SPATIO -TEMPORAL ANALYSIS OF MATERNAL MORTALITY IN JIGAWA STATE, NIGERIA

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UNIVERSITI SAINS MALAYSIA

2021

SPATIO -TEMPORAL ANALYSIS OF MATERNAL MORTALITY IN JIGAWA STATE, NIGERIA

by

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Thesis submitted in fulfilment of the requirements
for the degree of
Doctor of Philosophy

October 2021

ACKNOWLEDGEMENT

For any successful work, there is no doubt that, the contribution and encouragement by people in one way or the other is inevitable. My sincere gratitude goes to my creator (**Almighty ALLAH**) for giving me the life, health and strength to undertake this research and for granting me the capability to complete my **PhD** programme.

I owe my deepest gratitude to my supervisors **Professor Dr Narimah Binti Samat** and **Professor Dr Ruslan Bin Rainis** Without their enthusiasm, encouragement, support and continuous optimism this thesis would hardly have been completed. **PROFESSOR DR NARIMAH BINT SAMAT,** please accept my heartfelt gratitude for all the support and motivation! You are so helpful, kind, and generous with your time and energy. Thank you so much for being an excellent Supervisor. **Professor DR RUSLAN BN RAINIS**, (who's after retirement became my Co-supervisor) Sir your encouragement and simplicity to me is a very rare commodity in the World. Sir, I have no word to say thank you but rather to keep on praying for you up to the end of my life may Allah reward You with Jannatul Firdausi, Amen. I express my warmest gratitude.

My profound gratitude also goes to the Universiti Sains Malaysia for offering me a place to study there, Head of Geography Section School of Humanities USM, Dean School of Humanities Universiti Sains Malaysia (USM) **PROFESSOR NARIMAH SAMAT** for their sound criticism, advice and taking their time to teach me how to write good research and write a paper and got published, thank you very much.

My acknowledgment will be incomplete without mentioning the contribution of **my External and internal examiners**, may Allah reward you abundantly. To all members of the Academic Staff of Geography Section School of Humanities, USM, who have hugely contributed to the success of this work; special thank go to my mentor, Professor Yusuf Adamu (PhD) and Dr Murtala Uba Mohammed.

I am deeply indebted to all the members of Jigawa State Ministry of Health Research Ethical Committee for granting me the full Ethical Clearance Letter without which the research would not have been possible. It is a pleasure to thank my friends at the USM especially at Student reading room, Eissa Alshammari, Rufai Suleiman, Ammar and Nurafiqah, for the wonderful times we shared, specially the Halab Restaurant dinners. In addition, I would like to thank all my friends in School of Humanities and Desassiswa Bakti Permai (H17) who gave me the necessary distractions from my research and made my stay in Penang, Malaysia memorable.

Finally, my deep and sincere gratitude to my family for their continuous and unparalleled love, help and support. I am grateful to my sister for always being there for me as a friend. I am forever indebted to my parents for giving me the opportunities and experiences that have made me who I am. They selflessly encouraged me to explore new directions in life and seek my own destiny. This journey would not have been possible if not for them, and I dedicate this milestone to them.

And for those I failed to mention, you are not forgotten.

THANK YOU!

Alhamdulillah, may Allah continue to guide us.

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LIST OF ABBREVIATION

AIC	Akaike Information Criterion
AICc	Akaike Information Criterion
AIDS	Acquired Immune Syndrome
ANC	Antenatal Care
CFR	Case Fertility Rate
CRVS	Civil registration and vital statistic
GIS	Geographical Information System
GWR	Geographically Weighted Regression
HMIS	Health Management Information System
ICD	International Classification of Death
ICU	Intensive Care Unit
LDCS	Least Developed Countries
LGA	Local Government Area
LMIC	Low and Middle Income Countries
MDG	Millennium Development Goals
MM	Maternal Mortality
MMR	Maternal Mortality Ratio
MICS	Multiple Indicator Cluster Survey
NDHS	Nigeria Demographic and Health Survey
NGOs	Non-Governmental Organizations
RAMOS	Reproductive-age mortality studies
SBA	Skilled Birth Attendants
SDG	Sustainable Development Goals
SMI	Safe Motherhood Initiative
TBA	Traditional Birth Attendant
WHO	World Health Organization

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ANALISIS RUANG MASA KEMATIAN MATERNAL DI NIGERI JIGAWA, NIGERIA

ABSTRAK

Kematian ibu masih merupakan risiko utama bagi wanita usia subur di Nigeria. Nigeria menanggung 14% beban global kematian ibu. Nisbah kematian ibu negara tetap meningkat walaupun terdapat usaha untuk mengurangkan kematian ini Walaupun terdapat perbezaan kesihatan antara Utara dan Selatan Nigeria, terdapat kekurangan bukti mengenai anggaran dan penentu kematian ibu untuk wilayah-wilayah ini. Trend kes kematian ibu meningkat setiap tahun di Nigeria terutamanya di Negeri Jigawa. Tinjauan terkini oleh Demografi kesihatan Nasional (NDHS, 2018), dan Multiple Cluster Indicator Survey menunjukkan ia merupakan negeri yang mempunyai profil penyakit yang tinggi dan nisbah kematian ibu negeri sangat tinggi dan masih tidak memuaskan. Oleh itu, kajian ini dilakukan untuk mengenal pasti trend kematian ibu, corak spatial dan memodelkan penyebab kematian ibu di Negeri Jigawa, Nigeria. Data kematian ibu selama Sepuluh tahun (2008 hingga 2017) diperoleh dari Kementerian Kesihatan Negeri Jigawa, Unit statistik. Analisis trend dilakukan dengan kaedah deskriptif bagi meneroka pola kes kematian ibu dan pengelompokan dilakukan dengan menggunakan Moran's I, Indeks Moran tempatan (LISA), Getis-Ord Gi *. Analisis regresi linear digunakan untuk mengkaji faktor-faktor secara global yang mempengaruhi kematian ibu. Analisis Geography Weighted Regression (GWR) digunakan untuk menentukan kesan tempatan faktor risiko terhadap kematian ibu. Taburan ruangan kematian ibu berkelompok dan ketara bagi setiap tahun. Kluster titik panas untuk kematian ibu dari tahun 2008 hingga 2017 menunjukkan bahawa Jahun, Dutse, dan Hadejia adalah penting selama sepuluh tahun. Hasil regresi linear

menunjukkan bahawa ANC (2013, 2014, 2015, 2016, 2017) dan pariti (2015) adalah signifikan dengan nilai p <0.05. Sebagai tambahan, perbandingan nilai R-square dengan Kriteria Maklumat Akaike (AIC) antara sepuluh model (2008 hingga 2017) dilakukan. Penemuan semua hubungan pemboleh ubah menunjukkan bahawa terdapat perbezaan tempatan yang signifikan dengan AICc. Model GWR diwakilkan dengan baik berbanding model OLS kerana AICc GWR lebih rendah daripada nilai OLS AICc. Selanjutnya, model GWR mendapati bahawa setiap pemboleh ubah menunjukkan kesan yang berbeza terhadap kematian ibu di lokasi yang berbeza. Oleh itu, hubungan antara ruang tempatan dan pemboleh ubah menunjukkan pentingnya penyelidikan yang dilakukan di peringkat tempatan dalam mengenal pasti faktor-faktor yang meningkatkan kes kematian ibu di negeri Jigawa, Nigeria.

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ABSTARCT

Maternal mortality is still a major risk for women of childbearing age in Nigeria. Nigeria bore 14% of the global burden of maternal mortality. The national maternal mortality ratio has remained elevated despite efforts to reduce maternal mortality. Though health disparities exist between the North and South of Nigeria, there is a dearth of evidence on the estimates and determinants of maternal mortality for these regions The trend of Maternal Mortality case increases every year in Nigeria. especially in Jigawa State, based on the latest report and survey from National Demographic health survey (NDHS, 2018), and Multiple Cluster Indicator Survey placed the state as state with high burden of disease profile and Maternal Mortality ratio of the state as very high and is still unsatisfactory. Therefore, this study was conducted to identify trends of Maternal Mortality, spatial pattern and modelling the causes of Maternal mortality in Jigawa state, Nigeria. Maternal Mortality data for Ten years (2008 to 2017) was obtained from Jigawa state Ministry of Health, statists Unit. Trend analysis was conducted by descriptive method, exploration of maternal mortality case pattern and clustering was performed using Moran's I, local Moran's Index (LISA), Getis- Ord Gi*. Linear regression analysis was used to examine the factors influencing maternal mortality at global level. Geographically Weighted Regression (GWR) analysis was used to determine the local effects of risk factors on maternal mortality. The spatial distribution of maternal mortality was clustered and significant for each year. The clustering of hot spots for maternal mortality from 2008 to 2017 shows that Jahun, Dutse, and Hadejia are significant for all ten years. Linear

regression results show that ANC (2013, 2014, 2015, 2016, 2017) and parity (2015) is significant with p values <0.05. In addition, a comparison of R-square value with the Akaike Information Criterion (AIC) between ten models (2008 to 2017) was carried out. The findings of all relationship of the variables indicate that there is a significant local variance with the AICc. GWR model fitted well compared to OLS model because the AICc of GWR is lower than that of OLS AICc value. Furthermore, the GWR model shows that each variable shows a different impact on maternal mortality at different locations. Thus, the relationship between local spatial and the variables show the importance of research conducted at the local level in identifying factors that increase maternal mortality cases in Jigawa state, Nigeria.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

More than 200 million women get pregnant annually (Lawn et. al., 2016) yet safe deliveries that are celebrated worldwide but sometimes, this event turns tragic to many women and families most of whom are poor and powerless. This is because in some countries women die because of pregnancy or childbirth from causes that are preventable. More than 350,000 women die annually from complications during pregnancy or childbirth , 99 percent are in developing countries, in developed regions, a woman's maternal mortality risk is 1 in 5,600 as against in sub-Saharan Africa 1 in 30 (WHO, 2019). Maternal mortality (MM) is unacceptably high. About 830 women die from pregnancy or childbirth-related complications around the world every day. It was estimated that in 2015, roughly 303,000 women died during and following pregnancy and childbirth. Almost all these deaths occurred in low-resource settings, where most cases have been prevented (Bhavin, 2018).

The risk of a woman dying because of pregnancy or childbirth varies around the world. While the chances of a woman dying in developing countries is 1:48 as in developed countries which is one in several hundred (Bergevin, Fauveau, & McKinnon, 2015). As indicated in table 1.1, the death of women in Africa is the largest, where the chance of women dying in Africa is 1 in 16 meaning that out of every 16 women 1 will likely to die as a result of pregnancy or childbirth as against in Europe which 1 woman will likely to die out of 1,400 women. In North America is even better because this is 1 woman out of 130. In developing countries, the tendency of woman to die is 1 out of 48 as against developed world of 1 woman in 1,800. This

is the evidence that the figure of MM is high in Africa and Latin America and the Caribbean.

Table 1.1 Women's lifetime risk of dying from pregnancy-related complications.

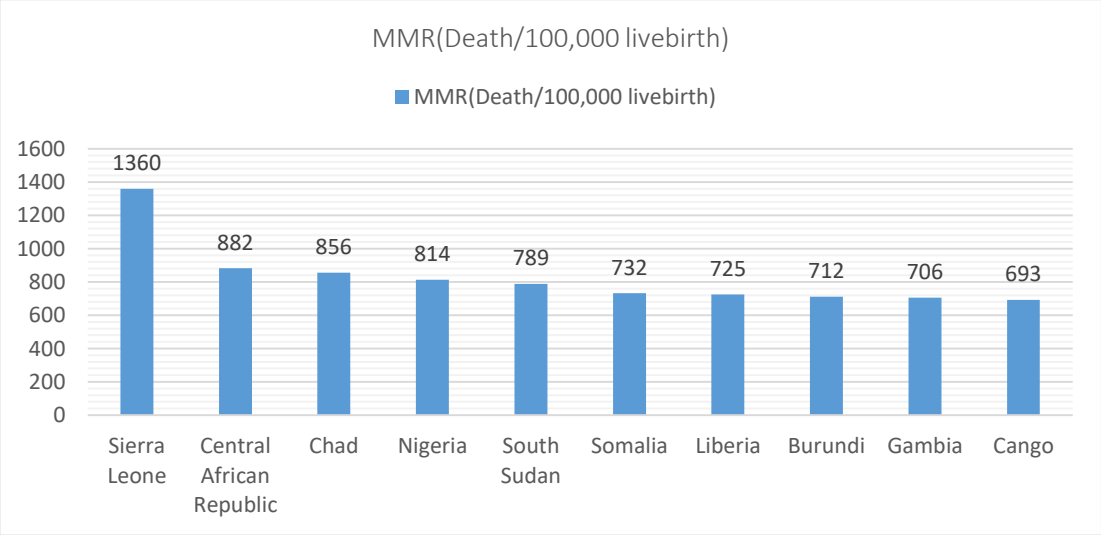
Region	Risk of dying
Africa	1 in 16
Asia	1 in 65
Latin America & the Caribbean	1 in 130
Europe	1 in 1,400
North America	1 in 3,700
All developing countries	1 in 48
All developed countries	1 in 1,800

Source: World Health Organization (2017)

MM is the death of a woman while pregnant or within 42 days after termination of pregnancy, irrespective of the duration of the pregnancy, from any cause related to or aggravated by the pregnancy excluding all accidental causes of death (MacDorman, Declercq, Cabral, & Morton, 2016). In the 1980s, some scholars argued that there are many deaths that occurred after 42 days after termination of pregnancy. Therefore Koonin and other scholars extended the period up to a year after termination of pregnancy (MacDorman et. al., 2016).The vast majority of these deaths (94%) occurred in low resource settings, and most of the cases could have been prevented (WHO, 2018). Sub-Saharan Africa and Southern Asia accounted for approximately 86% (254,000) of the estimated global MM in 2017. Sub-Saharan Africa alone accounted for roughly two thirds (196,000) of MM, while Southern Asia accounted for nearly one-fifth (58,000) (Perlman & Roy, 2008). At the same time, between 2000 and 2017, Southern Asia achieved the greatest overall reduction in Maternal Mortality rate (MMR): a decline of nearly 60% (from an MMR of 384 down to 157). Despite its very high MMR in 2017, sub-Saharan Africa as a sub-region also achieved a

substantial reduction in MMR of nearly 40% since 2000 (Odekunle, 2016). Additionally, four other sub-regions roughly halved their MMRs during this period: Central Asia, Eastern Asia, Europe and Northern Africa. Overall, the MMR in less-developed countries declined by just under 50% (FE Okonofua, Ntoimo, & Ogu, 2018).

The high number of MM in some areas of the world reflects inequalities in access to quality health services and highlights the gap between rich and poor (Kassebaum et. al., 2016). The MMR in low income countries in 2017 is 462 per 100,000 live births versus 11 per 100,000 live births in high income countries. In 2017, according to the Fragile States Index, 15 countries were considered to be "very high alert" or "high alert" being a fragile state (South Sudan, Somalia, Central African Republic, Yemen, Syria, Sudan, the Democratic Republic of the Congo, Chad, Afghanistan, Iraq, Haiti, Guinea, Zimbabwe, Nigeria and Ethiopia), and these 15 countries had MMRs in 2017 ranging from 500 to 1,400 cases (Carlsen & Bruggemann, 2017) (Refer to Figure 1.1 which shows MMR death per 100,000 live birth in countries in Africa).



Source: WHO (2017)

Figure 1.1 MMR death per 100 000 live birth in countries in Africa

The risk of MM is highest for adolescent girls under 15 years old and complications in pregnancy and childbirth are higher among adolescent girls age 15-19 (compared to women aged 20-24) (Bishai et. al., 2016). Women in less developed countries have, on average, many more pregnancies than women in developed countries, and their lifetime risk of death due to pregnancy is higher (Acosta et. al., 2016). Moreover, a woman's lifetime risk of MM is the probability that a 15-year-old woman will eventually die from a maternal cause. In high income countries, this is 1 in 5,400, versus 1 in 45 in low income countries (Bhavin, 2018). Sadly, the African continent has registered the highest number of MM in the world, with more than 253,000 women dying during pregnancy or following childbirth annually (WHO, 2018). In sub-Saharan Africa, several countries halved their levels of MM since 1990. In other regions, including Asia and North Africa, even greater headway was made. Between 1990 and 2015, the global MMR (the number of MM per 100,000 live births) had declined by only 2.3% per year between 1990 and 2015 (Bacci, 2017).

Developing countries, such as Nigeria, has accounted for over 99% of the recorded deaths. Furthermore, Nigeria is having only 2% of the world's total population, yet, it has accounted for 10% of the world's total MM in 2010. Nigeria's MMR has exceeded 1,000 deaths per 100,000 live births which is much higher than the African continent with the average of 800 deaths per 100,000 live births (Zozulya, 2010). Northern Nigeria experienced high MM and has become a serious concern in Nigeria, especially in the North West, north eastern region and in the rural south. The distribution of MM is not even worldwide; the risk of a woman dying from a maternal related cause during her lifetime in a less developed country like Nigeria is about 23 times higher compared to a woman living in a developed country (Lawn et. al., 2016). In the mid-19th century, even the developed countries experienced high MM

historically, but by the 1940s MM was virtually weak and becomes rare in countries like Britain, Sweden, Belgium and New Zealand (Harris, 2016). The main reasons for the decline of MM were due to the improvement in obstetric care such as the introduction of blood transfusion, penicillin with better anesthesia and training of obstetric services (WHO, 2019).

Global initiatives to intensify policy intervention for MM began with the Safe Motherhood Initiative (SMI) in 1987 and the1994 International Conference on Population and Development. The SMI was launched during the Nairobi Kenya conference on women in 1984. The SMI was a global effort to reduce MM at least by half by the year 2000 (Blencowe et. al., 2016). This Initiative aimed to bring the issue of reproductive health to the forefront of health priorities and called for political, social and economic commitments of Governments, Non-Governmental Organizations (NGOs), communities, and individuals toward achieving this noble goal. Moreover, SMI recognized the need for multi-disciplinary research, considering the multi-factorial complexity of MM. Furthermore, additional studies were needed to gain better country and locale- specific information on MM, its immediate causes, where its root causes are known, yet is ignored or is not given emphasis.

Another initiative, the International commitment on reproductive health that focus on MM has improved when reduction in MM became one of eight goals in the in the Millennium Declaration (Nixon et. al., 2018). At the Millennium Summit in 2000, the resolution was to reduce MM by three-quarter by the year 2015. This international commitment is encapsulated in the MDGs, which was derived from the Millennium Summit commitments. In MDGs, Goal 5 targeted to improve maternal health where the reduction of MM had been the outcome chosen to assess progress of this goal. After 15 years, the MDGs had reached their target date of 2015, and the

global community has moved onto new agenda, namely the Sustainable Development Goals (SDGs). The SDGs integrate three dimensions namely social, economic and environment of sustainable development for people, the planet, prosperity, peace and partnerships (Anastasi et. al., 2015). The SDGs has 17 goals and 169 targets. One of the goal is to ensure healthy lives and promote wellbeing for all at all ages (Stevenson, Tomlinson, Hunt, & Hanlon, 2018). Furthermore, the conference on 'Global strategy for Women's, Children's and Adolescents' health hosted in Mexico City in October 2015 had discussed the unfinished agendas of the MDGs. The focus was on the increasing equitable coverage of quality health care and provision of integrated services delivered through a gradually strengthened primary health care system (Regmi et. al., 2016) .

Despite longstanding international commitments to reduce MM, the progress has been quite unsatisfactory. This was probably due to the programme or initiatives undertaken lacks locational or ignored locational factors (Kwan, 2013; Delmelle & Kanaroglou, 2016). Spatially targeted intervention strategy should be undertaken where investigation on the pattern, spatial causes and possible solution to reduce the MM

The study of MM is part of Population and Medical Geography or Spatial Epidemiology which concern with two fundamental questions, Where and when do diseases tend to occur? and why do such patterns exist? This field has experienced substantial growth over the last decade with the widespread recognition of the concept of "place" which plays a significant role in the understanding of individual health (Kwan, 2013). Furthermore, the advances in geographical modelling techniques have provide approach to conduct spatial analysis at different granularities, both spatially and temporally (Delmelle & Kanaroglou, 2016).

The development of Geographical Information System (GIS) has assisted in the decision support systems that involve the integration of location-referenced data in a problem-solving environment (Makanga, 2016). The application of GIS in health has gained recognition (Nykiforuk & Flaman, 2011) since its ability to elucidate risk factors for adverse maternal events, measure the relationship between access to care and maternal outcomes. Furthermore, GIS has the ability to integrate data on health-related social and environmental risk factors and thus, explain variations in maternal outcomes. GIS also has the capacity to link the social and environmental risk factors to disease outcomes which is consistent with the call to reduce global ill health, including adverse maternal outcomes, through action on social determinants (Bhatt & Joshi, 2012). GIS also has data visualization using mapping and geospatial analyses which has played a significant role in addressing the emerging need for improved spatial investigation at subnational scale. This includes mapping key maternal health service provision indicators as well as associated determinants, analyzing geographic access to maternal health services such as the access to emergency obstetric care; and modelling potential actions to identify how best to increase such access to maternal and neonatal health services. GIS, therefore, can be utilized to identify key challenges and make recommendations in improving maternal health especially in the poor resource settings environment.

The integration of GIS and spatial statistical tools provide new approach to analyse the generated clinical data to detect spatial patterns of disease distribution and delineate hot spots to assess true situation for better public surveillance and for improving our understanding of the transmission dynamics of disease such as MM (Kracalik et. al., 2012). Spatial autocorrelation statistics has been used to analyse the correlation of a variable in relation to the location of variable. Moran's I, for example

has become a popular tool for measuring spatial autocorrelation (Mathur, 2015). Global Moran's I has been used to measure and analyse the degree of dependency among observations in geographic space. On the other hand, local spatial autocorrelation statistics such as local Moran's I and Getis and Ord are useful in identifying locations of spatial clusters or "Hot spots" and outliers (Getis, 2010). At present however, the application of GIS and spatial statistics to analyse and assist in the control of MM has been very limited. This was probably due to unavailability of the data.

MM has remained a serious concern in Nigeria, especially in the northern parts of the country and in the rural south (Ebeniro, 2012). This was probably due to Nigeria has been a traditionally a male-controlled society in which women are discriminated against from infancy (Adamu, 2008). In the rural setting, gender disparity has been observed with women generally receiving less attention than men (Abdelsalam, 2017). Therefore, poor access to medical services has been compounded by socio-cultural, economic and demographic factors including the behaviour of families and communities, social status, education, culture, income, health decision making power, age, access to health facilities, and availability of health services (Delamater, Messina, Shortridge, & Grady, 2012). Those factors have played a vital role in the delay of getting maternal care which has caused MM. In northern Nigeria, Jigawa State that has high case of MM, although the decision to seek maternal medical care has been influenced by socio-culture factor, spatial factor has played vital role. Therefore, this study aimed to investigate spatial and temporal pattern of MM in order to develop a model which can assist in understanding and providing policy solution for reducing MM in this state.

1.2 Statement of Research Problem

Pregnancy and childbirth are physiological events that should bring joy to the woman, the family and the society at large, but sometimes it turns out to be a source of sorrow. For some women in certain parts of the globe, particularly in developing countries, the reality of motherhood is often grim. For those women, motherhood is often marred by unforeseen complications or even a loss. MM is one of the major health system challenges to the world and in the unindustrialized countries where it is a major killer of women (Harpham, 2009). Therefore, the International community addressed the problem and targeted to reduce the MMRs by including it in the MDGs and later in the SDGs (Kumar, Kumar, & Vivekadhish, 2016).

Effort to reduce high MM has gained international attention. Various conferences such as the World Summit for Children (WSC) in 1990; the International Conference on Women in 1994; the Fourth Conference on Women in 1995; the Beijing Conference were held across the globe targeted to reduce the levels of MM by fifty percent (50%) (Mojekwu & Ibekwe, 2012). Furthermore, in the year 2000, United Nations Millennium Summit was held, which developed the MDGs to enable the poorest countries to improve the quality of health and the life of their citizens, with a resolution to achieve these goals by 2015. At regional basis, there are number of treaties, policies and declarations, including the African Charter (O.A.U, 1982); The Maputo Protocol in 2008 and the 2001 Abuja declaration in which 15% of annual budget of African Union governments are pledged to be allocated towards improving the health sector (Union, 2015).

At National level, many policies such as the National Policy and strategy were introduced to achieve health for all citizens of the country (Mirzoev et. al., 2015), 2004

Revised National policy replaced the 1988, Reproductive health policies 2008, the integrated maternal new born and child health strategy in 2007. Other initiatives were the National MDGs 2008 and Save One Million lives 2019. Despite all these efforts, very small reduction of MM has been achieved. African and many other developing countries have failed to reach the standards set by the World Health Organization's initiative on SMI (WHO, 2015).

Nigeria has been mentioned by the United Nations as one of the countries that have the highest MMR in the world (Liu et. al., 2016).Initiative such as SMI which was formally launched in Nigeria in 1990, has not being able to solve MM issue (Smith, Ameh, Roos, Mathai, & van den Broek, 2017). In addition several policies, strategies and other health services systems such as the 1988 National Health Policy and Strategy to achieve health for all Nigerians, which was Nigeria's first comprehensive health policy, the 2004 revised National Health Policy replaced the 1988 National Health Policy; The Integrated Maternal and New-born Child Health Strategy in 2007 and Save One Million Lives programme (Oladapo et. al., 2016). have been set, Moreover, the 1988 National Health Policy and Strategy which was Nigeria's first comprehensive health policy, the 2004 revised National Health Policy replaced the 1988 National Health Policy; The Integrated Maternal and New-born Child Health Strategy in 2007 and Save One Million Lives programme (Oladapo et. al., 2016) also aimed at reducing MM and improve society well-being. However, as reported by the Centre for International and Strategic Studies that over her life time, a Nigerian women's risk of dying is 1 in 29 (Alkema et. al., 2016).

The issue of MM and morbidity is still an important health problem in Nigeria the MMR was estimated at 1,000/100,000, the situation is getting worse. Within Nigeria, MMR varies from place to place (Adedini, Odimegwu, Imasiku,

Ononokpono, & Ibisomi, 2015). The situation of northern Nigeria is even more worrying as the estimated MMR exceeds the national estimate (Betrán et. al., 2016). The study by Findley and Afenyedu (2012) confirmed that MMR in the northern states of Yobe, Jigawa, Zamfara and Katsina were higher than the national estimate. It was estimated that MMR was 1,271/100,000 as compare to the national average at 545/100,000 (Solanke, 2018).

The Federal Ministry of Health, Nigeria had set the target to reduce MM by fifty percent (50%) by 2016. However, this target was not achieved, and the maternal health situation became worse than in previous years (Koffi et. al., 2017). Jigawa state has unacceptably high MMR and burden of diseases profile. The 2018 Multiple Indicators Cluster Survey (MICs) and National Demographic and Health Survey (NDHS) showed that the MMR of the state was 2,000/100,000 live births. Furthermore, Jigawa State is one of the States with poor health indices in Nigeria. The benchmarking exercise carried out in 2000 placed Jigawa State among those having lowest health indicators, especially diseases/conditions targeted for reduction by 2015 under MDGs such as MM, infant and under five mortalities, malaria and HIV/AIDS. This health situation in this state has attracted the support of the development partners for the state to reform its health sector (Lamidi, 2015).

In Jigawa State, efforts have been made to reduce the number of MM with policy changes. The state government budgets, for example, have provided sufficient funds for the upgrading of obstetric care facilities in hospitals, the recruitment of obstetricians and gynecologists and the provision of ambulances at the local level. The ambulances were made available to transport pregnant women experiencing delivery complications to the nearest health facilities under a programme called Successful delivery (*HaihuwaLafiya).* It is a Hausa expression meaning successful delivery.

Although the effort to improve successful delivery, the number of women dying because of pregnancy related problems is still unacceptable high.

Various studies were undertaken to investigate MM issues. Those studies however, are only characterized by large scale generalization, such as at the international, regional and national levels. Less attention was given to the local areas where many facts were lying. For example, at the international level, the study by UNICEF (2015) focused on the international statistics of MM. At the national level, the study was conducted by (Ebeniro, 2012) focused on the problems at the National level. Those studies showed statistics related to MM. At the local level, the study was conducted by Adamu (2003) in rural Kano state, Kolo (2013) in Borno State, Ameh (2015) in Katsina state (Daura Emirate) revealed the situation using sisterhood method to show the cases of MM.

Although studies were undertaken at the local level, those studies have put less emphasis on the spatial and temporal patterns of the MM. Furthermore, previous studies undertaken in relation to MM failed to address geographical aspect where map can potentially be used to visualize spatial and temporal distribution of MM. In addition, in order to efficiently produced spatially targeted intervention policy, the cluster of MM should be detected. Spatial statistics such as Geographically weighted regression can potentially be used to identify cluster and towards addressing MM problem locally. Based on the high cases of MM in Jigawa state, it is timely therefore to find local solution to this problem.

1.3 Research Questions

This study will be designed to provide answers to the following questions:

i. What are the temporal patterns of maternal mortality, obstetric complications, and deliveries in Jigawa State?

ii. What are the spatial patterns of maternal mortality in Jigawa State?

iii. Is there a model for Maternal mortality in Jigawa state?

1.4 Aim and Objectives

The aim of study is to assess and model the spatial and temporal variations in the incidence of MM in Jigawa state. The specific objectives through which this aim will be achieved are as follows:

i. To identify the temporal and spatial patterns of maternal mortality, obstetric complications and deliveries in Jigawa State;

ii. To determine the factors influencing the spatial and temporal patterns of maternal mortality in Jigawa State.

iii. To model the spatial and temporal variations of Maternal Mortality in Jigawa state

1.5 Scope of the Study

The main subject of this research is MM with respect to its spatial and temporal characteristics as well as the causes, based on the health facilities in Jigawa state. To have comprehensive understanding of the subject matter other related issues such as level of ante-natal care services, utilization by women as well as the pattern and the

trends of hospital deliveries will also be examined. The study will make use of the data obtained from the health facilities available in the study area from 2008 to 2017 to examine the level of obstetric causes, the trends and the pattern of MM and to estimate the MMR. The study is only limited to Jigawa state and the State has only Twenty-Seven (27) local government area. The choice of Jigawa State is no doubt is the best thing because, the state has high MMR in Nigeria and the state has poor health indicator and high burden of disease profile as confirmed by many international and national survey among which includes NDHS (2018), Multiple Cluster Indicator Survey.

The study will not be extended to the assessment of the quality of manpower and technical quality provided at the health facilities such as health system infrastructures, availability and functionality of medical equipment, and availability of medications among others. The study employed the used of spatial autocorrelation (Moran's I and Hot spot analysis) and Geographically Weighted Regression (GWR) for modelling.

1.6 Justification of the Study

The state of maternal health is one of the key indicators of a society's level of development, as well as an indicator of the performance of the health care delivery system. Consequently, reduction in MM is a major agenda of many global initiatives such as the MDGs and SDGs. However, as 2015 is the targeted year for achieving a global reduction in MM, the continuing high MMR in Nigeria remains worrisome. Northern Nigeria and Jigawa state is not an exception as it has unacceptably high MMR and burden of diseases profile. In Jigawa state MMR is estimated at 2,000 deaths per 100,000 live births (JSSHDP 2010-2015).

There has been a complete lack of comprehensive study on geographical patterns of MM in Jigawa State. The study will significantly have contributed to the field of medical geography. The research, therefore; will increase knowledge and add to literature in this academic field. It is important to expand knowledge on the geographic distribution of MM for it allows the identification of high and low prevalence areas. The study also will aim at using GIS and spatial statistics for spatial mapping of MM hot and cold spots areas. The study, therefore; will form a pioneering attempt towards identification of clustered areas and serve as an important tool for planning future intervention. Identification of hot spot regions would greatly assist government (local, state and federal), international agencies, non-governmental organizations, philanthropists among other donors to make judicious use of their limited financial resources by targeting high risk areas. The analysis of this study will enable us to discover variations in the incidence of the disease and highlight any significant trend. The findings of the study will also highlight the magnitude of the burden associated with the disease and indicate the extent of need for appropriate intervention. Result of the study will also help to gain deeper understanding of MM pattern in the state.

1.7 Organization of the Thesis

This thesis is organized as follows: Chapter 1 presents the background of the study. Review of the extant literature and description of the theoretical framework are presented in chapter 2. Chapter 3 presents the methodology employed in this study. The temporal pattern of maternal mortality, obstetric complication and hospital deliveries are presented in chapter 4. Chapter 5 presents the spatial pattern of MM, and

modelling using GWR was presented in chapter 6. Finally, a summary and recommendations for future research are presented in chapter 7.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter presents a critical review of the relevant literature and theoretical framework of the thesis. The first part describes MM and the geography for MM. This is then followed by the spatial patterns of MM in Nigeria and the determinant of MM. This chapter, then discusses the application of GIS. This is followed by the theoretical framework to be used this study. This chapter is concluded by presenting the summary.

2.2 Maternal Mortality

MM is the death of a woman while pregnant or within 42 days after termination of pregnancy, regardless of the duration of the pregnancy, from any cause related to the pregnancy, all accidental causes of death are excluded (WHO, 2019). Because many MM occur late or later than 42 days after termination of pregnancy, some definitions extend the period up to a year after termination of pregnancy (Zozulya, 2010). Although the WHO (2019) definitions have been adopted and accepted, many scholars have reported that other definition's may as well be included accidental and incidental causes. These include deaths secondary to violence against women that may be related to the pregnancy and be affected by the socio economic and cultural environment. About 10% of MM may occur beyond 42 days after termination of pregnancy or delivery (Apolot, 2018).

Direct obstetric complication has been defined by the International Classification of Diseases (ICD) as those deaths resulting from obstetric complications of the pregnant state (pregnancy, labour, puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of them. For example, pre-eclampsia/eclampsia, infection, obstructed labour, unsafe abortion, ectopic pregnancy, hemorrhage, embolism, and anesthesia-related deaths (Organization, 1978). The ICD also defines indirect obstetric deaths as those resulting from previous existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes but was intensified by the biological effects of pregnancy (Organization, 1978). The indirect causes of deaths tend to be fewer in number than direct causes. For example, hepatitis, anemia, malaria, heart disease, tuberculosis, AIDS and tetanus causative factors include all the aspects that influence the care sought and received during pregnancy, childbirth, and the postpartum period. They are less or easier to classify than medical syndromes or diseases but include the following: delay in seeking care; delay in arriving at appropriate level of care; delay at the health facility before arrival of the health personnel; the availability and quality of resources at the last level of the health services that was reached; and the availability and quality of the personnel of health services that was reached.

The direct causes of MM accounted of 80% of global MM, and the most common cause of MM is hemorrhage (25%) (Abosse, Woldie, & Ololo, 2010). Other causes include infection (15%), followed by unsafe abortion (13%) and hypertensive disease of pregnancy (pre-eclampsia and eclampsia) (12%). About 5% of pregnant women (7 million women) need surgery; most often a Caesarean section (Hasegawa et. al., 2016) and many do not have access to emergency obstetric care (Neutens, 2015). Although 40% of women give birth in a hospital or health center, only 58% of

women in developing countries deliver with the assistance of a health professional (a midwife or doctor). About 61% of MM take place during delivery or in the immediate post-partum period (Aboagye, Degboe, & Obuobi, 2010).

Obstetric complications refer to those resulting in a woman who has been pregnant regardless of site or duration of the pregnancy from any cause related to, or aggravated by, the pregnancy or its management but not from accidental or incidental causes. Many literatures shown that the major obstetric causes of MM are hypertensive disease of pregnancy like pre-eclampsia and eclampsia, ante partum and post-partum hemorrhage, obstructed labour, ruptured uterus, puerperal (or genital) sepsis, anemia and abortion.

Globally, around 80% of MM are due to obstetric complications; mainly hemorrhage sepsis, unsafe abortion, pre-eclampsia and eclampsia, and prolonged or obstructed labour (Akinleye, Falade, & Ajayi, 2009). Complications of unsafe abortions account for 13% of MM worldwide and 19% of MM in South America (Lin et. al., 2017). Almost all cases of MM are preventable. An estimated 74% of MM could be averted if all women had access to the interventions for preventing or treating pregnancy and birth complications, emergency obstetric care (Alkema et. al., 2016). In many countries with high MMRs, there is a need to increase provision of appropriate quality services. Poverty, gender and other inequalities, a lack of information, weak health systems, a lack of political commitment, and cultural barriers are other obstacles that need to be overcome if women are to access technical services and information that can often prevent MM and morbidity. In the last twenty years, a series of international commitments and initiatives has pledged to reduce the MM.

a) Definition of Relevant Terms

This section presents operational definition used based on published literature, which will be used in this thesis.

i. **Maternal Mortality Ratio (MMR):** MMR is the annual number of MM from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, per 100,000 live births, for a specified year. It is also one of the yardsticks used to monitor progress towards the success of the goal of improving maternal health programmes (Bayley et. al., 2015). The MMR is calculated by dividing recorded (or estimated) MM by total recorded (or estimated) live births in the same period and multiplying by 100,000. The measurement requires information on pregnancy status, timing of death (during pregnancy, during childbirth, or within 42 days of termination of pregnancy), and cause of death. By calculating MM per live birth, rather than per woman of reproductive age, the MMR is designed to express direct or indirect obstetric risk: This formula will be used to calculate the MMR in this study.

$$\frac{\text{Total Number of MM}}{Total\ Number\ of\ Deliveries}\ X100{,}000 \qquad (2.1)$$

ii. **Maternal Mortality Rate (MMRate):** the MMrate, refers to the number of MM per 1,000 women of reproductive age, and the adult lifetime risk of MM, which considers both the probability of becoming pregnant and the probability of dying because of that pregnancy,

cumulated across a woman's reproductive years. MMRate is the number of resident MM within 42 days of pregnancy termination due to complications of pregnancy, childbirth, and the puerperium in a specified geographic area (country, state, county, etc.) divided by total resident live births for the same geographic area for a specified time period, usually a calendar year, multiplied by 100,000. This is a cause-specific death rate which is expressed as

$$\frac{\text{Total Number of MM}}{Number\ of\ Reproductive\ Age}\ X1000 \qquad (2.2)$$

iii. **The Case Fatality Rate (CFR):** CFR measures the number of deaths from the condition of interest, divided by the number of people with that condition. In this study, the term means the number of MM among women with obstetric complication in the health facility being studied. Expressed as:

$$\frac{\text{Total number of direct obstetric death (from selected causes) in health facilities studies}}{Total\ Complicated\ cases\ in\ the\ Health\ fcility\ studied}\ X100$$

(2.3)

iv. **Maternal health determinants:** used broadly to identify the associations between factors of interest and maternal health outcomes. These factors include pathogenic causes of mortality; biologically causal risk factors; and outcome-associated risk indicators (Ngwezi, Hornberger, & Vargas, 2018).

v. **Antenatal care (ANC):** routine or higher-level medical care received by a pregnant woman before delivery and provided by a skilled attendant. The ante-natal care, also known as prenatal care is a type of preventive healthcare with the goal of providing regular check-ups that allow doctors or midwives to treat and prevent potential health

problems throughout the course of the pregnancy while promoting healthy lifestyles that benefit both mother and child (Seeiso, 2017). Provision of special care, such as iron and folic acid supplements, and tetanus vaccination, can reduce pregnancy-related problems and the risk of infant and mother death.

vi. **Skilled attendant:** a health care professional who has received formal training in medicine. This includes physicians, nurses, midwives, and community health workers. Traditional birth attendants are not considered skilled attendants.

vii. **Healthcare facility:** a private or public health establishment recognized by the government that provides allopathic and/or osteopathic medical services. Examples include local community health centres, clinics, and hospitals.

viii. **Termination of Pregnancy:** Termination of pregnancy is defined by WHO as the process of ending a pregnancy, so it does not end in the birth of a baby. Depending on how many weeks a woman has been pregnant; the pregnancy is ended either by taking medicines or having a surgical procedure (WHO, 2018). Termination is not the same as miscarriage, where the pregnancy ends without medical intervention although medical treatment may be needed after a miscarriage (Moulder, 2016).

ix. **Delivery:** Labour is believed to be one of the most painful human experiences, but, it varies with every woman and may differ with every pregnancy. Some deliveries are more difficult than others, even with the woman. The experience of labour pain varies widely, just like

menstrual cramps, which can be more severe for one woman than the next, or from one period to the next (Shorter, 2017). Deliveries in the attendance of a qualified health professional such as a midwife, doctor or nurse who have been educated and trained to provide proper care during pregnancy, childbirth and the postnatal period, and to identify complicated cases is more preventive and secure (Zolala, 2011). In the absence of skilled attendant, delivery can put the lives of both the mother and child at risk. It has been shown that professional midwives play a crucial role in reducing maternal death by raising awareness of its importance and by maintaining good health habits during pregnancy, giving advice on how to do so, and providing expert care at the time of delivery and in the immediate post-natal period.

2.3 Maternal Mortality Overview

Annually there are 529,000 women die due to pregnancy or child birth (WHO, 2019). It is beyond doubt that MM have affected families in a variety of ways. The consequences of MM on family and society are increase of child mortality, decrease of household income, reduction in care available to elderly relatives and greater likelihood of early marriage for their daughters, which in turn is a risk factor for subsequent MM of that daughter (Woldegiorgis, 2018). The MM varies globally, it varies between one geographical region to the other, and also varies within the country, the MM also varies between year to year.

2.3.1 Spatio-temporal Variations of Maternal Mortality in the World

The global estimates for the year 2017 indicate that there were 295,000 MM; 35% lower than in 2000 when there were an estimated 451,000 MM (UNICEF, 2014). The global MMR in 2017 is estimated at 211 MM per 100,000 live births, representing a 38% reduction since 2000, when it was estimated at 342. The average annual rate of reduction (ARR) in global MMR during the 2000–2017 periods was 2.9 %. This fact is illustrated in table 2.1 below. Furthermore, on average, the global MMR declined by 2.9% every year between 2000 and 2017. The global lifetime risk of MM for a 15-year-old girl in 2017 was estimated at 1 in 190; nearly half of the level of risk in 2000 which is at 1 in 100 (Taylor-Robinson et. al., 2019) (Refer to Table 2.2). The overall proportion of deaths to women of reproductive age (15–49 years) that are due to maternal causes was estimated at 9.2% in 2017 and it was reduced by 26.3% since 2000. This means that compared with other causes of death to women of reproductive age, the fraction attributed to maternal causes is decreasing.