MATERNAL MORTALITY IN ZIMBABWE: A GEOSPATIAL ANALYSIS OF SOCIOECONOMIC FACTORS

A RESEARCH REPORT SUBMISSION FOR THE MASTER OF ARTS PROGRAMME IN HEALTH DEMOGRAPHY, SCHOOLS OF SOCIAL SCIENCES AND PUBLIC HEALTH, FACULTY OF HUMANITIES, WITWATERSRAND UNIVERSITY

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MARCH, 2020

DECLARATION OF ORIGINALITY

I, Kumbirai Madziwa do hereby declare that the research titled **''Maternal Mortality in Zimbabwe: A geospatial analysis of socioeconomic factors''** is a record of original research work undertaken by me. The research submission is being made in partial fulfilment of the requirements for the Master of Arts Degree in Health Demography at the University of the Witwatersrand, Johannesburg, South Africa. To the best of my knowledge, the report has not been submitted elsewhere, in part or in full, for any award, or title. I also certify that thoroughgoing effort has been taken to ensure that presentation of this work does not infringe upon academic and ethical regulations governing research protocols established by Witwatersrand's Human Research Ethics Committee (Non –Medical). Neither does this work violate any people or organization's copy and proprietary rights. All ideas and techniques made use of in this research report which belongs to others have been acknowledged through in-text citation and a complete reference list. Wherever necessary, permission has been formally sought to use ideas belonging to others.

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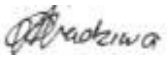
Student Signature: 

Date: 16th day of March 2020

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In the name of the most gracious God, with the submission of this research report, I have managed to satisfy all the requirements for a highly competitive Master's degree programme at Wits. Yes, at Witwatersrand University! When I enrolled for this program, the odds of completion appeared closer to the null. Well, statistics are faithless, but he [God], is faithful for He cannot flout himself [*2 Timothy 2:13*]. Foremost, I thank him, the 'great mentor' and 'promise keeper', for providing me with sufficient inspiration and wisdom to complete this project.

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DEDICATIONS

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LIST OF ACRONYMS

DHS	Demographic and Health Survey
ICD (11)	International Statistical Classification of Diseases and Related Health Problems (11th Revision)
MMM	Maternal Mortality Module
MMR	Maternal Mortality Ratio
MMRate	Maternal Mortality Rate
MMRatio	Maternal Mortality Ratio
MNH	Maternal and Neonatal Health
MoHCW	Ministry of Health and Child Welfare
SDGs	Sustainable Development Goals
SSA	Sub Saharan Africa
RHP	Reproductive Health Policy
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
WHO	World Health Organisation
ZDHS	Zimbabwe Demographic and Health Survey
ZNFPC	Zimbabwe National Family Planning Council
ZIMSTAT	Zimbabwe National Statistics Agency

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ABSTRACT

Background: Over the years, Zimbabwe has struggled to reduce the incidence of maternal mortality making it one of the most dangerous places to give birth in, globally. The lack of understanding of the geospatial mechanisms and socioeconomic circumstances within which maternal mortality occurs in Zimbabwe is a hindrance to its sustainable management as a public health problem.

Methods: Four rounds of the nationally-representative Zimbabwe Demographic and Health Survey (ZDHS) data collected between 1999 and 2015, were employed to geospatially analyse the levels and changes in the socioeconomic factors associated with maternal mortality in Zimbabwe. Computation of maternal mortality rates and ratios across provinces, mapping of hot spots and cold spots of maternal mortality, and logistic regression models of selected socioeconomic factors with maternal mortality across provinces comprised the analyses employed in the study.

Results: Of the total maternal deaths recorded in Zimbabwe between 1999 and 2015, the majority were recorded in provinces such as Manicaland (20%), Mashonaland Central (13%) and Harare (13%). Except for predominantly urban provinces such as Harare (580 to 501 death per 100 000) and Bulawayo (490 to 460 deaths per 100 000), MMRatios across provinces increased in the 2010-2015 period. Provinces with notable MMRatios increase include Masvingo (630 to 790 deaths per 100 000) and Matebeleland North (490 to 728 deaths per 100 000). Compared to the 1999-2005 period, the 2010-2015 period also had a higher concentration and spread of maternal mortality hot spots across the country. Harare and Bulawayo were cold spots. Selected places in the immediate peripheries of major cities, borderline areas and the stretch of areas in the predominantly rural provinces such as Masvingo, Mashonaland East and Central were maternal mortality high spots.

Overall, parity, age, education, cost of healthcare and religion were observed as significantly associated with maternal mortality. Statistically significant ($p < 0.05$) regression analysis outcomes with the highest odds include those involving the cost of healthcare in Matebeleland South (aOR = 25.50) and Harare (aOR =14. 12). In terms of wealth index, the highest odds were noted among those identified as “poor” in Harare (aOR=2.45) and Mashonaland Central (aOR=1.69. On religion, Protestantism in Bulawayo (aOR=2.25) and Pentecostalism in Matebeleland South had relatively high odds of association with maternal death. In terms of statistically significant odds by education, primary education in Masvingo (aOR=13.34) and Harare (aOR=4.04) were the most notable. The strength of association between maternal death and education categories such as primary education overall improved between the 1999-2005 and 2010-2015 period (aOR = 2.95 to 2.35), while with those noting distance to the facility as a big challenge the odds had worsened (aOR = 0.80 to 1.29)

Conclusions: maternal mortality in Zimbabwe is a national crisis requiring protracted investment to nullify it. Equally important is recognising that the experience of maternal mortality across time and space is not homogeneous, thus in the short term, it is imperative to identify places that require more attention than others. The occurrence of maternal deaths involves the intersection of multiple geographic demographic and socio-economic factors operating at different levels and strengths The formulation of maternal health policies will thus need to be cognisant of the dynamism and relativism of the socioeconomic and geographic contexts within which maternal mortality is instigated.

Keywords: *maternal mortality; geospatial, subnational, socioeconomic, Zimbabwe*

CHAPTER ONE:

INTRODUCTION

1.1. Background

While the world celebrates a near 50% milestone reduction in the number of maternal related deaths attained between 1990 and 2015, the pattern and pace of this reduction across geographical boundaries has been a relatively uneven one (Weimann *et al*.,2016; Donnay, 2015; WHO, 2015). Empirical evidence proves that over the past decades, some countries and regions have performed better than others in reducing the number of maternal attributable deaths. The persistence of maternal health inequalities is a concerning trend, one that has resulted in the renewal of global commitments aimed at nullifying this outcome under the 2030 Sustainable Development Goals (SDGs) framework (Gabremedhin, 2018; Kes *et al.,* 2015). Beyond the worry with countries whose progress has been slower and, in some cases, stalled, even more concerning are those whose toll of maternal deaths has worsened (Radkar, 2018). Contrary to the narrative of progress generally reported at a global scale, in countries such as Zimbabwe, maternal mortality indicators have seriously degenerated over the years (Zakeyo & Lange, 2015).

According to the 11th iteration of the International Classification of Diseases (ICD-11) (2018), maternal mortality refers to "the death of a woman while pregnant, during childbirth or within 42 days of the termination of pregnancy, irrespective of the duration, site or factors aggravating the death, however excluding accidental or incidental causes". Globally, at least 290 women for every 100 000 live births die from maternal relatable causes, such as pre-eclampsia and eclampsia (hypertension) and puerperal sepsis (infection) (Iyanda *et al.,* 2018; Rodrigues e*t al.,* 2016). This translates to a global average of one maternal relatable death every two minutes, and nearly a quarter of a million deaths recorded annually (Radkar, 2018).

Geographically, there remain stark differences in the distribution of maternal deaths between developed and developing countries (Iyanda *et al*., 2018; Garenne, 2015). Of the total global count of maternal deaths, approximately 99% of these are from the developing countries, and over two-thirds of these are identified as occurring in sub-Saharan Africa (SSA) alone (Global

Burden of Diseases [WHO], 2018; Iyanda *et al*., 2018). In general, maternal mortality communicates to poverty, social exclusion, relative deprivation to accessing health services and unmet women's reproductive health needs (Merdad *et al.,* 2018; Girum & Wasie, 2017; Lalthapersad-Pillay & Udjo, 2012). Although maternal deaths are preventable, the severe socioeconomic circumstances that are characteristic of most developing countries have continued sabotaging efforts to prevent these from further occurring (Garenne *et al.*, 2010).

According to Howson (2017), 14 of the 20 countries that have the highest Maternal Mortality Rates (MMRates) are in sub-Saharan Africa. These include countries such as Sierra Leone (with 1 360 maternal deaths per 100 000 live births), Central Africa Republic (882 deaths per 100 000 live births; 2016), Chad (865 deaths per 100 000 live births; 2015) and Nigeria (814 deaths per 100 000 live births; 2018). The risk of maternal mortality among women is 1 in 4900 in developed countries while in the developing countries it stands at 1 in 180 (Castells, 2017; Ebener *et al*., 2015). It is the worlds' poorest countries, usually war-torn and those designated as failed states that have the highest burdens of maternal mortality (Institute for Health Metrics and Evaluation [IHME], 2015; Merdad *et al*., 2013).

In Zimbabwe, more than twice (650 deaths per 100 000 live births) the global average of maternal deaths are reported annually (Munodawafa *et al*., 2017; ZIMSTAT, 2015). Even at the regional level (350 deaths per 100 000 live births; 2015), and relative to its neighbouring countries such as South Africa (280 deaths per 100 000 live births; 2016), Botswana (127 deaths per 100 000 live births; 2015) and Zambia (483 deaths per 100 000 live births; 2015), Zimbabwe has made very slow progress (Loquiha *et al.*, 2018; Mmusi-Phetoe, 2016; Banda, 2015). A country that once had very impressive health indicators, including a comparably lower maternal mortality ratio (191 deaths per 100 000 live births) regionally in the 1990s, has had all of these gains disappear twenty-five years later. With a 30% worsening of maternal health indicators reported to have occurred since then, Zimbabwe has been classified among countries where maternal mortality is a serious challenge (MMIEG, 2015; Zakeyo & Lange, 2015).

The evidence of geographic disparities in maternal mortality is well established at the global and regional levels. The prevalence of regional variations in maternal mortality underscores the need to investigate these variations within countries, particularly those with maternal

health indicators that have remained persistently poor. Evidence points out to variations and overtime changes in factors that influence maternal mortality across regions, and these may also exist within individual countries (Girum & Wasie, 2017). Understanding the within-country differences and changes in maternal mortality has been proven elsewhere as vital in ensuring the sustainable provision of maternal health services and efficient resource allocation toward the reduction of maternal deaths (Iyanda *et al*., 2018; Girum & Wasie, 2017). Yet very little has been investigated regarding maternal mortality differences in Zimbabwe, a country in urgent need of intervention to stop the occurrence of these deaths. It is from this perspective that this study was undertaken to investigate geospatially, the differences and changes in the levels and socioeconomic factors associated with maternal mortality in Zimbabwe.

1.2. Problem Statement

It is not only from the point of comparison with other countries or its past trends that there is a concern with the issue of maternal mortality in Zimbabwe. The fact that in the 21st century nearly 3 000 preventable pregnancy-related deaths still occur in the country every year is disturbing (Chinogurei, 2018; Munodawafa *et al.*, 2017). For the reproductive-aged women, the reality of 1 in 74 chances of not surviving past the maternal period, makes the supposedly natural and harmless process of pregnancy a 'one foot in the grave' exposure (GBD, 2018, Dodzo & Mhloyi, 2017; Gurwe *et al.,* 2017). According to the World Health Organisation [WHO] (2015), this is unacceptable.

In Zimbabwe women are established caregivers and labourers. According to a labour survey in 2016 women in Zimbabwe play an important role in the economy, contributing to at least 56% of the labour force. The majority of the women in the labour force are of reproductive ages, with their income predominantly utilised for the welfare of their families (Kes *et al.,* 2015). These women, whose lives are at a high risk upon becoming pregnant are also the heaviest contributors (58%) to the country's agrarian sector (Multiple Indicator Cluster Survey [MICS] report, 2017). Agriculture is the mainstay of the country's economy, hence women contribute heavily to food security and nutritional health both at the household and community levels (Chinogurei, 2018; MICS Survey Report, 2017). Their elevated risk of dying prematurely before fulfilling these roles is a threat to the intergenerational progress and productivity of the society (Godefay *et al*., 2015). The fact that such high numbers of maternal relatable deaths occur in

the country annually, therefore become a concern because of the disruptive impact posited to the family and society both in the immediate and long term period (Girum & Wasie, 2017).

A generally preferred background in the various attempts at finding the resolve to maternal health challenges in Zimbabwe is the tide of social-economic and political challenges the country has suffered over a protracted period (MICS Report, 2017; Chinogurei, 2013; Mlambo *et al*., 2013). Under these conditions, the capacity of the health sector to ensure quality and timely provision of healthcare services has been compromised. Also, skilled health personnel and medical supplies including vital drugs have become a major challenge (Gurwe *et al.*, 2016; Ministry of Health and Child Welfare [MoHCW], 2014). Along with the non-availability of vital health resources, the hyperinflationary environment inevitably triggered has meant that the affordability of these health services has also been an issue for the majority. (Gurwe *et al.*, 2016). It is through this reflection that suggestions on the possible vast geographical disparities in the socio-economic factors attributable to maternal deaths have been made. In this argument, rural areas are suggested as bearing the heaviest brunt of these deaths (Chinogurei, 2018; MoHCW, 2014).

Insight on the geographical disparities in maternal mortality outcomes in Zimbabwe has also been dominantly scoped on the continuum between unintended pregnancy, engagement in unsafe and illegal abortion practices and the culmination of medical complications (Centre for Reproductive Rights [CRR], 2017). In Zimbabwe, options for the termination of unintended pregnancies among women remain very limited (Cullum, 2017). Abortion is illegal in Zimbabwe (Maternowska *et al.,* 2018). Yet it is estimated that approximately 66 847 (17.8%) pregnancies among women aged between 15 and 49 years end up in abortion (Maternowska *et al.,* 2018). Again, compared to urban women, the majority of maternal deaths relatable to abortions are reflected as occurring in rural areas (Maternowska *et al*., 2018). Most women end up engaging in clandestine and unsafe abortions, the majority of which result in maternal related complications and deaths (Mlambo *et al.,* 2013). The escalation of medical complications and deaths as a result of abortions has thus been pertinent to the discussion of maternal mortality in many different contexts. However, for all that is known regarding the state, causes of and disparities in maternal mortality, there remains very limited knowledge regarding the within-

country spatial composition, distribution, changes and differences in the socioeconomic factors related to these deaths.

From a research point of view, the association between socio-demographic and economic factors and maternal mortality has not been sufficiently problematized. Among the various studies that have been undertaken to establish the factors contributing to maternal mortality in Zimbabwe, the majority have focused on medical factors leaving out the socioeconomic and demographic factors (Joseph *et al.*, 2015; Pande *et al.,* 2015). The urgent need for the resuscitation and establishment of new medical facilities including obstetric care units, improving quality of health services cannot be overemphasised. However, the medical emphasis on treating complications arising from childbirth has not stopped women from dying daily. Further to medical factors such as uterus rupture, excessive bleeding, obstructed labour, there has equally a need to consider the socioeconomic circumstances in which these arise (Banda, 2018; Loquiha *et al.,* 2018).

Other studies have made attempts at providing insight into both the medical and non-medical factors associated with maternal mortality. In the majority of cases where this has applied, the non-medical factors seemingly have been employed as a preamble or in some cases a 'convenient counter-argument' to the full-scale discussion of the medical factors leading to maternal mortality (Feresu *et al.,* 2005; Buor *et al.,* 2004). In this regard, the true association between the social-economic factors and maternal deaths is hardly ever investigated but rather derived or generalised from other studies. The contexts and socioeconomic circumstances shaping the experience of maternal mortality, however, has proven elsewhere to be diverse and complex (Garenne *et al.,* 2008; Stanton *et al.,* 2001). McCarthy & Maine (1992), further stipulates that unlike with medical factors, the relationship between socioeconomic factors and maternal mortality is not direct or automatic hence the need for empirical understanding.

Furthermore, the understanding of geospatial differences and changes in maternal mortality has been lacking. For the most part, the geospatial differences and changes that have been documented around maternal mortality have been limited to the very broad the rural-urban level. In a context of rapid change in settlement and land use pattern as has occurred in Zimbabwe, limiting analysis of complex public health problems such as maternal mortality to

rural-urban level is fast becoming irrelevant (Robertson *et al*, 2008). Several scholarships have reflected on the unavailability of large scale, routine and dependable data to allow examination of maternal mortality at lower administrative levels as the greatest constraint (Udo & Lalthapersad-Phillay, 2015; Hill *et al.,* 2018). While this is true, the continued treatment of the 'rural' and the 'urban' as two distinctive features relating to population settlement rather than extremes existing in a continuum may be masking a lot of variations important to understanding and addressing maternal mortality (Feresu et al., 2005; Merdad & Ali, 2018). It is therefore from the reflection on the magnitude of maternal mortality and the limitations of current research insight on it that this study was undertaken.

1.3. Significance of the Study

The examination of subnational changes in the levels of maternal mortality and the identification of associated geospatial clusters and socioeconomic factors potentially could aid the identification of priority areas (areas where intervention is urgently needed relative to others) in Zimbabwe (Moseson *et al.,* 2014; Radkar, 2018). As previously mentioned, the national level and rural-urban lenses from which the frequency of maternal deaths has been examined is insufficient to determine any important variations (Hill *et al.,* 2018). Beyond the identification of the priority areas, the study also could aid in identifying what these priorities are at the subnational level from a socioeconomic perspective, which has been identified before as lacking (Zakeyo & Lange, 2015; Mlambo *et al*., 2013).

Under article 12 of the International Convention on Economic, Social and Cultural Rights (ICESCR) of 1996 the needs and rights of women to the attainment of a high standard of healthcare are stipulated (Kassebaum *et al.,* 2013, Merdad; 2007). Under the convention, for which Zimbabwe is a member state, women's right to accessing maternal health services and establishment of maternal health support systems is emphasized. Zimbabwe has propagated the implementation and adoption of the numerous pieces of legislation to maximize on achieving the agreements of the convention under section 76 of its constitution. Under sections 76 (1) and 76 (3), the constitution of Zimbabwe, states that 'every citizen and permanent resident of Zimbabwe has the right to access basic healthcare services' and 'no person may be refused medical treatment in any healthcare institution' respectively (GoZ, 2013). While the legislation is progressive it has provided little attention to the diverse socio-

demographic and economic realities of women in Zimbabwe, which is a cornerstone of the setting up of a responsive maternal health system in Zimbabwe.

At the regional level, the reduction of maternal mortality has been on the front burner over the years. Under the African Union (AU) led the campaign on the Accelerated Reduction of Maternal Mortality (CARMMA) it has been noted that maternal deaths and under 5 mortality in Africa are intolerably high (Meh, 2019). Maternal mortality has also been recognised as disastrous to the development agenda for countries in Africa (Lalthapersad-Pillay & Udjo (2015). Under the theme, 'The Universal Access to Healthcare Services: Improving Maternal and Neonatal Health, Health Ministers from AU countries paved way for the onset of the CARMMA campaign. The actual campaign was endorsed in 2010 at the Ordinary Session of the African Union Assembly held in Uganda. Under the theme 'Africa Cares: No Woman Should Die While Giving Life', Heads of States from African countries including Zimbabwe drafted a list of actions to reduce maternal mortality initially by 2015, and later on by 2020 (Meh, 2019; Alkema *et al.,* 2016). Under CARMMA there are three main concerns, one of which includes ensuring the equitable provision of maternal and reproductive health services to women in Africa. This also communicates to the use of policy dialogue and government resource mobilisation (particularly domestic financing and investment) and soliciting societal and behavioural change in support of maternal health programmes. As the study identifies the variation in the geographical location and social-economic factors relatable to maternal mortality in Zimbabwe, it is relevant to the concerns of CARMMA. The study potentially could aid the identification of equity challenges affecting the maternal health system in Zimbabwe, thus culmination in their redress and attainment of the goals of the regional agreements.

In addition to the above, there remain several other regional agreements formulated in the direction of acknowledging maternal mortality as a crisis requiring commitment and scaling-up of capacity building efforts including research to reduce it (Ashraf *et al.,* 2017; Aremu *et al.,* 2011). Despite having an increase in its maternal mortality indicators, Zimbabwe has over the years committed to achieving the goal to reduce maternal mortality under several agreements. These agreements include; the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW) of 1994, and The Protocol to the African Charter on Human and People's Rights on the Rights of Women of 2005 (Maternowska *et al.,* 2014; Patton *et al*., 2009). With the latter, it has been stipulated as the governments' responsibility to protect and

guarantee the rights of women regarding their fertility as well as their choices to contraception, family planning or even terminate the pregnancy as enshrined in Article 14 of the protocol (Zakeyo & Lange, 2016). In a Zimbabwean context where abortion and other reproductive health rights enshrined in the internationally and regionally binding agreements are illegal or not recognized, many women continue to die of avoidable causes. The study becomes relevant in against a background of increased pressure from various stakeholders including Human Right Agencies, political actors and the academia for revision of what other scholarships have viewed as 'retrogressive abortion and reproductive health laws' (Madziyire *et al.,* 2018; Longue, n.d.a). By reflecting on the differential effects of maternal mortality across diverse contexts, the study provides an empirical perspective, upon which the potential 'redesigning' of policies may benefit from.

Also, the stewardship and monitoring of maternal health programs in the Sustainable Development Goals (SDGs) era have become a top priority at the international level (Weimann *et al*., 2016; WHO, 2015). Overall, SDG number three has been designed to inspire political leaders and policymakers and other actors concerned, to further accelerate their work in improving the health and wellbeing of women, children and adolescents (Godefay, 2015). Precisely, SDG target 3.1 expresses the commitment toward reduction of maternal mortality ratio to 71 deaths per 100 000 live births globally by 2030, with no country having a ratio twice more than the global average (Gabremedhin, 2018). Countries such as Zimbabwe with high mortality ratios, and signatories to the agreement, have more to do at an individual level toward ensuring these goals are met (Rodrguez-Aguilar, 2018). The improvement in the measurement and report precision of maternal mortality, which includes geospatial analysis, are established as key components for monitoring the progress of individual countries in line with vision 2030 (Radkar, 2018). The study is thus relevant to the global-local concerns of the global health agreements.

The study strongly identifies with the objectives of the Zimbabwe Maternal and Neonatal Health (MNH) roadmap formulated by the government of Zimbabwe through the Ministry of Health and Child Welfare (MoHCW) in 2013. The framework provides an overarching strategy aimed at scaling up institutional efforts toward curbing the burden of maternal mortality (Chihota & Nyoni, 2017). A key component to the framework is the suggestion for the decentralisation of maternal health services and the need to provide adequate and quality

prenatal and postnatal health services at lower levels of health delivery. The unstable socioeconomic and political environment in which the MNH roadmap has been instituted has, unfortunately, provided a very little financial and operational incentive for its implementation across the entire country as originally intended (Jerebvu & Manyonganise, 2017). With a geospatial analysis of maternal mortality, the study could aid and ensure attainment of commitments outlined in the NMH roadmap through the identification of mechanisms for the priority-based provision of maternal health services. The health services include for example the provision of skilled birth attendants, family planning and medical resources and these are key to the reduction of maternal deaths (Zakeyo & Lange 2015).

1.5. Main Objective and Sub Objectives

The main objective of the study is to examine; *the levels and geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe.* Specifically, the research seeks to:

1. Examine levels and changes in maternal mortality in Zimbabwe between 1999-2005 and 2010-2015,sub-nationally
2. Identify geospatial clusters of maternal mortality in Zimbabwe.
3. Determine the geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe.

1.6. Main Question and Sub Research Questions

The main research question is; *what are the levels, clusters and geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe?*

1. What are the levels and changes in maternal mortality in Zimbabwe between 1999-2005 and 2010-2015, sub-nationally?
2. What are the geospatial clusters of maternal mortality in Zimbabwe?
3. What are the geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe?

1.7. Hypotheses

This study is premised on the following null (H_0) and alternate (H_a) hypotheses:

- $H1_0$: There is no statistically significant geospatial clustering of maternal mortality in Zimbabwe.
- $H2_0$: There are no significant geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe
- $H1_a$: There is a statistically significant geospatial clustering of maternal mortality in Zimbabwe.
- $H2_a$: There are significant geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe.

1.8. Organisation of the Research Report

The foregone chapter was an introduction to the research report. Chapter Two is a review of related literature as well as a presentation of the theoretical and conceptual frameworks adopted for the study. In Chapter Three, the methodology adopted for the study is presented. Chapter Four is a presentation of the study results. The penultimate chapter (Chapter Five), is a discussion of the study findings. The research report concludes in Chapter Six with a conclusion based on the main findings, a discussion of the limitations of the study as well as recommendations for future studies.

CHAPTER TWO:

LITERATURE REVIEW, THEORETICAL & CONCEPTUAL FRAMEWORKS

2.1 Introduction

Overall, this chapter is a review of the current depth of knowledge regarding the socioeconomic factors associated with maternal mortality. The chapter is divided into two major sections. The first highlights key factors associated with maternal mortality as discussed from previous global, regional and local (Zimbabwean) studies. The emphasis in this section is the different conclusions these studies have arrived at concerning in particular, the influence of socioeconomic factors on maternal mortality. The section is also concerned with identifying the gaps in previous studies on socioeconomic factors relatable to maternal mortality. The second section discusses the theoretical and conceptual frameworks adopted for this study.

2.2. Overview of Factors Associated with Maternal Mortality

There are different perspectives regarding factors associated with maternal mortality that are presented by scholars in current literature. Scholars generally classify factors associated with maternal death into two main distinct categories which are; medical and, non-medical factors (Pande *et al.*, 2015; Longue, 2013; Rytkonen *et al.*, 2004). Medical factors refer to the direct obstetric causes of maternal death, while the non-medical factors include the social-economic and demographic factors such as population group, income, type of place of residence (Banda, 2015; Longue, 2013).

Other scholarships suggest slightly more refined categorisation and, characterise these factors associated with maternal death into three. They distinguish between distal, intermediate and immediate factors of maternal mortality (Wilmoth, 2009; Feresu *et al.*, 2005). Distal factors are those influences that are further back in the maternal mortality causal chain and act through intermediary factors to influence maternal death. According to Smith (2001), distal factors usually represents the underlying non-medical state of vulnerability to maternal death. Intermediate factors, on the other hand, refer to proximal risk factors, or factors that precipitate the occurrence of maternal death (Amstrong *et al.,* 2015; Wilmoth *et al.*, 2012).

Immediate factors refer to those factors directly relatable to the occurrence of maternal death such as haemorrhage, sepsis or infections and obstructed labour (McCarthy & Maine, 1992). This review presents both the direct medical and indirect factors to gain an in-depth understanding of these factors as has been discussed in the literature. However, as the study is primarily focused on identifying the socioeconomic (indirect) factors associated with maternal mortality, the section gives more attention to these.

2.2.1. Direct Causes/Factors

Direct causes of maternal mortality are complications or disease that occurs during pregnancy or its culmination. These may occur naturally or as a result of the intervention, incorrect medical or non-medical treatment and omissions all which could result in death (Abou Zahr *et al.*, 2004). In SSA haemorrhage, hypertensive disorder (eclampsia), obstructed labour, puerperal sepsis and abortion were observed among the leading direct causes of maternal death.

2.2.2. Indirect Factors: Socioeconomic Factors

There are several socio-economic factors important to the understanding of the occurrence of maternal deaths. The thematic categories in which most of these factors are placed in literature provides a reference for the review in this section. These categories include factors related to women's, individual characteristics; household characteristics, external environment or community characteristics, reproductive status, access to health care services, use of health care service and health status.

2.2.2.1. Women's Characteristics

Educational Status

In current literature, the positive association between education and maternal health outcomes is well established (Ashraf *et al.*, 2015; Garenne, 2015: Graham *et al.,* 2008; Feresu *et al.*, 2005). Several mechanisms through which the education of a woman facilitates the reduction of maternal death are identified across studies. Ashraf *et al* (2014), for example, pointed out to the empowerment of a woman or the increase in their bargaining power as the relevant means through which education influences a reduction in maternal death. Educated women in this regard have amongst other important attributes, high bargaining power in negotiating the use of contraceptives to avoid unwanted pregnancy (Ahmed et al., 2014). Education is also linked to improvement in women's decision-making capacity and control in

issues relating to their reproductive health wellbeing which including the number of children, and access and use of health services (Hill *et al.,* 2018).

While a majority of studies in developing countries focuses on the relationship between maternal death and formal education, in the developed countries such as the United States of America, the emphasis is on the less formal however maternal related education (Suplee *et al.,* 2018: Graham *et al.*, 2008). The emphasis on maternal related education is preceded by the realisation that while women may be formally educated, they may lack specifically antenatal and postpartum education crucial during the maternity period (Suplee *et al.,* 2018). Women without antenatal and postpartum education have been observed less likely not to recognise hence in most of the cases fail to respond on time to signs of pregnancy complication (Di Orio *et al.,* 2014; Kassebaum *et al*, 2014;).

According to Iyanda *et al*., (2018), investment in the education of women is an important policy lever in curtailing the death of women during pregnancy, delivery or in the aftermath. As part of the WHO Global Survey on Maternal and Perinatal Health, Karlsen *et al* (2011), conducted a study over four years on 287 035 maternal inpatients from across 24 different countries. The prospective cohort study aimed to determine the impact of several factors including education on maternal health outcomes. In the study, in comparison to women with at least 12 years of formal education, those without education were 2.7 times (p-value <0.05) more likely to experience a maternal related complication including death. Those with between 1 and 7 years were almost twice as much likely (OR = 2.04) to experience maternal complications.

Using panel data from 108 developing countries Bhalotra & Clarke (2013), also attempted to estimate the association between maternal mortality and educational attainment between 1990 & 2010. In their study, they concluded that the impact of educational attainment was equal to the impact that delivery through Skilled Birth Attendants (SBAs) had on maternal outcomes. In the 20-year retrospective study, the finding was that with increasing levels of education women were less likely to engage in reproductive and health behaviours associated with an elevated risk of maternal death such as a high number of births, non-use of contraceptive and non-use or infrequent use of skilled birth attendants during delivery. In their worldwide survey McAlister & Baskett (2006), also found out that female literacy combined with enrolment in education programs were significant predictors of maternal mortality rates (MMRates). In most Scandinavian countries such as Sweden and Denmark, high female literacy

and enrolment in education after controlling for other factors such as income, age and race, were likely to be associated with significantly lower MMRates. It was in countries where women generally had lower educational attainment such as Somalia and Afghanistan, that the rates of maternal mortality were explosive.

Only a few studies have found no statistically significant association between women's education and maternal mortality (Abou Zahr, 2013; Wilmoth *et al.*, 2009). Even in those studies, the researchers have often considered their findings unusual, with some running few more models factoring other potentially required adjustments. In the case of Gustavo & Sanankore (2012), in Pakistan for example, the realisation after running their first multivariable model was that that there was no significant difference in the risk of maternal death between more educated and less educated women. Stratifying the results by rural-urban residence, age, income status, and other factors identified to have an effect modification, the difference was then noted. In the second and third models, that the researchers ran, it was only among the high income-urban women where education was identified as not affecting the risk of maternal death. Among poor women, education was relevant and significant (p-value < 0.05) predictor of maternal mortality. In comparison to those with higher levels of education, rural women with lower and moderate levels of education had 1.57 and 1.30 times respectively increased risk of maternal death.

A study by Kruk *et al* (2015), concluded that higher levels of health expenditure do not automatically mean substantially greater use of skilled birth attendants by poor women. In addition to this they also, found that at any given level of health care spending, poor women's use of skilled birth attendants varies substantially, depending on the equity in the distribution of education. In high-income countries, delivery is often a positive and fulfilling experience but for many women in low-resource countries, it is associated with suffering, morbidity and in many cases maternal deaths (Kruk *et al.*, 2015). The result also reveals that the educational level of women, birth order and wealth index were significant predictors in explaining ante-natal and delivery care. Controlling the effect of other variables, the predictive power of women's educational level, was positively associated with antenatal care and use of skilled birth attendants during delivery.

Marital Status

Several scholarships have examined the association between marital status and maternal mortality. However, there seems to be little consensus regarding the influence posited by marital status on the risk of maternal death. For Ahmed & Hill (2011), being married had a protective effect to the risk (1 in 201) of maternal death, while being single placed women at an elevated risk of maternal death (1 in 97). Even in comparison to cohabiting women, those who were reported unmarried at the time of their death were worse off, that is, they had a higher risk (1 in 78) of experiencing maternal deaths. With these findings in hand, they concluded that the differences in maternal outcomes by marital status suggested the importance of strong socioeconomic support systems for women during their maternal period. According to Ahmed & Hill (2011), married women were more likely to have both the material and non-material support of their spouses, additional to that of their families on both strands of the husband-wife kin's network. Unmarried-single or cohabiting counterparts, on the other hand, were likely to be deprived or receive a very minimum of this vital support.

In their concurrent mixed methods study, Moyo *et al* (2018), noted it as a common practice among Zambians, that when a woman fell pregnant before getting married, arrangements were immediately made to have them married. The common reason for remaining unmarried once pregnant was the event that a man having rejected paternity of the child and therefore declined to support the expecting mother. Non-marriage of expecting women was also more common when financial resources on the man's side were scant to allow formalisation of marriage (Moyo *et al.*, 2018). The latter was observed more common among teen-fathers who at the time of impregnating often had insufficient means to generate income to support the pregnant woman and the unborn child. In either of the reflected cases the conditions for supporting pregnancy that is ensuring recommended check-ups, access and use of safe facilities were limited. With these constraints, there was an implicit suggestion that pregnant unmarried women had an elevated risk of experiencing maternal related deaths (Chileshe *et al.*, 2017)

In their study among Burkinabe women Alkema *et al* (2016), suggest somewhat contradictory evidence of the influence of marriage on maternal deaths relative to other studies. Compared to unmarried women, the odds of exposure to the risk of maternal death among married women was up to three times higher. In the context of this study, they concluded that marriage limited the avenues for women's autonomy and decision making especially in matters that

pertained to their reproductive health. This included matters related to the use/non-use of contraceptives and seeking health services. While the type of place residence was suggested potentially an effect modifier of this observed association, in general, unmarried women with a greater deal of autonomy were less likely to experience maternal deaths.

Religious Affiliation

In a retrospective analysis of the factors associated with maternal mortality in Nigeria using nationally representative DHS data, Ariyo *et al* (2017), noted that religion was significantly associated with maternal mortality. Compared to Christian women (control), Muslim women were approximately half the times more likely to experience maternal death (OR: 1.52: 95% CI 1.10-2.11). In discussing this disparity, they acknowledged the importance of religion and associated belief systems in determining health outcomes. The Islamic religion which is dominant in the Northern part of Nigeria is discussed in the study as preserving tenets that emphasise on strict obedience of the woman to the husband including asking for permission to leave the household. The religious belief system also legitimises the strict confinement of women within the respective households (purdah). As a result of this women were often left powerless and without control to the important issues of their health. Delays in diagnosing potential complications as well as seeking emergency health services were key to the aggravation of maternal death among Muslim women (Donnay *et al*., 2015; Betran *et al*., 2005).

Among Burkinabe women, Pambe *et al* (2014), found that religion was a significant factor associated with maternal health. According to Pambe *et al* (2014), compared to women belonging to other religious groups, those of Protestant faith were found less likely to experience maternal death. Unlike other religious faiths, Protestantism promoted women's involvement in decision making regarding health care access and use, hence the reduced likelihood of experiencing maternal death. On the other hand, women belonging to other religious groups were noted as facing constraints in their attempt to access or use health facilities. In extreme cases of religiosity Merdad *et al* (2018), noted deaths that occurred because the women had been denied approval by religious authorities to use vital medical services including caesarean section and blood transfusion processes during deliveries. Protestant women on the other hand hardly reported such obligations and as a result, tended to have better health outcomes. Elsewhere in Cameroon, Meh (2018) found religion as a

significant influence on women's health-seeking behaviour. According to Meh, (2018), most religions including Islam tended to promote marriage and viewed it as the only acceptable condition for procreation. As a result of this preference, most young women in these highly religious societies tended to get married at very early ages, increasing, therefore, the exposure to the risk of pregnancy through sexual coitus.

Although they found a high concentration of health facilities owned by churches in Zimbabwe, Zakeyo & Lange (2015), concluded some religious tenets also tended to prevent the use of specific health services. They identified in their study influential churches and figures including Catholics who discouraged female members from using modern contraceptives. As a result of the non-use or little use of modern contraceptives, Catholic women tended to have high fertility and compared to women of other religious group had higher MMRates. Compared to women of other religious belongings Catholic women were up to 1.36 times more likely to experience maternal complications including death.

In a qualitative study among 15 purposively selected apostolic sect members, a denomination under Christianity in Zimbabwe, Dodzo *et al* (2016), also concluded that belief practices had a huge bearing in the culmination of death during pregnancy, delivery or after. 'Apostolicism' was discussed in this study as promoting amongst other risk factors to maternal death, early marriage of women, non-use of contraceptives, high fertility and non-use of health care services (Chinogureyi *et al.,* 2017; Dodzo *et al.,* 2016). The study concluded that Apostolic Faith beliefs were important factors in increasing the risk of death during pregnancy. The use of customised spiritual but unsafe maternal health systems accompanied by delays in recognition of pregnancy danger signs and non-use of health services were concluded as leading to maternal death among women from this religious sect (Dodzo *et al.*, 2016).

2.2.2.2. Household Factors

Wealth Index

In many developing countries, accessing data related to household income and wealth is also often a challenge (Alexander *et al.*, 2017; Zakeyo & Lange, 2015). Particularly is Sub-Saharan Africa, there is a lack of reliable data on income and expenditures, which are assumed the traditional indicators used to measure household economic status. The use of the wealth index

is, therefore, a proxy measure generally used by researchers to explore how much household economic status affect health outcomes (Shoo & Mboera, 2017; Ahmed & Hill, 2011).

The wealth index is used to refer to a composite measure of the household's cumulative living standards (Bazile *et al.*, 2015; Donnay, 2015). Its association with maternal mortality has been of interest in several studies. However, despite being a dominant area of empirical research, the nature of the association between socioeconomic status and maternal health outcomes remains highly complex and ambiguous. According to Dennis *et al* (2012), the conventional measures of socioeconomic status premised on indicators such as income, occupation or education have questionable construct validity in many populations. For Nyoni (2015), it is the precise mechanisms through which lower socioeconomic status translates into maternal health disadvantage that has never been fully understood. This is because maternal health outcomes or status may be reflective of socioeconomic status-related protective or risks factors whose effect are cumulative and not necessarily current. In this regard, the reliability of measuring the association between maternal outcomes and socioeconomic status based on cross-sectionally designed studies has been questioned. Further to the above mentioned, indicators commonly used generate socioeconomic status index such as homeownership, social ranking and family wealth is often considered very difficult to quantify. These indicators are based on subjective and context-based reporting, making it difficult to compose a single measure across time and space.

Several studies concur that women's maternal health outcomes in most developing countries are reflective of their socioeconomic status, with the marginalized and poorer women usually having the highest risk of experiencing maternal death (Betran *et al*, 2005; Stanton *et al.*, 2001). Poverty for example in Africa is pervasive and women tend to be poorer than men. It is the majority of these contexts where maternal deaths occur (Udjo & Lalthapersad-Pillay, 2014). In poor areas, it is the very poorest who faces the highest risk (Thaddeus & Maine, 1994). Studies including Weimann *et al* (2016) and Ebener *et al* (2015), have examined the influence of household wealth with regards to health-seeking behaviour. In communities with improved awareness about the availability of services, economic factors such as financial barriers are particularly pertinent and negatively affect maternal health (Diorio & Crivelli-Kovach, 2014; Mumtaz *et al.*, 2014). The lack of money or insufficient funds poses a barrier to access to health as fees and cost of services limit demand and use of these services (Abou-Zahr & Royston,

1991). This is worse for women living in places where the cost of care is borne primarily by the individual (Amzat, 2015).

2.2.2.3. Women's Reproductive Status

Parity

The association between parity and maternal mortality has been discussed more frequently among reproductive health experts (Alexander *et al.*, 2017; Bazile *et al.,* 2015; Ebener *et al.*, 2015). Parity is defined as the total number of children born alive to a woman (Ebener *et al.*, 2015). The understanding of the association between parity and maternal mortality has often occurred at the broader international level, with countries ranked as having the highest total fertility rates also suggested to have the highest MMrates and ratios (Radkar, 2018; Munodawafa *et al.*, 2017; Robertson *et al*., 2008).

In their analysis of the variations of maternal mortality in Sub-Saharan Africa, Kes *et al* (2015), found out that maternal mortality incidence tended to be higher among those countries such as Chad (6.5 birth per woman; 2013) and Nigeria (4.5 births per woman; 2014) where the average number of births per woman were higher. For Moseson *et al* (2014), classifying women who had between two and four children as the reference category in a cross-sectional study in Kenya, women who had between five and seven children faced twofold the risk of experiencing a maternal death. Still using women who had between two and four children as the reference, the risk of maternal death tripled for women with eight or more children.

High parity in other studies was associated with a high risk of vascular complications and haemorrhagic stroke which in turn led to maternal deaths (Bazile *et al.,* 2015, Buor & Bream, 2004). However, it seems literature is equivocal regarding the specific mechanism through which the relationship between parity and maternal mortality operates. According to Steenland (2010), the association between parity and maternal mortality could be positive, however, there is need to check if the findings are at least partially not due to the confounding effects of other unmeasured variables such as one's socioeconomic status (Donnay *et al.*, 2015; Bazile, 2005). In the variety of studies on the parity- maternal mortality relationship, scholars have commonly acknowledged their inability to control other background variables such as body mass index (BMI=weight (kilograms)/height (m2), ages at birth and menarche respectively (Bazile *et al,* 2015; Buor & Bream, 2004). The inability to control for these potential confounders thus remains the main reason for the lack of unanimity amongst scholars.

Age

Age, which relates to the total number of years lived by an individual is one of the socioeconomic factors related to reproductive health whose association with maternal mortality has been examined quite extensively in current literature. A majority of studies have conceptualised the relationship between age and maternal mortality in terms of a j-shaped positive association (Hill *et al.*, 2018; Loquiha *et al.,* 2018; Buor & Bream, 2004; McCarthy & Maine, 1992). This is to imply that the risk of mortality is higher at younger ages, declines midway and starts to rise towards the end of the woman's reproductive ages. Based on this conceptualisation maternal deaths are noted most likely to occur amongst those in their early reproductive ages, that is 15 years to 20 years and those after the age of 30.

For those in their early reproductive age groups, the likelihood of maternal death has been attributed to several factors. According to Baxter & Moodley (2015), the high odds (3.07) of maternal death among adolescent women, were mainly attributed to incomplete physiological development at the time of pregnancy which meant a high risk of complications. Among the same age group, there were also high rates of unintended pregnancies that were usually accompanied by clandestine attempts at abortion. For Patton *et al* (2009), the high risk (25%) of maternal death among young girls was likely to be related to their lack of information concerning their bodies, therefore, the lack of preparation to deal with needs that come with pregnancy and childbirth.

Other qualitative studies have made attribution of the high risk of maternal deaths among adolescents to the societal stigma and disapproval of their early-age pregnancy, the stress and pressure usually coming from the family and the supposed partner (Mlambo *et al,* 2013; Longue, 2013). The discouragement that was felt by young expecting mother in seeking appropriate health care services due to the 'real' or 'expected' negative attitude from health service providers was also highlighted a possible factor leading to lower use of health service and ultimately maternal complications (Pullum, 2014; Mlambo *et al.,* 2013). Based on these and other related factors, women aged 15-20 years are alluded to have the highest risk of maternal death.

Besides the adolescents, research has also found the risk of maternal death to increase after the age of 30, having receded in the '20s. While there is no conclusive agreement to the factors that elevate the risk of maternal death for older women (30 to 49 years) factors relating to the women's declining physiological capacity to sustain pregnancy have often been cited (Rodriguez-Aguilar, 2018; Pande *et al.*, 2015). In addition to this, others have mentioned the elevated relative risk of older women to having conditions such as hypertension and diabetes (Pande *et al.*, 2015; Robertson *et al.,* 2008). In the event of pregnancy, these conditions are likely to trigger maternal related complications. In their population-based surveillance study in rural South Africa, Houle *et al* (2014), found out that compared to women aged between 25 to 29 years old, those between the ages 30 to 34 years of and 35 to 39 years, were 2.25 and 3.07 more times likely to experience maternal related death respectively. Controlling for HIV status and race in a study in America, of the 800 deaths that were recorded relatable to maternal causes in 2016, MacDorman (2017), found out that 27% (highest) of the total deaths occurred among the 15-19 years, while 19% (second highest) of the deaths were among the 35-39 years, age group.

2.2.2.4. Access to Health Services

The issue of accessibility of health services while reflective of several important underlying socioeconomic issues, it remains a broad and diffusely defined variable of assessment (Shah *et al.,* 2014). In the context of most studies on maternal health, health facilities are considered important in providing quality, safe and sustainable healthcare services to women (Bandile & Chauke, 2017). Other than health facilities such as clinics and hospitals, there remains a limit of equally safe alternatives. According to Weimann (2016), the inaccessibility of health facilities during pregnancy, delivery or in the aftermath is a serious compromise to the safety of both the mother and the baby.

Cost of Accessing Health Services

Amongst other scholarships, Zakeyo & Lange (2015), relates accessibility closely to affordability. According to Zakeyo & Lange (2015), some health facilities or institutions may become inaccessible because potential users cannot afford the fees required before the service can be rendered. Unless incentivised by the government or the health services are

offered through multi-agent donor funding agencies hence free, in most parts of Africa most women cannot afford maternal health services (Girum & Wasie, 2015).

The differences in terms of financial accessibility of health services and the associated effects are documented in several studies (Ahmed *et al,* 2014; Radkar, 2018). In their study among women Nigeria's Oyo and Imo states, Odom *et al* (2014) found out that compared to those who indicated being able to afford hence access public health services (reference group), those who indicated affordability of private health service had 65% (OR: 0:35) decreased odds of experiencing maternal complications. Meanwhile in the same study states, those who indicated neither able to afford public nor private health services had up to 5.07 times the risk of having maternal attributable deaths in comparison to the reference.

Distance to the facility

For other scholars, accessibility relates to the distance one has to cover to get to the health facility (Sarpong *et al.*, 2013). The use of health maternal services and other services generally, is viewed as a function of how easily accessible in terms of distance the health facility generally is (Silva *et al*, 2014). In their study among women in rural Zimbabwe, Munodawafa *et al*, (2017), found that compared to those who lived within 0-3km health facility radius (reference category), women who lived between 4-6 km radius had 0.75 (25%) decreased odds of using a specific health facility.

2.2.2.5. Geospatial and Location Factors

Type of place of Residence

The 'Type of place of residence', 'region', or 'neighbourhood' is regarded in the literature as a variable that offers a relevant context for the understanding of health disparities. Studies argue that 'The region of residence' has a direct effect on one's health status through the environment or the less tangible effects such as an area's social capacity (Merdad, 2013). Geography may play an important role in the delivery of health services through; historical and cultural inheritances and regional price variations; and the geographical distribution of health care facilities may affect utilisation, through the differential opportunity of access to services (Pande *et al.,* 2018). To address the effect of the region of residence on health outcomes in general and maternal health outcome precisely Pullum, 2014, discusses five principles which are important to understand. These are; the area effects on health, area effects on healthcare

production, area effects on health care utilization, geographical equity in health finance and ability to pay.

In terms of the area effects on health, the impact on the health of variations in local economic conditions, such as the dominant type of employment, might create an important area effect. Inadequacies in social support systems, such as transport, social care and education services, might have adverse implications for local health outcomes (Mlambo *et al.*, 2016; Robertson *et al.,* 2008). Less tangibly, local culture might affect lifestyle in numerous ways (such as diet and smoking), giving rise to an apparent area effect on health including maternal health outcomes (Merdad *et al*., 2013).

By 'area effects on healthcare production', Pullum (2014), argues that input prices can vary substantially between areas. This, in turn, affects the aggregate level of finance required to deliver a standard level of health care. This might also have an important influence on the way that health care is organised. For example, Robertson *et al.,* (2008), in their analyses of maternal mortality differences in Zimbabwe argued that rural and urban areas presented quite different challenges for the optimal design of health services. Given increasing returns to scale, it was considered more costly to deliver the same level of hospital care to rural areas as in urban areas. Rural areas in most instances do not secure the economies of scale obtained in urban areas and might need to be offered extra finance to allow for the provision of standard level of care. Such provisions are not always available in poor countries. Very remote rural communities may suffer a lower level of services than their urban counterparts, may have to travel further to secure such services, or may receive health care differently hence the effect of geographical location

In terms of area effects on health care utilisation, there is strong evidence to suggest that geographical access to services has a profound effect on health care utilisation (Rodriguez *et al.,* 2018; Pande *et al.,* 2015). Such effects might take the form of "supplier induced demand", in the sense that, in areas with the relatively high provision of health care, individuals might be "induced" to make more use of services than their counterparts in less well-provided areas.

The majority of studies have focused on the effect of type of place of residence, precisely the rural-urban differences on maternal health behaviours, not necessarily the outcome. In their study, Sword *et al* (2015), for example, explored the influence of neighbourhood variation in

maternal health behaviours in a Canadian City. Significant clustering was observed for instance in the industrial and downtown part of the city. They also found out that the majority of women (76%) infrequently made utilization of the maternal health services offered by health facilities in these downtown areas. Also, those the majority of those who reported non-use of maternal health services were uneducated, unemployed and also impoverished.

Banda *et al* (2015) study draw closer to exploring what the current study also intends to explore. In their study of rural-urban differentials in maternal mortality Zambia Banda *et al* (2015), found the adjusted adult female mortality higher in adolescent age female living in rural areas compared to that in the urban areas. Using Census data Banda et al (2015) found out that a 15-year-old reproductive age woman living in rural areas had a 1 in 3 times chance of dying from a maternally related cause before reaching her 50th birthday. In comparison to the observed risk among rural women, those living in urban centres had a lessened (1 in 4) risk of experiencing a maternal related death by the time they reached menopause. Of the percentage total number of deaths attributable to maternal complications, overall those women in rural areas almost doubled (17.9%) that observed among urban women (9.8%).

In their study in France, Saucedo *et al* (2011), also attempted to assess the risk of post-partum mortality by region and investigate if there were differences in the quality of care that the deceased received by region. After adjusting for nationality and maternal age, Saucedo *et al* (2011) found out that the risk of maternal death was significantly higher in lle-de France region (aOR 1.6, 95%, CI 1.2-2.0) and the Overseas Districts (aOR 3.5, 95% CI 2.4-5.0) in comparison to those in continental France. In lle-de France and Overseas districts, the excess risk of death from haemorrhage, amniotic fluid embolism and hypertensive disorders was significant. In continental France, after further controlling for women's obstetric characteristics, the risk of maternal death in Ile-de-France remained higher (aOR 1.8. 95% CI 1.3–2.6). From the results of the study, they concluded that that quality of care and organisation of health services may play a role in the differential risk of maternal mortality between regions in France.

2.3 Theoretical Framework

2.3.1. Framework for Analysing Determinants of Maternal Mortality

McCarthy and Maine's (1992) Framework for Analyzing the Determinants of Maternal Mortality (FADMM) informs the theoretical frame adopted for this study. McCarthy & Maine's (1992) frameworks offer a comprehensive and integrated analysis of the socio-cultural behavioural and biological factors that influence maternal morbidity and mortality. By drawing from widely accepted frameworks in the analysis of fertility and child mortality, the FADMM explains the mediation of socioeconomic and environmental variables through direct determinants to cause maternal morbidity and mortality (McCathy & Maine, 1992; Bongaarts, 1984; Mosley & Chen, 1984).

The FADMM is organized into three major stages which precede the occurrence of maternal complications (McCarthy & Maine 1992). Pregnancy-related complications including the risk of mortality occur on the condition that a woman has fallen pregnant, without which there is no risk. According to Kassebaum *et al* (2014) in the FADMM, pregnancy is a necessary condition whose state or some other pre-existing health problems may aggravate complications that result in maternal morbidity (including disability) or mortality.

Next to the possible outcomes of pregnancy previously described, the framework identifies a set of five intermediate factors. These intermediate factors or determinants as shown in Figure 2.1 are the woman's, health status, access to health care services, health-seeking behaviour, reproductive status and unknown or unpredicted factors (Abou-Zahr & Royston, 1999; McCarthy & Maine, 1992). These factors are preceded by distal determinants which McCarthy & Maine (1992), sub-divided into three categories. These categories are the pregnant woman's status in her family and community, the status of her family and the status of the woman's community.

According to McCarthy & Maine (1992), there is an association between distal factors, intermediary factors and possible maternal outcomes. Distal factors have an indirect influence on maternal outcomes. This implies that distal factors operate through other intermediary mechanisms for them to influence a specific maternal outcome. Thus, for example, a woman's status in the family or community would be a relevant but not all-sufficient factor for one to experience maternal death. The influence of a woman's status (distal factor) on the risk of maternal death become relevant through for example the health behaviours (intermediary) they display during pregnancy. A woman's failure to take antenatal care visits during pregnancy could be a result of their lower social standing in the household. It is then the failure to take

antenatal care visits that results in complications such as a ruptured uterus (McCarthy & Maine, 1992).

Intermediary factors have a direct association with maternal outcomes. It is possible that as a result of a woman's health status (immediate factor) such as having a parasitic or infectious disease as a woman may die during pregnancy. Pregnancy results in a woman's reduced body immunity and the odds of recovery from parasitic infections during this period are expected to be lower than when a woman is not pregnant. It is also possible that as a result of a parasitic infection during pregnancy other complications could be triggered. For example, Mahande & Mahande (2016) found out that women that were infected with malaria during pregnancy in Tanzania had 1.13 times increased risk of having preterm deliveries than those that were not infected.

Distal Factors

The distal factors consist of 3 categories. These are the women's socioeconomic status, (SES) within the household and community, the status of other members of the household within the community. The lower the SES at any level, the greater the odds of dying from maternal related causes. In terms of the woman's SES within the household and the community, considered are factors such as education, occupation and income status (Moreson, 2014). The less educated the woman is, for example, the greater the odds of her dying from a maternally related cause (Hill *et al.,* 2018; Robertson *et al.,* 2008). In terms of the family's status within the community, the FADMM considers amongst other factors, the family's aggregated level of income educational and occupational status. Finally, in terms of the community status, considered is the status of the community's aggregated health status, community resource ownership, available infrastructure, health services and resources such as doctors, ambulatory services and clinics.

Intermediate determinants

Woman's Health status

As an intermediate factor-related to maternal mortality, McCarthy & Maine (1992), identified as an element to woman's health status, her nutritional status. According to Longue (2013), a woman requires more in terms of nutrients under conditions of pregnancy. However, the providence of these in conditions of poverty cannot be guaranteed. Without adequate

nutrition which usually encompasses a lack of iron and folic acids, there is a heightened risk of maternal death. Apart from nutritional status McCarthy and Maine (1992), identified the prevalence of infections and parasitic disease chronic conditions such as fistula, meningitis, hypertension among women during pregnancy.

Reproductive Status

The reproductive status communicates to the woman's attributes that potentially could predispose her to the risk of maternal death. Identified under this category include age, parity and marital status. In their explanation of the relationship between parity and maternal mortality, women with fewer children as well as those with many children, are more likely to die from maternal related complication. The same is also true with age, where the risk of maternal death was observed to be higher at a younger age and older ages. At younger and older ages women are more likely to experience conditions such as prolonged periods of labour and develop other complications such as fistula or die from obstructed labour (McCarthy & Maine, 1992). At an advanced age, again the risk of death was noted to elevate. Declining physiological capacity to sustain pregnancy and the increased odds of having other chronic conditions such as hypertension and diabetes have been held explanatory of high incidence maternal mortality among women (Rodriguez-Aguilar, 2018).

Access to Health Services

The FADMM also consider access to health services as an important factor relatable of maternal mortality. Access to health services in the framework is presented as a composite concept that is based on two dimensions. The first of these is availability, that is, the financial accessibility. Poor financial accessibility access to a health facility could increase the risk of poor maternal health outcomes. Secondly, there is the dimension of physical access which covers aspects such as distance to the health facility and availability of the health services such as family planning and prenatal care for women. The availability of abortion services for women who may want to terminate the pregnancy, primary health care and antenatal service for those seeking successful and safe birth is also key (Ebener, 2015; Shah *et al.,* 2014). Others have also identified access to information relating to services such as the provision of contraceptives also as an important element relatable to access. The absence of any of those communicates to unmet need and likely to impact on the increased risk of maternal complications.

Health Care seeking behaviour

According to McCarthy &Maine's (1992), the availability of health services does not always guarantee their use. The use of health services is a multifaceted process starting before pregnancy. This allows for the diagnoses of pre-existing health complications. During delivery, the use of services allows for possible treatment of complications that may arise or would have been identified earlier on. Other behaviours other than those related to the use of health facilities are also examined. These include behaviours such as the use of unsafe abortion practices and use of unskilled birth attendants.

Unknown or Unpredicted factors

In the FADMM, there is the acknowledgement that maternal complications may arise from - factors other than those related to limited of access use of health facilities, woman's poor health condition before or during pregnancy or reproductive status. There also stands the possibility that even women with adequate access to health services and excellent health status may also experience obstetric complications or death. Obstetric complications may still occur among women with non-identifiable or known risk factors hence the inclusion of the 'unpredicted factors' element to the framework.

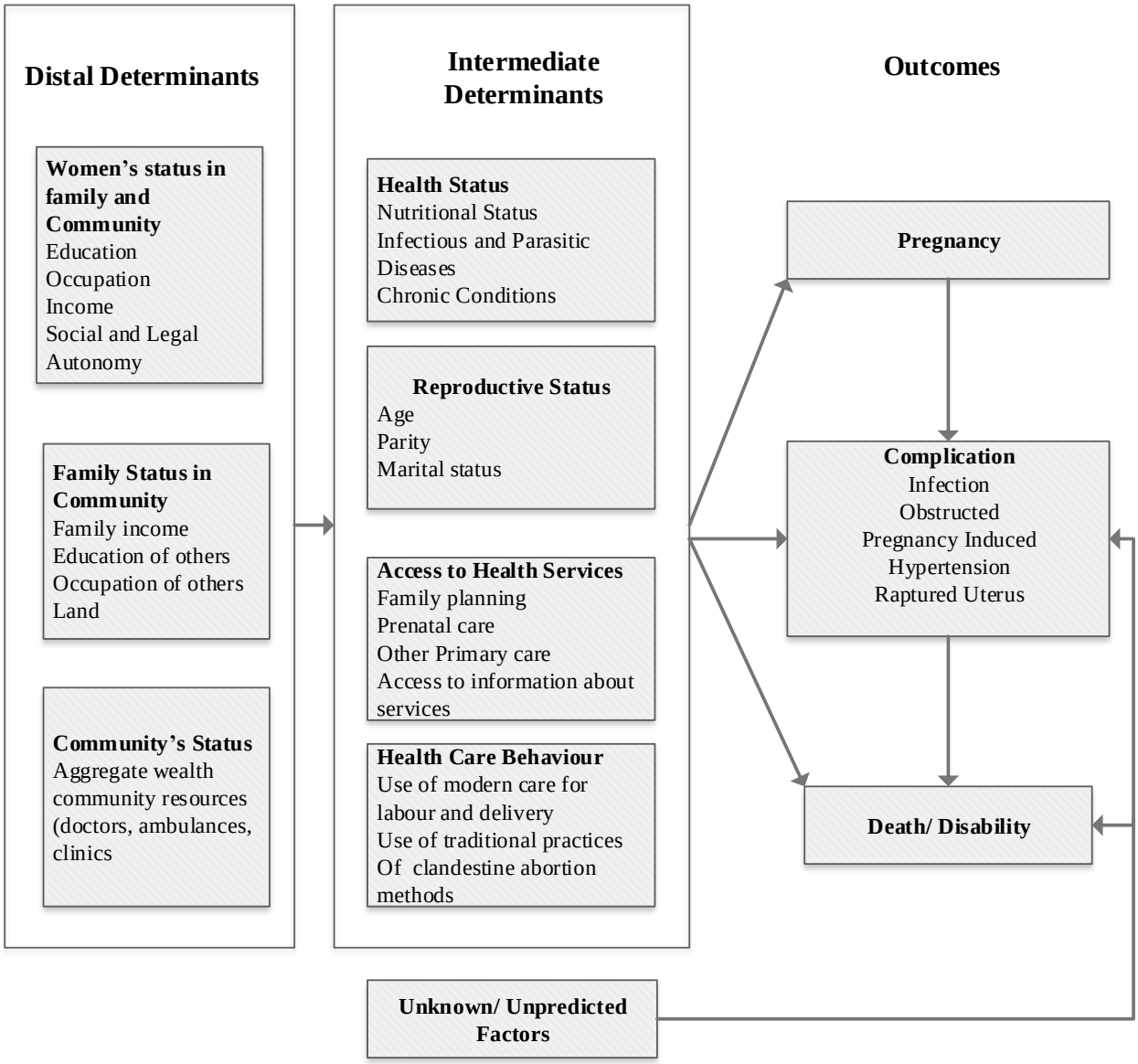

Figure 2. 1: McCarthy and Maine's Framework for Analyzing the Determinants of Maternal Mortality (FADMM)

2.4. Conceptual Framework

In light of the evidence from the reviewed literature on maternal health and mortality in Zimbabwe and outside, McCarthy & Maine's (1992), FAMMD is adapted as a conceptual guide to this study. The adoption of the conceptual framework is designed to capture the geospatial and socioeconomic factors associated with maternal mortality (Figure 2.2). Since McCarthy and Maine's (1992) framework did not include all the distal and intermediate determinants of maternal mortality identified in the literature, these have been included along with the existing ones to the study conceptual framework. These variables include affordability of health care, distance to the health facility, household headship, education, religion and marital status.

Overall these factors in the adapted framework have been further categorized by grouping factors at the distant and intermediate factors. This was to capture the complexities of factors that have been shown in the literature to operate at both levels (Iyanda *et al.,* 2018; Kes *et al*., 2018). The geospatial aspect of the study has also been included in the adapted framework. This is captured by the 'region of residence variable'.

Relationship between Distal, Intermediate and Outcome factors

In the conceptual model adapted for this study, it is suggested that the influence that distant and immediate factors have on the maternal outcome (mortality) is unique to one's region of residence. This brings about the 'geospatial analysis of socioeconomic factors' aspect of the study. It is the woman's geographical location that determines the likely influence other factors distal and socioeconomic have on the risk of mortality.

In the conceptual framework, distal factors such as a woman's educational status, religious belonging, marital status and wealth index have an indirect association with maternal death. This implies that distal factors identified in the conceptual model operate through another set of factors to influence maternal outcomes. Belonging to a lower wealth quintile or having a lower level of educational attainment, for example, is an underlying vulnerability or susceptibility to the risk of death. The influence of the underlying vulnerability (distal factor) only becomes understandable in the context of an intermediary mechanism. In this framework, the intermediate mechanism is a factor that is between the distal factor and the direct cause of maternal death. The influence of lower wealth status on the risk of maternal death becomes visible when one does not afford healthcare thus missing out on antenatal care visits for example. Another example would be educational attainment. The effect of education on the risk of maternal death could be understood in the context of a woman parity status. A less educated woman is likely not to understand the risk of having many children (reproductive behaviour).

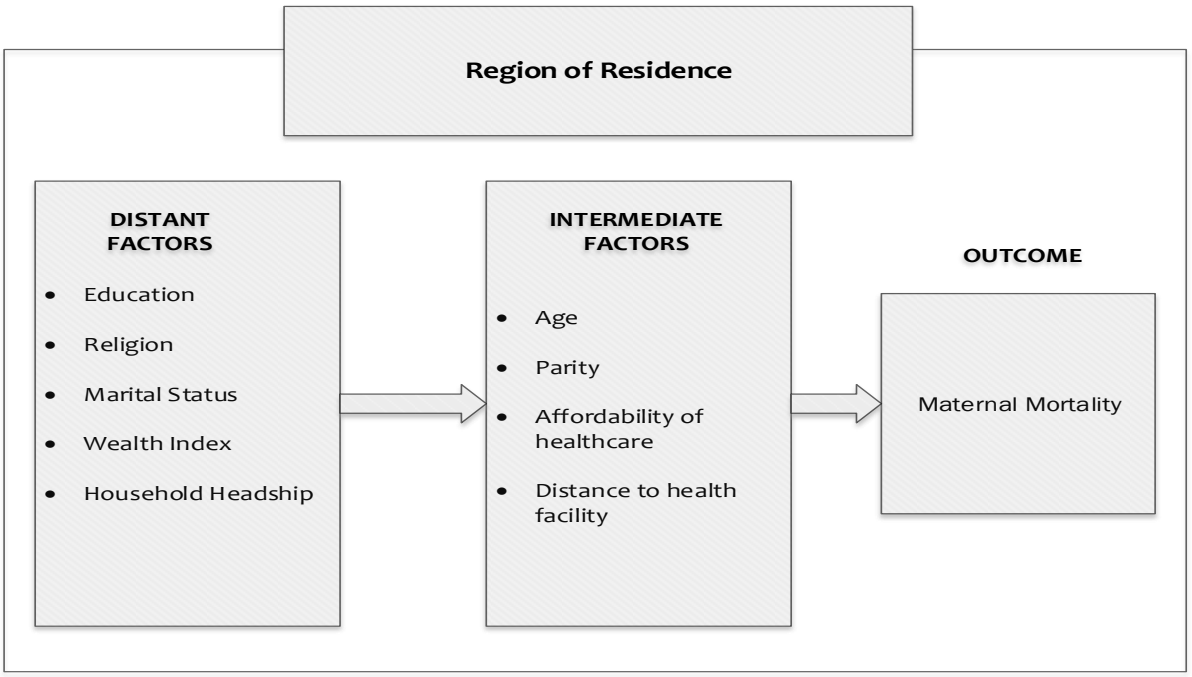

Figure 2. 2: Conceptual framework for analysing factors associated with maternal mortality (Adapted from McCarthy & Maine 1992)

CHAPTER THREE:

METHODOLOGY

3.1. Introduction

This chapter presents the methodology that was adopted in analysing the socioeconomic factors associated with maternal mortality in Zimbabwe, geospatially. Among other important issues that relate to the methodology, the chapter presents and justifies the use of a cross-sectional study design and secondary data in analysing maternal mortality in Zimbabwe. Also provided in this chapter is a detailed explanation of the selection of the study population and sample, definitions of selected variables and the analysis plan. In concluding the chapter, an account of the ethical protocols that were followed in sourcing and employing the Demographic and Health Survey (DHS) data for this study is provided.

3.2. Description of the Study Area

Zimbabwe is a developing country in Southern Africa and is located between geographical coordinates 19.0154° S and 29.1549° E (Madzore *et al.*, 2017; Spencer & McMillan, 2010). With a total landmass area of 386 850 km^2, Zimbabwe is one of the sixteen countries in Africa that are completely landlocked (Munodawafa *et al*., 2017). As shown in Figure 3.1, the country shares its borders with five countries; Zambia to its north; Mozambique to the east, South Africa to the south, Namibia at a quadripoint to the west and Botswana to the south-east.

As of the year 2018, the country's population was estimated at 16 million (International Census Bureau, 2019; ZIMSTAT, 2018). According to the ZIMSTAT (2015), from the last nation-wide census conducted in 2012, Zimbabwe's population has been growing at an average intercensal rate of 1.9 persons per year. In terms of administrative divisions, as of 2018, the country had a total of 10 provinces. Of these 10, Harare and Bulawayo are metropolitan cities to whom provincial statuses have been bestowed. The 10 provinces are subdivided into 59 districts. Within the districts are wards or municipalities, and these cumulate to 1200 across the entire country (ZIMSTAT, 2018). With regards to age structure, Zimbabwe's population is predominantly youthful, with at least 39% of the population estimated to be males and females under the age of 15 years (Madzore *et al*., 2017; ZIMSTAT, 2015). At least 20% of the

population is aged between 15 and 24 years, and 33% is aged between 25 and 64 years (ZIMSTAT, 2015). The remaining 8% consists of those who are over 65 years of age. Life expectancy as of 2016 was averaged at 59 years, with the statistic slightly higher among females relative to their male counterparts (IHME, 2017; Madzore *et al.*, 2017).

In terms of the population distribution by type of place of residence, the country has been noted from its census report of 2012 as experiencing a 'growth anomaly', or a phenomenon that has been described in other studies as 'counter-urbanization' (Madzore *et al*., 2017). This relates to the decline in the proportion of people living in areas designated as 'urban'. While there remain contestations regarding the continued designation of some areas as 'urban' or 'rural', official figures stipulate that around 65% of Zimbabwe's population reside in 'rural areas' (Pazvakavambwa *et al.,* 2017; Pullum, 2014). The remaining 35% of people live in areas classified as 'urban', with the majority of this total found in Harare and Bulawayo metropolitan provinces respectively.

Figure 3.1: Map of Zimbabwe showing the country's provinces (10) and districts (59) Source: ZIMSTAT, 2015

3.3. Study Design

A pooled cross-sectional study design was employed to examine the levels and changes in the socioeconomic factors associated with maternal mortality in Zimbabwe, geospatially. Pooled cross-sectional designs allow for an examination of the outcome and exposures in the same lag time. To achieve this, multiple data on a population collected across different periods are combined to obtain a single averaged analysis, reporting and interpretation of results (Wilmoth, 2009; Polla, 2007). The pooling of data is in cross-sectional studies is based mainly on the need to provide a general overview of prevalence, distribution and identification of the factors associated with an outcome of interest over-time. Also in cases where data is scant as in the instance of this study (to be described in the next section), pooled cross-sectional study designs are employed to improve the statistical robustness of the analyses and interpretations. Given these attributes, it was therefore proper that the study employs a cross-sectional design.

3.4. Description of Data Source

Nationally representative secondary data from the Zimbabwe Demographic and Health Survey (ZDHS) were employed in this study. Demographic and Health Surveys (DHSs) in Zimbabwe are implemented every five to seven years by the Zimbabwe National Statistics Agency (ZIMSTAT) with the financial and technical support of several organisations and international agencies including the Government of Zimbabwe (GoZ), ICF International and USAID (Geshiere & Wilmoth, 2017; Pullum, 2014; DHS Program, 2005). The use of multiple agencies in the collection of DHS data ensures that adequate personnel with expertise on different aspects of data collection are involved, hence its superior and dependable quality (DHS International, 2017).

Six DHSs have been carried out in Zimbabwe since 1988, with the 2015 survey being the most recent (Mafukidze *et al.,* 2017). Four consecutive rounds of ZDHS data starting with 1999, 2005, 2010 and 2015 were utilised in this study. The use of the data collected between 1999 and 2015 was a decision made in consideration of the nature of the outcome variable in this study. As maternal mortality is a statistically rare outcome, a single or even two rounds of ZDHSs would not have provided an adequate sample size for one to provide valid assessments of its association with the selected explanatory variables at the subnational level (Girum & Wasie, 2017; Pullum, 2014). It was, therefore, necessary to pool four surveys together to increase the statistical power of inferences (Gladiere & Melrose, 2010). Given the standardised

nature of DHS surveys, it was also possible to pool the four rounds of ZDHS data on maternal mortality with minimum risk of introducing sample bias often associated with pooling substantially different datasets together (Pullum, 2014).

In the absence of well-functioning civil and vital registration systems in most developing countries, Zimbabwe included, DHSs are an invaluable source of regular, comparable and nationally representative data on population and health parameters including maternal health (DHS International, 2017, Moseson *et al*., 2014). In the ZDHS, data is collected through a series of interviewer-administered survey questionnaires. The questionnaire specifically used for collecting information on maternal deaths is identified in the DHS as the individual women recode (IWR). This questionnaire is administered to usual female members of a selected household aged between 15-49 years, or those present in the household on the night before the interview day. The recruitment of survey participants is based on a multi-stage stratified random sampling procedure. Overall, the sample size selection is designed to represent the diversity in the demographic composition and distribution of the population across the entire country (Longue, 2018; DHS International, 2015; Godefay *et al.,* 2015).

3.5. Study Population

The population of interest in this study comprised of reproductive-aged women (15-49 years) in Zimbabwe, either alive or deceased and whose data were collected at any one of the previously mentioned DHS survey points between 1999 and 2015. (DHS International, 2017; Pullum, 2014; Silva *et al.*, 2014). Those deceased from maternal relatable factors comprised the primary population of interest. Those who were alive on the other hand provided a reference group to those whose deaths were to be identified as relatable to maternal factors.

Alive [Respondents] - Participants

The reference group was selected from among the female respondents from whom information on dead siblings was collected. Following from the work of others, being a reproductive-aged woman however while necessary, it was considered insufficient on its own to elevate one's risk of experiencing a maternal relatable death in this study (Rudolph, 2017; McCarthy & Maine, 1992). According to Jameson & Roy (2010), a reproductive-aged woman is only exposed to the risk of maternal death upon becoming pregnant, without which there is no risk regardless of age. The study sample therefore only included reproductive-aged women

who had been pregnant before and had either escaped or succumbed to the risk of maternal death.

Those who escaped the risk of maternal death were female respondents whom the study could identify as having ever had at least one child in their reproductive life before the survey. By indicating having had at least one child before the time of the survey, the respondent's previous exposure to the risk of maternal mortality could be ascertained. Included in the DHSs' IWR questionnaire is a question on 'children ever born' for which a respondent can state any number between 0 and 20, as an indication of the number of the child(ren) they have ever had (Meh, 2017). Those who indicated not having given birth in their lifetime (nulliparous women) were excluded from the study. Their exclusion was based on the presumption that they had not faced the risk of maternal death despite being in the reproductive age cohort (Meh, 2017).

The question on children ever born was preferred ahead of the more specific one asking information on pregnancies ever conceived because with the latter, it has been noted that most respondents are unwilling to provide such details (Meh, 2017; Hill et al., 2015; Jameson & Roy, 2010). Particularly in cases where the pregnancy did not result in a live birth or may have been terminated DHS has noted a general lower response rate from among participants (DHS International, 2017). The choice of the question on children ever born relative to the one on the number of previous pregnancies was this informed with concerns with reliability.

Deceased [Siblings]

Eligibility into the study among the deceased participants was determined from a set of questions posed to the participants regarding their siblings' pregnancy status at the time of death. The set of questions known collectively as the Sibling Survival Module (MMM) in the DHS, and summarised in Figure 3.2, requires that respondents provide survival-mortality information of their siblings (DHS International, 2015; Hill *et al.*, 2015). Siblings are defined from the mother's side, hence only those siblings with whom the respondents biologically share a mother with are included (Hill *et al.*, 2015). The female siblings whom the respondents identified as dead, and in the follow-up questions were indicated as having experienced deaths attributable to maternal causes, as previously mentioned were the main interest of the study. In the ZDHS questionnaire, those whose deaths are attributable to maternal causes are those who experienced death either during their pregnancy, during delivery, or within two months

after giving birth (WHO, 2017). Based on this criterion, those who were identified as deceased, but their deaths were not attributable to maternal causes were excluded from the study.

3.6. Sample Size

Satisfying the inclusion criteria specified for this study was a weighted total of 26 079 women (1999: (n) = 6 271; 2005 (n) = 6 368; 2010 (n) = 6 540 and 2015 (n) =6 900). DHS's weighting conventions for the women recode were employed. Weighting DHS women's recode data in STATA software employed for analysis in the study, involved dividing the weighting variable (v005) by 1 000 000. Since the survey employed data from four different surveys, data were weighted individually before the relevant pooling procedures were performed. Of the total samples generated at each survey point, the number of maternal deaths recorded was 166 in 1999, 285 in 2005, 485 in 2010 and 315 in 2015.

In general, maternal deaths considered were all those that were counted at each of the four different survey point included in this study. This means all maternal relatable deaths regardless of the number of the years they had occurred before the survey were considered. However, in response to the objective that sought to determine the levels of maternal deaths, only those that occurred within seven years preceding each survey point were considered. Seven years (84 months) preceding a survey point is the standard lag period used for the estimation of maternal mortality rates and ratios in the DHS (Garenne, 2015; Moreson, 2010). Further explanation of the application of cut off points for maternal deaths at each survey point is provided in the analysis plan section to the first objective of this study at the end of this chapter.

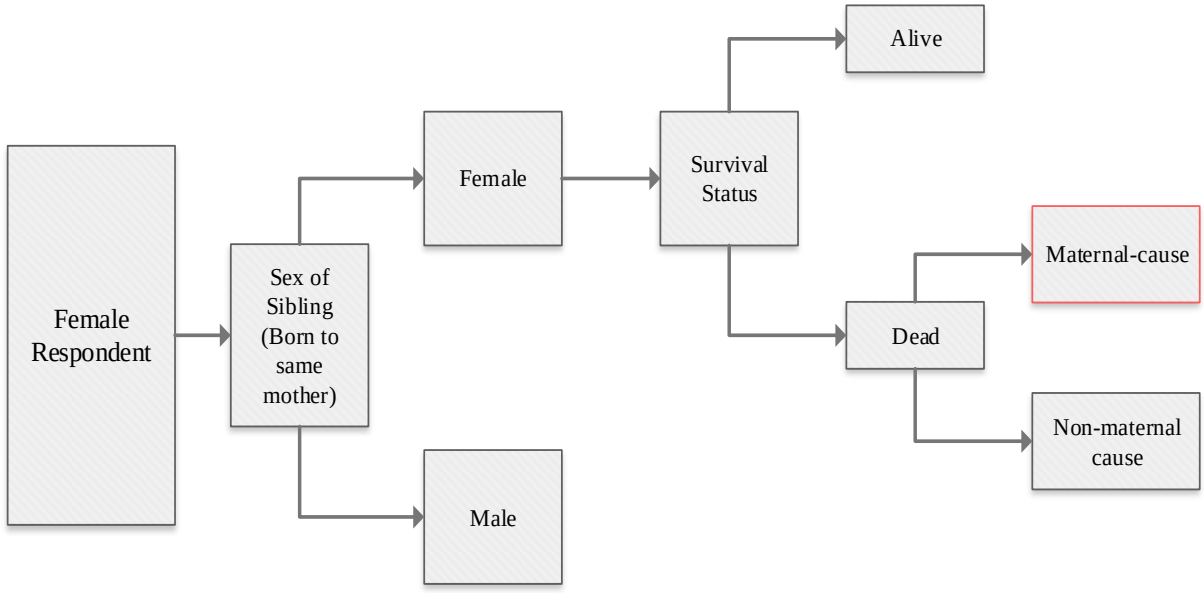

Figure 3. 2: Flow chart summarising the identification of siblings whose death are maternally related in the DHS sibling survival history module

3.7 Study Variables and Measurement

3.7.1 Outcome Variable

The main outcome of interest in this study was maternal mortality. Maternal mortality was coded as a binary variable. As previously stated, maternal mortality in this study was defined as the death of women while pregnant, during childbirth or within two months of the termination of pregnancy, (ICD-11, 2018; DHS, 2017). Those whose deaths were indicated by the respondents to have been relatable to maternal causes; that is, identifiable to at least one of the three cases, were coded 'maternal death' =1. Those who were alive, but had faced and escaped the risk of maternal death (have at least one child) were coded as 'maternal survival' = 0.

The DHS Programme provides a detailed outline and related statistical files with commands to assist with the coding of the maternal mortality variable (DHS, 2018; Rutstein & Rojas, 2013). The STATA syntax commands provided by DHS were adapted to the data used in this study to generate the outcome for the study.

To begin with, in the women's questionnaire, the questions on whether a sibling died during pregnancy, delivery or two months after delivery are separate. For data management purposes, the DHS combines the response for each individual into a single variable labelled 'pregnancy and death'. However, this variable also includes those whose deaths are not related

to maternal causes. To solve this challenge, a separate independent file identifying those siblings whose deaths were relatable to maternal causes was first created before appending it to the respondent's file. To append the maternal cases file to that of the respondents, data was reshaped from wide to long format. The use of the maternal index variable (mmidx) and the respondent's identifier (ID) gave the provision for data configuration in the format required that is, allowing the deceased siblings to become observations of their own in the new file. All other siblings were dropped from the file if they were alive, male, or missing.

A new variable was then created for survival status to identify the deceased siblings. The values of this new variable were replaced with the response categories from the ZDHS variable for mortality. This new variable was then recoded where 0 was for non-maternal death (never pregnant, death not related, 2 months after delivery, and don't know), 1 for respondent (has a deceased sibling from maternal mortality) and 2, was for maternal death (died while pregnant, died during delivery, since delivery, and 6 weeks after delivery). All non-maternal deaths were then excluded.

All non-maternal deaths were then excluded. This sibling (selected deceased female) file was then appended to the respondent file. Respondents who had a sibling die of maternal related causes and whose information were ascribed to the deceased sibling were then excluded from the final sample using the survival status variable for which they were coded as 1 (has a deceased sibling from maternal mortality). In the final sample, respondents who had missing information(because they had no sibling die from maternal mortality) for survival status variable for maternal mortality, they were assigned a value of 0 which identified them as for alive. The final survival status, therefore, had 0 for alive and 2 for deceased. For this study, this variable was coded as 0 for alive and 1 for maternal death.

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3.7.2. Explanatory Variables

Beyond survival status and/or pregnancy status if deceased, very little other information is provided in the DHS with regards to the respondent's sister. For the deceased, only information relating to their age and the number of children, they had before death is provided. There is no follow up verbal autopsy (VA) instituted to identify other pertinent information about the deceased hence information remains scant (Abou Zahr *et al.*, 2004). The identification of explanatory variables associated with maternal related deaths in this study was made with the assumption backed by literature that the deceased had been part of the same household or were part of a similar network as the respondents (Iyanda *et al.,* 2018; Girum & Wasie, 2017; Alkema *et al.*, 2015; Bazile *et al*., 2015). The deceased in this study was assumed therefore to share similar socioeconomic characteristics as their surviving sibling.

Based on the assumption that siblings share similar characteristics, the ascription of selected factors of the surviving sister to the deceased was possible in this study (Meh, 2017). Table 3.1 and 3.2 provide summaries of the explanatory variables selected in this study. The tables specify the name and definition of each of the explanatory variables as per the research study specifications. Separation of variables in Table 3. 1 to those in Table 3. 2 is in cognisance of different ways the variables are applied in the study. As indicated in the conceptual model of this study, the influence that other distal and intermediate factors have on maternal mortality is relative to one's region of residence. From this conceptualisation, the region of residence becomes an overarching mediating factor hence necessary to emphasise its difference from other variables.

Table 3. 1: Definitions and coding specifications for adopted explanatory variables.

Variable Name	Label in DHS Data	Category	Definition/ Measurement	Coding
1. Age**	V12 & mm7	Woman's Characteristics	The number of completed years a respondent has lived	15, 16, 17, 18, 19, 20,21, 22, 23….49
2. **Parity****	V201 & mm14	Reproductive Status	The number of children the sibling (sister) has had	1, 2, 3, 4, 5, 6,7, 8….24
3. **Education***	V106	Woman's Characteristics	Respondents' highest level of education	(1) Non-formal 2) Primary 3) Secondary 4) Tertiary

Variable Name	Label in DHS Data	Category	Definition/ Measurement	Coding
4. Marital Status*	V501	Woman's Characteristics	Respondents relationship status with a significant other /spouse	Single-Unmarried (0) Married (1)
5. Household* Headship	V150	Family Characteristics	Status as head of a household-based on age, economic providence and decision making (DHS Manual, 2005).	1) Self (female) 2) Male Spouse 3) Other
6. Religion*	V130	Woman's Characteristics	Respondents 'religion	(1) ATR (2) Protestant (3) Pentecostal (4); Other (5) None
7. Wealth Index*	V190	Family Characteristics& Resources	Composite measure of the total income generated within the households by member living/ not living within the household.	1) Poor 2) Medium 3) Rich
8. Distance to Health facility*	v467d	Access to health facilities	Ascertains whether or not accessing health facilities from the place of residence is a problem	0) not a problem 1) a big problem 2) A small problem
9. Cost of healthcare*	v467c	Access to health facilities	Ascertains whether or not getting money to access healthcare facility is a problem	0) not a problem 1 a big problem 2) A small problem

*** Indicates that the variable is separately available for both the surviving (respondent) and deceased sibling.*

**. Indicates the variable is only available for surviving sibling (respondent) therefore ascribed to the deceased sibling.*

Table 3. 2: Definitions and coding specifications for adopted explanatory variables.

Variable Name	Label in DHS Data	Category	Definition/ Measurement	Coding
10. Region of residence*	V24	Geospatial Location	Identifies one region/province of residence	1) Manicaland 2) Mashonaland Central 3) Mashonaland East …

**. Indicates the variable is only available for surviving sibling (respondent) therefore ascribed to the deceased sibling.*

Age - As previously alluded to, age along with parity were the only variables of interest that were available for both the respondents and the deceased sibling. Age in the ZDHS Women's questionnaire is captured as one of the background variables. Respondents are asked to indicate 'How old they were at their last birthday?' For this question, respondents would indicate their age in terms of the completed years. As for the age of the deceased sibling, the question 'what was (name) age at death?' is used to ascertain their age at death. In terms of measurement, both the respondent and the deceased sibling's ages were retained as continuous.

Parity - To measure parity, in the ZDHS the respondents are probed to confirm the total number of children ever born. The total given is then compared with the total number combined for female and male children they would have previously indicated separately (Pullum, 2014). For the respondent, the response options are limited between 1 child and 20 children. As for the deceased, the respondents are asked for the 'total number of sibling's children'. In the case of the deceased sibling's children, the response options are between 1 child and 24 children. In both cases, the 'total number of children ever born' variable is assumed to include both the children who are still alive and those who have died. Parity was also retained as a continuous variable.

Education – There are two questions in the ZDHS from which the educational status of the respondent is derived. Females are first asked to indicate whether or not they have 'ever attended school', with those indicating 'yes' expected to answer a follow-up question regarding the 'highest level' they ever completed. The response options to the follow-up question, could either be 'Primary level', 'Secondary level' or 'Tertiary level'. These categories are consolidated into four in the final ZDHS measure to include those who indicated in the preceding question having 'no education'. As the consolidation is based on the level an individual indicates to have completed, there is the, for example, the possibility that an individual may have attended primary school but did not complete (Graham *et al*., 2008). While four categories are maintained in this study, instead of having 'no education' among the

observations, the category is renamed to 'less than primary education'. Education is measured as a categorical variable in this study.

Marital Status – Like age, marital status is inferred from the respondents in the ZDHS as one of the background information. From a list provided, the respondents are expected to select their marital status. Seven response options are provided for this question, and these include those who 'have never been in a union', 'married', 'living with a partner', 'widowed', 'divorced', and 'separated'. In this study, those identified as 'living with a partner' were collated with those who identified as 'married'. Women who were married or living with a spouse were classified for statistical analysis in this study as Married= 1. Those who were not in a union regardless of the circumstances or reason mentioned were recoded to 'single'. In this regard, those who 'have never been in a union', 'widowed', 'divorced' and 'separated' were classified as one category (Single =0).

Religion - In the ZDHS, the religious affiliation of respondents is identified through the question, 'what is your religion?' Respondents are expected to make an identification of their religion from the nine categories on the selection list provided. The categories are 'Traditional', 'Roman Catholic', 'Protestant', 'Pentecostal', 'Apostolic sect', 'Other Christian', 'Muslim', 'None', and 'Other'. Based on evidence from literature suggesting variation of maternal deaths by denomination, all categories except for 'None', 'Other', and 'Other Christian' retained their original status existence (Mlambo *et al.,* 2013). The three were combined into one category, labelled Other-Combined. The consolidation was based on the small number these categories represented which would be unsuited for statistical modelling.

Household- Headship – Household headship in the ZDHS questionnaire is identified through the question 'what is your relationship with the head of this household?' For this question, eleven response options are given. Amongst these options is an indication that the female respondent is either, 'the head of the household herself', 'wife', 'daughter', 'daughter in law', 'mother' or 'mother in law' to the household head. The eleven response categories were reduced to three. Those who indicated that they were themselves the 'head of the household' and those who indicated that they were 'a wife to the head' retain their original status. The category who were identified as heads of their households, however, was renamed to 'Female-headed households' (1). The category of 'wives' to the heads of households was renamed to

'Male headed households' (=2). The remaining 9 categories were combined to make one, which was identified as 'Other-head'.

Wealth Index - In the ZDHS the wealth index is a composite measure of socioeconomic standing, generated using the principal component method (Longue et al., 2013). The single asset score generated from the index is based on a statistical collation and assessment of assets such as radio, television and other household goods and items that reflect the general standard of living (Girum & Wasie, 2017). From the sum of scores generated from the indication of ownership of specific household assets, the wealth index is generated. The wealth quintiles generated in ZDHS are 'poorest', 'poorer', 'middle', 'richer' and 'richest' (DHS Program, 2016). In this study 'poorest' and 'poorer' were consolidated into Poor (=1). The category 'middle' retained its status and was not collated with any other. The 'richer' and the 'richest' were collated into one category, 'Rich' (=3).

Distance to the facility - The variable is part of a set of question used in the ZDHS to check on the accessibility of the health facility to the population. In accessing a health facility, the respondent is asked whether or not the distance between their place of residence and facility constitutes a challenge. Those who opine that in terms of distance the health facility is a challenge are expected to choose the response option, 'it is a big problem' or 'it is a small problem'. Those who are of the view that the accessing health facility in terms of distance is not challenging are expected to choose the option, 'not a problem'. The original labels of categories in this variable were retained.

Cost of healthcare – The structure of the question on the cost of accessing health services is the same as that on health facility accessibility (see above). Respondents who opine that monetary resources needed for health care are difficult to satisfy or afford, are expected to choose the response option 'it is a big challenge' or 'it is a small problem'. Those who perceive the cost of healthcare as a requirement they can manage, are on the other hand expected to select the response option 'not a challenge'. There was no alteration made to this variable.

Region - In the ZDHS, the variable 'region' identifies the province an individual resides. The ten provinces in Zimbabwe including Harare, Bulawayo, Midlands, Manicaland and Masvingo are captured in the DHS data. There was no manipulation of categories to this variable in any way.

3.8. Missing Data

Table 3.3 identifies the variables that had missing observations, where applicable the reasons for the missing observations and the actions that were taken towards resolving these. Most of the variables including age, religion, distance to facility and cost of healthcare had missing observations amounting to less than 1% of the total participants. The observations with missing values were excluded from the study. As these were very few, their exclusion was considered not to pose a serious impact to the estimation of parameters, loss of information, decreased or statistical power of the study (Dong & Peng, 2013). The wealth index variable was not calculated for in the 1999 survey, hence nearly a quarter of the total study sample had missing values on that variable. While the wealth index was not calculated for in the ZDHS in the 1999 survey, all the variables used to calculate it in the later surveys were available. The STATA syntax of wealth index for the 2005 survey was employed on the 1999 survey data to produce a wealth quintile variable with five categories (Poorer, poor, medium, rich, richest). As with the other surveys, these categories were recoded into three categories (Poor, Medium and Rich). The sample of the study was only considered after the missing values had been excluded or accounted for.

Table 3. 3: Number of missing observations for variables after pooling four surveys.

Variable	Number of missing observations	Reason for Missing	Action
1. Age	2 (0.007%)	Random non response	Excluded
2. Parity	0		
3. Education	0		
4. Marital Status	26 (0.09%)	Random non response	Excluded
5. Household headship			
6. Religion	11 (0.04%)	Random non response	Excluded
7. Wealth Index	6 271 (24.05%)	The index measure was not calculated for the survey before	An index was constructed in STATA using the principal component method –

Variable	Number of missing observations	Reason for Missing	Action
		2000 (ZDHS International, 2008)	following closely the 2005 construct of the index. Select household variables were, similar to those included in the 2005 survey were included
8. Distance to the health facility	9 (0.03%)	Random non-response	Excluded
9. Cost of healthcare	7 (0.03%)	Random non response	Excluded
10. Region	0		
11. Survival Status	0		

3.9. Analysis Plan

The statistical procedures employed in answering the research objectives of this study were primarily performed in STATA SE (V15.1) (StataCorp, 2016). Microsoft Excel spreadsheet was utilised for tabular and graphical outputs. For the mapping component, ArcGIS 10.3 was used (ESRI, 2016). ArcGIS is a Geographic Information System (GIS) designed to capture, store, manipulate, analyse, manage, and present spatial or geographic data (Radkar, 2018). In line with the study objectives analyses provides both descriptive and analytical inferences to the data. Overall, descriptions of the study results were accompanied by; numerical tables and bar charts for the first objective, maps for the second objective, and statistical tables for the third objective.

Objective 1: To examine levels and changes in maternal mortality in Zimbabwe between 1999-2005 and 2010-2015,

Basic demographic methods and descriptive statistics were applied to satisfy the first objective. Univariate analysis was performed to show the distribution of maternal deaths across the periods of interest to the study. Estimation of the levels of maternal mortality was performed

through the computation of Maternal Mortality Rates (MMRates) and Maternal Mortality Ratios (MMRatios) at both the national and subnational-provincial levels.

MMRates are a measurement of the risk of maternal death among reproductive-aged women (15-49 years) (Ahmed, *et al.*, 2014). The MMRate is used to identify maternal mortality as the specific cause of death among an identified cohort of reproductive-aged women (Ahmed *et al.,* 2014). Computation of the MMRate was performed using the formula;

$$MMRate\ (t_1 - t_2) = \frac{MD_x\ (t_1 - t_{2)}}{W_x\ (t_1 - t_2)} \times 1\,000 \quad (1)$$

Where: $MD_x\ (t_1 - t_{2)}$ *= the number of maternal deaths from time* t_1 *to* $t_{2)}$, $W_x\ (t_1 - t_{2)}$ *is the number of person-years* t_1 *to* $t_{2)}$ *among women and* $1\,000$ *= is a constant.*

The MMrate was calculated at the national level (overall) and for each of the 10 provinces in Zimbabwe across two different time intervals (1999-2005 and 2010-2015). The enumerator for the formula, allowing computation of the MMRates was the pooled weighted totals per province of the number of deaths identified to be relatable to maternal causes for the two time periods specified for the study

To calculate the number of person-years relevant as a denominator to the computation of MMRates, the researcher first set the reference period of assessment to seven years in the data. The number of woman person-years is the sum of the number of years an individual is exposed to the risk of maternal death with an identified age cohort (Rodriguez-Aguilar, 2018). By setting the reference cut off period to seven years preceding each round of the survey utilised in the study, one could ascertain exposure years to the risk of maternal mortality and identify the total number of deaths that occurred in the same lag time. Since maternal deaths are statistically rare and almost scant in survey data, the DHS recommends the calculation of maternal mortality based on an aggregation of all maternal relatable deaths occurring within seven years before the survey (Hill *et al.*, 2018; Merdad *et al*., 2013). For this study, deaths occurring within the last seven years preceding the 1999 survey were collated with those occurring with the preceding seven years of the 2005 survey. Those occurring within seven years preceding the 2010 survey and the same for the 2015 survey were collated to compare the difference with earlier rounds of data (1999-2005)

The cut-off and data pooling procedures in the MMRates were similarly applied in the computation of MMRatios. The MMRatio is an expression of the total number of death per 100 000 live births (Garenne, 2015). Computation of the MMRatio was done at the subnational provincial level based on the formula

$$\boldsymbol{MMRatio\ (t_1 - t_2)} = \frac{\boldsymbol{MMRatio\ (t_1 - t_2)}}{\boldsymbol{GFR_{15-49}\ (t_1 - t_2)}} \times \mathbf{100\ 000} \quad (1)$$

Where: $MMRatio\ (t_1 - t_{2)}$ *= the number of maternal deaths expressed over a person's time exposure, multiplied by 1 000 from time* $t_1\ to\ t_{2)}$, $GFR_{15-49}\ (t_1 - t_2)$ *= average number of births per woman of reproductive age (15-49) from* $t_1\ to\ t_{2)}$ *among women and* $1\ 000$ *= is a constant.*

The computation of the maternal death ratios already performed, there remained a need to calculate the general fertility rate (GFR). The GFR was calculated as the total pooled number of births per province divided by the number of women aged 15-49 years per province for the identified period multiplied by 1 000.

Objective 2: To identify the geospatial clusters and patterns of maternal mortality in Zimbabwe

The Global Moran 1's, a local indicator of spatial autocorrelation (LISA) toolsets were used to determine statistically significant clusters of maternal mortality across different regions of Zimbabwe. According to Schmitz *et al* (2016), spatial autocorrelation is the association of a variable in one region with a high value of the same variable values of the same variable observed in neighbouring regions and can show dispersion, clustering, or spatial randomness. Based on the null hypothesis of maternal deaths being heterogeneously (randomly) distributed within the study area LISA were used to identify the following statistically significant local clustering and outlier patterns;

- *High-high cluster (hotspots):* a region within a province with a statistically higher-than-average MMRatio, and its neighbouring areal units also had statistically higher-than-average rates.
- *High-low outlier:* a particular region within an identified province that had a statistically higher-than-average MMRatio, while neighbouring sub-counties had statistically lower-than-average rates.

- *Low-high outlier:* a particular region within an identified province that had a statistically lower-than-average MMRatio, while neighbouring regions had statistically higher-than-average rates.
- *Low-low cluster (coldspots):* a region within a province that had a statistically lower-than-average MMratio, with neighbouring regions also having statistically lower-than-average rates.

Software and Mapping

The toolsets, which for this study were accessed on the ArcGIS10.6 mapping software were used to evaluate spatial autocorrelation that is, the identification of possible clustering of maternal mortality within provinces of in Zimbabwe. The following formula was used to determine spatial clustering;

$$Z(G_i^*) = \frac{\sum_{j=1}^{n} x_j - \bar{x}\sum_{j=1}^{n} w_{ij}^2}{s\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{ij}^2 - (\sum_{j=1}^{n} w_{ij})^2\right]}{n-1}}} \quad (1)$$

Where x_j specifies the value attribute for feature j, $\mathcal{W}_{ij}$ is the spatial weight between feature i and j, n is the summation of all features and

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} X_j^2}{n} - (\bar{x})^2} \quad (3)$$

A prerequisite to determining the possibility of clustering using spatial autocorrelation is that there be at least thirty features or area demarcations (vectors) within an identifiable shapefile. As previously alluded to, Zimbabwe has only ten provinces, and based on this it would not be possible to determine to clusters of maternal death using the data points provided at this level. Taking into cognisance this limitation, analyses were to be interpreted from spatial autocorrelation computations performed at the district level. In this regard, the identification of clusters of maternal mortality would be analysed and interpreted from sub-places (districts) identified within specified districts.

Objective 3: *Determine the geospatial differences in the socioeconomic factors associated with maternal mortality in Zimbabwe over time*

Unadjusted and adjusted multivariable logistic regression analysis was performed in STATA to satisfy the objective. Unadjusted analyses were performed to assess associations between the maternal mortality outcome variable and each explanatory variable. Simple logistic regressions were performed to assess the crude association between each explanatory variable and the outcome variable for the whole sample, by the survey year periods 1999-2005 and 2010-2015 and for all the 10 provinces in Zimbabwe. The significance of these tests was set at $p<0.05$.

Survey adjusted multivariable logistic regression analyses were used to investigate the association of the explanatory factor variables and the outcome of maternal mortality while controlling for other variables. The following formula as used for the logistic regression analyses;

$$\hat{p} = \frac{\exp(b_0 + b_1X_1 + b_2X_2 + ... + b_pX_p)}{1 + \exp(b_0 + b_1X_1 + b_2X_2 + ... + b_pX_p)} \quad (1)$$

Where $\hat{p}$ is the expected probability that the outcome is present; X_1 through X_p are distinct independent variables, and b_0 through b_p are the regression coefficients.

Odds ratios (OR) were obtained as the measure of association between different exposures and the outcome (mortality). In this study OR represents the odds that maternal mortality occurred given selected exposures, compared to the odds of maternal mortality occurring in the absence of that exposure (Merdad *et al.,* 2013). Statistical significance for all regressions performed was determined at $p<0.05$.

To test for the general association of the explanatory factors and the outcome (maternal mortality), unadjusted logistic regression models were presented. The first unadjusted model is for the overall pooled data that is from 1999 to 2015. The pooled overall unadjusted model helped to identify the crude association of each of the explanatory factors with the outcome. 10 additional unadjusted models were also run at the regional level, to check overall the crude association of each of the explanatory factors with the outcome.

To test the independent association of each socioeconomic variable while controlling for others, multivariable logistics regression models were run both at the national and subnational provincial level (10 models). A reverse stepwise regression model for the overall pooled data (1999-2015) was also run at the national level (Results attached in the appendices). This

reverse stepwise regression model was aimed at identifying overall, the factors that were best explained the association between socioeconomic factors to maternal mortality for the study. The study hypothesised that there would be differences between the association of socioeconomic factors and maternal mortality at the national level compared to the subnational level. It was, therefore, necessary to run models at both levels, for comparison purposes, that is, to identify how much results at the subnational level deviated from those at the broader national level.

In addressing the change aspect of the objective, data were split into two periods that is 1999-2005 (t1) and 2010-2015 (t2). Two models, t1 and t2 multivariable regression models were run at the national level and the results compared to find out how the influence socioeconomic factors on maternal mortality changed overtime. The same, time-based logistic regression models were not run at the subnational level. Splitting the data into two sets for a statistically rare outcome, and then running regression models across 10 levels as would have been the case in this study would have rendered the results insignificant.

3.10. Survey Adjustments and Multicollinearity Tests

ZDHS is complex survey data that may introduce bias through oversampled subpopulations if unequal weights, non-responsiveness, stratification and clustering are not adjusted for (Meh 2017. The use of survey sampling weights allowed for adjustments for these issues to ensure stable estimates and standard errors. Also, strata with 1 sampling unit were entered at the grand mean and not stratum mean (Wilmoth, 2009)

To test for model fitness multicollinearity tests were performed. A multicollinearity test examines the level of collinearity among the study variables. In this study, this was be done using correlation matrix, variance inflation factor (VIF) in using Stata. A very high correlation coefficient above (0.80) between study variables as well as a tolerance value above 0.1 and VIF value of 10 or more may be an indication of multicollinearity. The result of the correlation matrix presented in the appendices section showed that there was no evidence of multicollinearity among the study variables. Similarly, with a tolerance value of 1.42.78 (1-R2) which is greater than 0.1 and 32, a VIF value of 1.28 (1 Tolerance) which is very much less than 10 implies that the model fits perfectly and that the variables did not collinear with another.

None of the standard errors of coefficients of the in the predictor variables in the model was inflated more than twice the basic size in a normal model.

3.11. Statement on ethics

Access to the data used in this study was authorised to the researcher under the DHS International microdata public access protocols (Alkema *et al.,* 2016). The protocols authorise the researcher to use the already anonymised secondary DHS data sorely for this study. The protocols also extents however with the need for a separate motivation, to access of geospatial data. With geographical data, the anonymity of the location and confidentiality of participants is ensured through the random displacement (within 2km in urban areas and 5 kilometres in rural areas) of the GPS latitude and longitude positions for all surveys (Iyanda *et al.*, 2018).

The collection of DHS data is in strict compliance with ethical entailments governing the conduct of research with subjects reviewed and approved by the IFC Institutional Review Board (IRB) (Ahmed & Hill, 2011). Additional to the IFC international standing approval, local IRBs approval for the ZDHS are also sought (Geishere, 2018). The Medical Research Council of Zimbabwe (MRCZ), Centre for Disease Control and Prevention (CDCP) and Macro International were responsible for the local IRB approval of the four waves of DHS data used in this study (Buor & Bream, 2004). The conduct of the survey follows therefore from a meticulous to implementation the ethical regulations presupposed requisite for the survey. Based on this assumption of adherence, there was no ethical clearance that was required for the undertaking of the study. Instead, an ethics waiver from the University of Witwatersrand Human Research Ethics Committee was applied and granted under protocol number WDEMG2019/07/14 to the researcher ensuring, therefore, finalisation of the study.

CHAPTER FOUR:

RESULTS

4.1. Introduction

The study aimed at estimating the levels and changes in the geospatial clusters and socioeconomic factors associated with maternal mortality in Zimbabwe. Presented in this chapter are the results established concerning the aforestated study objectives. The chapter is divided into three main sections; the first being largely a descriptive section. It profiles the characteristics of study participants and presents the levels and changes of maternal mortality over time across different provinces in Zimbabwe. Hotspot and cold spot areas of maternal mortality in Zimbabwe are identified in the second major section of this chapter. The third section presents the geospatial differences and changes in the factors associated with maternal mortality in Zimbabwe.

4.2. Demographic Characteristics of Participants

Table 4.1 provides a summary of the characteristics of the weighted sample of participants pooled for the study. The pooled characteristics of the participants are provided both at the national and sub-national levels between the years 2005 and 2015.

Table 4. 1: Descriptive profile and characteristics of the study participants overall and disaggregated by regions of residence (pooled) in Zimbabwe: 1999- 2015.

Characteristics	Overall	Manicaland (n= 3 532)	Mashonaland Central (n=2251)	Mashonaland East (n=2 383)	Mashonaland West (n=2 965)	Matebeleland North (n=1373)	Matebeleland South (n= 1 267)	Midlands (n=3 296)	Masvingo (n=2 983)	Harare (n=4 227)	Bulawayo (n=1 512)
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Age	31.54 (8.28)	31.80 (8.37)	31.25 (31.80)	31.69 (8.35)	31.31 (8.17)	31.62 (8.61)	31.61 (8.74)	31.16 (8.21)	31.60 (8.30)	31.32 (7.75)	32.33 (8.18)
Parity	3 (1.98)	3 (2.19)	3 (1.98)	3 (1.89)	3 (1.90)	3 (2.16)	3 (2.10)	3 (2.06)	3 (2.13)	2 (1.45)	3 (1.59)
	n (%)	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n(%)*	*n (%)*
Education											
Non-Formal	1 129 (4.33)	190 (5.37)	225 (8.83)	75 (3.15)	173 (5.82)	98 (7.13)	38 (3.01)	131 (3.98)	141 (4.75)	31 (0.74)	26. (1.70)
Primary	9 391 (35.99)	1511 (42.78)	1 176 (46.09)	858 (36.02)	1 181 (39.84)	700 (50.96)	545 (43.04)	1153 (34.99)	1326 (44.44)	670 (15.80)	272 (18.01)
Secondary	14 390 (55.15)	1694 (47.97)	1 089 (42.69)	1 380 (57.89)	1 493 (50.35)	544 (39.63)	633 (49.92)	867 (56.64)	1395 (46.75)	3220 (76.18)	1 075 (71.14)
Tertiary	1 180 (4.52)	137 (3.89)	61 (2.40)	70 (2.94)	118 (3.99)	31 (2.28)	51 (4.03)	144 (4.38)	120 (4.05)	308 (7.28%)	25 (9.14)
Marital Status											
Married/ living with a partner	20 208 (77.45)	2759 (78.11)	2 105 (82.52)	1889 (79.24)	2 388 (80.53)	1 026 (71.71)	840 (66.32)	2586 (78.46)	2381 (79.80)	3216 (76.09)	1 018 (67.34)
Single/Unmarried	5 882 (22.55)	773 (21.89)	445 (17.48)	495 (20.76)	557 (19.47)	347 (25.29)	427 (33.68)	710 (21.54)	603 (20.20)	1011 (23.91)	494 (32.66)
Household headship											
Female Head	8 025 (30.76)	1 282 (36.29)	626 (24.55)	769 (32.26)	794 (26.78)	379 (27.57)	515 (40.63)	839 (25.46)	1081 (36.22)	1290 (30.51)	451 (29.82)
Male Head	12 152 (46.58)	1472 (41.67)	1 433 (56.17)	1 134 (47.56)	1 150 (52.28)	601 (43.75)	357 (28.14)	1632 (49.51)	1220 (40.90)	2078 (49.16)	676 (44.69)
Other Head	5 913 (22.67)	779 (22.04)	492 (19.27)	481 (20.18)	621 (20.94)	394 (28.68)	396 (31.23)	825 (25.03)	683 (22.88)	859 (20.32)	385 (25.48)
Religion											
Apostolic Faith	8 708 (33.43)	1459 (41.35)	1 271 (50.71)	990 (41.57)	966 (32.56)	356 (25.94)	402 (31.86)	932 (28.30)	1210 (40.57)	827 (19.67)	295 (19.50)

Characteristics	Overall	Manicaland (n= 3 532)	Mashonaland Central (n=2251)	Mashonaland East (n=2 383)	Mashonaland West (n=2 965)	Matebeleland North (n=1373)	Matebeleland South (n= 1 267)	Midlands (n=3 296)	Masvingo (n=2 983)	Harare (n=4 227)	Bulawayo (n=1 512)
Protestant	9 023 (34.64)	1170 (33.18)	544 (21.49)	747 (31.36)	951 (32.08)	450 (32.81)	414 (32.79)	1337 (40.60)	984 (32.98)	1780 (42.63)	644 (42.66)
Pentecostal	4 752(18.24)	554 (15.70)	544 (12.34)	368 (15.45)	573 (19.31)	237 (17.27)	162 (12.86)	539 (16.37)	459 (15.38)	1 198 (28.43)	349 (23.13)
Traditional	451(1.73)	127 (3.61)	105 (4.15)	33 (1.38)	68 (2.28)	17 (1.26)	10 (0.80)	28 (0.84)	30 (1.01)	23 (0.56)	10 (0.66)
Other	1 553 (5.96)	75 (2.14)	108 (4.26)	58 (2.47)	144 (4.85)	191 (13.94)	159 (12.59)	300 (9.12)	175 (5.86)	209 (4.95)	134 (8.89)
None	1 558 (5.98)	142 (4.02)	192 (7.60)	186 (7.42)	264 (8.92)	120 (8.77)	115 (8.10)	157 (4.77)	125 (4.20)	177 (4.21)	78 (5.15)
Wealth Index											
Rich	12 434 (47.68)	890 (25.20)	462 (18.10)	679 (24.48)	1 038 (35.02)	213 (15.54)	285 (22.51)	1020 (30.95)	589 (19.73)	3253 (76.95)	1197 (79.16)
Middle	3 791 (14.54)	8.54 (2.18)	499 (19.55)	607 (25.46)	452 (15.23)	112 (8.15)	291 (22.93)	476 (14.44)	456 (51.30)	218 (5.16)	74 (0.49)
Poor	9 854 (37.79)	1788 (50.62)	1591 (62.35)	1 097 (46.06)	1475 (49.75)	1048 (76.31)	691 (54.56)	1800 (54.62)	1938 (64.97)	756 (17.89)	307 (20.35)
Distance to Health Facility											
Not a problem	2 457(9.42)	328 (9.27)	137 (5.39)	112 (4.71)	212 (7.14)	91 (6.60)	123 (9.67)	281 (8.53)	260 (8.72)	635 (15.03)	280 (18.53)
Big problem	9 869 (37.84)	1672 (47.32)	1 362 (53.38)	1 013 (42.49)	1 168 (39.43)	701 (51.05)	654 (51.61)	1270 (38.54)	1337 (44.85)	534 (12.64)	159 (10.56)
Small problem	13 752 (52.73)	1533 (43.40)	1 052 (41.23)	1 259 (52.81)	1 582 (53.43)	582 (42.35)	490 (38.72)	1245 (52.94)	384 (46.43)	3053 (72.33)	1 071 (70.91)
Cost of Healthcare											
Not a problem	1 975 (7.57)	259 (7.32)	172 (6.73)	120 (5.04)	172 (5.82)	134 (9.79)	114 (9.02)	231 (7.01)	210 (7.06)	404 (9.58)	157 (10.40)
Big problem	13 283 (50.93)	2 72 (58.66)	1 446 (56.68)	1300 (54.55)	1491 (50.32)	757 (55.12)	668 (52.72)	1372 (47.70)	1696 (56.92)	1661 (39.33)	620 (41.01)
Small problem	10 822 (41.40)	1202 (34.02)	933 (36.59)	963 (40.11)	1 299 (43.86)	482 (35.08)	485 (38.26)	1492 (45.28)	1074 (36.02)	2158 (51.09)	734 (48.59)
Survival Status											
Alive	**24849 (95.20)**	3 281(92.89)	2 392 (93.78)	2 286 (95.94)	2 828 (95.35)	1 317 (95.89)	1 207 (95.26)	3149 (95.53)	2852 (95.60)	4063 (96.11)	1 464 (96.86)
Deceased	**1 251 (4.80)**	251 (7.11)	159 (6.22)	97 (4.06)	137 (4.65)	56 (4.11)	60 (4.74)	147 (4.47)	131 (4.40)	164 (3.89)	48 (3.14)

Overall, of the 26 079 study participants, 95.20% (n=24 849) were alive (respondents) while the remaining 4.80% (n=1 251) were female siblings identified to have died from maternal related factors. All the provinces had over 90% of responses classified as 'alive'. Of the total 3 532 participants whose region of residence was identified as Manicaland province, 7.11% had died from maternal related causes. This was the highest proportion of deaths per total number of people selected from each of the 10 provinces. From the 2 251 participants from Mashonaland Central, at least 6.22% had died from maternal related causes while 93.78% had survived. Several provinces including Harare (3.89%), Bulawayo (3.14%) and Masvingo (4.40%) had less than 5% of the total participants reported as having had maternal relatable deaths

In provinces such as Manicaland, Mashonaland East, Matebeleland North and South and Bulawayo the participants had an average age of 32 years. In the remaining provinces including Harare, Midlands, Mashonaland West and Central the average age was 31. In terms of parity, the average for all provinces except for Harare (parity count =2) was 3.

Except for Mashonaland Central and Matebeleland North dominated by those with primary education, the majority of participants had completed at least secondary level education across all provinces. Harare, for example, had over 76% of participants with high school level education. Of the total residents in Bulawayo (n=1512), 71.14% of women had secondary level education. Apart from having the majority (50.95%) women with primary level education, Mashonaland Central also had a significantly higher proportion (8.83%) of women without any formal level education completed. In Manicaland, approximately 5% of women were identified as having had no formal level education. Harare (0.74%) and Bulawayo (1.70%) had the least proportions of women without formal level education. Mashonaland Central (2.40%) and Matebeleland North (2.28%) had the least number of women with tertiary level education. Bulawayo (9.14%) and Harare (7.28%) provinces, on the other hand, had the highest proportions of women with a tertiary level qualification.

In terms of marital status, the highest proportions of women who were classified as married or living with a partner were found in Mashonaland Central (% =82.52), Mashonaland West (80.53%) and Mashonaland East (79.24%). Matebeleland South (66.32%) and Bulawayo (67.34%) had the least percentages of women identified as married or living with a partner.

The majority of women across provinces identified with households where their spouses were household heads. Mashonaland Central had the highest proportion (56.17%) of women classifying their household's as headed by their spouses. Mashonaland West (52.28%) and Midlands (49.16%) also had high proportions of households classified as 'male-headed'. Matebeleland South had the least (28.14%) proportion of male-headed households. The majority of households in Matebeleland South (40.63%) were classified as led by the female participants in the study. This was the highest proportion of female-headed households across all the provinces, followed closely by Manicaland (36.29%). Matebeleland North had the highest proportion (28.68%) of households headed by other family members besides the respondent or their spouses.

In terms of religious status, Apostolic Faith, and in selected provinces, Protestant religion were dominant. In Mashonaland Central, at least 50% of women (n =1 271) belonged to the Apostolic faith Christian sect. Apostolic faith religion was also dominant in Manicaland and Mashonaland East with 41.35% (n =1 459) and 41.57% (n =990) belonging to the sect respectively. Harare (19.67%) and Bulawayo (19.50) had the lowest proportion of Apostolic Faith believers in comparison to other provinces. Relative to other provinces, Harare (42.63%) and Bulawayo (42.66%), however, had the highest proportions of protestant believers including Catholics. Other provinces except for Mashonaland Central which had a slightly lower proportion (21.49%), provinces had on average around 30% protestant believers. There were relatively lower percentages of African Traditional religion believers across provinces, with the highest being the 4.15% (n = 105) identified in Mashonaland Central. On the other hand, Mashonaland West (8.92%), Matebeleland North (8.77%) and South (8.10%) had the highest proportions of women who identified with no religion

4.3. Profile of Maternal Deaths in Zimbabwe

Figure 4.1 shows the percentage distribution of maternal deaths recorded for surveys between 1999 and 2015. Of the total number of maternal deaths recorded as related to maternal causes for the period for which data were pooled in the study, a fifth of these (20%) occurred in Manicaland province alone. Harare and Mashonaland Central provinces each contributed to 13% to the total number of deaths attributed to maternal causes. Midlands province contributed 12% to the total number of deaths attributed to maternal causes, while Mashonaland west province contributed 11%. Mashonaland East contributed 8% to the total death output attributable to maternal related factors. Matebeleland South and Matebeleland North province contributed 5% apiece to the total number of maternal related deaths. Bulawayo province had the lowest (4%) percentage contribution to the total maternal death output.

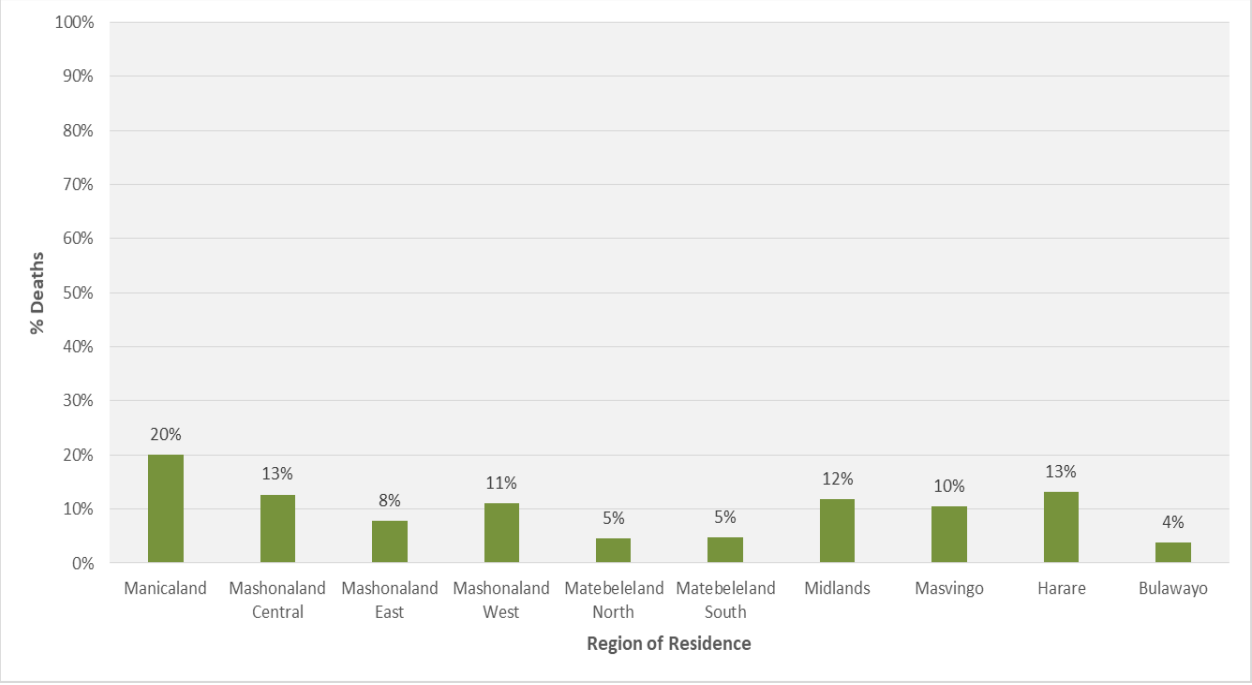

Figure 4. 1: Distribution of maternal deaths in across 10 provinces; Zimbabwe 1999-2015.

In terms of the observed maternal mortality ratio (MMRatio) estimated per 100 000 live births, there was an observed increase from time interval 1999-2005 and 2010-2015. Figure 4.2 shows that overall the MMRatio shot from 480 deaths per 100 000 live births during the 1999-2005 period to 702 deaths per 100 000 live births during the 2010-2015 period. While Masvingo had

recorded a slight decline in the rate of deaths observed per 1000 reproductive-aged women (MMRate), in terms of the Maternal ratio it grew worse (630 deaths to 790 deaths per 100 000 live births). By the second interval, Masvingo had replaced Midlands as the province with the highest MMRatio. Midlands witnessed a decline in the levels of MMRatio between 1999-2005 and 2010-2015. By the second time interval, apart from Masvingo, Mashonaland Central province, Matabeleland North and South were some of the provinces that had MMratios greater than 700. There was a little improvement in the MMRatio estimated per 100 000 live births in Bulawayo from 1999-2005 (490 deaths per 100 000 live births) and 2010-2015 (460 deaths per 100 000).

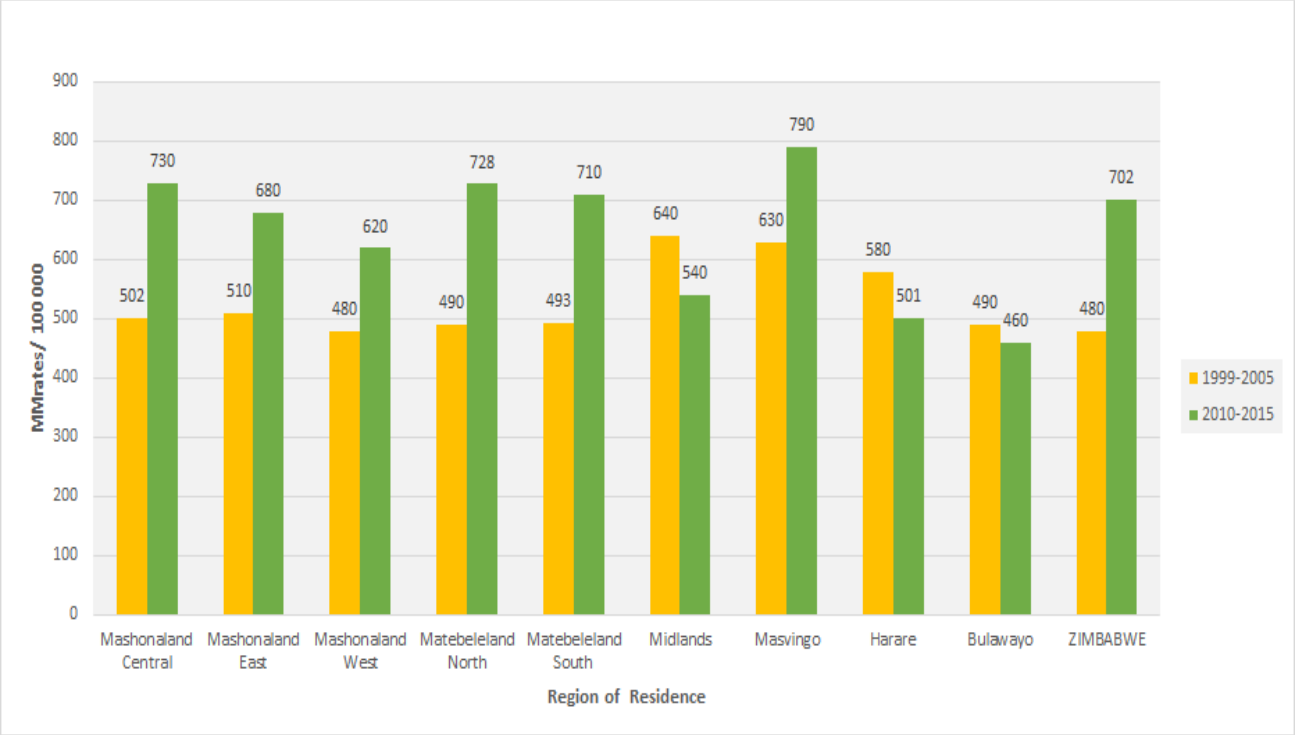

Figure 4. 2: Distribution of maternal mortality ratios across different regions in Zimbabwe in the 1999-2005 and 2000-2015 time intervals.

4.4. Geospatial Clusters of Maternal Mortality

The mapping of hot spots and cold spots in this study revealed several differences and changes in the clustering of maternal deaths. From the overall visualisation of the maps that were run and presented in Figure 4.3 and Figure 4.4 respectively, there was a higher concentration of hot spot areas of maternal death in Zimbabwe during the 2010-2015 (t2) period than there were in the 1999-2005 (t1) period (Confidence Intervals[CI] =90%). Across the two time periods, the Northern and Eastern parts of the country (Mashonaland Central, Mashonaland

East, Mashonaland West and Manicaland Provinces) generally had the greatest concentration of statistically significant hot spots of maternal deaths (CI =90%). Harare, Bulawayo and Gweru (Midlands) had, on the other hand, a higher concentration of cold spots across the two periods. While there was a high concentration of cold spot areas in Harare province, immediately to its northern border (Mashonaland Central) there was high clustering of maternal mortality hotspots, particularly in the 2010-2015 period. The same trend can be noted with Bulawayo. The area immediately outside Bulawayo province to the South (Matebeleland South) showed significant hot spot clusters of maternal death, particularly in the 2010-2015 period. Across the two time periods, the even distribution of hotspot and cold spot areas in Mashonaland West and Midlands provinces did not change much. In the 1999-2005 (t1) period, Manicaland had a high concentration of statistically significant hot spots clusters of maternal death a few of which were replaced with cold spots areas in the 2010-2015 period.

The stretch of maternal mortality colds spots found in the southernmost part of the country bordering with South Africa in 1999-2005 was replaced with cold spot areas in the 2010-2015 period. In the Matebeleland South area particularly the area sharing the border with Botswana, there were also sparsely distributed hotspot area in the 2010-2015 period than there had been in the earlier period. The high concentration of hotspot areas in Manicaland province on the Eastern side of the country in 1999-2005 had not changed significantly by the 2010-2015 period. In the Midlands province, the distribution of statistically significant hot spot areas expanded from the centre to be evenly distributed across the entire province during the 2010-2015 period. In the Matebeleland North province, although maternal death occurred in the 1999-2005 period, there were no statistically significant clustering that was identified (CI = 90%). In the 2010-2015 period, statistically, significant maternal mortality hot spots, particularly in the areas bordering with Zambia, can be seen.

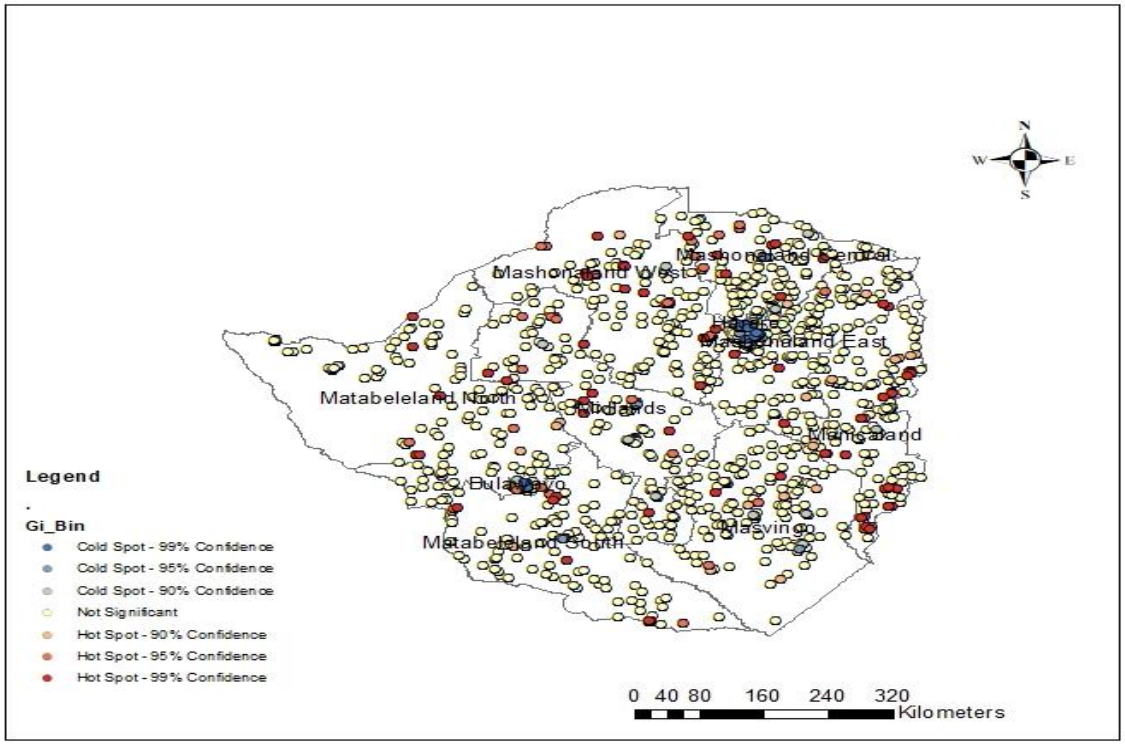

Figure 4. 3: Hot Spot and Cold Spot Clusters of Maternal Deaths for Zimbabwe between 1999 and 2005.

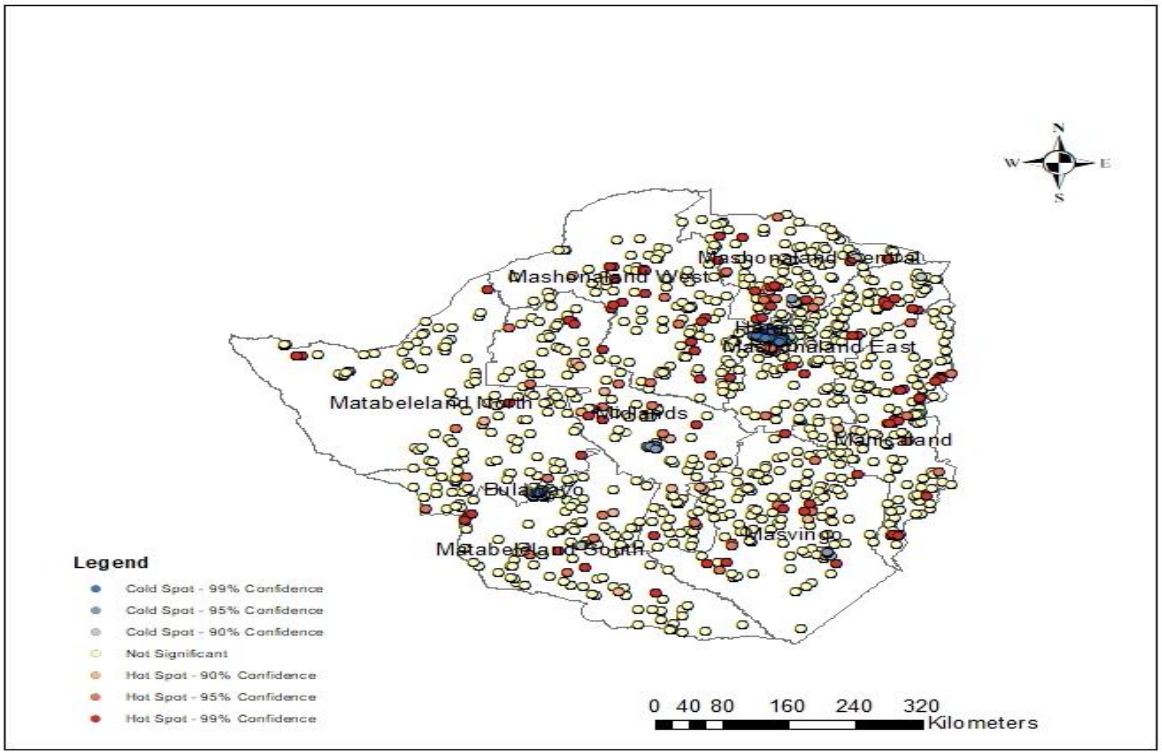

Figure 4. 4: Hot Spot and Cold Spot Clusters of Maternal Deaths for Zimbabwe between 2010 and 2015

4.5. Socioeconomic Factors and Maternal Mortality

The distribution of maternal deaths was examined for each of the selected explanatory variables in the crude (unadjusted) logistic regression analysis. The bivariate analysis was performed for the overall pooled sample and the pooled provincial (10) data samples. The results of these analyses are reported in Table 4.3.

Overall Pooled Unadjusted Regression Analysis

Table 4. 2: Pooled unadjusted logistic regression analysis results for selected socioeconomic factors and maternal mortality overall and across 10 provinces (pooled) in Zimbabwe, 1999-2015

Variables	Overall	Manicaland	Mashonaland Central	Mashonaland East	Mashonaland West	Matebeleland North	Matebeleland South	Midlands	Masvingo	Harare	Bulawayo
	OR (pvalue)	*OR (pvalue)*	*OR (p value)*	*OR (p value)*	*OR (p value)*	*OR (p value)*	*OR (p value)*	*OR (p value)*	*OR(pvalue)*	*OR (pvalue)*	*OR(pvalue)*
Age	1.13 (0.000)	1.13 (0.000)	1.21 (0.000)	1.11 (0.071)	1.13 (0.010)	1.01 (0.747)	1.21 (0.000)	1.18 (0.000)	1.07(0.241)	1.09(0.102)	1.09 0.244)
Parity	0.62 (0.000)	0.68 (0.000)	0.57 (0.000)	0.50 (0.000)	0.67 (0.000)	0.77 (0.041)	0.68 (0.000)	0.53 (0.000)	0.47(0.000)	0.26(0.000)	0.88(0.462)
Education											
Tertiary	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Secondary	1.20 (0.242)	0.74 (0.458)	1.20 (0.613)	1.05 (0.932)	0.59 (0.132)	0.32 (0.033)	1.35 (0.622)	1.67 (0.398)	5.76 (0.079)	1.55(0.344)	0.88 0.736)
Primary	1.63 (0.031)	1.26 (0.541)	2.31 (0.001)	1.33 (0.631)	0.35 (0.002)	0.75 (0.394)	1.38 (0.620)	2.30 (0.178)	5.03(0.11)	2.80(0.034)	0.53(0.201)
Non formal	1.40 (0.104)	1.12 (0.840)	-	-	0.23 (0.011)	-	2.74 (0.172)	3.39 (0.047)	-	-	-
Marital Status											
Married	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Single	1.38 (0.000)	1.69 (0.001)	1.58 (0.012)	1.64 (0.022)	1.41 (0.092)	0.87 (0.591)	1.79 (0.041)	1.29 (0.217)	0.96 (0.88)	1.59 (0.021)	1.30 (0.287)
Household Headship											
Female head	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Male head	0.89 (0.102)	0.74 (0.051)	0.95 (0.789)	0.86 (0.521)	1.39 (0.163)	1.28 (0.344)	0.49 (0.004)	1.32 (0.226)	1.31(0.24)	0.47 0.000)	0.78(0.411)
Other head	0.91 (0.272)	1.09 (0.620)	0.70 (0.711)	0.83 (0.563)	1.75 (0.033)	0.89 (0.704)	0.54 (0.012)	1.01 (0.976)	1.09(0.76)	0.72(0.192)	1.32(0.345)
Religion											
Traditional	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Protestant	0.75 (0.000)	0.58 (0.000)	0.89 (0.492)	0.66 (0.101)	0.58 (0.023)	0.84 (0.552)	1.29 (0.371)	0.64 (0.033)	1.07(0.79)	1.19 (0.501)	1.91 (0.084)
Pentecostal	0.84 (0.051)	0.46 (0.000)	0.49 (0.022)	1.06 (0.803)	0.84 (0.456)	1.16 (0.632)	1.48 (0.245)	0.77 (0.333)	1.78 (003)	1.18 (0.542)	1.72 (0.912)
Other	0.83 (0.112)	0.74 (0.324)	0.95 (0.865)	0.65 (0.471)	0.51 (0.122)	0.58 (0.174)	2.54 (0.000)	0.43 (0.021)	1.39(0.390	0.99 (0.982)	1.83 (0.287)
None	0.58 (0.000)	0.64 (0.272)	0.88 (0.701)	0.35 (0.083)	0.24 (0.001)	0.69 (0.421)	1.56 (0.253)	0.48 (0.162)	-	1.19 (0.761)	-

Variables	Overall	Manicaland	Mashonaland Central	Mashonaland East	Mashonaland West	Matebeleland North	Matebeleland South	Midlands	Masvingo	Harare	Bulawayo
Wealth Index											
Rich	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Middle	1.10 (0.021)	1.70 (0.000)	1.39 (0.252)	0.85 (0.56)	0.98 (0.932)	1.36 (0.432)	0.63 (0.159)	1.37 (0.292)	0.75 (0.377)	0.91 (0.817)	-
Poor	1.23 (0.143)	1.16 (0.421)	1.69 (0.012)	0.77 (0.73)	0.89 (0.554)	0.79 (0.932)	1.06 (0.822)	1.44 (0.075)	0.65(0.051)	0.89 (0.694)	0.55(0.082)
Distance to Health Facility											
Not a problem	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
big problem	1.50 (0.012)	3.38 (0.001)	0.93 (0.854)	2.56 (0.20)	1.04 (0.913)	0.86 (0.888)	1.68 (0.172)	0.92 (0.811)	1.06(0.881)	1.10 (0.830)	1.35(0.581)
Small Problem	1.23 (0.079)	2.53 (0.001)	0.76 (0.434)	2.35 (0.24)	0.99 (0.464)	0.51 (0.081)	1.58 (0.712)	0.64 (0.147)	1.55(0.252)	1.60 (0.181)	1.85(0.091)
Cost of Health Care											
Not a problem	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
big problem	2.24 (0.012)	4.37 (0.012)	3.20 (0.010)	1.42 (0.10)	0.91 (0.821)	0.61 (0.1219	15.51 (0.001)	1.96 (0.151)	1.02(0.952)	10.55(0.222)	2.83(0.083)
Small Problem	1.86 (0.000)	3.30 (0.041)	2.09 (0.122)	-	0.89 (0.752)	0.76 (0.388)	7.68 (0.047)	2.05 (0.132)	1.42(0.402)	8.17 (0.042)	3.14(0.065)

Independent analyses of the crude association between age and maternal death were statistically significant across at the national level (uOR =1.13; p=0.000), and across all provinces except for Matebeleland North, Masvingo, Harare and Bulawayo (p<0.05). In the majority of provinces with statistically significant results, an increase in age was associated with increased odds of maternal death. In terms of parity, all test of independent associations with maternal mortality by province were statistically significant, except in Bulawayo (p =0.462). The protective effect of age on the odds of maternal death was strongest in Harare province (uOR =0.26; p =0.000).

None, except in Matebeleland North was having secondary education significantly associated with maternal death (OR = 0.32; p=0.033). Having only primary education relative to having tertiary education was associated with increased odds of maternal death. However, in the crude odds analyses statistically significant results (p<0.05) were only obtained for in Mashonaland Central and Harare provinces. In several provinces, the sample for those without formal level education was too small for unadjusted analyses. However, in the selected provinces where odds of maternal death among this category was estimated, the risk of maternal death was higher. It was only in the Midlands province the independent association between no formal education and maternal mortality among women was statistically significant (p<0.05).

The odds of maternal death among single unmarried women relative to those who were married, produced statistically significant (p<0.05) crude odds in Manicaland (uOR =1.69), Mashonaland Central (uOR =1.58), Mashonaland East (uOR = 1.64), Matebeleland South (uOR = 1.79) and Harare (uOR = 1.59). Male household headship relative to female headship produced statistically significant lowered odds of maternal deaths in provinces such as Manicaland (uOR=0.74), Matebeleland South (uOR = 0.49) and Harare (uOR = 0.47). Relative to female/ participant-led households, those headed by other individuals besides spouses to respondent showed lowered and some provinces increased odds of maternal death. In Mashonaland West, for example, the odds of maternal death were higher (uOR =1.41; p=0.092) while in Matebeleland South the odds were lower (uOR = 0.54; p =0.041).

Pentecostal faith was associated with statistically significant (p. <0.05) decreased odds of maternal death in Manicaland (uOR = 0.46) and Mashonaland Central (uOR =0.49) relative to practising ATR. Not being affiliated with any religion relative to being identified with ATR in Mashonaland West province was associated with statistically significant decreased odds of maternal death.

Classification as 'poor', relative to being classified as rich (reference) was associated with statistically significant increased odds of maternal mortality only in Mashonaland Central (uOR =1.69; p =0.012). Classification as 'middle' on the other hand, relative to being classified as 'rich' (reference) was associated with statistically significant increased odds of maternal mortality only in Manicaland (uOR =1.70, p=0.000). Those to whom distance to the health facility was identified as 'a major problem, relative to those who identified distance as 'a non-issue', were more likely to experience maternal death in several provinces. However, only the odds for Manicaland province were statistically significant (uOR=3.38; p=0.001). Those to whom the cost of health was identified as 'a major problem relative' to those who identified cost as 'not a problem', were more likely to experience maternal death in several provinces. The odds of maternal death in the groups that identified cost as 'a big challenge' were higher and significant in Manicaland (uOR =4.37;p=0,012) and Matebeleland South provinces (uOR=15.51; p=0.001).

Multivariable Adjusted Regression Analysis Disaggregated by Region of Residence (Pooled 1999-2015)

Table 4. 3: Pooled multivariate logistic regression analysis results for selected socioeconomic factors and maternal mortality across 10 provinces in Zimbabwe, 1999-2015

	Manicaland	Mashonaland Central	Mashonaland East	Mashonaland West	Matebeleland North	Matebeleland South	Midlands	Masvingo	Harare	Bulawayo
	OR (p-value)	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*	*OR (p-value)*
Age	1.07 (0.000)	1.13 (0.000)	1.07 (0.000)	1.09 (0.000)	1.04 (0.036)	1.08 (0.000)	1.10 (0.000)	1.10 (0.000)	1.06 (0.000)	1.03 (0.132)
Parity	0.65 (0.00)	0.49 (0.000)	0.59 (0.000)	0.64 (0.000)	0.70 (0.000)	0.63 (0.000)	0.50 (0.000)	0.53 (0.000)	0.47(0.000)	0.89 (0.273)
Education										
Tertiary	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Secondary	0.78 (0.564)	1.27 (0.508)	1.39 (0.603)	0.63 (0.197)	1.00	1.49 (0.520)	2.26 (0.158))	11.48 (0.017)	1.96 (0.188)	1.08 (0.845)
Primary	1.54 (0.323)	2.56 (0.012)	2.07 (0.242)	0.35 (0.012)	0.17 (0.000)	1.36 (0.591)	3.33 (0.046)	13.34 (0.012)	4.04 (0.005)	0.79 (0.663)
Non formal	1.20 (0.707)	1.00	1.00	0.22 (0.020)	0.53 (0.097)	3.20 (0.122)	5.25 (0.014)	1.00	1.00	3.31(0.112)
Marital Status										
Married	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Single	1.11 (0.632)	1.53 (0.131)	1.25 (0.369)	1.30 (0.304)	1.00 (0.974)	1.37 (0.143)	1.43 (0.199)	0.73 (0.324)	0.76 (0.457)	0.92 (0.793)
Household Headship										
Female Head	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Male head	0.95 (0.766)	1.47 (0.155)	1.24 (0.441)	1.83 (0.025)	1.25 (0.443)	0.62 (0.128)	1.62 (0.077)	1.36 (0.234)	0.50 (0.005)	0.87 (0.683)
Other	0.98 (0.908)	0.74 (0.338)	0.84 (0.586)	1.89 (0.001)	0.81 (0.553)	0.63 (0.125)	0.88 (0.925)	1.00 (0.879)	0.65 (0.189)	1.61 (0.143)
Religion										

	Manicaland	Mashonaland Central	Mashonaland East	Mashonaland West	Matebeleland North	Matebeleland South	Midlands	Masvingo	Harare	Bulawayo
Traditional	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Protestant	0.62 (0.023)	0.93 (0.727)	0.73 (0.278)	0.38 (0.000)	0.43 (0.460)	1.37 (0.246)	0.57 (0.01)	0.95 (0.947)	1.26 (0.456)	2.25 (0.041)
Pentecostal	0.47 (0.002)	0.58 (0.081)	1.09 (0.778)	0.67 (0.123)	0.98 (0.942)	2.14 (0.033)	0.82 (0.545)	1.65 (0.080)	1.25 (0.417)	1.62 (0.253)
Other	0.75 (0.480)	0.75 (0.472)	0.58 (0.358)	0.49 (0.092)	0.20 (0.218)	2.40 (0.004)	0.51 (0.090)	1.36 (0.386)	0.86 (0.739)	1.78 (0.254)
None	0.65 (0.301)	0.63 (0.243)	0.35 (0.082)	0.24 (0.009)	0.36 (0.379)	1.55 (0.335)	0.43 (0.146)	1.00	1.20 (0.713)	1.00
Wealth Index										
Rich	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
Middle	1.46 (0.008)	1.24 (0.502)	0.78 (0.486)	1.30 (0.389)	0.92 (0.883)	0.59 (0.138)	1.55 (0.208)	1.00 (0.941)	0.91 (0.678)	1.00 (0.513)
Poor	1.06 (0.807)	1.69 (0.050)	0.97 (0.932)	1.52 (0.125)	0.61 (0.117)	1.35 (0.330)	1.75 (0.063)	1.08 (0.791)	2.45 (0.028)	0.75 (0.801)
Distance to Health Facility										
Not a problem	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*	*RC*
big problem	1.83 (0.223)	0.37 (0.021)	0.60 (0.577)	0.99 (0.950)	1.18 (0.792)	0.57 (0.218)	0.46 (0.288)	0.78 (0.775)	0.98 (0.798)	0.90 (0.922)
Small Problem	1.43 (0.458)	0.33 (0.012)	0.51 (0.465)	0.78 (0.599)	0.59 (0.365)	0.47 (0.135)	0.30 (0.963)	0.89 (0.918)	1.72 (0.492)	1.11 (0.921)
Cost of Healthcare										
Not a problem	RC	RC	RC	RC	RC	RC	RC	RC	RC	RC
big problem	2.21 (0.234)	4.91 (0.021)	1.45 (0.152)	0.71 (0.511)	0.52 (0.112)	25.50 (0.002)	3.50 (0.005)	0.85 (0.767)	14.12 (0.013)	2.61 (0.182)
Small Problem	1.99 (0.329)	4.01 (0.015)	1.00	0.65 (0.441)	0.86 (0.791)	13.87 (0.015)	5.17 (0.004)	1.06 (0.873)	11.07 (0.024)	2.76 (0.160)

In terms of age, all results from the pooled provincial multivariable analysis were significant (p. < 0.05) except Bulawayo (p= 0.13). Table 4.3 shows that in general an increase in age was associated with an associated increase in the risk of maternal death among women across all provinces. Mashonaland Central, for example, had the highest odds (aOR = 1.13; p=0.000) of maternal mortality for each year increase in age, followed by Masvingo with an odds ratio of 1.10. In Manicaland, each year increase in age was associated with a 1.07 times (p=0.000) the increase in the risk of maternal death among reproductive-aged women, while in Matebeleland South the odds stood at 1.08 (p=0.00) for each unit increase in age. There was almost no difference in the odds of maternal death for each year increase in age for women in Matebeleland North (aOR =1.04; p =0.036).

Except for Bulawayo province, all results calculated for parity were statistically significant (p. < 0.05). For the nine provinces with statistically significant results and even the one without, an increase in parity count was associated with a relative decrease in the odds of maternal death among reproductive-aged women. In the Midlands, for instance, an increase in parity count was associated with almost half the times decrease odds (aOR = 0.50; p = 0.000) in the risk of maternal mortality. This was almost similar to the case with Mashonaland Central (aOR =0.59; p= 0.00) and Mashonaland East (aOR = 0.49; p=0.000). In Harare province, an increase in parity count was associated with a 0.47 (p=0.000) decreased odds of maternal mortality among women, while in Matebeleland north there was a near 30% (aOR = 0.70; p=0.000) decreased odds of maternal mortality among women.

Although not significant for all provinces (p. > 005), those whose marital status was classified as single or unmarried seem to have increased odds of experiencing a maternal death. It was only in Harare (aOR=0.76, p= 0.457) and Bulawayo (aOR =0.92; p=0.793) were the odds of maternal death decreased among those identified as single or unmarried relative to the married or those staying with a partner (Reference category).

Analyses of household headship status factor categories against the outcome had statistically significant results (p. < 0.05) only in Mashonaland West and Harare provinces. In Harare province, women who identified with a spouse or male-headed households had almost 50% (aOR = 0.50; p=0.005) decreased odds of experiencing maternal death relative to those participants who were heads themselves (Reference category). Relative to female participant headed households, in Mashonaland West province the opposite was true. Male household

headship was associated with almost 2 times increased risk in the odds of maternal mortality among women. For 'Other household headship status', the results were only significant in Mashonaland West province ($p < 0.05$). In this province, women from households headed by 'other individuals' beside the women themselves or their spouses had up to 1.89 times increased odds of maternal mortality relative to those from households headed by female respondents (reference category)

Factor categories selected for religion produced different outcomes across different provinces where they were analysed against the study outcome. Classifying those who identified with African Traditional Religion (ATR) as the reference category, of the ten results estimated for, only those identifying with Protestant faith religion in Manicaland, Mashonaland West and Bulawayo were significant ($p. <0.05$). In Manicaland Protestant faith among women was associated with a 0.62 (0.023) decrease in the odds of maternal mortality, compared to those who identified with ATR. The odds of maternal death were even lower (aOR = 0.38; p= 0.00) among Protestant women in Mashonaland West in comparison to the reference. In Bulawayo on the contrary women who were identified as Protestant believers had 2.25 ($p = 0.041$) increased odds of experiencing maternal death relative to the reference group.

As for results calculated for Pentecostal faith women relative to the reference category (ATR), were only significant ($p. <0.05$) in Manicaland and Matebeleland South provinces. Compared to women classified under ATR, those classified as Pentecostal had 0.47 ($p=0.002$) times decreased odds of experiencing maternal death. In Matebeleland South, Pentecostal women had 2.14 (p= 0.033) times increased odds of experiencing maternal mortality relative to those classified under ATR.

Women who identified with 'other' religious groups besides Protestants, Pentecostals, or Apostolic faith had 2.40 (p= 0.004) times increased risk of experiencing maternal death in Matebeleland South. The results for those identified who identified with 'other' religious group were not statistically in the remaining nine provinces. On the other hand, those who did not identify with any religious group faced decreased odds (aOR = 0.24; p= 0.009) of maternal death in Mashonaland West, while in other provinces the results for this category were not statistically significant ($p. > 0.05$).

Women whose households were classified as 'poor' in the composite wealth index measure in Mashonaland Central and Harare provinces were more likely to experience maternal death relative to those that were classified as 'rich' (reference category). In Mashonaland Central, for example, women whose households were classified as 'poor' were almost half the time more likely (aOR =1.69; p=0.049) to experience maternal death relative to those classified as 'rich'. In Harare, the odds of experiencing maternal death were even higher (aOR = 2.45; p=0.028) among women from 'poor' households in comparison to those who were classified as 'Rich'. On the other hand, none of the results for those identified as 'middle' in terms of wealth index was statistically significant.

In terms of distance to the facility, none of the results was statistically significant (P. < 0.05) except for those for Mashonaland Central. Relative to those who perceived distance to a health facility as a 'not a problem' (reference category), those who perceived it 'a huge problem' had 0.37 (p=0.021) decreased odds of experiencing maternal death in Mashonaland Central. At the same time, those who perceived distance to the facility as 'a small problem' in Mashonaland Central had 0.33 (p=0.012) decreased odds of experiencing maternal death than those who perceived distance as a 'not a problem'.

The cost of healthcare was associated with some of the largest odds of maternal death in the pooled provincial multivariable analysis. For women who identified the cost of healthcare as 'a big problem'' and 'a small problem', logistic regression results were significant (P. <0.05) for Mashonaland Central, Matebeleland South and Harare provinces. In Mashonaland Central, for example, women who stated the cost of healthcare as 'a big problem' were up to 4.91 (p= 0.021) times more likely to experience maternal death compared to those who stated that the cost was 'not a problem' (reference category). Those who perceived cost 'a small problem' in the same province had up to 4 times increased odds of experiencing maternal mortality relative to the reference category. In Matebeleland South, those who perceived cost 'a big problem' were up to 25.50 (p=0.00) times more likely to experience maternal death compared to those who did not perceive the cost as a challenge. Those who perceived cost 'a small problem' in the same province were 13.87 (p=0.015), times more likely to experience maternal mortality relative to the reference. In Harare, those who perceived cost 'a big problem' were up to 14.12 (p=0.013) times more likely to experience maternal death relative to those who perceived cost a non-issue to them. Those to whom the cost of healthcare was 'a small problem' in Harare

were 11 times more likely to experience maternal death compared to the reference group (p=0.024).

Changes in the Socioeconomic Factors of Maternal Mortality between 1999-2005 and 2010-2015

Table 4. 4: Comparison of national-level multivariable logistic regression analyses results for selected socioeconomic factors and maternal mortality for 1999-2005 and 2010-2015.

	1999 – 2005 (ti1)				**Pooled 2010-2015 (ti2)**			
	Odds Ratio	p-value	95% Conf. Interval		Odds Ratio	p-value	95% Conf. Interval	
Age	1.09*	0.000	1.079	1.110	1.06*	0.000	1.052	1.075
Parity	0.49*	0.000	0.446	0.529	0.68*	0.000	0.640	0.721
Education								
Tertiary	*RC*				*RC*			
Secondary	2.11	0.074	0.969	4.608	1.44*	0.004	1.002	2.080
Primary	2.95*	0.010	1.344	6.479	2.35*	0.000	1.593	3.463
Non formal	3.38*	0.009	1.421	8.021	1.85*	0.044	1.008	3.403
Marital Status								
Married	*RC*				*RC*			
Single	1.13	0.193	0.849	1.511	1.20	0.071	0.981	1.460
Household Headship								
Female Head	*RC*				*RC*			
Male head	1.09	0.476	0.828	1.442	1.18	0.094	0.980	1.422
Other head	0.68*	0.046	0.505	0.923	1.07	0.493	0.866	1.314
Religion								
Traditional	*RC*				*RC*			
Protestant	0.90	0.293	0.685	1.193	0.92	0.441	0.756	1.124
Pentecostal	1.01	0.733	0.706	1.438	0.96	0.669	0.786	1.172
Other	0.77	0.212	0.496	1.186	0.89	0.434	0.683	1.162
None	0.59*	0.049	0.356	0.991	0.55*	0.001	0.378	0.795
Wealth Index								
Rich	*RC*				*RC*			
Middle	1.96*	0.000	1.350	2.850	1.07	0.522	0.856	1.334
Poor	1.98*	0.000	1.430	2.749	1.21*	0.005	0.995	1.469
Distance to health Facility								
Not a problem	*RC*				*RC*			
Big problem	0.80	0.221	0.576	1.118	1.29*	0.003	1.089	1.528
Small Problem	0.64*	0.003	0.441	0.940	-	-		
Cost of Healthcare								
Not a problem	*RC*				*RC*			
big problem	1.89*	0.001	1.295	2.765	1.15	0.109	0.979	1.348
Small Problem	2.13*	0.000	1.428	3.163	-	-		

[1] (RC) denotes reference category, [2] (*) denotes statistically significant result [3] (-) denotes odds ratio not calculated because of missing values for the category. [4] (ti) Denotes time interval

Finally, Table 4.4 shows the multivariate analysis results for time interval 1999-2005 also identified as time 1 (t1) and time interval 2010-2015 also identified as time 2 (t2). Whereas in the 1999-2005 period a year increase in age was associated with 1.09 (p = 0.000) times increased odds of maternal death, in the 2010-2015 period age was associated with 1.06 (p=0.000) times the odds of maternal death. A unit increase in parity count in the 1999-2005 period was associated with almost half the times (aOR = 0.49; p=0.000) decreased odds of maternal death while in the 2010-2015 period odds had slightly lowered to 0.68 (p=0.000).

In the 1999-2005 period, women with secondary level education were 2.11 times more likely to experience maternal death relative to those who had tertiary level education (reference). However, for this period, the result was not statistically significant (p>0.05. In the 2010-2015 period, the odds of maternal death among women with secondary education relative to those with tertiary level qualification (reference category) had decreased to 1.14 (p = 0.004). Meanwhile, those with primary education were approximately 3 times (P=0.010) more likely to experience maternal mortality compared to those with tertiary level qualification (reference category) in t1. In t2 risk of maternal death remained positive however slightly lower (aOR = 2.35; p= 0.000) for women with primary education level. Of all the categories identified under the education variable, the highest odds (aOR =3.38, p =0.009) of maternal death were experienced among those without formal education in t1. In t2, relative to the reference group (tertiary education) the odds of maternal death had declined to 1.85 (p=0.044).

In both periods none of the explanatory categories identified under marital status variable was significantly associated (p. < 0.05) with maternal mortality. Being single or unmarried, however, was associated with increased odds of maternal deaths compared to being married or staying with a partner in both periods. Except for household headship status identified as 'other' in the 1999-2005 period, none of the household headship status categories was statistically significant (p <0.05). In t1 being in a household where someone else other than the participants or their spouses were household heads were associated with 0.68 (p=0.046) decreased odds

of maternal mortality in comparison to the reference category (respondent or female-headed households).

Except for those who identified as having no religious affiliation in both time stamps, none of the categories for religious status were statistically significant (p. < 0.05). In the first period (t1) those who did not identify with any religious group had 0.59 lowered odds of experiencing maternal death compared to the reference (African Traditional Religion). In the second period (t2), the odds of experiencing maternal death in this category decreased further to 0.55 in comparison to the reference group.

In terms of wealth index, in t1 being in a household identified as 'middle' relative to being in a household identified as 'rich' was associated with 1.96 (p=0.000) times increased odds of maternal mortality. By the 2010-2015 period, the odds of dying from maternal relatable causes among women from 'middle level' wealth status households had lowered to 1.07 (p=0.522). Being in a household classified as 'poor' was associated with increased odds of maternal mortality in both t1 and t2. Relative to t1 (aOR=1.98; p=0.000) the odds of maternal mortality among households classified as 'poor' had lowered (aOR=1.21; p=0.005) but remained greater to those of the reference category (rich). None of the factor categories for the variable 'distance to facility' were statistically significant (p<0.05) during t1. In t2, those who identified distance to the facility as 'a big challenge' were up to 1.29 (p=0.00) times more likely to die from maternal relatable causes relative to those to whom distance was 'not a problem' (reference category).

The cost of healthcare was only associated with statistically significant results (p<0.00) in the 1999-2005 period. Those who indicated cost as 'a big challenge' during the t1 period, for example, had 1.89 (p=0.001) times increased odds of experiencing maternal death relative to those to whom cost was 'not a problem' (reference category). At the same time, those to whom cost was identified as 'a small challenge' had 2.13 (p=0.000) times increased odds of experiencing a maternal relatable death relative to those to whom cost was a non-issue (reference category)

CHAPTER FIVE:

DISCUSSION

5.1. Introduction

Having in the preceding chapter presented results for which this study was prompted, this chapter discusses these study findings. The discussion of study results occurs in the context of existing related literature and theoretical frameworks, the majority of which were presented in the second chapter of this report. To begin with the discussion, a recap of the study objectives and the main results are provided after which various arguments relating to the subject of maternal mortality are presented. The chapter concludes with a discussion of the applicability of the study conceptual framework, emphasising the main points derived from the discussion.

5.2. Discussion

The undertaking of the study on maternal mortality in Zimbabwe was premised on three specific study objectives. These objectives were to; examine the level and changes in maternal mortality from between 1999-2005 and 2010-2015 in Zimbabwe sub-regionally; examine the geospatial clusters of maternal mortality, and identify the sub-regional differences and changes in the socioeconomic factors associated with maternal mortality.

5.2.1. Levels and Changes in Maternal Mortality in Zimbabwe, Sub nationally

The study showed that increases in maternal mortality witnessed at the national level were also common at the subnational level. All regions except Harare, Bulawayo and Midlands experienced increases in both the MMRatios and MMRates from the 1990s into the 2000s. The provinces that experienced maternal mortality decline when the rest of the country was having a surge are the ones that have the greatest concentration of urban districts. In this regard, the study thus confirms to a greater extent what other studies have found concerning the changes in the distribution of maternal death in Zimbabwe over time (Munodawafa *et al.,* 2018; Bazile, 2008; Feresu *et al.,* 2005). According to Munodawafa *et al* (2018), although after 2010 (the peak) there was a general decline in the overall MMRatio in Zimbabwe, it is not a decline that was particularly striking, given that 70-80% of regions in the country were yet to realise the

changes. Munodawafa *et al* (2018) further stipulate that it is the urban provinces that had started to benefit from the substantive effort aimed at reducing maternal death through the resuscitation of health facilities and provision of medical staff, however very little in the rural areas (Bazile *et al.*, 2015). According to Robertson (2015), over the past two decades, Zimbabwe's maternal health situation has worsened and the effects have been more devastating in rural places in comparison to the urban areas.

Although scholarships provide diverging viewpoints regarding the rise in maternal mortality in Zimbabwe in the 2000s, it is a well-documented aspect. The rise in maternal mortality has been mostly discussed as triggered by the collapse of the country's health system. With the socio-economic and political struggles the country has been embroiled in for nearly two decades, Dodzo & Mhloyi (2017), discusses the ripple effect this, in turn, has caused on the health system. The massive exodus of skilled health personnel from the country in search of better opportunities has amongst other issues resulted in a heavy drop in the quality of services offered in a health institution (Dodzo & Mhloyi, 2017; Chinogurei, 2015). The discussion on human resource challenges leading to a rise in maternal deaths in qualitative studies has also been scoped on the poor incentivisation of the few available medical stuff resulting in low morale, striking action and sometimes negligence when dealing with those in desperate need of their services (Madziyire *et al*., 2018; Mlambo *et al*., 2013).

The needed refurbishment and improvement of health facilities to accommodate a growing population has also lagged. For Mlambo et al (2013) the non-availability of infrastructure and medical supplies in public health facilities such as hospitals has resulted in other section of the population opting for private services. However only a few people can afford private health services, and the rest have to risk having home deliveries for which in the majority of cases there is no assistance from qualified health personnel (Mlambo *et al*., 2013; Munodawafa, 2017). Also with low affordability, expecting mother often miss out on antenatal care visit which may help detect or prevent complications resulting from delivery. Munodawafa *et al* (2017), for example, confirmed that up to 33% of expecting women did not have antenatal care visits during pregnancy in the 2015.

For Maternowska (2018) and Munodawafa et al (2017), the debate on the rise in maternal mortality in Zimbabwe ought to be understood from a high incidence of unsafe abortions which often lead to complications resulting in death. Abortion in Zimbabwe except in few

circumstances including rape and incest is illegal. It is there from clandestine attempts at abortion and failure to receive proper medical assistance that a lot of maternal relatable complications including death are triggered.

The fact that urban places such as Harare have lower MMRatio compared to the rural provinces elsewhere in the country is consistent with results established form other studies. Mbonye (2001), for example, established that maternal mortality was lower in the Central region where the capital Kampala was, relative to other predominantly rural regions in the country. Again several factors such as the availability of health facilities were discussed as explanatory of lower maternal mortality ratio in Central region relative to the other regions. Banda *et al* (2015), also established that in Zambia pregnancy-related deaths comprised 17.9% in rural areas while in urban areas these comprised 9.8%, thus overall there were fewer deaths in the urban areas than the rural areas.

As hypothesised in the justification of this study, the problem of maternal mortality cannot be assumed homogenous across the entire country. Indeed, findings from this study confirm that the reality of maternal mortality is not the same across different provinces in Zimbabwe. Some provinces such as Manicaland and Mashonaland Central have contributed more to the burden of maternal death than others such as Bulawayo and Matebeleland North and South, this study confirmed. The reason Manicaland province has the highest percentile contribution is unclear, but it is perhaps not the most surprising outcome especially when one considers the fact that it is the most populous non-metropolitan province in Zimbabwe (MICS, 2017; Nyathi & Gurundoro, 2010; Muzarabani; 2010). As of the 2012 national census, the Manicaland province contributed 13.42% to the population of 13 million people enumerated across the entire country (Nyoni, 2017). The provinces' greater proportional representation in terms of population size, subtly implies the higher number of women who are exposed to the risk of maternal death (Stanton *et al*., 2001). In addition to the above, 83% of the province is characterised as rural. With rural areas infamous for high levels of maternal mortality, it is comprehensible that a very populous largely rural province has a high toll of maternal deaths (Gatsi & Manyonganise, 2019).

While Manicaland stands out in terms of its proportional representation to the toll of maternal deaths, it is not the worst when it comes to its maternal mortality rate and ratio. In terms of the number of maternal deaths per 1 000 reproductive-aged women, it is the provinces

designated as poorest in the country that stands out above the rest (ZIMSTAT, 2018; Zakeyo & Lange, 2013). In the 2012 census report, Matebeleland North, Matebeleland South, Mashonaland Central and Mashonaland had poverty levels of at least 70%. It is in these provinces that the highest MMrates are reported particularly. Although one cannot conclude based on these results alone that poverty is related to maternal deaths, there is sufficient justification to derive such a hypothesis. According to Kes *et al* (2015), in terms of health access, poverty is an issue that communicates to the issue of availability of care as well as its affordability. It is possible that amongst other challenges women in these provinces could be facing are issues of availability and affordability of maternal health care (Gatsi and Manyonganise, 2019).

5.2.2. Geospatial clusters of Maternal Mortality

Very interesting findings were made with regards to the geospatial distribution of maternal mortality hot spots and cold spots across different areas in Zimbabwe. The changes over time in the maternal mortality indicators (see the previous section) across the country were also accompanied by changes and in some parts no changes in the distribution of maternal mortality hot spots and cold spots.

The result that, compared to the 1999-2005 period, the 2010-2015 period had a greater concentration and spread of maternal mortality hot spots is hardly surprising. This coincides with the period where maternal mortality reached its peak in Zimbabwe according to literature (Chinoguya, 2013; Pazvakavambwa & Nyoni, 2017). In 2010, according to ZIMSTAT MMRatio in Zimbabwe was estimated at over 750 deaths per 100 000 live births in the 7 years that preceded the survey. Other estimates have put the MMRatio figure beyond 800 deaths per 100 000 live births (MMIEG, 2011). The political and economic crisis in Zimbabwe which saw the mass exodus of medical staff, the decline in the quality of service provided in hospitals along with other social-economic challenges may have had such negative implications on the quality of services (Pamushana & Dedza, 2010). Health services moved beyond the affordability of many, and during this period high levels of non-institutionalised births were recorded (Munodawafa, 2015). Others who could afford to move to seek medical healthcare outside the country could, but the majority had no other alternatives (Chinoguya, 2012, Robertson *et al,* 2017). The period before 2010 was marked by instability, but after 2010, during the

government of national unity (GNU) period the situation improved (Pazvakavambwa & Nyoni, 2017). In this regard, the results from the 2015 survey had improved maternal mortality statistics. The increase in the spread and concentration of hotspots during 2010-2015 thus confirms the extent of the health crisis witnessed during this period. A socioeconomic crisis accompanied by an increase in the total fertility rate according to Chinoguya (2012), was a 'recipe for disaster' in the maternal health sector.

The finding that Harare and Bulawayo were consistent cold spots of maternal mortality was again expected, given these provinces had lower MMRatios and MMRates. Literature has reflected that compared to rural areas, urban places such as Harare and Bulawayo will always do better (Pamushana & Dedza, 2010). This is because the areas enjoy better health services than the rest of the country which major medical centres Parirenyatwa and Mpilo hospitals found in these provinces (Mutinhiri, 2019). Most medical personnel are also willing to work in these areas because they are not remote to other services (Pande *et al.*, 2017). In addition to government health facilities, there is also a high concentration of private hospitals in these areas which are expected to offer better services (Betras, 2014; Chinoguya, 2013). The availability and high use of contraceptives also mean relatively lower unwanted pregnancies lower fertility and ultimately lower MMRates (Sterlin & Gladiere, 2014). It also implies better education among other factors which have been cited for the better maternal health outcomes in these regions (Muzondiwa & Isheunesu, 2015).

While urban centres are cold spots, the study also found the areas immediately out these are hot spots. One would have assumed that given the proximity to the metropolitan cities, there would be a lower count of hot spots since there is a possibility of also accessing maternal health services. Places such as Harare and Bulawayo, however, have been experiencing urban sprawl over the years. Urban sprawl in Zimbabwe unlike in other places has been accompanied by little infrastructural development and service provision (Muringazuba, 2011). Most of the places in the fringes of urban centres, therefore, have been suggested to lack services such as hospitals and clinics. The lower socioeconomic statuses of people who live in these areas would also be relatable to poor maternal health outcomes.

The evidence of maternal mortality hot spots in the borderline area particularly in the Beitbridge (Zimbabwe-South Africa border) and the places around area such as Plumtree (Zimbabwe-Botswana) contradicts slightly what others have established. Women in the border

towns such as Beitbridge have been noted to easily move into the neighbouring countries for delivering and maternal health services. However, literature does not indicate really if the women who sought health care services from neighbouring countries were from the borderline areas specifically. That said, the numbers of how many do manage to cross into neighbouring countries for medical services versus the number that remains behind are not clear. There may be very few who manage to cross into other regions.

The spread on hotspots along Manicaland, Masvingo and Mashonaland Areas is expected. Issues such as high fertility, early marriages, religion to be discussed in the next section could be relevant explanations for are statistically significant maternal mortality hot spots

5.2.3. Sub-regional Differences in SE Factors Associated with Maternal Mortality

Results from this study showed that the effect of various socio-economic factors on the risk of maternal death varies across different regions. In terms of the effect of parity on the odds of maternal deaths, overall across provinces, the results in this study were unexpected. This study revealed that an increase in parity count was associated with decreased odds of maternal deaths. This finding contradicts what others have established with regards to the relationship between parity count and maternal death. McCarthy & Maine (1994), has conceptualised the association between the two as a j-shaped association. This implies that the odds of maternal death are high during the early reproductive years, declining midway and increasing towards the end. Others have found out that the risk of maternal death tended to increase with unit increment in age. This is not to say there are no studies that have linked women with less or no births to increased risk of maternal death compared to those with many. Kozuki *et al*., (2013) for example found out that nulliparous women <18 years of age had the highest odds of adverse neonatal outcomes. To this finding, they suggested a possible biological explanation.

None of the tests for the association between marital status and maternal mortality was statistically significant across all provinces. It is interesting however to note that the odds of maternal death were consistently lower among those who were married relative to those who were unmarried. This finding is consistent with what others have established regarding the association between the two. According to Iyanda *et al* (2018) compared to married women, those who are unmarried are likely to be deprived of material and non-material support for their pregnancy. Other studies also revealed that compared to the pregnancy of married

women that of unmarried women was likely to be unplanned. In this case, the risk of maternal death could then be elevated through unsafe attempts at aborting the pregnancy and the stresses likely to be triggered as a result of unwanted pregnancy.

Cost of healthcare was associated with high odds of maternal death in Matebeleland South, Mashonaland Central and Harare provinces. Women to whom the cost of healthcare was identified as a big problem in Matebeleland, for instance, had up to 25 times increased risk of maternal death. According to Hoi *et al* (2012) the issue of the cost of health care is one that closely relates to affordability. It is not surprising that the cost of health care is beyond affordable for women in the poverty-stricken province of Matebeleland. Even in Mashonaland poverty is also rampant in and women are likely not to be able to afford health care. As women cannot afford formal maternal health services, they cannot get detected early for any potential complications that may result from the culmination of pregnancy. Further to missing antenatal care visits, women to who cost is a challenge is also likely to give birth outside the health facilities without assistance from a trained midwife or healthcare practitioners. With regards to women in Harare to whom the cost of health is a challenge, it is also not surprising the risk of maternal death is high. However compared to the largely rural provinces of Matebeleland and Mashonaland Central, the possible mechanism through which cost impacts on the likelihood of maternal death is potentially different. In urban areas such as Harare. The cost of living is generally higher in urban areas compared to rural areas. Those who cannot afford health care in urban areas are at an increased risk of receiving sub-standard care in public health facilities. Amzat (2015) also found out that poor people living in urban areas were also likely to receive delayed care or experience home deliveries.

Difficulty with distance to the health facility was uniquely associated with maternal mortality in the Mashonaland West, provinces in Matebeleland and at the national level. In the Mashonaland West, it was found that women who reported a big problem with getting to health facility had an increased odds of maternal death compared to women who had no problem with getting to the health facility. Though difficulty with distance to the health facility was significant, it needs further exploration because this it does not capture the actual distance. This finding of higher odds of maternal death with difficulty getting to a health facility is consistent with other studies that showed an increased risk of maternal death with distance to the facility (Dodzo & Mhloyi, 2017; Egbe *et al*., 2016; Amzat, 2015).

The problem of distance to the health facility in these provinces could be because of the high proportion of women (about 70%) who reside in rural areas. With hospitals and health centres mostly in urban areas, accessing the sparse health centres in rural areas would pose a major challenge these women. The impact of distance is often influenced by the lack of transportation. Distance to the health facility and lack of transportation were the most frequent reasons given by women in Tanzania for not delivering at a health facility (Choe *et al*., 2016). This may be the situation in the above-identified Matebeleland South province for example where over 60% of women were in the poor quantile and may have been without a means of transportation. Also, this finding of difficulty with accessing health facility could be capturing a problem of accessing the health facility of choice and not necessarily the nearest facility to women's home. The severe shortage of health workers in areas such as Matebeleland North (Kidia, 2018) may mean numerous understaffed health facilities (plagued with long wait times for health services). For instance, some health staff have reported difficulty getting to some hospitals which are located in remote, provinces (Pemunta & Fubah, 2015). This may cause women to delay seeking care, opt for alternative (traditional) healthcare, or not seek healthcare at all; increasing their odds of maternal mortality.

Having had some education was associated with reduced odds of maternal mortality in most of the provinces, and it was also seen at the national level (pooled), and in both 1999-2005 and 2010-2015. This finding was consistent with the literature where women with limited or no education were more at risk of maternal death compared to educated women (Karlsen *et al.,* 2011). Having any education (primary, secondary or higher) was protective in the Harare whereas only women with secondary or higher education had a significantly lower odds of maternal mortality.

5.2.3. Discussion on Applicability of Frameworks

Overall the conceptual framework that was adopted provided useful insight and direction to the study. The conceptual framework derived from McCarthy and Maine's Framework for Analysing Determinants of Maternal Mortality (FADMM) (McCarthy and Maine, 1992) pointed out maternal mortality as an outcome brought about by distant factors operating through intermediate factors. Of the distant factors selected in the conceptual framework, level of education, religion and wealth index had a frequent statistically significant association with maternal mortality while household headship and marital status were often not. Even after

disaggregating the data to provincial-level analysis, the latter provided little evidence of association with maternal mortality. While there are studies that have previously identified strong associations between family structure variables (household headship and marital status), there are also others that have not found statistically significant levels of association (Kidia, 2018; Egbe *et al.,* 2016; Garenne, 2015; Feresu *et al.,* 2015; Koenig *et al*., 2007).

On the other hand, all of the intermediate factors (age, parity, affordability of healthcare and distance to the facility) frequently had significant levels of association with maternal mortality. As other studies have argued, intermediate factors are reflective of the proximate factors that flatten or worsen the risk of maternal death (Madziyire et al., 2018; Kozuki *et al*., 2013; Mlambo *et al.,* 2013). While the association of other intermediate factors such as age and parity with maternal mortality were unexpected, it is not surprising that all of these factors still explained the occurrence of maternal mortality in Zimbabwe. The conceptualisation of the relationship between distant factors, intermediate factors and maternal mortality and the outcomes of the analysis provide strong empirical evidence of the complexity and severity of maternal health issues in Zimbabwe (Mlambo *et al*., 2013)

The evidence of the operation of background factors leading to poor maternal health outcomes points to a challenge that demands a systematic approach that will attend to all factors. The finding that the conceptual framework was found applicable in the study, cements conclusion that maternal mortality is more than a medical complication which other studies in SSA and other developing countries have established (Pande *et al.*, 2015; Di Orio & Crivelli-Kovach, 2014; Mumtaz *et al.,* 2013).

CHAPTER SIX:

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

This study measured the levels of maternal mortality and identified its associated factors within the provinces in Zimbabwe overtime. All the three objectives specified in this study (see chapter one) were achieved.

Overall instability of maternal mortality indicators in Zimbabwe is an upsetting trend given that in the preceding years these indicators had been promising. Improving on these indicators is a desperate need especially for the rural and other areas located in the peripheries of service delivery as proved by the geospatial mapping. At the same time, this study has concluded that maternal mortality in Zimbabwe is a complex and dynamic issue. It involves the intersection of multiple demographic and socio-economic factors operating at different levels and strengths across time and space. While there are data challenges to the understanding of maternal deaths at lower administrative levels, findings from this study revealed that approaches to tackling the issue of maternal mortality in Zimbabwe will require paying attention to the diversity in the population attributes at these levels. This diversity is reflective is of the varying needs across different spaces. While there are diverging levels of need, the cost of healthcare is a national concern and attention will be demanded in this regard. The attainment of global, regional and national commitments toward the reduction of the burden of maternal death demand that relevant data at lower administrative level be strengthened to improve on the insights obtained.

Regarding the analysis of maternal mortality levels and changes which was the first objective of the study, on the whole, the maternal health indicators (MMRatio and MMRate) worsened overtime. While in the predominantly ruralised provinces such as Masvingo, maternal mortality has exploded and contributed heavily to the national burden, the generally urbanised provinces such as Harare have shown signs of improvement over time. Indeed, the experience of maternal health inequalities across time and space has not been uniform. However, even

the comparably better provinces in terms of maternal mortality rates and ratios, are also still a cause for concern. This is because MMRatios in Zimbabwe's urbanised provinces is worse than the regional and global averages, thus overall, maternal mortality is a national crisis.

That be the case, acknowledging maternal mortality as a protracted national crisis, the study proved that there are areas that perhaps require more attention than others, particularly in the immediate term. With the first objective, one could have possibly drawn such inferences from the results in provinces such as Matebeleland South and Masvingo. Some of these provinces have had consistently higher than average maternal mortality rates and ratios over time. With the geospatial mapping of maternal mortality hotspots, the second study objective, deriving areas needful of the intervention was even more enlightening. It is clear such as Harare and Bulawayo are not maternal mortality hotspots. However, places in the immediate peripheries of metropolitan provinces and cities and those located near regional or national boundary areas, in particular, the stretch of rural provinces in the northern and eastern parts of the country are maternal mortality hot spots. Again, some areas appeared perennial maternal mortality hotspots, others are cold spots, and with others, there is little that could be derived in this regard (no data). The study reinforces the fact that the mapping of the hotspot and cold spot areas of maternal mortality is critical to the structuring of intervention cum target specific maternal health plans. However, this will also require improvement in the data for more informed findings. In light of the geospatial analysis that was planned for this study, results were not as vigorous as was planned because of the data limitations (to be explained in the limitations section).

In addition to the above, The Zimbabwe Maternal and Neonatal Health (MNH) adopted in 2013 is committed to the scaling up of institutional efforts to the management of maternal mortality. The study has provided strong empirical evidence that the scaling up of these efforts is necessary. In Zimbabwe, maternal health is an issue that is yet to stabilise. The scaling up of institutional efforts will need far-reaching to include demographic and socio-economic factors. The decentralisation of maternal health services and the need to ensure quality prenatal and postnatal services the framework recommends are requisite to the sustainable management of maternal mortality. The differences in terms of the population characteristics at lower

administrative levels need to be taken into cognisance to adequately respond to the maternal health needs of each population segment.

Insightful differences and changes in the socioeconomic factors associated with maternal mortality were identified with the third objective. Overall, it can be concluded from the regression modelling analysis that was performed in light of this objective, that parity, age, education, wealth index, religion, cost of health care and distance to the facility have the most relevant socioeconomic factors relatable to maternal mortality in Zimbabwe. Relevant they may have been, the effect of these socioeconomic factors has changed over time. Unexpectedly though, was the result that increases in age or parity were associated with the corresponding decrease in maternal mortality. The risk of death was noted higher among young women and those with lower parity count. The inequalities in maternal mortality go along with the reproductive health statuses of women. This underscores the need for identifying and providing solutions to barriers that make it difficult for women to survive through their first pregnancies or young pregnancies.

Also, provinces that are plagued with the highest levels of poverty, experience severe shortages of health care providers, and where healthcare affordability is a challenge are the ones that have the greatest burden of maternal mortality. The need to address the socioeconomic circumstances within which maternal deaths arise thus is realised as important. Even more important, however, would be addressing these socioeconomic factors in line with the differential effect they have on maternal mortality across provinces and time. The cost health of care, for example, is a general challenge but in provinces such as Matebeleland North and Harare, it is even greater. Additionally, over time, the effect of a socioeconomic factor is changing. While education has remained a significant factor associated with maternal mortality, the strength of the association is shifting towards the null in places such as Harare. The formulation of maternal health policies will thus need to be cognisant of this dynamism and relativity

6.2. Recommendations

This study revealed important issues relating to maternal mortality in Zimbabwe. From this study, important points to potential policies that the government of Zimbabwe could adopt to reduce maternal mortality can be deduced. Based on the findings of this study, the following recommendations are offered.

6.2.1 Future research

Future large studies on maternal mortality in Zimbabwe would be of interest. This study found that in selected provinces education and religion were associated with maternal mortality. These are factors that are interrelated with other socio-cultural factors and thus, several questions remain to be resolved; in particular what as of a religious group that makes the women of that group at risk of maternal mortality. Hence, there is need for further research in the quality of health services which may inform strategies for improvements in the delivery of care in the formal healthcare sector.

Studies that focus on measuring the distance to facilities and their effects on maternal health outcomes will be required. The estimation of the effect of ones' distance to the facility in this study was based on the subjective views of the respondents and not the actual measurement. Given that the study identified distance to the facility as a statistically significant factor, the implementation of responses to address this could benefit more from actual distance mapping techniques. The same goes for the cost of healthcare, also assessed in this study. Beyond knowing how much of a big problem, the cost of healthcare is, there is also a need to know the actual monetary value respondents attach to cost Strategies aimed at incentivising and wavering healthcare in resource-deprived setups will require a full-scoped understanding of the nature of cost difficulties women face resulting in the escalation of maternal mortality.

6.3. Limitations

In light of the important issues this study discussed, there were also limitations. The use of the sisterhood method of estimating maternal mortality required, the study to assume that the respondent accurately reported the information related to death and pregnancy status of the siblings. This could prove a huge assumption particularly amongst respondents who are the youngest amongst in the family (Ahmed *et al*., 2014). The respondents may not have been able

to remember or be knowledgeable about those siblings who may have been born and died before they were born. Recall bias could thus have resulted in the underestimation of maternal mortality in this study (Merdad & Ali, 2018).

Also, the underestimation of maternal mortality potentially could have arisen from the respondent's reluctance to divulge information if the death of the sibling was pregnancy-related. This is quite common for deaths aggravated by illegal abortion (Munodawafa *et al.,* 2017; Musekiwa & Nyoni, 2012). In the case of Zimbabwe, the fear of culpability for abortion-related deaths could have resulted in respondent's non-disclosure (Munodawafa *et al*., 2017). The cultural sensitiveness of the issue around pregnancy and death, as noted in other studies could also have prompted the respondent's non-disclosure (Munodawafa *et al*., 2017).

Other than fear or reluctance on the part of the respondent, inaccurate measurement of the number of deaths could also have resulted from a genuine lack of information regarding the sibling's pregnancy status at the time of death (Pullum, 2014). This lack of knowledge is especially common in cases where the deceased may have migrated away from home at the time of death, never lived with the respondent or had a different biological father than the respondent (Pullum, 2014, Robertson *et al.*, 2008).

On the other hand, there also stands the possibility of overestimating maternal death, through overcount of siblings. A respondent may include siblings who were adopted into the household or those from a different mother but the same father (Merdad & Ali, 2018; Pullum, 2014)

Finally, maternal mortality is statistically rare. The precise estimation of these deaths at the subnational level ordinarily requires complete population data such as the national census. However, census data is not available for Zimbabwe and even old data is not currently available to the public. There is no explanation provided by the Zimbabwe Statistical Agency (ZIMSTAT), the national statistical service, as to the reason the non-availability of the data in the public domain, and the reason it cannot be requested for research use. Even if the data were available, census data is still noted for other limitations including the inadequacy of the questions on maternal deaths which could result in the overestimation or undercount of maternal deaths. Again just as with the survey data, the validity of census data relies on the ability or knowledge of the respondent to accurately report on the death(s) as related to maternal causes.

There is a challenge of potentially generating results that are not statistically robust or that have large confidence interval hence unreliable with survey data when used for rare outcomes at the small area level (Rodriguez *et al*., 2018). Although much insight could have been drawn with the estimation of maternal mortality to the smallest geographical enumeration area, the current study could only provide insight at the provincial – district- levels (Abou Zahr *et al.,* 2004).

Notwithstanding the limitations noted, several steps were made to address these one hand and strengthen the study on the other. Although maternal mortality is statistically rare making it difficult to generate significant estimates of its occurrence at the subnational levels, pooling of data for example allowed for the generation of statistically robust findings at least at the provincial –level. On the other hand, although recall bias is common in the reporting of maternal deaths, this bias is reduced if the period in question is shorter. Also, while the respondents my report on any death that occurred, the study considered in the estimation of maternal mortality rates and ratios only that had occurred five years preceding an identified survey point. While underreporting of maternal risk may result from the reluctance of respondents to report of pregnancy status or outcomes, the study identified a more reliable question on parity. Other studies have found the question on the number of births one has had to provide a more reliable estimate of maternal mortality risk than the one on the number of pregnancies one has ever had.

6.4. Study Contributions

Reducing maternal mortality in Zimbabwe remains an important goal. This study is the first to examine the factors associated with maternal mortality in Zimbabwe using national representative data and exploring differences across various regions in the country. The main findings show regional differences in the levels and factors associated with maternal mortality. An implication of this is the impact the adoption of regional interventions will have on the national scale. Targeting specific regional determinants of poor maternal outcomes will not only improve health conditions for women of the respective region but also contribute towards the reduction of maternal mortality at the national level. For instance, subsidizing healthcare especially in the poorest provinces such as Matebeleland South potentially could allow those without reducing the odds of maternal death among women in these areas. This study can

form part of the basis for efforts to improve the sparse data on maternal mortality in Zimbabwe. The findings are useful for current and future programs for maternal health. Through the provision of improved information, the findings of this study can serve as baseline data to evaluate the impact of programs implemented to address the identified problems leading to maternal mortality. Also, the findings may have implications for other health indicators and subpopulations like children's health, which share similar determinants like maternal mortality. Programs to improve maternal health will, in turn, benefit children and families of women whose wellbeing is heavily influenced by maternal mortality.

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Appendices : Literature Review Matrix

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
					Local Studies				
1	Munyaradzi K, D., Marvellous, M., Stanzia, M., & Memory, D. M. (2016).	Praying until Death: Apostolicism, Delays and Maternal Mortality in Zimbabwe.	Qualitative Study Design	Primary Data	Key Informant Interviews (KIIs) selected through an opportunistic sampling procedure, snowballing sampling	Three delays model	*Individual woman * Region (selected rural areas)	* Religion (apostolicism) is associated with risk factors to maternal, mortality –high fertility, non-use of contraceptives, none use of health facilities * Religiosity leads to delays in recognising pregnancy danger signs, seeking appropriate health care	* Sample size was too small, only 15 KIIs used for the study, selection bias. * Potential for recall bias. * Results are not generalizable * No comparison group – apart from interviewing those who did not receive help from trained SBAs, should have considered those who did. * Only focused on rural areas neglected urban – could give a new perspective
2.	Chitura, M., & Offat, I . (2013)	Exploring the Determinants of Maternal Mortality Dynamics in Zimbabwe	Mixed Methods Design	Secondary Data	Census reports, Zimbabwe Demographic Health Survey reports, research papers, and expertise in maternal health issues.		* National level – focus in on country level estimates	*Sepsis (infection), HIV and AIDS, obstructed labour, high blood pressure, unsafe abortion, lack or not antenatal clinics s stated among the leading cause of	*Study is a report of what other previous studies (report) have reported on – does not add much new insight on factors relatable to maternal death

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
					Desktop report of previous studies			maternal death in Zimbabwe. *Inequalities in the access to health services, the widening socioeconomic gap between rural and urban areas – relatable to maternal death	*Methodology approach used to assess various sources of maternal mortality evidence is not well articulated – the methodology is missing. There is no clear/ precisely followed method to evaluate various data sources *The document deals with various conflicting data sources for maternal mortality-. Does not satisfactorily explain how these were reconciled.
3.	Murewanhema, F.M., *et al.* (2017).	Evaluation of maternal mortality surveillance in Mutare district, Zimbabwe, 2014-2015: A cross-sectional study	Descriptive Cross-Sectional Study Design	Secondary Data Source Zimbabwe Maternal and Perinatal Mortality data (2007-08)	Standard primipara method to asses quality obstetric care				*Study is not generalizable – only covers a small part of the country

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
4.	Mlambo, C., Chinamo, C., & Zingwe (2013)	An Investigation of the Causes of Maternal Mortality in Zimbabwe	Qualitative design	Primary data	20 conveniently sampled participants- nurses, health officers midwives etc. In-depth interviews		Institution - facility	Direct determinants such as haemorrhagec abortion, sepsis hypertension among the leading cause mortality	*Study based on 1 facility – results not generalizable to the rest of the country *Focus on the evidence presented by staff members and does not consider the reproductive-aged women who may have faced and escaped the risk of maternal death * Does give adequate consideration of the underlying causative factors of maternal mortality
Sub Saharan Africa Studies									
5.	Kolo, M.A, *e al.*, (2017)	Spatial and Temporal Variations of Maternal Deaths in the Borno State of Nigeria: An Institutional Based Study	Quantitative study: Retrospective patient record study	Health Information Management System (HIMS) (Borno State Ministry of Health Repository)					

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
6.	Moseson, H.*, et al* (2014)	Estimation of maternal and neonatal mortality at the subnational level in Liberia	Population-based quantitative study	Quantum Geographic Information System Software	multivariate logistic regression				The study was sample size was too small. To estimate maternal mortality with sufficiently narrow margins of error at the subnational level would require a household census
6	Merdad, L., & Ali, M.M. (2018)	Timing of maternal death: Levels, trends, and ecological correlates using sibling data from 34 sub-Saharan African countries	Quantitative Study	84 standard Demographic and Health Surveys (DHS) from 34 sub-Saharan African countries			Country-level		

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
7	Kes, A., *et al* (2015)	The economic burden of maternal mortality on households: evidence from three sub-counties in rural western Kenya	Concurrent mixed methods design	Primary data Data collected between 2011-13 Aided by Health and Demographic Surveillance System's (HDSS) tools for locating sampling areas	Questionnaires In-depth and focus group discussions		Household Community County levels	*****Maternal mortality is predominantly a burden in already economically and socially disadvantaged households *****Asset liquidation, straining of consumption expenditure associated with maternal mortality	*****Limits the study to the rural part of Kenya hence not representative of the country *****Focuses on the immediate economic impact only- neglects other long terms socioeconomic impact
8	Mmusi-Phetoe, R.M.M. (2015	Social factors determining maternal and neonatal mortality in South Africa: A qualitative study	Phenomenological Qualitative study	10 purposively sampled women	face-to-face interviews	Social Determinants of Health (SDH)	Household Level	Findings revealed that poverty is an underlying factor to the vulnerability to maternal deaths Nutritional inadequacies, neglect and abuse by male partners, inattention to reproductive health, poor health care provision	Unrepresentativeness: the study only limited to a small area in the KwaZulu Natal province within South Africa The

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
								associated with high maternal deaths	
	Banda, P.C. (2015)	Status of maternal mortality in Zambia: Use of routine data	Descriptive cross-sectional cum quantitative study	Zambian Health Management Information System (ZHMIS) Secondary data			Provincial-level	There are significant geographic variations in lifetime risk of death and maternal mortality, which suggests the importance of maternal health interventions at the subnational level Rural provinces have higher maternal mortality rates compared to urban provinces.	Only include only hospital deaths Inability to assign the underlying cause of death meant the inability to precisely classify whether the death was direct, indirect or incidental. Data source utilised lack individual variables on maternal mortality. Sufficiency and efficacy of the data source in answering the research questions, not satisfactory
	Gabremedhin, S (2018)					McCarthy and			Calculation of MMRatio in this study depends on

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
		Development of a new model for estimating maternal mortality ratio at national and subnational levels and its application for describing sub-national variations of maternal death in Ethiopia	A descriptive repetitive cross-sectional study	Demographic and Health Surveys Maternal Health Surveys (MHS), Maternal Health Surveys (MHS) World Bank and the World Health Organization mortality statistics	Data were analysed using SPSS software	Maine model of maternal mortality	Regional and country-level analyses Subnational provincial level		model estimation whose validity can only be assessed based on the value of the coefficient. There is no rigorous evaluation using independent data Performance of the model in predicting below the observed range from which the model was developed is questionable
	Lougue, S. (2013)	The methodological approach of the spatial distribution of maternal mortality in Burkina Faso and explanatory factors associated		DHS Data Census Data	R Software used of statistical analysis Pearson Chi-squared test Wilcoxon Mann Whitney test Multivariate logistic regression models time-series model				

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
	Aguilar, R.R. (2018)	Maternal mortality in Mexico, beyond millennial development objectives: An ageing period-cohort model							

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
	Manyeh A. K. (2012)	Spatial pattern and trends of maternal mortality over 5 years and associated risk factors in Ifakara health and demographic surveillance sites (IHDSS)	Longitudinal quantitative study	Ifakara Health and Demographic Surveillance Site (IHDSS) in Tanzania, from 2006 to 2010	Inverse distance weighted (IDW) method of interpolation in ArcGIS was used to assess spatial patterns Cox proportional hazards regression was used to identify and quantify risk factors associated with maternal mortality.				
	Ebeniro, J (2013)	The geography of maternal mortality in Nigeria	Quantitative	Federal Ministry of Health data to estimate maternal mortality rates (year ending 2010) Nigeria Demographic and Health Survey for	Use of a correlation matrix through factor analysis predicts the relationship between variables ArcGIS used to produce maps illustrating the spatial patterns of	Human Ecology Model and Maternal Health	State-level analysis	The socioeconomic factors are important determinants of geospatial differences in maternal mortality in Nigeria. These determinants include religion and education Early marriage (15-19 years) associated with Northern Muslim states was more likely	The study makes use of medical data- the data only accounts for deaths that occurred while at a medical institution – underreporting, the accuracy of estimates remain critical issues unresolved

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
				explanatory variables	maternal mortality			to result in childbirth complications resulting in deaths	
	Iyanda, A.E., et al (2018)	Using GIS to detect cluster and spatial disparity in maternal health indicators: a need for social health interventions		Ghana Demographic and Health Survey (GDHS)	Spatial Statistics, geovisualization, and GIS techniques.	Human Behavioural Model of Health care (Andersen, 1968)	District _cluster level analysis		The author acknowledges a recent change in the number of districts in Ghana (From 170 to 210). Unfortunately, analysis is performed using old divisions, necessitating, therefore, the need for a study that takes into analysis the new spatial demarcations Findings in the study subject to the influence of the modifiable areal unit problem (MAUP), which limit statistical explanatory capacity regarding differences in

#	Author(s)	Title of Research	Study Design	Data Source	Methods	Theories (y/n)	Level of Analysis	Results / Findings	Gaps
									maternal mortality across space. There is a need for robust spatial statistics such as spatial regression models, the authors acknowledge

Overall profile and characteristics of the study participants; Zimbabwe 1999-2015.

Characteristics	**Sample = 26 079**	
	Mean	Standard Deviation (SD)
Age	31.54	8.28
Parity	3	1.98
	Freq.	*Per cent (%)*
Survival Status		
Alive	24 849	95.20
Deceased	1 251	4.80
Education Status		
Non-Formal	1 129	4.33
Primary	9 391	35.99
Secondary	14 390	55.15
Tertiary	1 180	4.52
Marital Status		
Married/ living with a partner	20 208	77.45
Single/Unmarried	5 882	22.55
Household headship		
Female-Headed	8 025	30.76
Male Headed	12 152	46.58
Other Head	5 913	22.67
Religion		
Apostolic Faith	8 708	33.43
Protestant	9 023	34.64
Pentecostal	4 752	18.24
Traditional	451	1.73
Other	1 553	5.96
None	1 558	5.98
Wealth Index		
Poor	12 434	47.68
Middle	3 791	14.54
Rich	9 854	37.79
Distance to Health Facility		
Not a problem	2 457	9.42
Big problem	9 869	37.84
Small problem	13 752	52.73
Cost of Healthcare		
Not a problem	1 975	7.57
Big problem	13 283	50.93
Small problem	10 822	41.40
Region		

Characteristics	Sample = 26 079	
Manicaland	3 532	13.54
Mashonaland Central	2 551	9.78
Mashonaland East	2 383	9.13
Mashonaland West	2 965	11.37
Matebeleland North	1 373	5.26
Matebeleland South	1 267	4.86
Midlands	3 296	12.63
Masvingo	2 983	11.43
Harare	4 227	16.20
Bulawayo	1 512	5.79

Reverse Stepwise Multiple Logistic Regression Model Showing Association Between Selected Socioeconomic Factors and Maternal Mortality in Zimbabwe, 1999-2015.

Outcome: Maternal Death	Odds Ratio	P. Value	95% conf. Interval	
Age	1.07	0.000	1.06	1.08
Children ever Born	0.38	0.000	0.35	0.42
Education	1.42	0.000	1.29	1.57
Wealth	1.17	0.000	1.08	1.26
Cost of Healthcare	1.11	0.530	1.00	1.23
Religion	0.90	0.000	0.85	0.94
cons	0.01	0.000	0.01	0.01

Variance Inflation Factors of Selected Socioeconomic Variables and Maternal Mortality (Outcome), Zimbabwe 1999 -2015.

Collinearity Diagnostics				
Variable	VIF	SQRT/VIF	Tolerance	R-Squared
Age	1.78	1.33	0.56	0.44
Children Ever Born	1.83	1.35	0.55	0.50
Education	1.33	1.15	0.75	0.25
Marital Status	1.05	1.02	0.95	0.05
Household Headship	1.13	1.06	0.88	0.12
Religion	1.01	1.00	0.99	0.01
Wealth Index	1.66	1.29	0.60	0.40
Distance to Facility	1.63	1.27	0.62	0.39

Cost of Healthcare	1.40	1.18	0.71	0.29
Mean VIF	1.42			

	Eigenvalue	Cond Index
1	8.82	1
2	0.36	4.92
3	0.23	6.16
4	0.2	6.68
5	0.11	8.76
6	0.1	9.47
7	0.08	10.6
8	0.05	13.7
9	0.04	15.1
10	0.01	28.5
Condition Number		28.5

Correlation Matrix and Significance Level Matrix of Selected Variables and Maternal Mortality (Outcome), Zimbabwe 1999 -2015.

e(V)	Age	Children Ever Born	Education	Marital Status	Household Headship	Religion	Wealth Index	Distance To Facility
Age	0.000							
Children Ever Born	-0.000	0.000						
Education	-0.000	-0.000	0.000					
Marital Status	-0.000	0.000	-0.000	0.000				
Household Headship	0.000	0.000	-0.000	-0.000	0.000			
Religion	-1.050	0.000	-0.000	-0.000	8.870	0.000		
Wealth Index	0.000	-0.000	-0.000	0.000	-0.000	0.000	0.007	
Distance to Facility	-4.380	0.000	0.000	-0.000	4.170	0.000	0.009	0.333
Cost of Healthcare	7.830	-0.000	0.000	0.000	-0.000	0.000	0.003	-0.013
Cons	-0.000	0.000	-0.000	0.000	0.000	-0.000	0.048	-0.048

Letter of Authorisation to Use DHS Geospatial Data on Zimbabwe

Aug 05, 2019

Kumbirai Madziwa
University of the Witwatersrand
Zimbabwe
Phone: +27842903907
Email: ljmarapara@gmail.com
Request Date: 08/03/2019

Dear Kumbirai Madziwa:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: " Maternal mortality in Zimbabwe: A geospatial analysis of associated socio-economic factors":

Zimbabwe

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

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