	76864	6091	0.15	0.42	0.34	0.67	281	226	448
Total	398	377463			1.05	1.05	1.31			

Table A4.7 Full Analysis Of The Direct Sisterhood Method For Estimating Maternal Mortality Rate And Ratio, 2008 For Different State With 95% CI.

States	Maternal death	Women Exposure	Births	GFR	MMRate	Lower limit	Upper limit	MMRatio	Lower limit	Upper limit
Kogi	2.72	8560.77	707.33	0.15647844	0.317387	0.110512	1.054785	202.8313	70.6245441	674.077194
Niger	8.83	9277.67	1284.69	0.25524351	0.951397	0.556057	2.031944	372.7408	217.85367	796.080451
Abuja	1.6	4398.41	348.78	0.15512405	0.364006	0.103257	1.784292	234.6551	66.5638327	1150.23527
Nasarawa	3.42	5133.04	449.55	0.16497117	0.665854	0.268127	2.043321	403.6184	162.529396	1238.5927
Benue	19.84	12546.8	1140.47	0.20101815	1.581304	1.315129	3.146525	786.6473	654.233865	1565.29383
Kwara	1.54	5355.65	578.94	0.17335536	0.287512	0.064947	1.177742	165.8514	37.4644088	679.380373
Yobe	7.76	5702.61	837.73	0.26137115	1.361003	0.720714	2.860308	520.7166	275.74339	1094.34742
Borno	15.51	9239.96	1484.81	0.27440107	1.678232	1.035686	2.772133	611.5984	377.435277	1010.24843
Adamawa	18.01	8805.79	995.65	0.22058151	2.044932	1.485076	3.706892	927.064	673.255043	1680.50907
Gombe	7.72	5135.28	729.83	0.26035224	1.503154	0.825213	3.28651	577.3542	316.96019	1262.33207
Bauchi	13.98	10977.26	1597.19	0.27122955	1.273684	0.831608	2.343347	469.5963	306.606641	863.971828
Taraba	13.52	6888.4	675.15	0.19708615	1.962471	1.351816	3.873755	995.743	685.901052	1965.51333
Sokoto	6.09	7050.99	1372.46	0.28212774	0.864002	0.340051	1.599475	306.245	120.530808	566.932841
Zamfara	34.88	7243.84	1140.49	0.25704574	4.814841	3.406096	6.584065	1873.146	1325.09329	2561.43713
Katsina	12.77	12074.12	2183.13	0.26005507	1.05737	0.540043	1.59526	406.5948	207.664816	613.431521
Jigawa	4.76	8724.45	1484.1	0.25023586	0.54607	0.207352	1.181201	218.2223	82.8624658	472.035095
Kano	26.85	21732.43	3315.97	0.266811	1.235589	0.889268	1.885491	463.095	333.294922	706.676473
Kaduna	25.84	16341.91	1699.74	0.21344803	1.580918	1.317579	2.833962	740.6571	617.283337	1327.70602
Kebbi	19.7	6183.9	976.03	0.21767481	3.186079	1.729578	4.147398	1463.688	794.569469	1905.31829
Plateau	3.82	10043.8	834.14	0.17831992	0.380119	0.186426	1.284243	213.1666	104.545581	720.190246
Anambra	8.05	14288.25	1051.62	0.16882741	0.563524	0.391177	1.516386	333.7872	231.702435	898.187244
Enugu	3.4	8567.83	609.12	0.13538198	0.3971	0.156868	1.201044	293.3183	115.870379	887.151861
Ebonyi	7.3	6435.66	614.95	0.17742671	1.134679	0.608558	2.516644	639.5199	342.991113	1418.41329
Abia	18.91	9854.59	617.9	0.13251003	1.919245	1.553942	3.795335	1448.377	1172.69737	2864.1869
Imo	8.56	12695.49	794.55	0.14761876	0.673876	0.486158	1.812255	456.4974	329.333307	1227.65907
Edo	7.23	10108.71	772.11	0.16898984	0.715271	0.457713	1.90637	423.2627	270.852675	1128.09721
Cross River	16.19	9331.99	763.81	0.17504753	1.734793	1.352546	3.546447	991.0411	772.673828	2025.99099
Akwa Ibom	14.6	10781.74	828.31	0.14645209	1.354212	0.934006	2.575191	924.6792	637.755348	1758.38479
Rivers	25.32	18265.33	1223.71	0.13742245	1.386188	1.151084	2.495112	1008.705	837.624341	1815.65095
Bayelsa	4.99	5167.37	468.98	0.18144772	0.96551	0.451251	2.475036	532.1146	248.694955	1364.04914
Delta	1.67	13684.15	916.59	0.14248297	0.121784	0.038224	0.629506	85.4724	26.8273646	441.811356
Oyo	3.42	13405.65	1316.08	0.17825091	0.255356	0.102605	0.781244	143.2566	57.5618859	438.28354
Osun	4.96	9642.06	664.88	0.12820757	0.514905	0.228625	1.259553	401.6182	178.323979	982.432581
Ekiti	3.72	5896.01	496.74	0.15467133	0.631349	0.250795	1.766889	408.1875	162.146918	1142.35096
Ondo	2.98	9147.99	748.79	0.16126852	0.325487	0.127032	1.10593	201.8292	78.7703826	685.76901
Lagos	11.76	28844.42	1914.3	0.12843647	0.407534	0.272998	0.843464	317.304	212.555232	656.716953
Ogun	5.56	9928.25	950.24	0.17929468	0.559956	0.283368	1.428275	312.3102	158.046175	796.607608
TOTAL	397.7685	377462.6	18688.7	0.00187	1.053796	1.029918	1.314231			

Table A4.8 Full Analysis of The Direct Sisterhood Method for Estimating Maternal Mortality Rate and Ratio, 2013 For Urban/Rural With 95% CI.

Place of Residence	Maternal Death	Women Exposure	Births	GFR	MMRate	Lower limit	Upper limit	MMRatio	Lower limit	Upper limit
Urban	173	195616	15341	0.16	0.89	0.91	1.23	565	581	782
Rural	307	247486	29282	0.22	1.24	1.22	1.52	565	555	693
Total	480	443102	44623		1.05	1.13	1.35			

Table A4.9 Full Analysis Of The Direct Sisterhood Method For Estimating Maternal Mortality Rate and Ratio, 2013, Geopolitical Zones With 95% CI.

Geopolitical Region	Maternal death	Women Exposure	Births	GFR	MMRate	Lower limit	Upper limit	MMRatio	Lower limit	Upper limit
North Central	87.25	66081	6109	0.19	1.32	1.27	1.93	712	684	1040
North East	88.93	63491	7786	0.23	1.40	1.25	1.90	612	547	828
North West	188.02	125246	16737	0.24	1.50	1.37	1.83	628	574	763
South East	42.07	55400	3920	0.15	0.76	0.70	1.27	520	476	869
South South	31.45	58904	4104	0.14	0.53	0.45	0.90	380	319	640
South West	42.20	73979	5967	0.16	0.57	0.49	0.90	367	318	581
TOTAL	480	443102			1.05	1.05	1.31			

Table A4.10 Full Analysis Of The Direct Sisterhood Method For Estimating Maternal Mortality Rate and Ratio, 2013 For Different State With 95% CI.

States	Maternal death	totexp	births	GFR	mrate	Lower limit	Upper limit	Mmratio	Lower limit	Upper limit
Kogi	3.15	8062.14	561.403221	0.14058789	0.391144	0.155355	1.278655	278.2199	110.504141	909.505614
Niger	38.72	16309.99	1938.66258	0.22285366	2.374107	1.931843	3.61495	1065.321	866.86637	1622.11809
Abuja	2.93	3842.68	282.707077	0.14466106	0.762858	0.309369	2.733348	527.3414	213.858092	1889.48395
Nasarawa	5.01	7248.7	660.620544	0.1826279	0.691749	0.359026	1.961871	378.7753	196.588615	1074.2448
Benue	26.15	15328.92	1412.75404	0.19621689	1.70566	1.43621	3.075071	869.2728	731.950407	1567.17945
Kwara	1.4	6376.1	554.039735	0.16037709	0.220091	0.051843	1.056631	137.2337	32.3257553	658.841324
Yobe	16.7	11023.2	1372.10285	0.24152722	1.515278	1.066125	2.755034	627.3736	441.409962	1140.67245
Borno	31.44	12372.35	1549.0172	0.18814402	2.540785	1.568679	3.142292	1350.447	833.765091	1670.15224
Adamawa	10.86	9700.89	996.55832	0.2040323	1.119802	0.727356	2.347609	548.8355	356.490758	1150.6066
Gombe	6.78	6517.53	824.320929	0.25150529	1.039556	0.586158	2.55332	413.3337	233.059835	1015.21521
Bauchi	7.04	13310.35	1983.30581	0.28718644	0.529147	0.293545	1.245111	184.252	102.214095	433.554825
Taraba	16.11	10566.92	1060.30802	0.21077774	1.524777	1.172768	3.082339	723.4049	556.400277	1462.36448
Sokoto	15.57	11633.51	1623.14335	0.25166409	1.33817	0.864611	2.310293	531.7287	343.557562	918.006509
Zamfara	8.07	14290.65	2285.70352	0.29027084	0.56452	0.306999	1.18857	194.4805	105.762841	409.469249
Katsina	20.15	16723.98	2438.17162	0.26558238	1.205018	0.855212	2.032877	453.7266	322.013929	765.441064
Jigawa	27.83	12926.05	2230.92604	0.27426888	2.152953	1.418044	2.966281	784.9791	517.026904	1081.5229
Kano	43.21	35966.01	4219.07774	0.22885485	1.201491	1.005683	1.82108	525.0014	439.441392	795.736012
Kaduna	37.41	20126.41	2124.63349	0.16984038	1.858728	1.271309	2.405178	1094.397	748.531375	1416.14039
Kebbi	35.78	13579.6	1815.61509	0.24577134	2.635116	2.071226	3.97351	1072.182	842.74522	1616.75089
Plateau	9.88	8912.46	698.643961	0.17386864	1.108707	0.804247	2.742949	637.6691	462.560143	1577.59842
Anambra	2.62	12539.5	877.650423	0.13813749	0.209047	0.078926	0.781773	151.3324	57.1359595	565.938292
Enugu	10.38	11954.44	762.669853	0.13443501	0.868093	0.596988	1.978556	645.7345	444.071529	1471.75675
Ebonyi	20.28	12961.19	1059.1141	0.16212879	1.564381	1.169591	2.772481	964.9001	721.396006	1710.0487
Abia	3.11	7063.17	455.104477	0.14054094	0.439867	0.206187	1.721539	312.9816	146.709382	1224.93747
Imo	5.7	10882.02	765.067407	0.15191514	0.523467	0.30592	1.513612	344.5787	201.37539	996.3536
Edo	1.64	9148.55	593.343288	0.14069019	0.179163	0.053652	0.901389	127.3456	38.134629	640.691086
Cross River	3.21	8520.91	745.459333	0.16951409	0.377078	0.159913	1.29269	222.4466	94.3361628	762.585783
Akwa Ibom	7.5	9799.54	614.942045	0.12236777	0.765525	0.428926	1.742272	625.5934	350.522183	1423.80009
Rivers	12.04	15738.92	1029.58186	0.13191696	0.764879	0.538687	1.642454	579.8187	408.353054	1245.06664
Bayelsa	0.55	4108.59	335.655779	0.16413472	0.133586	0.016802	1.325653	81.38818	10.236529	807.661766
Delta	6.51	11587.5	785.327814	0.13796005	0.561658	0.308264	1.382338	407.1168	223.444432	1001.98462
Oyo	12.3	17962.27	1549.17895	0.16363893	0.684641	0.450552	1.358057	418.3855	275.332744	829.910945
Osun	1.4	8039.13	613.81594	0.13553475	0.174678	0.040503	0.824909	128.8806	29.8835277	608.632786
Ekiti	1.91	3798.51	261.259387	0.13736801	0.503209	0.154788	2.165587	366.3221	112.681257	1576.48578
Ondo	4.31	10219.12	768.803765	0.1610711	0.421629	0.213355	1.322125	261.7655	132.460383	820.832902
Lagos	16.25	24357.91	1756.09063	0.1441191	0.667194	0.51037	1.336541	462.9464	354.130419	927.386265
Ogun	6.03	9602.13	1018.09378	0.18327373	0.62807	0.312298	1.48029	342.6949	170.39966	807.693778
Total	479.94	443101.8	44622.87		1.118716	1.126779	1.347351			

Table A4.11: Birth in past year, Children Ever Born and Total women according to Age group of Respondents, Rural and Urban Nigeria DHS 2008 and 2013

Age group	Birth in past year	CEB	Total number of women in age group	Birth in past year	CEB	Total number of women in age group
Rural		**2008**			**2013**	
15-19	512	1274	4564	537	1358	4511
20-24	1110	5522	4102	1123	5978	3967
25-29	1174	11184	4193	1229	12801	4171
30-34	880	12834	3089	856	13805	3053
35-39	603	14591	2708	543	15729	2665
40-44	287	13176	2137	250	13925	2146
45-49	115	14444	2103	73	14509	2020
Total		73025	22896	4611	78105	22533
Urban						
15-19	118	252	2027	134	295	3308
20-24	430	1788	2001	561	2197	2790
25-29	678	4678	2110	782	5757	2974
30-34	449	5448	1468	567	7838	2414
35-39	232	5988	1175	325	9056	2053
40-44	73	5532	906	114	7433	1474
45-49	35	5270	802	35	8602	1402
Total		28956	10489	2518	41178	16415

Table A4.12:Birth in past year, Children Ever Born and Total women according to Age group of Respondents, Northern Nigeria DHS 2008 and 2013**.**

Age group	**Birth in past year**	**CEB**	**Total number of women in age group**	**Birth in past year**	**CEB**	**Total number of women in age group**
North Central		**2008**			**2013**	
15-19	81	220	1264	60	185	1154
20-24	219	1048	1220	252	1160	1043
25-29	268	2429	1276	289	2739	1124
30-34	159	2442	822	184	3010	772
35-39	96	2744	692	90	3028	613
40-44	43	2573	571	53	2794	500
45-49	22	2688	521	15	2247	366
Total	888	14144	6366	943	15163	5574
North East						
15-19	153	368	1256	148	397	1190
20-24	282	1468	1105	315	1775	1068
25-29	272	2859	1171	302	3341	1060
30-34	182	2971	832	218	3669	787
35-39	132	3368	740	143	4176	679
40-44	52	2834	568	58	3491	500
45-49	29	2916	545	14	3434	482
Total	1102	16784	6217	1198	20283	5766
North West						
15-19	239	637	1245	329	792	2428
20-24	475	2739	1335	625	3417	2042
25-29	445	4914	1349	682	7518	2151
30-34	381	5972	1068	476	8103	1623
35-39	240	5939	866	322	9330	1399
40-44	130	5961	732	149	7421	1069
45-49	68	6170	702	66	9566	1164
Total	1978	32332	7297	2649	46147	11876

Table A4.13: Birth in past year, Children Ever Born and Total women according to Age group of Respondents, Southern Nigeria DHS 2008 and 2013.

Age group	Birth in past year	CEB	Total number of women in age group	Birth in past year	CEB	Total number of women in age group
South East		**2008**			**2013**	
15-19	33	63	774	33	66	894
20-24	134	467	682	140	484	801
25-29	200	1318	627	224	1345	794
30-34	132	1577	454	151	1750	560
35-39	85	2199	437	82	2130	513
40-44	30	1984	334	38	2403	470
45-49	5	2332	359	3	2792	445
Total	619	9940	3667	671	10970	4477
South South						
15-19	73	135	1031	43	130	1033
20-24	198	836	950	193	663	868
25-29	251	2012	926	336	1454	900
30-34	185	2404	657	245	2038	681
35-39	116	2941	524	132	2585	613
40-44	41	2477	379	35	2290	435
45-49	12	2554	346	7	2283	411
Total	876	13359	4813	991	11443	4941
South West						
15-19	48	101	1021	43	82	1121
20-24	213	752	811	193	677	936
25-29	379	2333	954	336	2161	1116
30-34	256	2920	724	245	3074	1042
35-39	148	3385	624	132	3537	900
40-44	52	2882	459	35	2961	646
45-49	14	3052	432	7	2794	554
Total	1110	15425	5025	991	15286	6315

Table A4.14a: Indirect Sisterhood Estimates of Maternal Mortality Ratio, All Nigeria 2008

Age group of respondent	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	6591	8663	63	0.107	927	0.068
20-24	6103	10895	127	0.206	2244	0.057
25-29	6303	13203	158	0.343	4529	0.035
30-34	4557	10022	136	0.503	5041	0.027
35-39	3883	8325	151	0.664	5528	0.027
40-44	3043	6218	142	0.802	4987	0.028
45-49	2905	5596	138	0.9	5036	0.027
Total	**33385**	**62922**	**915**		**28292**	**0.0323**
TFR: 5.7 **MMratio=575**						

Lifetime risk of dying of pregnancy-related causes of 1 in 67 women

$$MMR = 1 - \left[(1 - 0.0323)^{\frac{1}{5.7}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9892)^{0.2124}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9977]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 575}$$

CI = 538 - 612

Table A4.14b: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Urban Residents 2008

Age group of respondent	**Number of respondents**	**Number of sisters exposed**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	2027	2660	15	0.107	535	0.00017
20-24	2001	3783	29	0.206	1085	0.00070
25-29	2110	4638	43	0.343	1941	0.00152
30-34	1468	3414	40	0.503	1998	0.00367
35-39	1175	2690	37	0.664	1975	0.00313
40-44	906	2002	36	0.802	1720	0.00337
45-49	802	1618	29	0.9	1438	0.00676
Total	10489	20805	229		9220	0.02484
TFR: 4.709	**MMratio=534**					

Lifetime risk of dying of pregnancy-related causes of 1 in 40 women.

$$MMR = 1 - \left[(1 - 0.02484)^{\frac{1}{4.709}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9752)^{0.2124}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9947]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 534}$$

CI = 465 - 603

Table A4.14c: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Rural Residents 2008

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	4564	6003	48	0.107	642	0.0747
20-24	4102	7112	98	0.206	1465	0.0669
25-29	4193	8565	115	0.343	2938	0.0391
30-34	3089	6608	96	0.503	3324	0.0289
35-39	2708	5635	114	0.664	3742	0.0305
40-44	2137	4216	106	0.802	3381	0.0313
45-49	2103	3978	109	0.9	3580	0.0304
Total	**22896**	42117	686		**19072**	**0.0360**
TFR: 6.282 MMRatio= **580**						

Lifetime risk of dying of pregnancy-related causes of 1 in 64 women

$$MMR = 1 - \left[(1 - 0.0360)^{\frac{1}{6.282}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9640)^{0.1592}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9942]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 580}$$

CI = 537 – 623

Table A4.14d: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North Central 2008

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1264	1713	4	0.107	183	0.0218
20-24	1220	2242	17	0.206	462	0.0368
25-29	1276	2723	18	0.343	934	0.0193
30-34	822	1872	12	0.503	942	0.0127
35-39	692	1506	16	0.664	1000	0.0160
40-44	571	1252	14	0.802	1004	0.0139
45-49	521	1087	27	0.9	978	0.0276
Total	**6366**	**12395**	108		**5503**	**0.0196**

TFR= 5.411 MMRatio = 366

Lifetime risk of dying of pregnancy-related causes of 1 in 98 women

$$MMR = 1 - \left[(1 - 0.0196)^{\frac{1}{5.411}}\right] x\ 100{,}000$$

$$MMR = 1 - \left[(1 - 0.0196)^{\frac{1}{5.411}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9804)^{0.1848}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9804]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 366}$$

Confidence interval 298 - 435

Table A4.14e: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North East 2008

Age group of respondents	Number of respondents	Sisters ever married,	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	f =ce	g =d/f
15-19	1256	1597	27	0.107	171	0.158
20-24	1105	1972	38	0.206	406	0.094
25-29	1171	2587	44	0.343	887	0.050
30-34	832	1889	43	0.503	950	0.045
35-39	740	1621	43	0.664	1076	0.040
40-44	568	1139	49	0.802	913	0.054
45-49	545	1107	41	0.9	996	0.041
Total	**6217**	11912	285		**3774**	**0.0528**
TFR = 7.16 MMRatio = **750**						

Lifetime risk of dying of pregnancy-related causes of 1 in 50 women

$$MMR = 1 - \left[(1 - 0.0528)^{\frac{1}{7.16}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9472)^{0.1397}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9925]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 750}$$

Confidence interval (664 – 837)

Table A4.14f: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North West 2008

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1245	1462	21	0.107	156	0.134
20-24	1335	2070	47	0.206	426	0.110
25-29	1349	2348	46	0.343	805	0.057
30-34	1068	2067	40	0.503	1040	0.038
35-39	866	1678	50	0.664	1114	0.045
40-44	732	1282	46	0.802	1028	0.045
45-49	702	1220	35	0.9	1098	0.032
Total	7297	12127	285		5668	0.0503

TFR = 7.297 MMRatio = **704**

Lifetime risk of dying of pregnancy-related causes of 1 in 50 women

$$MMR = 1 - \left[(1 - 0.0503)^{\frac{1}{7.297}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9497)^{0.1370}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9930]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 704}$$

CI= 623 - 786

Table A4.14g: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South East 2008

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(c)	(f=ce)	(g=d/f)
15-19	1245	774	1	0.107	83	0.0121
20-24	1335	682	10	0.206	140	0.0712
25-29	1349	627	19	0.343	215	0.0883
30-34	1068	454	8	0.503	228	0.0350
35-39	866	437	11	0.664	290	0.0379
40-44	732	334	14	0.802	268	0.0523
45-49	702	359	14	0.9	323	0.0433
Total	7297	3667	77		1548	0.0497
TFR =4.823 MMR= **1057**						

Lifetime risk of dying of pregnancy-related causes of 1 in 83 women

$$MMR = 1 - \left[(1 - 0.0497)^{\frac{1}{4.823}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9530)^{0.2073}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9901]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 1057}$$

CI = 824 - 1293

Table A4.14h: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South South 2008

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1031	1464	5	0.107	157	0.0319
20-24	950	1842	13	0.206	379	0.0343
25-29	926	2121	21	0.343	728	0.0289
30-34	657	1564	23	0.503	787	0.0292
35-39	524	1180	22	0.664	784	0.0281
40-44	379	824	14	0.802	661	0.0212
45-49	346	695	13	0.9	626	0.0208
Total	**4813**	9690	111		4120	0.0269
TFR= 4.69 **MMR = 580**						

Lifetime risk of dying of pregnancy-related causes of 1 in 67 women

$$MMR = 1 - \left[(1 - 0.0269)^{\frac{1}{4.69}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9731)^{0.2073}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9944]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 580}$$

CI = 472 - 687

Table A4.14i: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South West 2008

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1021	1213	5	0.107	130	0.0385
20-24	811	1388	2	0.206	286	0.0070
25-29	954	1949	10	0.343	669	0.0150
30-34	724	1574	10	0.503	792	0.0126
35-39	624	1379	9	0.664	916	0.0098
40-44	459	977	5	0.802	784	0.0064
45-49	432	802	8	0.9	722	0.0111
Total	**5025**	9282	49		4297	0.0114
TFR = 4.5 **MMR = 255**						

Lifetime risk of dying of pregnancy-related causes of 1 in 88 women

$$MMR = 1 - \left[(1 - 0.0114)^{\frac{1}{4.5}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9886)^{0.2222}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9975]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 255}$$

CI = 183-326

Table 4.15a: Indirect Sisterhood Estimates of Maternal Mortality Ratio, All Nigeria 2013

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	7820	9700	73	0.107	1038	0.070
20-24	6758	12044	127	0.206	2481	0.051
25-29	7145	15063	155	0.343	5167	0.030
30-34	5467	12025	162	0.503	6049	0.027
35-39	4717	10707	164	0.664	7109	0.023
40-44	3620	8106	161	0.802	6501	0.025
45-49	3422	7365	190	0.9	6629	0.029
Total	**38949**	75010	1032		34973	0.0295
TFR: 5.5 **MMR=543**						

Lifetime risk of dying of pregnancy-related causes of 1 in 89 women

$$MMR = 1 - \left[(1 - 0.0295)^{\frac{1}{4.709}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9705)^{0.2124}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9936]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 543}$$

CI = 510 - 576

Table A4.15b: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Urban Residents 2013

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	3308	3943	18	0.107	422	0.0427
20-24	2790	4861	36	0.206	1001	0.0360
25-29	2974	6080	52	0.343	2085	0.0249
30-34	2414	5094	54	0.503	2562	0.0211
35-39	2053	4383	58	0.664	2910	0.0199
40-44	1474	3324	58	0.802	2666	0.0218
45-49	1402	3042	64	0.9	2738	0.0234
Total	**16415**	30727	340		14385	0.0236
TFR: 4.709	**MMR=508**					

Lifetime risk of dying of pregnancy-related causes of 1 in 89 women

$$MMR = 1 - \left[(1 - 0.0236)^{\frac{1}{4.709}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9764)^{0.2124}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9949]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 508}$$

CI = 454 - 562

Table A4.15c: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Rural Residents 2013

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	4511	5757	55	0.107	616	0.0893
20-24	3967	7183	91	0.206	1480	0.0615
25-29	4171	8983	103	0.343	3081	0.0334
30-34	3053	6931	108	0.503	3486	0.0310
35-39	2665	6324	106	0.664	4199	0.0252
40-44	2146	4782	103	0.802	3835	0.0269
45-49	2020	4323	126	0.9	3891	0.0324
Total	**22533**	44283	692		20588	0.0336
TFR: 6.185 **MMR = 551**						

Lifetime risk of dying of pregnancy-related causes of 1 in 64 women

$$MMR = 1 - \left[(1 - 0.00336)^{\frac{1}{6.185}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9966)^{0.1617}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9994]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 551}$$

CI = 510 - 592

Table A4.15d: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North Central 2013

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1154	1573	20	0.107	168	0.119
20-24	1043	2094	15	0.206	431	0.035
25-29	1124	2769	17	0.343	950	0.018
30-34	774	1995	23	0.503	1003	0.023
35-39	613	1641	23	0.664	1090	0.021
40-44	500	1296	24	0.802	1039	0.023
45-49	366	998	20	0.9	898	0.022
Total	**5574**	12366	142		5580	0.0254
TRF=5.277		**MMR**	**485**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0254)^{\frac{1}{5.277}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9746)^{0.1592}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9959]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 485}$$

CI = 406 - 565

Table A4.15e: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North East 2013

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1190	1594	13	0.107	171	0.0762
20-24	1068	2194	44	0.206	452	0.0974
25-29	1060	2735	32	0.343	938	0.0341
30-34	787	2060	42	0.503	1036	0.0405
35-39	679	1882	42	0.664	1250	0.0336
40-44	500	1367	42	0.802	1096	0.0383
45-49	482	1196	40	0.9	1076	0.0372
Total	**5766**	13028	255		6019	0.0424
TFR	6.303	**MMR**	**685**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0424)^{\frac{1}{6.303}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9576)^{0.1587}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9931]\ x\ 100{,}000$$

$$\boldsymbol{MMR =}$$

CI = 601 -769

Table A4.15f: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North West 2013

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	2428	2291	29	0.107	245	0.118
20-24	2042	2839	33	0.206	585	0.056
25-29	2151	3467	66	0.343	1189	0.056
30-34	1623	2785	59	0.503	1401	0.042
35-39	1399	2465	54	0.664	1637	0.033
40-44	1069	1764	50	0.802	1415	0.035
45-49	1164	1869	78	0.9	1682	0.046
Total	**11876**	17480	369		8154	0.0453
TFR	6.678	**MMR**	**689**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0453)^{\frac{1}{6.678}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9547)^{0.1497}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9931]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 689}$$

Cl = 619 - 759

Table A4.15g: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South East 2013

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	894	1273	3	0.107	136	0.0220
20-24	801	1462	10	0.206	301	0.0332
25-29	794	1828	14	0.343	627	0.0223
30-34	560	1362	15	0.503	685	0.0219
35-39	513	1246	13	0.664	827	0.0157
40-44	470	1102	16	0.802	884	0.0181
45-49	445	955	25	0.9	860	0.0291
Total	**4477**	9228	96		4320	0.0222
TFR	4.707	**MMR=477**				

Lifetime risk of dying of pregnancy-related causes of 1 in 100 women

$$MMR = 1 - \left[(1 - 0.0222)^{\frac{1}{4.707}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9899)^{0.2124}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9952]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 477}$$

Cl = 382 - 572

Table A4.15h: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South South 2013

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1033	1687	4	0.107	181	0.0222
20-24	868	1990	14	0.206	410	0.0342
25-29	900	2147	15	0.343	736	0.0204
30-34	681	1840	10	0.503	926	0.0108
35-39	613	1663	17	0.664	1104	0.0154
40-44	435	1231	10	0.802	987	0.0101
45-49	411	1156	9	0.9	1040	0.0087
Total	**4941**	11714	**79**		5384	0.0147
TFR	4.273	**MMR**	**343**			

Lifetime risk of dying of pregnancy-related causes of 1 in 142 women

$$MMR = 1 - \left[(1 - 0.00147)^{\frac{1}{4.273}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9853)^{0.2340}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9965]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 343}$$

Cl = 268 - 419

Table A4.15i: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South West 2013

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1282	2179	4	0.107	137	0.0292
20-24	1465	1913	11	0.206	302	0.0364
25-29	2117	2490	11	0.343	726	0.0151
30-34	1983	2242	13	0.503	997	0.0130
35-39	1810	1949	15	0.664	1202	0.0125
40-44	1346	1360	19	0.802	1079	0.0176
45-49	1191	1078	18	0.9	1072	0.0168
Total	11194	**13211**	91		137	0.0292
TFR	4.55	**MMR**	**361**			

Lifetime risk of dying of pregnancy-related causes of 1 in 142 women

$$MMR = 1 - \left[(1 - 0.0292)^{\frac{1}{4.55}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9708)^{0.2198}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9935]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 361}$$

Cl = 287 - 435

Table A4.16a: Indirect Sisterhood Estimates of Maternal Mortality Ratio, All Nigeria 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	8423	10712	79	0.107	1146	0.069
20-24	6844	12469	126	0.206	2569	0.049
25-29	7203	15376	175	0.343	5274	0.033
30-34	5997	13637	223	0.503	6859	0.033
35-39	5406	12527	215	0.664	8318	0.026
40-44	4057	9096	210	0.802	7295	0.029
45-49	3891	8409	188	0.9	7568	0.025
Total	41821	82226	1216		34973	0.0295
TFR: 5.5 **MMR=574**						

Lifetime risk of dying of pregnancy-related causes of 1 in 34 women

$$MMR = 1 - \left[(1 - 0.0295)^{\frac{1}{4.709}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9705)^{0.2124}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9936]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 574}$$

CI = 542 - 606

Table A4.16b: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Urban Residents 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	3376	4318	23	0.107	462	0.0498
20-24	2618	4711	25	0.206	970	0.0258
25-29	2884	6088	47	0.343	2088	0.0225
30-34	2572	5787	71	0.503	2911	0.0244
35-39	2305	5429	71	0.664	3605	0.0197
40-44	1622	3646	62	0.802	2924	0.0212
45-49	1607	3517	78	0.9	3165	0.0246
Total	16984	33496	377		16126	0.0234

TFR: 4.7 **MMR=502**

Lifetime risk of dying of pregnancy-related causes of 1 in 89 women

$$MMR = 1 - \left[(1 - 0.0236)^{\frac{1}{4.709}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9764)^{0.2124}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9949]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 502}$$

CI = 452 - 553

Table A4.16c: Indirect Sisterhood Estimates of Maternal Mortality Ratio, Rural Residents 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	5047	6394	56	0.107	684	0.0819
20-24	4226	7758	101	0.206	1598	0.0632
25-29	4319	9288	128	0.343	3186	0.0402
30-34	3425	7850	152	0.503	3949	0.0385
35-39	3101	7098	144	0.664	4713	0.0306
40-44	2435	5450	148	0.802	4371	0.0339
45-49	2284	4892	110	0.9	4403	0.0250
Total	24837	48730	839		22903	0.0366
TFR: 6.19 **MMR = 601**						

Lifetime risk of dying of pregnancy-related causes of 1 in 64 women

$$MMR = 1 - \left[(1 - 0.00336)^{\frac{1}{6.185}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9966)^{0.1617}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9994]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 601}$$

CI = 560 - 642

Table A4.16d: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North Central 2018

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1597	1986	3	0.107	213	0.0141
20-24	1330	2458	4	0.206	506	0.0079
25-29	1442	3206	15	0.343	1100	0.0136
30-34	1031	2495	14	0.503	1255	0.0112
35-39	990	2338	20	0.664	1552	0.0129
40-44	696	1733	29	0.802	1390	0.0209
45-49	686	1621	19	0.9	1459	0.0130
Total	7772	15837	104		7475	0.0139
TRF=5.3		**MMR**	**264**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0254)^{\frac{1}{5.277}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9746)^{0.1592}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9959]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 264}$$

CI = 213 - 315

Table A4.16e: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North East 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1661	2219	39	0.107	237	0.1643
20-24	1414	2715	65	0.206	559	0.1162
25-29	1355	3087	74	0.343	1059	0.0699
30-34	1048	2454	79	0.503	1234	0.0640
35-39	917	2271	84	0.664	1508	0.0557
40-44	685	1536	83	0.802	1232	0.0674
45-49	559	1233	51	0.9	1110	0.0460
Total	7639	15515	475		6939	0.0684
TFR	6.3	**MMR**	**1119**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0424)^{\frac{1}{6.303}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9576)^{0.1587}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9931]\ x\ 100{,}000$$
$$\boldsymbol{MMR} =$$

CI = 1019 - 1220

Table 4.16f: Indirect Sisterhood Estimates of Maternal Mortality Ratio, North West 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	2253	3055	33	0.107	327	0.1010
20-24	1811	3453	42	0.206	711	0.0590
25-29	1726	3851	60	0.343	1321	0.0454
30-34	1415	3388	71	0.503	1704	0.0417
35-39	1142	2837	66	0.664	1884	0.0350
40-44	930	2111	45	0.802	1693	0.0266
45-49	852	1910	62	0.9	1719	0.0361
Total	10129	20605	379		9359	0.0405
TFR	6.678	**MMR**	**615**			

Lifetime risk of dying of pregnancy-related causes of 1 in 56 women

$$MMR = 1 - \left[(1 - 0.0453)^{\frac{1}{6.678}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9547)^{0.1497}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9931]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 615}$$

Cl = 553 - 677

Table 4.16g: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South East 2018

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	1066	1510	1	0.107	162	0.0062
20-24	739	1430	3	0.206	295	0.0102
25-29	883	1916	11	0.343	657	0.0167
30-34	810	1875	16	0.503	943	0.0170
35-39	766	1786	16	0.664	1186	0.0135
40-44	577	1275	15	0.802	1023	0.0147
45-49	730	1513	23	0.9	1362	0.0169
Total	5571	11305	85		5627	0.01511
TFR	4.7	**MMR=323**				

Lifetime risk of dying of pregnancy-related causes of 1 in 100 women

$$MMR = 1 - \left[(1 - 0.0222)^{\frac{1}{4.707}}\right] x\ 100{,}000$$
$$MMR = 1 - [(0.9899)^{0.2124}]\ x\ 100{,}000$$
$$MMR = 1 - [0.9952]\ x\ 100{,}000$$
$$\boldsymbol{MMR = 323}$$

Cl = 255 - 392

Table 4.16h: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South South 2018

Age group of respondents	**Number of respondents**	**Sisters ever married**	**Maternal deaths**	**Adjustment factor**	**Sister units of risk exposure**	**Lifetime risk of maternal death**
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	929	1087	3	0.107	116	0.0258
20-24	740	1225	8	0.206	252	0.0317
25-29	830	1585	9	0.343	544	0.0166
30-34	795	1660	35	0.503	835	0.0419
35-39	720	1504	21	0.664	999	0.0210
40-44	569	1250	19	0.802	1003	0.0190
45-49	497	1024	21	0.9	922	0.0228
Total	5080	9335	116		4670	0.02484
TFR	4.3	**MMR**	**583**			

Lifetime risk of dying of pregnancy-related causes of 1 in 142 women

$$MMR = 1 - \left[(1 - 0.00147)^{\frac{1}{4.273}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9853)^{0.2340}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9965]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 583}$$

Cl = 478 - 689

Table 4.16i: Indirect Sisterhood Estimates of Maternal Mortality Ratio, South West 2018

Age group of respondents	Number of respondents	Sisters ever married	Maternal deaths	Adjustment factor	Sister units of risk exposure	Lifetime risk of maternal death
(a)	(b)	(c)	(d)	(e)	(f=ce)	(g=d/f)
15-19	917	855	0	0.107	91	0.0000
20-24	810	1188	4	0.206	245	0.0163
25-29	967	1731	6	0.343	594	0.0101
30-34	898	1765	8	0.503	888	0.0090
35-39	871	1791	8	0.664	1189	0.0067
40-44	600	1191	19	0.802	955	0.0199
45-49	567	1108	12	0.9	997	0.0120
Total	5630	9629	57		4959	0.0115
TFR	4.6	**MMR**	**251**			

Lifetime risk of dying of pregnancy-related causes of 1 in 87 women

$$MMR = 1 - \left[(1 - 0.0292)^{\frac{1}{4.55}}\right] x\ 100{,}000$$

$$MMR = 1 - [(0.9708)^{0.2198}]\ x\ 100{,}000$$

$$MMR = 1 - [0.9935]\ x\ 100{,}000$$

$$\boldsymbol{MMR = 251}$$

Cl = 186 - 316

Table A4.17: Parity and Fertility Ratio Based on Children Ever Born and the Age Pattern(s) of Respondents, Nigeria 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
Nigeria 2008										
			RECORDED	CALCULATED						
15-20	0.235	0.1267	0.0966	0.1138	0.1267	0.1138	1.1126	0.1119	0.1110	0.1114
20-25	1.192	0.2390	0.2478	0.2582	0.3656	0.3720	0.9828	0.2538	0.2518	0.2528
25-30	2.514	0.2798	0.2878	0.2898	0.6455	0.6619	0.9752	0.2848	0.2826	0.2837
30-35	3.945	0.2820	0.2792	0.2746	0.9274	0.9365	0.9903	0.2699	0.2678	0.2688
35-40	5.260	0.2273	0.2088	0.2016	1.1547	1.1381	1.0146	0.1981	0.1966	0.1973
40-45	6.170	0.1348	0.1151	0.1056	1.2895	1.2437	1.0369	0.1038	0.1030	0.1034
45-50	6.864	0.0483	0.0522	0.0440	1.3378	1.2877	1.0389	0.0433	0.0429	0.0431
MEAN AGE OF CHILDBEARING:		28.55		28.21						
TOTAL FERTILITY RATE:		6.69		6.44				6.33	6.28	6.30

Table A4.18: Parity and Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, Urban Nigeria 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
			RECORDED	CALCULATED						
15-20	0.111	0.0703	0.0520	0.0629	0.0703	0.0629	1.1191	0.0632	0.0592	0.0612
20-25	0.790	0.1956	0.1874	0.2017	0.2659	0.2645	1.0053	0.2027	0.1898	0.1963
25-30	1.924	0.2438	0.2738	0.2770	0.5097	0.5415	0.9412	0.2784	0.2607	0.2696
30-35	3.190	0.2555	0.2570	0.2501	0.7652	0.7916	0.9666	0.2514	0.2354	0.2434
35-40	4.426	0.2256	0.1678	0.1584	0.9908	0.9500	1.0429	0.1592	0.1491	0.1541
40-45	5.387	0.1418	0.0701	0.0643	1.1326	1.0143	1.1166	0.0646	0.0605	0.0626
45-50	5.968	0.0507	0.0396	0.0335	1.1833	1.0479	1.1292	0.0337	0.0316	0.0327
MEAN AGE OF CHILDBEARING:		29.66		28.55						
TOTAL FERTILITY RATE:		5.92		5.24				5.27	4.93	5.10

Table A4.19: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, Rural Nigeria 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF		ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP		
					A.S.F.R.	FERTILITY PATTERN BY AGE AT BIRTH		20-25	25-30	20-30
			RECORDED	CALCULATED						
15-20	0.235	0.1267	0.0966	0.1138	0.1267	0.1138	1.1126	0.1119	0.1110	0.1114
20-25	1.192	0.2390	0.2478	0.2582	0.3656	0.3720	0.9828	0.2538	0.2518	0.2528
25-30	2.514	0.2798	0.2878	0.2898	0.6455	0.6619	0.9752	0.2848	0.2826	0.2837
30-35	3.945	0.2820	0.2792	0.2746	0.9274	0.9365	0.9903	0.2699	0.2678	0.2688
35-40	5.260	0.2273	0.2088	0.2016	1.1547	1.1381	1.0146	0.1981	0.1966	0.1973
40-45	6.170	0.1348	0.1151	0.1056	1.2895	1.2437	1.0369	0.1038	0.1030	0.1034
45-50	6.864	0.0483	0.0522	0.0440	1.3378	1.2877	1.0389	0.0433	0.0429	0.0431
MEAN AGE OF CHILDBEARING:		28.55		28.21						
TOTAL FERTILITY RATE:		6.69		6.44				6.33	6.28	6.30

Table A4.20: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, North Central 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NC 2008										
			RECORDED	CALCULATED						
15-20	0.174	0.0902	0.0823	0.0976	0.0902	0.0976	0.9240	0.0791	0.0772	0.0782
20-25	0.859	0.1823	0.2270	0.2384	0.2724	0.3360	0.8109	0.1933	0.1887	0.1910
25-30	1.904	0.2158	0.2790	0.2808	0.4882	0.6167	0.7916	0.2277	0.2223	0.2250
30-35	2.971	0.2103	0.2628	0.2565	0.6986	0.8732	0.8000	0.2080	0.2031	0.2055
35-40	3.965	0.1636	0.1777	0.1701	0.8622	1.0433	0.8264	0.1379	0.1346	0.1363
40-45	4.506	0.0849	0.0911	0.0831	0.9471	1.1264	0.8408	0.0674	0.0658	0.0666
45-50	5.159	0.0310	0.0576	0.0511	0.9781	1.1775	0.8307	0.0414	0.0404	0.0409
MEAN AGE OF CHILDBEARING:		28.35		28.20						
TOTAL FERTILITY RATE:		4.89		6.00				4.77	4.66	4.72

Table A4.21: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, North Fast 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NE 2008										
			RECORDED	CALCULATED						
15-20	0.293	0.1527	0.1688	0.1987	0.1527	0.1987	0.7684	0.1327	0.1324	0.1326
20-25	1.329	0.2249	0.3620	0.3666	0.3776	0.5652	0.6680	0.2449	0.2443	0.2446
25-30	2.442	0.2231	0.3373	0.3361	0.6006	0.9013	0.6664	0.2245	0.2240	0.2242
30-35	3.571	0.2211	0.3101	0.3072	0.8217	1.2085	0.6799	0.2052	0.2047	0.2050
35-40	4.551	0.1467	0.2676	0.2591	0.9684	1.4675	0.6599	0.1731	0.1726	0.1729
40-45	4.989	0.0692	0.1373	0.1255	1.0377	1.5930	0.6514	0.0838	0.0836	0.0837
45-50	5.350	0.0254	0.0752	0.0653	1.0631	1.6583	0.6411	0.0436	0.0435	0.0436
MEAN AGE OF CHILDBEARING:		26.93		27.49						
TOTAL FERTILITY RATE:		5.32		8.40				5.54	5.53	5.53

Table A4.22: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, North West 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NW 2008										
			RECORDED	CALCULATED						
15-20	0.512	0.2572	0.1711	0.1980	0.2572	0.1980	1.2989	0.2118	0.2241	0.2179
20-25	2.052	0.2994	0.3199	0.3223	0.5566	0.5203	1.0696	0.3448	0.3648	0.3548
25-30	3.643	0.3709	0.2965	0.2992	0.9275	0.8195	1.1317	0.3200	0.3386	0.3293
30-35	5.592	0.3380	0.3212	0.3187	1.2655	1.1383	1.1118	0.3409	0.3607	0.3508
35-40	6.858	0.2153	0.2529	0.2465	1.4808	1.3848	1.0693	0.2637	0.2790	0.2714
40-45	8.143	0.1666	0.1612	0.1473	1.6474	1.5322	1.0752	0.1576	0.1668	0.1622
45-50	8.789	0.0589	0.0855	0.0760	1.7063	1.6082	1.0610	0.0813	0.0860	0.0837
MEAN AGE OF CHILDBEARING:		27.31		27.84						
TOTAL FERTILITY RATE:		8.53		8.10				8.60	9.10	8.85

Table A4.23: Parity and Fertility Ratio Based on Children Ever Born and the Age Pattern(s) Of Respondents, South East 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
SE 2008										
			RECORDED	CALCULATED						
15-20	0.081	0.0484	0.0426	0.0518	0.0484	0.0518	0.9331	0.0592	0.0551	0.0571
20-25	0.685	0.2246	0.1716	0.1873	0.2729	0.2392	1.1412	0.2138	0.1992	0.2065
25-30	2.102	0.2852	0.2823	0.2857	0.5581	0.5249	1.0633	0.3261	0.3038	0.3150
30-35	3.474	0.2887	0.2511	0.2442	0.8469	0.7691	1.1011	0.2787	0.2597	0.2692
35-40	5.032	0.2854	0.1739	0.1674	1.1323	0.9365	1.2091	0.1910	0.1780	0.1845
40-45	5.940	0.1520	0.0988	0.0877	1.2843	1.0242	1.2540	0.1001	0.0932	0.0966
45-50	6.496	0.0541	0.0139	0.0101	1.3384	1.0342	1.2941	0.0115	0.0107	0.0111
MEAN AGE OF CHILDBEARING:		30.12		28.81						
TOTAL FERTILITY RATE:		6.69		5.10				5.90	5.50	5.70

Table A4.24: Parity and Fertility Ratio Based On Children Ever Born and The Age Pattern(s) Of Respondents, South South 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
SS 2008										
			RECORDED	CALCULATED						
15-20	0.131	0.0765	0.0698	0.0817	0.0765	0.0817	0.9363	0.0892	0.0884	0.0888
20-25	0.880	0.2264	0.1853	0.1959	0.3030	0.2776	1.0913	0.2138	0.2120	0.2129
25-30	2.173	0.2679	0.2462	0.2499	0.5709	0.5275	1.0821	0.2728	0.2705	0.2716
30-35	3.659	0.3551	0.2527	0.2498	0.9259	0.7773	1.1912	0.2726	0.2703	0.2714
35-40	5.613	0.3347	0.2004	0.1933	1.2607	0.9706	1.2988	0.2110	0.2092	0.2101
40-45	6.536	0.1568	0.1029	0.0933	1.4175	1.0639	1.3323	0.1018	0.1010	0.1014
45-50	7.382	0.0557	0.0318	0.0251	1.4732	1.0891	1.3528	0.0274	0.0272	0.0273
MEAN AGE OF CHILDBEARING:		30.11		28.69						
TOTAL FERTILITY RATE:		7.37		5.20				5.94	5.89	5.92

Table A4.25: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, South West 2008

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
SW 2008										
			RECORDED	CALCULATED						
15-20	0.099	0.0720	0.0362	0.0464	0.0720	0.0464	1.5509	0.0586	0.0549	0.0568
20-25	0.927	0.2590	0.1998	0.2161	0.3310	0.2625	1.2610	0.2725	0.2556	0.2640
25-30	2.445	0.3182	0.2841	0.2862	0.6492	0.5487	1.1832	0.3609	0.3386	0.3497
30-35	4.033	0.3063	0.2541	0.2467	0.9555	0.7954	1.2012	0.3111	0.2919	0.3015
35-40	5.425	0.2290	0.1683	0.1608	1.1845	0.9563	1.2387	0.2028	0.1903	0.1966
40-45	6.279	0.1273	0.0871	0.0788	1.3117	1.0350	1.2674	0.0993	0.0932	0.0962
45-50	7.065	0.0458	0.0231	0.0178	1.3575	1.0528	1.2895	0.0224	0.0210	0.0217
MEAN AGE OF CHILDBEARING:		29.08		28.65						
TOTAL FERTILITY RATE:		6.79		5.26				6.64	6.23	6.43

Table A4.26: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, Nigeria 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
Nigeria 2013										
			RECORDED	CALCULATED						
15-20	0.211	0.1198	0.0858	0.1029	0.1198	0.1029	1.1645	0.1079	0.1046	0.1062
20-25	1.210	0.2607	0.2492	0.2599	0.3805	0.3628	1.0488	0.2726	0.2640	0.2683
25-30	2.597	0.2745	0.2815	0.2820	0.6551	0.6448	1.0159	0.2958	0.2865	0.2911
30-35	3.959	0.2737	0.2603	0.2545	0.9287	0.8993	1.0327	0.2669	0.2585	0.2627
35-40	5.253	0.2065	0.1842	0.1772	1.1353	1.0765	1.0546	0.1859	0.1800	0.1829
40-45	5.900	0.1012	0.1003	0.0915	1.2364	1.1680	1.0586	0.0959	0.0929	0.0944
45-50	6.756	0.0367	0.0316	0.0248	1.2732	1.1928	1.0674	0.0260	0.0252	0.0256
MEAN AGE OF CHILDBEARING:		28.06		27.87						
TOTAL FERTILITY RATE:		6.37		5.96				6.26	6.06	6.16

Table A4.27: Parity and Fertility Ratio Based on Children Ever Born and The Age Pattern(s) Of Respondents, Urban Nigeria 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
URBAN 2013										
			RECORDED	CALCULATED						
15-20	0.089	0.0649	0.0405	0.0514	0.0649	0.0514	1.2628	0.0516	0.0499	0.0507
20-25	0.787	0.2028	0.2011	0.2154	0.2677	0.2668	1.0035	0.2162	0.2092	0.2127
25-30	1.936	0.2479	0.2629	0.2641	0.5156	0.5309	0.9713	0.2650	0.2565	0.2608
30-35	3.250	0.2619	0.2351	0.2285	0.7776	0.7594	1.0240	0.2293	0.2219	0.2256
35-40	4.407	0.1756	0.1582	0.1509	0.9532	0.9102	1.0472	0.1514	0.1465	0.1489
40-45	5.046	0.0903	0.0774	0.0703	1.0435	0.9805	1.0643	0.0705	0.0683	0.0694
45-50	6.136	0.0329	0.0250	0.0196	1.0765	1.0001	1.0763	0.0196	0.0190	0.0193
MEAN AGE OF CHILDBEARING:		28.89		28.42						
TOTAL FERTILITY RATE:		5.38		5.00				5.02	4.86	4.94

Table A4.28: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, Rural Nigeria 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
RURAL 2013										
			RECORDED	CALCULATED						
15-20	0.301	0.1598	0.1190	0.1407	0.1598	0.1407	1.1353	0.1496	0.1472	0.1484
20-25	1.507	0.2991	0.2830	0.2908	0.4589	0.4316	1.0633	0.3092	0.3042	0.367
25-30	3.069	0.3012	0.2947	0.2951	0.7601	0.7267	1.0460	0.3138	0.3087	0.3112
30-35	4.522	0.2898	0.2804	0.2751	1.0499	1.0018	1.0480	0.2925	0.2878	0.2902
35-40	5.904	0.2174	0.2038	0.1969	1.2673	1.1987	1.0572	0.2094	0.2060	0.2077
40-45	6.492	0.0983	0.1166	0.1065	1.3656	1.3052	1.0463	0.1133	0.1114	0.1123
45-50	7.183	0.0357	0.0361	0.0284	1.4014	1.3336	1.0508	0.0302	0.0297	0.0300
MEAN AGE OF CHILDBEARING:		27.51		27.59						
TOTAL FERTILITY RATE:		7.01		6.67				7.09	6.97	7.03

Table A4.29: Parity and Fertility Ratio Based on Children Ever Born and the Age Pattern(s) Of Respondents, North Central 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NC 2013										
			RECORDED	CALCULATED						
15-20	0.160	0.1047	0.0520	0.0660	0.1047	0.0660	1.5851	0.0724	0.0726	0.0725
20-25	1.112	0.2458	0.2416	0.2537	0.3504	0.3197	1.0960	0.2780	0.2789	0.2785
25-30	2.437	0.2835	0.2571	0.2569	0.6339	0.5766	1.0993	0.2816	0.2824	0.2820
30-35	3.889	0.2655	0.2377	0.2307	0.8993	0.8073	1.1140	0.2528	0.2536	0.2532
35-40	4.940	0.1540	0.1468	0.1427	1.0534	0.9500	1.1088	0.1564	0.1568	0.1566
40-45	5.588	0.0887	0.1060	0.0985	1.1420	1.0484	1.0893	0.1079	0.1082	0.1081
45-50	6.139	0.0323	0.0410	0.0338	1.1744	1.0822	1.0851	0.0371	0.0372	0.0371
MEAN AGE OF CHILDBEARING:		27.88		28.26						
TOTAL FERTILITY RATE:		5.87		5.41				5.93	5.95	5.94

Table A4.30: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents, North East 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NE 2013										
			RECORDED	CALCULATED						
15-20	0.334	0.1816	0.1244	0.1475	0.1816	0.1475	1.2310	0.1591	0.1566	0.1578
20-25	1.662	0.3019	0.2949	0.3009	0.4835	0.4484	1.0783	0.3244	0.3193	0.3219
25-30	3.152	0.2949	0.2849	0.2850	0.7784	0.7334	1.0613	0.3073	0.3025	0.3049
30-35	4.662	0.3098	0.2770	0.2728	1.0882	1.0063	1.0814	0.2942	0.2896	0.2919
35-40	6.150	0.2490	0.2106	0.2035	1.3372	1.2097	1.1053	0.2194	0.2159	0.2177
40-45	6.982	0.1327	0.1160	0.1050	1.4699	1.3147	1.1181	0.1132	0.1114	0.1123
45-50	7.124	0.0476	0.0290	0.0222	1.5175	1.3369	1.1351	0.0239	0.0235	0.0237
MEAN AGE OF CHILDBEARING:		27.79		27.44						
TOTAL FERTILITY RATE:		7.59		6.87				7.21	7.09	7.15

Table A4.31: Parity And Fertility Ratio Based On Children Ever Born And The Age Pattern(s) Of Respondents,

North West 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
NW 2013										
			RECORDED	CALCULATED						
15-20	0.326	0.1705	0.1355	0.1593	0.1705	0.1593	1.0704	0.1767	0.1709	0.1738
20-25	1.673	0.3543	0.3061	0.3138	0.5248	0.4731	1.1093	0.3481	0.3367	0.3424
25-30	3.495	0.3231	0.3171	0.3171	0.8479	0.7902	1.0730	0.3517	0.3403	0.3460
30-35	4.993	0.3231	0.2933	0.2888	1.1709	1.0790	1.0852	0.3204	0.3099	0.3151
35-40	6.669	0.2440	0.2302	0.2238	1.4150	1.3028	1.0861	0.2483	0.2401	0.2442
40-45	6.942	0.0665	0.1394	0.1283	1.4815	1.4311	1.0352	0.1424	0.1377	0.1400
45-50	8.218	0.0244	0.0567	0.0470	1.5059	1.4782	1.0188	0.0522	0.0505	0.0513
MEAN AGE OF CHILDBEARING:		27.15		27.75						
TOTAL FERTILITY RATE:		7.53		7.39				8.20	7.93	8.06

Table A4.32: Parity and Fertility Ratio Based on Children Ever Born and The Age Pattern(s) Of Respondents, South East 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF		ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP		
					A.S.F.R.	FERTILITY PATTERN BY AGE AT BIRTH		20-25	25-30	20-30
			RECORDED	CALCULATED						
15-20	0.074	0.0514	0.0369	0.0459	0.0514	0.0459	1.1178	0.0418	0.0424	0.0421
20-25	0.604	0.1641	0.1748	0.1910	0.2154	0.2370	0.9091	0.1737	0.1762	0.1749
25-30	1.694	0.2675	0.2821	0.2865	0.4830	0.5234	0.9227	0.2605	0.2643	0.2624
30-35	3.125	0.2589	0.2696	0.2612	0.7419	0.7846	0.9456	0.2374	0.2410	0.2392
35-40	4.152	0.1719	0.1598	0.1516	0.9138	0.9362	0.9760	0.1378	0.1399	0.1388
40-45	5.113	0.1239	0.0809	0.0700	1.0377	1.0061	1.0313	0.0636	0.0645	0.0641
45-50	6.274	0.0446	0.0067	0.0047	1.0823	1.0109	1.0706	0.0043	0.0044	0.0043
MEAN AGE OF CHILDBEARING:		29.73		28.64						
TOTAL FERTILITY RATE:		5.41		5.04				4.60	4.66	4.63

Table A4.33: Parity and Fertility Ratio Based on Children Ever Born and The Age Pattern(s) Of Respondents, South South 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF		ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP		
					A.S.F.R.	FERTILITY PATTERN BY AGE AT BIRTH		20-25	25-30	20-30
			RECORDED	CALCULATED						
15-20	0.126	0.0797	0.0552	0.0670	0.0797	0.0670	1.1901	0.0587	0.0662	0.0624
20-25	0.764	0.1473	0.1843	0.1920	0.2270	0.2590	0.8765	0.1683	0.1897	0.1790
25-30	1.616	0.2254	0.1967	0.1990	0.4524	0.4579	0.9879	0.1744	0.1966	0.1855
30-35	2.993	0.2806	0.2173	0.2149	0.7330	0.6728	1.0895	0.1883	0.2122	0.2003
35-40	4.217	0.2115	0.1599	0.1527	0.9445	0.8255	1.1441	0.1339	0.1509	0.1424
40-45	5.264	0.1445	0.0736	0.0635	1.0890	0.8891	1.2249	0.0557	0.0628	0.0592
45-50	5.555	0.0516	0.0073	0.0052	1.1406	0.8942	1.2755	0.0045	0.0051	0.0048
MEAN AGE OF CHILDBEARING:		29.97		28.14						
TOTAL FERTILITY RATE:		5.70		4.33				3.92	4.42	4.17

Table A4.34: Parity and Fertility Ratio Based on Children Ever Born and The Age Pattern(s) Of Respondents,

South West 2013

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF A.S.F.R.	CUMULATION OF FERTILITY PATTERN BY AGE AT BIRTH	ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP 20-25	25-30	20-30
SW 2013										
			RECORDED	CALCULATED						
15-20	0.073	0.0526	0.0384	0.0494	0.0526	0.0494	1.0654	0.0481	0.0424	0.0452
20-25	0.723	0.2134	0.2062	0.2239	0.2660	0.2733	0.9735	0.2180	0.1925	0.2052
25-30	1.936	0.2276	0.3011	0.3010	0.4936	0.5742	0.8596	0.2930	0.2587	0.2759
30-35	2.950	0.1941	0.2351	0.2254	0.6877	0.7996	0.8600	0.2194	0.1938	0.2066
35-40	3.930	0.1801	0.1467	0.1372	0.8678	0.9369	0.9263	0.1336	0.1180	0.1258
40-45	4.584	0.1045	0.0542	0.0479	0.9723	0.9848	0.9873	0.0467	0.0412	0.0439
45-50	5.043	0.0379	0.0126	0.0094	1.0102	0.9942	1.0161	0.0092	0.0081	0.0087
MEAN AGE OF CHILDBEARING:		29.01		27.96						
TOTAL FERTILITY RATE:		5.05		4.97				4.84	4.27	4