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TITLE:

**LEVELS AND FACTORS ASSOCIATED WITH MATERNAL DEATH IN
AGINCOURT, A RURAL SUB-DISTRICT OF MPUMALANGA
PROVINCE, SOUTH AFRICA**

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Declaration

I, RICHARD AFEDI NAGAI declare that this research report work is my own work. It is being submitted for the degree of Master of Science in Medicine in the field of Epidemiology and Biostatistics in the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination at this or any other University.

A handwritten signature in dark ink, appearing to read 'R. Nagai', with a stylized flourish at the end.

Signature of candidate

15th May, 2010

Dedication

I dedicate this work to Almighty God who remains faithful to His word through the years and to the love of my life, my lovely and wonderful wife, Mrs. Mavis Owusua Afedi-Nagai and my lovely kids, Gilda and Kobe Bryan Afedi-Nagai for their unwavering support, prayers, unquenchable love and enduring my absence for the entire period of my studies at the University of the Witwatersrand, South Africa.

Abstract

Introduction: The reduction of maternal death is a high priority for the international community, especially in view of the increased attention to Millennium Development Goal 5. Maternal mortality in developing countries has been estimated at 400 per 100,000 live births whereas levels in most developed countries are below 25 per 100,000 live births.

According to the World Health Organization (WHO), at least 500,000 women worldwide die every year from complications of pregnancy, abortions and delivery.

Objectives: The study main objectives were to establish the maternal mortality ratio and trend from 1993 to 2006 in the rural Agincourt sub-district; to describe the main causes of death of women of reproductive age from 1993 to 2006; and to identify socio-demographic factors associated with maternal death among rural pregnant women 15-49 years.

Methods: A retrospective cohort design was employed using secondary data collected as part of the Agincourt health and socio-demographic surveillance system. The total cohort size of 25,061 women who were pregnant was identified. Logistic regression was used in ascertaining which factors were associated with maternal death.

Results: Seventy maternal deaths were identified. There was an increasing risk of maternal death with increasing maternal age and parity. The maternal mortality ratio for the 14-year period was 287/100,000 live births and the trend was statistically significant. HIV/AIDS, respiratory tuberculosis and other ill-defined conditions were the major causes of death across the age groups with over 70% of all deaths of women of reproductive age related to HIV/TB.

Conclusion: Maternal mortality ratio increased per year from 1993 to 2006. Communicable diseases (largely HIV/AIDS) have emerged as the most common causes of death of women of reproductive age in the Agincourt sub-district, with major risk factors being increasing maternal age, complication during delivery, antenatal care visits and mother's socio-economic status.

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Table of Contents

Declaration.....	i
Dedication	ii
Abstract.....	iii
Acknowledgement	iv
List of Figures	viii
List of Tables	ix
Definition of Terms.....	x
List of Abbreviations and Acronyms	xi
CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW	1
1.1: Introduction.....	1
1.2: Problem Statement.....	2
1.3: Justification of the Study	3
1.4: Literature Review	4
1.4.1: Sub-Saharan Africa Perspectives.....	4
1.5: Study Question.....	7
1.6: Aim	7
1.7: Specific Objectives	7
CHAPTER TWO: MATERIALS AND METHODS	8
2.1: Demographic Characteristics of Study Area.....	8
2.2: Agincourt Health and Socio-Demographic Surveillance Systems.....	9
2.3: Role of Verbal Autopsy Technique	10
2.4: Study Population.....	11
2.5: Study Design.....	11
2.6: Inclusion and Exclusion Criteria.....	11

2.7: Data Sources	12
2.8: Measurement.....	12
2.8.1: Explanatory Variable	12
2.8.2: Outcome Variables.....	13
2.9: Data Management	14
2.9.1 Data Extraction Processing	14
2.9.2: Data Cleaning and Merging	14
2.10: Data Analysis.....	15
2.10.1: Descriptive Statistics.....	15
2.10.2: Analytic Statistics	15
2.11: Ethical Considerations	16
CHAPTER THREE: RESULTS	17
3.1: Socio-Demographic Characteristics of the Study Participants	17
3.2: Trends in Maternal Mortality Ratio and Rate	20
3.3: Trends in Maternal Mortality Ratio by Mother's Nationality.....	21
3.4: Maternal Mortality by Selected Demographic Characteristics	23
3.5: Maternal Mortality Ratio by Age Groups and Parity.....	25
3.6: Maternal Mortality Ratio by Age Groups and Socio-Economic Status.....	26
3.7: Main Causes of Deaths Among Women of Reproductive Age (15-49) years	27
3.8: Main Causes of Maternal Death in Agincourt Sub-district.....	29
3.9: Univariate and Multivariate analysis for maternal deaths.....	31
CHAPTER FOUR: DISCUSSION AND CONCLUSION.....	35
4.1: Maternal Mortality Level.....	35
4.2: Causes of Deaths.....	36
4.2.1: Communicable and Infectious Causes of Death	38
4.2.2: Non-Communicable Diseases and Accidents and Violence as Causes of Deaths	39

4.3: Risk Factors Associated with Maternal Deaths	39
4.4: Limitations of the Study	40
Conclusion	41
Appendix 1.0	47
Appendix 2.0	48

List of Figures

Figure 1: Map showing Bushbuckridge district where Agincourt study site is located	9
Figure 2: Overall trends of maternal mortality ratios per year across the 14-year period in Agincourt sub-district, 1993-2006	21
Figure 3: Trends in maternal mortality ratio by mother's nationality in Agincourt sub-district, 1993-2006	23
Figure 4: Maternal mortality ratio by age group and parity in Agincourt sub-district, 1993-2006	25
Figure 5: Maternal mortality ratio by age group and socio-economic status in Agincourt sub-district, 1993-2006	26
Figure 6: Percent distribution of Age-specific mortality of causes of death of women of reproductive age in Agincourt sub-district, 1993-2006	29
Figure 7: ROC curve for the multivariate logistic model predicting maternal death in Agincourt sub-district, 1993-2006	34

List of Tables

Table 1: Background characteristics of study subjects over 14-year period in Agincourt sub-district, 1993-2006	18
Table 2: Maternal mortality ratio and rate per year across a 14-year period in Agincourt sub-district, 1993-2006	20
Table 3: Maternal mortality ratio by mother's nationality in Agincourt sub-district, 1993-2006.	22
Table 4: Maternal mortality by selected demographic characteristics in Agincourt sub-district, 1993-2006	24
Table 5: Maternal mortality ratio by age group and parity in Agincourt sub-district, 1993-2006	25
Table 6: Maternal mortality ratio by age group and SES in Agincourt sub-district, 1993-2006..	26
Table 7: Major causes of death of women of reproductive age in Agincourt sub-district, 1993-2006.....	27
Table 8: Frequency distribution of age-specific mortality of causes of death among women of reproductive age in Agincourt sub-district, 1993-2006	28
Table 9: Leading top 5 main causes of death of women of reproductive age by age group in Agincourt sub-district, 1993-2006.....	Error! Bookmark not defined.
Table 10: Major causes of maternal deaths in Agincourt sub-district, 1993-2006.....	30
Table 11: Univariate and Multivariate logistic models for maternal death in Agincourt sub-district, 1993-2006	33

Definition of Terms

Maternal death: Death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (ICD-10) (1).

Maternal mortality ratio: Ratio of number of maternal deaths during a given time period per 100, 000 live births during the same time period

Maternal mortality rate: Number of maternal deaths in a given time period per 1,000 women of reproductive age in the same time period.

Proportionate mortality ratio: Maternal deaths as proportion of all female deaths of those of reproductive age, usually defined as 15–49 years in a given time period

Late deaths: Deaths occurring between 42 days and beyond after abortion or delivery that are due to direct and indirect maternal deaths

Socio-demographic characteristics: Related to personal characteristics of women such as maternal age, maternal education, marital status, birth order, household socio-economic status.

Health and Demographic Surveillance System (HDSS): Is a set of field and computing operations to handle the longitudinal follow-up of well-defined entities or primary subjects (individuals, households and residential units) and all related demographic and health outcomes within a clearly circumscribed geographic area. Unlike a cohort study, a DSS follows up the entire population of such a geographic area.(2)

Verbal Autopsy: Process of eliciting information about the circumstances of a death from family or friends of the recently deceased person in cases where medical certification of death is incomplete or absent (3;4).

List of Abbreviations and Acronyms

HIV	Human Immunodeficiency Virus
HDSS	Heath and Socio-Demographic Surveillance Site
AIDS	Acquired Immune Deficiency Syndrome
SES	Socio-Economic Status
WHO	World Health Organization
ICD	International Classification of Diseases
VA	Verbal Autopsy
CDF	Community Development Forums
ROC	Receiver Operator Characteristic

CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.1: Introduction

The reduction of maternal death is a high priority for the international community, especially in view of the increased attention to Millennium Development Goal 5:- improving of maternal health and reducing maternal mortality ratio by three fourths between 1990 and 2015 (5). Maternal deaths arise from risks attributable to pregnancy and delivery as well as from poor quality health care (6).

Maternal mortality in developing countries has been estimated at 400 per 100,000 live births, whereas levels in most of the developed world are below 25 per 100,000 live births (7). According to estimates by the World Health Organization (WHO), at least 500,000 women worldwide die every year from complications of pregnancy, abortion and childbirth (8). These women are exposed repeatedly to the risk of pregnancy and childbearing and, under existing socioeconomic conditions and the inadequacy of medical and health facilities, are at great risk of morbidity and mortality from causes related to pregnancy. The death of the woman who, in most developing countries, plays the principal role in child rearing and the management of family affairs, is a significant social and personal tragedy. However, national estimates of maternal mortality in most developing countries are based on limited and defective data. This problem is most prominent in high-mortality countries, where the majority of deaths go unregistered. Maternal mortality has been recognized as a public health problem in developing countries, as evidenced by an increasing number of publications on the magnitude and significance of the problem (9).

There are many factors that lead to maternal deaths. High rates of maternal deaths occur in countries that have high rates of infant mortality reflecting generally poor nutrition and medical

care. Low birth weight of the child is correlated with maternal death from cardiovascular disease. Reduced birth weight is associated with increased risk of maternal death. Conversely, heavier child birth weight is correlated with lower risk of maternal death (9).

1.2: Problem Statement

Maternal mortality remains poorly researched in Africa, and is likely to worsen dramatically as a consequence of HIV/AIDS (10). A recurring problem in assessing maternal mortality levels in developing countries has been the source of data- especially in situations where vital registration is deficient, which is the case for most of Africa (11). Many studies have tried to capture maternal mortality data from hospital-based studies. Of course, these studies have numerous biases, and they either over-estimate maternal mortality when hospitals function well and attract most of the complicated obstetric cases, or do not include deaths in communities when the population has little access to health infrastructure (10). In many low-income countries, complications of pregnancy and childbirth are the leading causes of death among women of reproductive age and it has been estimated that 99% of maternal deaths occur in developing countries (12). A study by Graham et al (2004) observed that the maternal mortality gap between well-resourced and resource-constrained settings is due to poverty (13). Based on currently available information, the Safe Motherhood Inter-Agency Group reported that skilled care at delivery should be a central element of any policy or program that aims to reduce maternal deaths (14). Moreover, the WHO reported that there are risk factors for maternal deaths and that these factors operate at several levels. For instance, the low social status of women in low income countries limits their access to economic resources and basic education, thus decreasing their ability to make decisions related to their health (15).

Previous studies have referred to several risk factors for maternal deaths, including advanced maternal age (16), low education levels (17), black and Hispanic ethnicity (18), occupation and number of antenatal care visits (19), marital status, pre-existing medical conditions, and lack of prenatal care(20-22). In most developing countries, data on the quantitative impact of risk factors of maternal deaths are limited. Therefore, the WHO encourages investigations to determine such factors (15), since knowledge about them is essential for the provision of adequate health care delivery in low income countries.

1.3: Justification of the Study

Maternal mortality is one of the best indicators of social, economic, political development and health-care delivery systems of any country (23;24). However, vital registration including registration of maternal deaths is generally lacking in infrastructurally weak areas where health and development problems are most pressing. Health and Socio-Demographic Surveillance System (HDSS) is a response to the lack of a valid information base that can provide high-quality longitudinal data on population dynamics, health, and social change to inform policy and practice (25). In particular for maternal deaths, HDSS provides information on deaths in the community which even a confidential enquiry into maternal deaths lacks.

Information on cause of death is very important and is needed by policy-makers, planners and managers at every level for enacting effective health and development policies and programmes at local, district, provincial, national and international levels (25-27). Programme monitoring and evaluation depend on it. Yet for much of the developing world, where scarce resources need to be carefully allocated, data on cause of death are incomplete or absent (27).

Maternal mortality data in South Africa have limitations. While routinely collected, vital statistics are of poor quality, reflecting marked under-reporting of deaths and classification of

their causes (28-30). Unreliable census data undermine the population base necessary for calculation of rates (29;30). The verbal autopsy (VA) is a tool to determine probable cause of death in areas lacking a vital registration system (27;31-39).

This study seeks to investigate levels and factors associated with maternal deaths in the rural Agincourt sub-district, South Africa between 1993 and 2006.

1.4: Literature Review

1.4.1: Sub-Saharan Africa Perspectives

Almost 99% of maternal mortality occurs in developing countries due to complications of pregnancy or childbirth, resulting in more than 500 000 maternal deaths per year. The main causes of maternal death are haemorrhage, infections and eclampsia, unsafe abortion and obstructed labour, and the majority of these deaths can be prevented by relatively simple measures. The highest incidence of maternal mortality is reported in sub-Saharan Africa. In Africa, maternal mortality ratios (number of maternal deaths per 100,000 live births) are more than 100 times higher than those in the developed world (40).

A number of studies in Sub-Saharan Africa (SSA) found hypertensive disorder (41), haemorrhage complications of pregnancy (41-45), early pregnancy (43), obstructed labour (43;44), anemia (43), hepatitis (43), eclampsia (42;44), jaundice in pregnancy (44) and fever (44), unsafe abortion (41;45), malaria (45), tuberculosis (45), ruptured uterus (41;42;46), sepsis (41;46) and caesarian section (46) as the major causes of maternal deaths. The majority of these deaths occurred in hospitals. Either they were referred late or there was inadequacy with the hospital management of pregnancies. Other causes perceived by the family members were traditional beliefs in witchcraft (45), hospital negligence and case mismanagement (45), inadequate resource availability (45) and employee's poor attitude towards work (45). Estimated

maternal mortality ratios were 424 per 100,000 live births (43) and 2151 per 100,000 live births (42). Thirty-four percent of the women who died did not attend any antenatal care clinic (44). Most of the deaths could have been prevented by prenatal care and prompt treatment to the obstetric emergencies.

Risk factors found to be associated with increased risk of maternal death in SSA were low standards of health care for obstetric referral (43), nulliparity(42), failure to recognize the severity of the problem at the community level (43), poverty (42), delays in starting the decision-making process to seek health care (43), lack of transport (43), sub-standard primary health care (43), illiteracy (42), lack of prenatal care (42), distance to the nearest clinic to receive care (24), increasing maternal age (18;41;47), ethnic and religious affiliation (47), low formal education of the husbands (47), medical procedures (45), low maternal education level (19), inadequate drugs and medical supplies availability (45), health workers' negligence (45), mismanagement (45), delayed referral (45), parity(18;47), shortage of health workers (45), secrecy of abortion and existence of chronic illnesses (45), number of antenatal care visits (21), place of delivery (48) and socio-economic status (48). In developing countries, as well as rural areas, the link between distance to the nearest clinic to receive care and maternal mortality is especially true. Traveling to and from the clinic is very difficult and costly, especially for poor families when time could have been used for growing crops, cooking and caring for their children. Even so, the nearest clinic may not provide decent care because of lack of staff and equipment. Increased attention needs to be given to formal education about maternal death of both men and women. In addition, education of the male decision-makers should be given high priority in the community, especially in matters concerning pregnancy and delivery preparedness, since their decisions greatly affect the survival of the pregnant and delivery women.

Causes of maternal death that were similar in most of the above mentioned studies were ruptured uterus, haemorrhage, unsafe abortion and sepsis; while malaria, tuberculosis, caesarian section and eclampsia differed between the studies.

A study by Garenne and others (2000) identified causes of death with particularly high mortality in the Agincourt sub-district as violent deaths (homicide and suicide), accidents (road traffic accidents and household accidents), certain infectious diseases (HIV/AIDS, tuberculosis, diarrhoea and dysentery), certain chronic diseases (cancer of genital organs, liver cirrhosis, gastrointestinal haemorrhage, maternal mortality, epilepsy, acute rheumatic fever, and pneumoconiosis) and malnutrition of young children (kwashiorkor). Causes of death with lower mortality than expected were primarily respiratory diseases (pneumonia, bronchitis, influenza, lung cancer), other cancers, vaccine preventable diseases (measles, whooping cough, tetanus), and marasmus (49). Garenne and others (2008) in their study estimated the maternal mortality ratio (MMR) for 2001 for South Africa as 542 per 100,000 live births and that of Agincourt between 2000-2002 periods was 305 per 100,000 live births (15/4912) (10). Weiner and others (2007) in their study pointed out problems with the health sector sources of data for maternal mortality, such as confidential enquiry and vital registration, which lead to underreporting. In rural Limpopo province for example, only 78% of maternal deaths were reported in 2002.

Hence, HDSS, which collects household-level data on all deaths and births in a defined population are able to identify maternal deaths that occur in the community which the health facilities are unable to capture. A review of maternal deaths that occurred in the Agincourt HDSS field site between 2000 and 2005 indicates that 6 out of the 26 maternal deaths occurred outside of the health system and this might have been missed by the notification system. These 6 deaths

could have been undetected and undocumented but through the verbal autopsy adopted by the HDSS, they were identified and documented (50).

1.5: Study Question

What are the levels, causes and factors associated with maternal deaths for pregnant women aged 15-49 years in the Agincourt sub-district during the period 1993 to 2006?

1.6: Aim

To investigate the levels, causes and factors associated with maternal mortality in the rural Agincourt sub-district of Mpumalanga Province between 1993 and 2006.

1.7: Specific Objectives

1. Establish the maternal mortality ratio and trend over the period 1993-2006 in the Agincourt sub-district.
2. Describe the main causes of death of women of reproductive age (15-49years)
3. Identify socio-demographic factors associated with maternal death among rural pregnant women 15-49 years

CHAPTER TWO: MATERIALS AND METHODS

This chapter describes the study area, the study design, data source, study population, the study sample, Measurement, data management, analysis plan and ethical considerations.

2.1: Demographic Characteristics of Study Area

The Agincourt HDSS study site is situated in the Bushbuckridge Local Municipality of Ehlanzeni district in the Mpumalanga province of South Africa, close to the eastern border with Mozambique. A third of the study population is of Mozambique origin, many having entered the country as refugees in the early to mid-1980s (25). The site covers 402 km², having 21 villages and has a population of about 70,000 people with a total of 11,700 households (25). The average number of household members is 4 persons per household. Its inhabitants are predominantly Tsonga speaking. The major religion in the study site is Christianity but there are a lot of traditional religious believers. Roads are largely gravel with minibus-taxis the predominant form of transport. All villages have a primary school and most have high schools. There is high unemployment and that contributes to temporary labour migration of men and women.

One private and one public health centre and five satellite clinics are located within the site, with three district hospitals between 25 and 60 km away. Most people access healthcare from public and private health professionals and traditional and faith healers (25). The site is based in Mpumalanga province, and borders the Limpopo province. Estimates of HIV seroprevalence, based on testing of pregnant women at antenatal clinics in the two provinces indicate an increase for the area from 1.7% in 1992 to 25% in 2003 (average for Mpumalanga and Limpopo Provinces) (25).

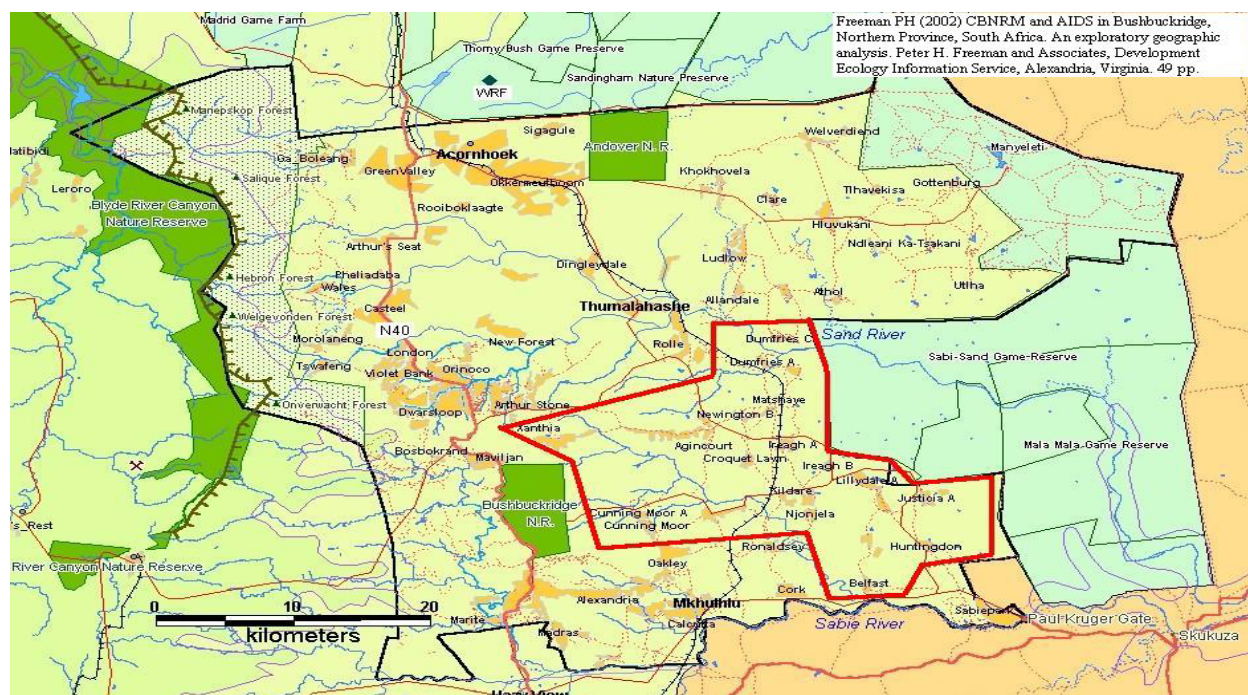


Figure 1: Map showing Bushbuckridge district where Agincourt study site is located (Source: Agincourt Health and Population Unit, Acornhoek)

Important causes of death other than HIV/AIDS are acute diarrhoeal, malnutrition, and accidents in children, and non-communicable diseases (cardiovascular disease in particular), accidents, and violence in adults (25).

2.2: Agincourt Health and Socio-Demographic Surveillance Systems

Health and Socio-Demographic Surveillance Systems (HDSSs) provide important information in situations where routine health information is incomplete or absent, particularly in developing countries. HDSSs rely on regular community-based surveillance as a means of vital event registration, among a sufficient population base to draw meaningful conclusions about rates and trends in relatively rare events such as maternal death. Enquiries into specific health problems can also then use this framework to quantify particular issues or evaluate interventions. The HDSS approach is useful in characterizing populations at the community level over a period of time, providing important information for health planning and intervention (51). In Agincourt

HDSS Site, demographic and health information is collected every year between August and November, and it involves update of all registered households and individuals in 21 villages. Data collected includes reports of all births, deaths and moves between households and in and out of the area.

2.3: Role of Verbal Autopsy Technique

The verbal autopsy technique provides population-based inquiries with an established and validated method for classifying probable causes of death (3;3;27;31). It is an epidemiological tool that is widely used to assign causes of death by interviewing persons who have lost their relatives and where such relatives were not under medical supervision at the time of death (27). Agincourt HDSS utilizes verbal autopsy to provide diagnosis of probable causes of death that occur outside the hospitals. In the Agincourt sub-district, all notified deaths of both registered and non-registered household members are followed up by a verbal autopsy interview. Each recorded death is subjected to a verbal autopsy in which trained fieldworkers interview the closest caregiver of the deceased in their mother tongue. The questionnaire is designed to have several parts, the most important part is the open section where the respondents (person most closely associated with the deceased during the terminal stage of the illness) describe all symptoms and signs preceding death in his/her own words. There are series of questions, which are asked for the purpose of clarifying the information received. Thereafter, two clinicians, blinded to each other's assessment and diagnosis, review the information and assign a diagnosis for each probable cause of death, if same diagnosis was reached by the clinicians. Where there is no agreement between them, a third clinician, blind to their assessment, makes a further independent assessment. If two of the three diagnoses correspond, the clinicians discuss the case and if consensus is achieved the diagnosis is accepted, otherwise the cause of death was

described as undetermined. As far as possible, a main cause of death, immediate cause of death and contributory causes of death are assigned. Deaths that occurred with field workers failing to locate close relatives who were available at the time of the death are classified as ‘non-respondent (27). These deaths therefore have unknown causes.

2.4: Study Population

The study population comprised all women who are resident in the Agincourt HDSS site and are 15-49 years of age as at January 1993-December 2006 with at least one valid pregnancy episode (by recorded birth outcome) or a maternal death.

2.5: Study Design

A retrospective cohort study was employed using longitudinal data collected over fourteen years. It was an open cohort because anyone who becomes pregnant and lives in the geographically defined area during the study period is captured into the database and hence becomes a participant of the study.

2.6: Inclusion and Exclusion Criteria

Pregnant women who were between the ages of 15-49 years as in 1993-2006 and were resident in the study site, as well as pregnant women whose deaths and live births were recorded by the Agincourt HDSS were included in the study. Pregnant women who were above 50 years or younger than 15 years of age were excluded. A total of 25,061 pregnant women met these criteria and were included in the study.

2.7: Data Sources

Secondary data were obtained from the Agincourt HDSS. Verbal autopsies (VAs) on all deaths recorded over the 14-year period 1993 to 2006 in a population of about 70,000 people were assessed. Individual data on each study participant was obtained from the Agincourt HDSS database.

2.8: Measurement

2.8.1: Explanatory Variable

Explanatory variables include: maternal characteristics (mother's age, nationality, education status, union status, delivery place, delivery complication, antenatal care visits, antenatal clinic and parity), household characteristics (household head gender, nationality and Socio Economic Status (SES)) and distance to the nearest clinic to receive care.

Education status indicates the highest level of education attained by an individual at time of observation. Levels of education were grouped into two categories: primary level (individuals with basic and up to primary education), secondary education and above (individuals with at least incomplete as well as complete secondary education). Mothers age in years was categorised into five groups: 15-19, 20-24, 25-29, 30-39 and 40-49. Parity was grouped into four categories: 1, 2 3 and 4 and above. Nationality indicates the individual's country of origin: South Africa, Mozambican or Others. Antenatal clinic was grouped into two categories: "Yes" indicates mother attended antenatal while pregnant and "No" indicates mother did not attend antenatal clinic while pregnant. Antenatal care visits indicates the number of times mother visited ANC while pregnant. It was grouped into three categories: "0" indicates no antenatal care visit while pregnant, "1-4" indicates mother attended at most four times and "5 and above" indicates mother attended at least 5 times. Delivery attendant

indicates who, if anyone, attended the delivery and it was grouped into four categories: Nobody (mother delivered without any assistance), skilled personnel (doctors and nurses), unskilled personnel (assistance from community member, family member and other) and unknown. Delivery complication indicates whether there was a complication with the delivery. Delivery complication was grouped into three categories: None (no complication with the delivery), caesarian section and other (caesarian section was done and others with minor complication) and Unknown. Delivery place indicates the place where the baby was delivered and was grouped into two categories: Health facility (indicates babies were delivered at hospitals, clinic and health centre) and Outside health facility (comprises of babies delivered at home and other places apart from health facility).

The household SES was generated from a household assets survey, which was conducted as a special module in 2005. In the household assets survey, field workers administered questionnaires in every household which included questions on type of dwelling; water and sanitation facilities; possession of livestock, bicycle, radio among other assets. The household SES was then determined by combining household assests using weights and giving an absolute score from 1(lowest), 2(low), 3(middle), 4(high) and 5(highest). Household head nationality indicates the individual's country of origin: South Africa, Mozambican or Others . Gender of household head was male and female.

2.8.2: Outcome Variables

The outcome variable was maternal death. Maternal mortality ratio was measured as the number of maternal deaths per 100 000 live births during that year. Within the same period, pregnant women who survived during pregnancy and delivery were measured as well. Maternal deaths from 1993 to 2006 were extracted from the death file of the Agincourt HDSS.

2.9: Data Management

2.9.1 Data Extraction Processing

The original data for this study was stored in Microsoft Structured Query Language (SQL) Server database system. The data extraction was done using Microsoft SQL server 2005. The data were stored in different tables; household membership table, individual table, socio-economic table, death table, pregnancy table, maternity history table and household head table. All these tables were linked through a unique identification code/number which ensured that individuals were linked across all the tables to their respective correct information. The data needed for the study was then drawn from these different tables where they were stored using MS SQL 2005 and later exported into stata version 10 for cleaning and analysis.

2.9.2: Data Cleaning and Merging

Stata version 10.0 was used for data handling, cleaning and statistical analysis. Data cleaning involved checking the quality of the data for missing and erroneous values. Erroneous values in the data were assigned as missing values. All these checks were guided by the original questionnaires used in collecting the different information. Three different datasets in Stata were used for this study including mortality, pregnancy outcome and birth datasets.

Pregnancy outcome and mortality datasets were merged first before merging with the birth dataset to produce a single master dataset used for the analysis. A binary outcome was defined for mortality and it was coded “1” for those mothers who died and “0” for those who survived (or were alive). Normality was assessed both graphically (using histogram and box and whisker plots) and statistically (using the Shapiro-Wilk test).

2.10: Data Analysis

2.10.1: Descriptive Statistics

A frequency table with number and percentage of all participants, maternal death and mother's who survived (alive) in each demographic variable was drawn (Table 1). Maternal mortality ratio was estimated as the number of maternal deaths per 100,000 live births. The overall maternal mortality ratios for each year from 1993 to 2006 were generated and the significance in the mortality trend was tested for. Graphs showing the trends in MMR, MMR by mother's nationality, MMR by age group and parity and MMR by age group and SES were drawn.

Using verbal autopsies, causes of deaths were identified and classified using the International Classification of Diseases 10 (ICD 10). Causes of death of women of reproductive age were classified into communicable, maternal and birth, non-communicable and violence and accident. Further analysis grouped causes of maternal deaths into obstetric and non-obstetric causes. Obstetric deaths were defined as maternal deaths resulting from obstetric complications of pregnancy, delivery or their management. Non-obstetric deaths were defined as maternal deaths resulting from previously existing disease or diseases that developed during pregnancy, delivery or puerperium.

2.10.2: Analytic Statistics

Logistic regression models were used in both univariate and multivariate analysis in assessing the association between socio-demographic characteristic and maternal death. Two models were fitted. Univariate analysis was first performed and crude odds ratios for the association of these variables with maternal death responses noted. This univariate model was to assess which variables independently predict maternal mortality in order to be included in the multivariate

model. Factors significant at 10% level in the univariate model were included in the final multivariate logistic model. Multivariate model was built where all the independently predictive variables were combined to adjust for each other and also interaction issues were assessed for. P values were calculated to test for statistical significance at the 5% level. Association between socio-demographic factors and maternal death was determined using univariate and multivariate logistic regression (Table 11).

The assumption of linearity in the logit scale was also assessed and the Hosmer-Lemeshow goodness of fit test was used for model prediction. Also the sensitivity of the model was obtained and the receiver operator characteristic (ROC) curve for the logistic regression model was plotted so as to calculate the area under the curve and assess the functionality of the model.

2.11: Ethical Considerations

Ethical approval with certificate reference number (M 090950) for the study was granted by the University of the Witwatersrand's Ethics Committee for Research on Human Subjects [Medical]. Ethical clearance certificate of the original study [protocol number (M 960720)] from which the secondary data (M 090950) was obtained for this study is attached as appendix to this research report. In addition, a data user agreement was signed between the investigator and the Agincourt HDSS site. The research report conformed to the ethical guidelines of the primary research project whose data were used in this analysis. The dataset used for this research report did not contain any information that would allow the investigator or anyone else to identify an individual respondent (it is anonymous), and the investigator only saw an internal identification number/code that could translate into information that would allow him to identify an individual respondent.

CHAPTER THREE: RESULTS

This chapter consists of two parts, descriptive and inferential analysis of the data. The descriptive analysis focuses on the socio-demographic characteristics of women aged 15-49 years who have been pregnant at least once during the period 1993 and 2006. It uses tabulation as well as graphical representations. The inferential analysis involves univariate and multivariate logistic regression to investigate the associations of variables of key importance. The chi-square test was used to compare the statistical significance of the difference observed among the various categories of variables of interest.

3.1: Socio-Demographic Characteristics of the Study Participants

Table 1 shows characteristics of the total cohort, 25,061 women who were pregnant, for the fourteen year period. The age distribution of the participants ranged between 15 and 49 years, with a mean of 28.2 years and a standard deviation of 7.4 years. More than 55% of the women were aged 25-39 years, and less than 7% aged 40-49 years.

Over 60% of women were South African and almost 40 % were of Mozambican origin.

On education, 18% of women had no formal education whilst 48% had completed secondary school as their highest level of education, and less than 5% had tertiary education. The proportion of women who had received no education increased with age.

On marital status, 71% of women were currently in a union. Unions comprised women who were married, in informal union and those who had married again. Only 29% were not in union, i.e widowed, divorced or separated from their husbands. About 59% of women's records were classified as missing, unknown or no response.

Over half of women (52.3%) were living in the lowest levels of socio-economic status (Table 1).

Table 1: Background characteristics of pregnant women over 14-year period in Agincourt sub-district, 1993-2006

Factors	Maternal Death	Alive	Overall
Cohort size: 25,061			
Dead			
Alive (Reference category)	-	24,991	24,991
Died	70	-	70
Maternal age at death			
Mean age in years (SD)	29.82 (6.59)	28.09 (7.44)	28.23 (7.38)
15-24	18 (27.71)	300 (39.42)	318 (38.27)
25-39	45 (64.29)	413 (54.27)	458 (55.11)
40-49	7 (10.0)	48 (6.31)	55 (6.12)
Parity			
1	40 (57.14)	18,016 (72.09)	18,056 (72.05)
2	25 (35.71)	5,063 (20.26)	5,088 (20.30)
3	2 (2.86)	1,415 (5.66)	1,417 (5.65)
4	2(2.86)	397 (1.59)	399 (1.59)
5	1 (1.43)	84 (0.34)	85 (0.34)
6	-	16 (0.06)	16 (0.06)
Mother's education			
No education	13 (18.57)	4,462 (18)	4,475 (18)
Primary	22 (31.43)	7,184 (28.98)	7,206 (28.99)
Secondary	30 (42.86)	11,993 (48.38)	12,023 (48.36)
Tertiary	5 (7.14)	1,151 (4.64)	1,156 (4.65)
Marital Status			
Not in Union	9 (100)	2,943 (28.67)	2,952 (28.74)
Currently in Union	-	7,321 (71.33)	7,321 (71.26)
Mother's nationality			
South African	46 (65.71)	16,100 (64.50)	16,146 (64.50)
Mozambican	24 (34.29)	8,854 (35.47)	8,878 (35.47)
Other	-	9 (0.04)	9 (0.04)
Socio-economic status (SES)			
Lowest	25 (37.88)	5,248 (23.08)	5,273 (23.12)
Low	10 (15.15)	6,648 (29.23)	6,658 (29.19)
Middle	13 (19.70)	3,664 (16.11)	3,677 (16.12)
High	12 (18.18)	3,118 (13.71)	3,130 (13.72)
Highest	6 (9.09)	4,065 (17.87)	4,071 (17.85)
Antenatal clinic			
No	3 (8.11)	505 (2.10)	508 (2.11)
Yes	30 (81.08)	23,278 (97)	23,308 (96.98)
Unknown	4 (10.81)	214 (0.89)	218 (0.91)
Delivery attendant			
No body	1 (1.43)	702 (2.81)	703 (2.81)
Unskilled Personnel	12 (17.14)	4,040 (16.17)	4,052 (16.17)
Skilled Personnel	22(31.43)	17,391 (69.59)	17,413 (69.48)
Unknown	35 (50)	2,858 (11.44)	2,893 (11.54)
Place of delivery			
Health facility	23 (63.89)	18,728 (78.57)	18,751 (78.55)
Outside Health facility	13 (36.11)	5,107 (2.43)	5,120 (21.45)

Complication			
None	17 (50)	14,623 (87.62)	14,640 (87.54)
Caesarean section/Other	13 (38.24)	1,627 (9.75)	1,640 (9.81)
Unknown	4(11.76)	439 (2.63)	443 (2.65)
Outcome of pregnancy			
Abortion	1 (2.70)	184 (0.74)	185 (0.75)
Live birth	35 (94.59)	24,326 (97.34)	24,361 (97.33)
Still birth	1 (2.70)	286 (1.14)	287 (1.15)
Unknown	-	195 (0.78)	195 (0.78)
Household head nationality			
South Africa	45 (64.29)	15,432 (61.80)	15,477 (61.81)
Mozambican	25 (35.71)	9,531 (38.17)	9,556 (38.16)
Other	-	7 (0.03)	7 (0.03)
Household head Gender			
Female	23 (32.86)	9,165 (36.70)	9,188 (36.69)
Male	47 (67.14)	15,809 (63.30)	15,856 (63.31)

Age ranges from 15 to 49 years (median age: 28)

Just under three quarters of women (72%) had only one delivery whilst about 2% of women had four or more deliveries. Parity ranged between 1 and 6.

Place of delivery

78% of women delivered at a health facility and of these, 69% had assistance during delivery by skilled personnel including doctors and nurses. Only about 3% delivered without any assistance, and 16% had assistance from unskilled personnel such as community and family members.

About 88% of women had no complications during delivery and about 10% had a caesarian section. About 97% of the women attended antenatal clinic during pregnancy.

Birth outcomes

97% of these pregnancies resulted in live births, 2% constituted pregnancies that ended with abortion and stillborn fetuses and about 1% of outcome was unknown.

About 62% of household heads were South Africans and 63% were male.

3.2: Trends in Maternal Mortality Ratio and Rate

During the study period, 70 maternal deaths were identified (Table 2). 25, 061 women gave birth to 24,361 live children, yielding a maternal mortality ratio of 287/100,000 live births.

Maternal mortality ratio was estimated annually to establish the trend across the study period. Both the number of maternal deaths and deaths of women of reproductive age increased across the period. No maternal death was recorded in 1995. Total live dropped markedly throughout the entire period.

An analysis of maternal mortality between 1993 and 2006 showed an initial decrease in maternal mortality between 1993 and 1997 followed by a general increase in maternal mortality from 1998 onwards (Figure 2). The trend test shows a statistically significant slope with a p-value=0.008 across the study period. The overall maternal mortality rate was 47/1,000 women of reproduction age (trend test shows a p-value=0.269) which is not statistically significant.

Table 2: Maternal mortality ratio and rate per year across a 14-year period in Agincourt sub-district, 1993-2006

Year of death	No. of maternal deaths (a)	Total live births (b)	No. of deaths of women of reproductive age (c)	MMR (a/b)*100,000	MMRate (a/c)*1,000
1993-1994	7	3821	68	183.2	100.0
1995-1996	2	3343	74	59.8	27.0
1997-1998	4	3424	103	116.8	38.8
1999-2000	9	3659	169	246.0	53.3
2001-2002	7	3201	272	218.7	25.7
2003-2004	15	3157	372	475.1	40.3
2005-2006	26	3756	427	692.2	60.9
Total	70	24,361	1,483	287.3	47.2

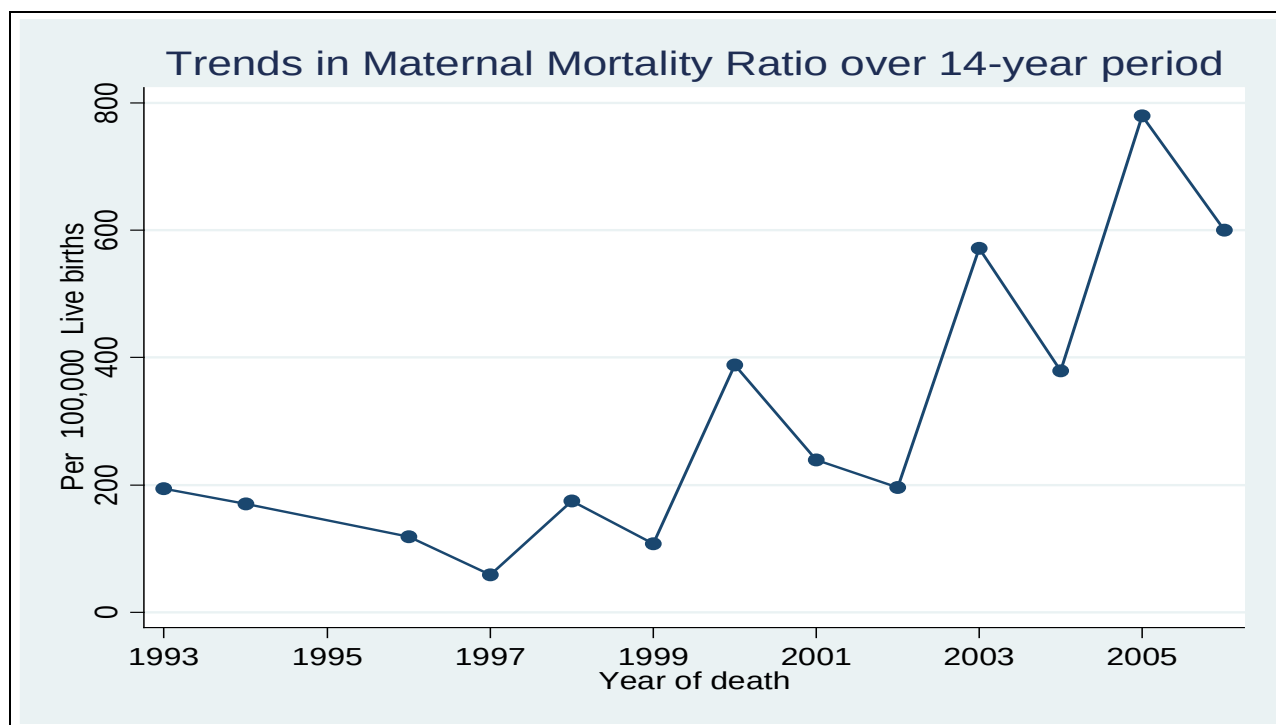


Figure 2: Overall trends of maternal mortality ratios per year across the 14-year period in Agincourt sub-district, 1993-2006

3.3: Trends in Maternal Mortality Ratio by Mother's Nationality

Total live births among South Africans were fairly stable but decreased slightly among women of Mozambican origin. Number of maternal deaths increased across the period for both South Africans and women of Mozambican origins (Table 3).

MMR among South Africans increased from 1993 to 1994 and then fluctuated until 2002 before rising sharply across the remainder of the period. No maternal death was recorded in 1995 and 1997 for South Africans, nor from 1994 to 1996 for women of Mozambican origin. Generally, MMR increased across the period for both South African as well as women of Mozambican origin. The highest peak of MMR for South Africans was in 2005 and that of women of Mozambican origin was in 2000. The MMR for South African women across the 14-year period

was 293 per 100,000 live births and that of women of Mozambican origin was 277 per 100,000 live births.

Table 3: Maternal mortality ratio by mother's nationality in Agincourt sub-district, 1993-2006

Year	Number of live births		Number of maternal deaths		MMR for South African (c/a*100,000)	MMR for Women of Mozambican origin (d/b*100,000)
	South African (a)	Women of Mozambican origin (b)	South African (c)	Women of Mozambican origin (d)		
1993-1994	2,338	1,465	6	1	256.6	68.3
1995-1996	2,061	1,277	2	-	97.0	-
1997-1998	2,200	1,223	2	2	90.9	163.5
1999-2000	2,392	1,266	4	5	167.2	394.9
2001-2002	2,108	1,093	2	5	94.9	457.5
2003-2004	2,102	1,054	11	4	523.3	379.5
2005-2006	2,481	1,273	19	7	765.8	549.9
Total	15,682	8,651	46	24	293.3	277.4

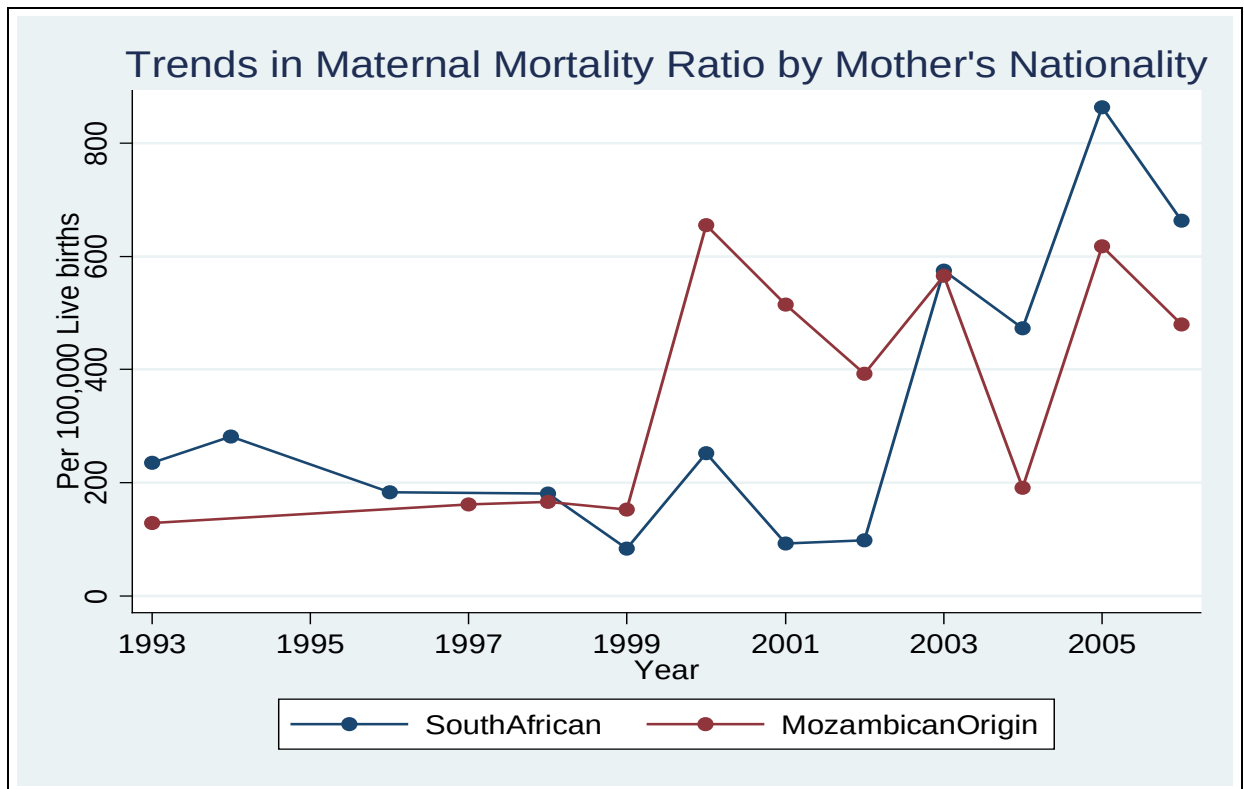


Figure 3: Trends in maternal mortality ratio by mother's nationality in Agincourt sub-district, 1993-2006

3.4: Maternal Mortality by Selected Demographic Characteristics

Maternal mortality exhibits a curvilinear –shaped relationship with maternal age (Table 4).

Maternal mortality ratios (MMRs) increased across the age groups. The number of live births decreased drastically across the age group as age increases. The age group, 15-24 had the highest number of live births with a 25% of maternal death. The highest number of maternal deaths occurred in the age group of 25-39 years with a percentage of 64.

Table 4: Maternal mortality by selected demographic characteristics in Agincourt sub-district, 1993-2006

Variable	No. of live birth	No. of maternal death	MMR	% of Maternal death
Maternal Age				
15-24	12, 288	18	146.5	25.7
25-39	10,911	45	412.4	64.3
40-49	1,162	7	602.4	10
Parity				
1	17,551	40	227.9	57.1
2	4,945	25	505.6	35.7
3	1,374	2	145.6	2.9
4	392	2	510.2	2.9
5	83	1	1,204.8	1.4
6	16	-	-	-
Education				
None	4,353	13	298.6	18.6
Primary	7,008	22	313.9	31.4
Secondary	11,690	30	256.6	42.9
Tertiary	1,123	5	445.2	7.1
SES				
Lowest	5,118	25	488.5	37.9
Low	6,491	10	154.1	15.2
Middle	3,588	13	362.3	19.7
High	3,039	12	394.9	18.2
Higher	3,958	6	151.6	9.09

Women who had one child had both the highest number of live births and maternal deaths. The risk of maternal mortality increased with progressive parity, even though the chi square test revealed that correlation was statistically non-significant (Chi square=0.220). The average education was 1.4 years for women at Agincourt sub-district, with higher maternal mortality ratios among women in those who had tertiary education than those with secondary or no education. The MMR by socio-demographic status declined as women with higher socio-economic status had the lowest MMR as compare with women with the lowest socio-economic status who had the highest MMR.

3.5: Maternal Mortality Ratio by Age Groups and Parity

There is a high correlation between maternal age and parity (Table 5 and Figure 6). Maternal mortality risks increase with increasing age. The most striking example of this is found among primipara women, where the mortality ratio for women aged 25-39 is sixteen times as high as for women aged 15-24 (0.7 vs. 11.2 per 1,000 live births). Multiparous women face substantially higher maternal mortality risks. The results suggested that higher maternal age appears to result in an increased risk of maternal death.

Table 5: Maternal mortality ratio by age group and parity in Agincourt sub-district, 1993-2006

Maternal age	Maternal mortality ratio			
	Parity 1-2	Parity 3-4	Parity 5-6	All parity
15-24	1.3 (12,109)	11.2 (179)	-	1.5 (12,288)
25-39	4.5 (9,465)	0.7 (1,370)	13.2 (76)	4.1 (10,911)
40-49	6.5 (922)	4.6 (217)	- (23)	6.0 (1,162)
All ages	2.9 (22,496)	2.3 (1,766)	10.1 (99)	2.9 (24,361)

Note: Numbers in parentheses are denominators of number of live births. Ratios are per 1,000 live births.

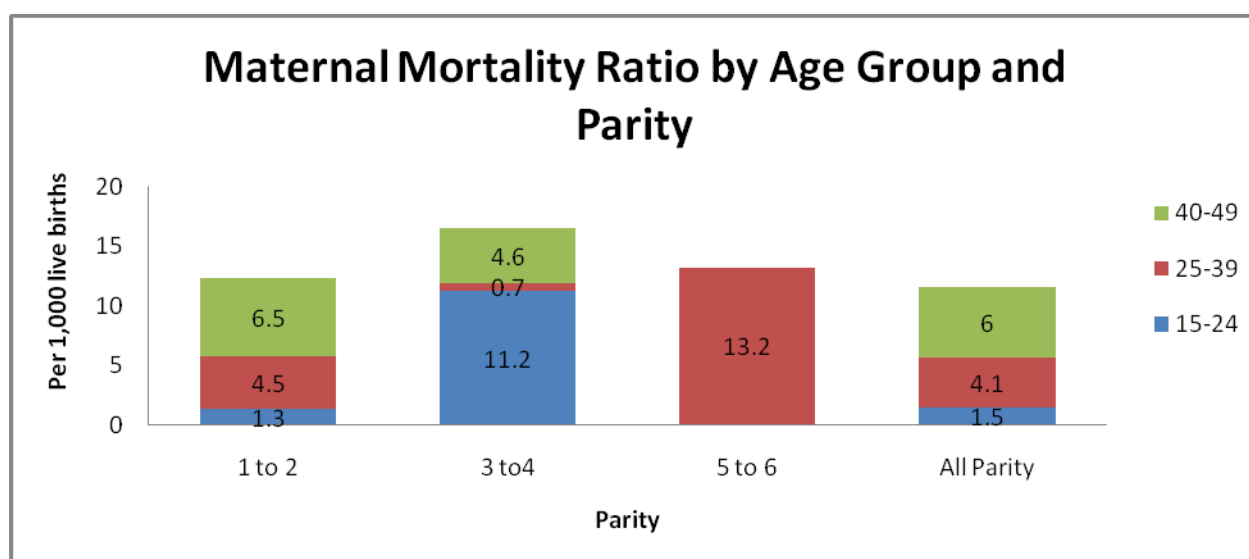


Figure 4: Maternal mortality ratio by age group and parity in Agincourt sub-district, 1993-2006

3.6: Maternal Mortality Ratio by Age Groups and Socio-Economic Status

Maternal mortality ratios of mother's socio-economic status increased within each category across age groups. But within the maternal age group category, maternal mortality ratio decreased across socio-economic status. Total live births also decreased within the socio-economic status levels across age group and again decreased within age group across the socio-economic status categories.

Table 6: Maternal mortality ratio by age group and SES in Agincourt sub-district, 1993-2006

Maternal age	Maternal mortality ratio SES					Total
	Lower	Low	Middle	High	Higher	
15-24	2.3 (2,628)	1.2 (3,326)	2.2 (1,823)	0.6 (1,568)	0.5 (1,929)	1.4 (11,274)
25-39	6.8 (2,198)	1.8 (2,845)	5.0 (1,602)	7.4 (1,350)	2.7 (1,864)	4.4 (9,859)
40-49	13.7 (292)	3.1 (320)	6.1 (163)	8.3 (121)	- (165)	6.6 (1,061)

Note: Numbers in parentheses are denominators of number of live births. Ratios are per 1,000 live births

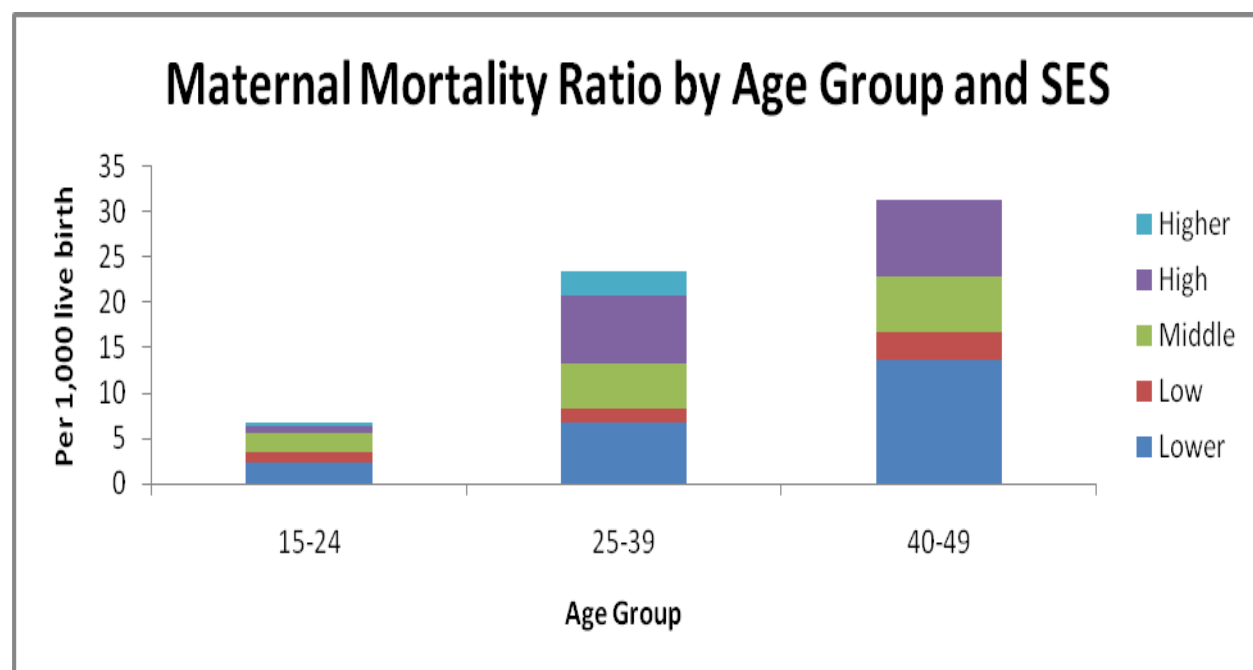


Figure 5: Maternal mortality ratio by age group and socio-economic status in Agincourt sub-district, 1993-2006

3.7: Main Causes of Deaths Among Women of Reproductive Age (15-49) years

During the 14 years, 1,270 deaths of women aged 15 to 49 years were recorded. Out of this, 213 cases were assigned as missing and not applicable. Causes of deaths were grouped into four categories: communicable, maternal and birth, non-communicable and accidents and violence. 77.3% of these deaths were from communicable diseases, 2.8% from maternal and birth, 14.6% were from non-communicable and 5.3% from accident/violence causes (table 7). Each death was classified according to the 20 categories defined by the International Classification of Diseases (ICD) (WHO 1995).

For communicable diseases, HIV/TB and other ill-defined conditions constituted major causes of death. 70.8% of women died from HIV/TB and 19.9% from other ill-defined conditions. Maternal and birth-related causes were mainly unspecified obstetric death (17%) and diarrhea (14.9%). With non-communicable diseases, 40% of deaths were related to malignant conditions of cervical uteri whilst 12% suffered from heart failure. 9.4% of women died from stroke and 6.3% from malignant neoplasm of breast. For accident and violence causes, cases were rated as the third major cause of death in the study site. 38.8% of women died through assaults and 35.8% died due to motor accidents and the rest died due to injuries. Deaths for which no cause could be determined constituted 16.7% of deaths of women of reproductive age (Table 7).

Table 7: Major causes of death of women of reproductive age in Agincourt sub-district, 1993-2006

Causes of death	n	%
Communicable		
HIV/TB	695	71.6
Ill-defined (unspecified)	195	20.1
Malaria	30	3.1
Meningitis	24	2.5
Pneumonia	14	1.4
Septicemia	5	0.5
Other and unspecified infectious diseases	5	0.5
Viral hepatitis	3	0.3
Sub-total	971	65.5

Maternal and birth-related

Unspecified obstetric death	8	17.0
Diarrhoea	7	14.9
Gestational hypertension and Eclampsia	5	10.6
Maternal infectious and parasite disease	5	10.6
Postpartum haemorrhage	4	8.5
Puerperal sepsis	4	8.5
Excessive vomiting in pregnancy	3	6.4
Complications following abortions	3	6.4
Ectopic pregnancy	2	4.3
Caesarean section	1	2.1
Other	5	10.6
Sub-total	47	3.2

Non communicable

Malignant conditions	74	40.0
Cardiovascular	61	33.0
Gastrointestinal	12	6.5
Endocrine	11	5.9
Nervous system	9	4.9
Genitourinary	4	2.2
Other	14	7.6
Subtotal	185	12.5

Accident/violence

Assault	27	40.3
Road traffic accident	24	38.8
Accidental injury	16	23.9
Subtotal	67	4.5
*No data/not applicable	213	14.4
Total	1,483	100

Table 8: Frequency distribution of age-specific mortality of causes of death among women of reproductive age in Agincourt sub-district, 1993-2006

Cause of death	Age group			All ages
	15-24	25-39	40-49	
Communicable	176 (77.9)	565 (79.9)	230 (68.2)	971 (76.5)
Maternal and birth	10 (4.4)	26 (3.7)	11 (3.3)	47 (3.7)
Non communicable	19 (8.4)	86 (12.2)	80 (23.7)	185 (14.6)
Violence/Accident	21 (9.3)	30 (4.2)	16 (4.7)	67 (5.3)
Total	226	707	337	1,270

Note: Percentages are in parentheses

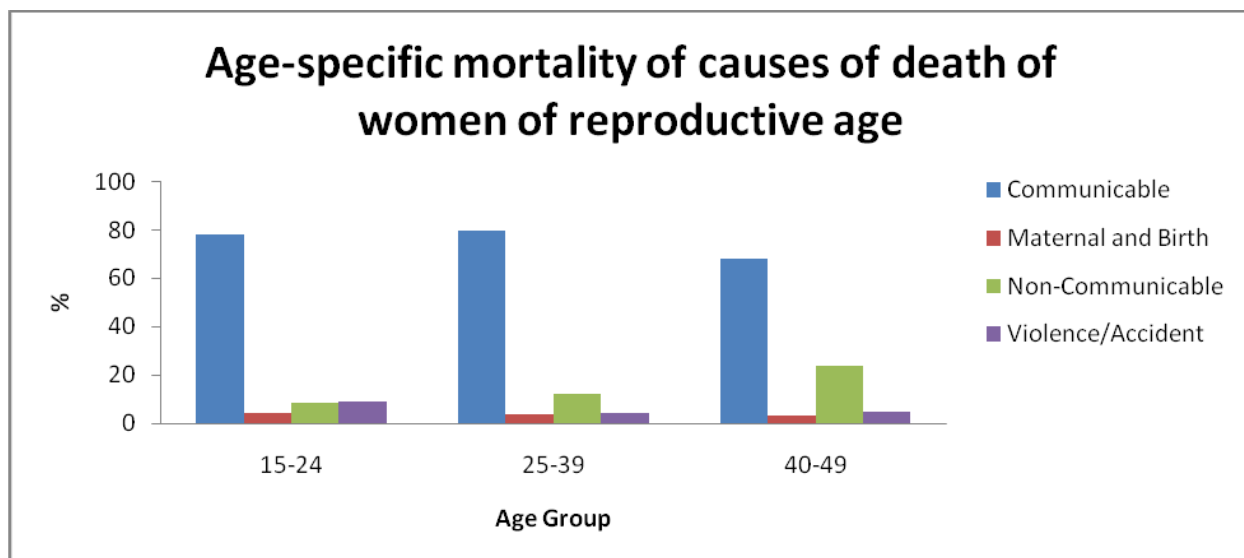


Figure 6: Percent distribution of age-specific mortality of causes of death of women of reproductive age in Agincourt sub-district, 1993-2006

76.5% of these deaths were from communicable diseases, 3.7% from maternal, 14.6% non-communicable, and birth-related and 5.3% accident and violence causes (Table 9). Most of the deaths due to communicable diseases occur across all the age groups. There was an increasing trend in the proportional mortality ratio (PMR) for non-communicable diseases and a decreasing trend for violence/accident.

3.8: Main Causes of Maternal Death in Agincourt Sub-district

Seventy (70) deaths were recorded and analyzed during the study period, accounting for 8.9% of all deaths in women of childbearing age. Thirty-four of the deaths (48.6%) were due to indirect obstetric causes. The leading cause of non-obstetric death was HIV/TB (52.9%). Other ill-defined conditions (17.6%) were the second most common cause of non-obstetric death. Four women (11.8%) died from maternal infectious and parasitic diseases, three women from malaria (8.8%) whilst pneumonia accounted for death of two women (5.9%). A case (2.9%) from malignant neoplasm of other female genital organ led to a death of a woman.

Thirty five maternal deaths (44.3%) were from obstetric causes. Of the 35 deaths, eight deaths were as the result unspecified obstetric causes (25.8%). Five (16.1%) of these women died from gestational hypertension and eclampsia. Four (12.9%) of these women had postpartum haemorrhage and puerperal sepsis and three deaths (9.7%) were due to complication following abortion and excessive vomiting. Two deaths (6.5%) were as the result of ectopic pregnancy. One of these women had complication of the puerperium and caesarian section. 7.1% of the deaths were not assigned any cause and it was regarded as missing data. HIV/AIDS constituted the main cause of maternal death in the Agincourt sub-district (Table 11).

Table 9: Major causes of maternal deaths in Agincourt sub-district, 1993-2006

Causes of death	n	%
<u>Non-obstetric</u>		
HIV/TB	18	52.9
Other ill-defined causes of mortality	6	17.6
Maternal infectious and parasitic diseases	4	11.8
Malaria	3	8.8
Pneumonia	2	5.9
Malignant neoplasm of other female genital organ	1	2.9
Sub-total	34	48.6
<u>Obstetric</u>		
Unspecified obstetric death	8	25.8
Gestational hypertension and Eclampsia	5	16.1
Postpartum haemorrhage	4	12.9
Puerperal sepsis	4	12.9
Excessive vomiting in pregnancy	3	9.7
Complication following abortion	3	9.7
Ectopic pregnancy	2	6.5
Caesarean section	1	2.9
Complications of the puerperium	1	2.9
Sub-total	31	44.3
*Missing	5	7.1
Total	70	100%

3.9: Univariate and Multivariate analysis for maternal deaths

The association between maternal death and other explanatory variables was investigated using logistic regression. Independent models were fitted for each explanatory variable to assess their significance in predicting maternal death. Factors that were significant at 10% level were included in the final multivariate model, with the exception of antenatal clinic attendance. These factors were maternal age at delivery, antenatal care visits, parity, delivery attendant, delivery place, socio-economic status and complication during delivery. As can be seen in Table 11, the multivariate logistic analysis identified maternal age, delivery complication, antenatal care visits and socio-economic status as predictors of maternal death in the study area.

The model showed that women aged 25 to 39 years were found to be at significantly higher risk of maternal death than in the age group 15-24 years. Comparing with women 15-24 years, the risk of maternal death was more than 3 times higher for women in other age group. The findings showed that women were more likely to die with increasing maternal age.

The model also showed that antenatal care visits was associated with the risk of maternal death. Women who attended antenatal care between 1 to 4 visits were 0.12 times less risk of dying compared to women who do not attend antenatal care. Women who attended antenatal care 5 times and above have significantly higher reduction in the likelihood of dying than those who attend 1 to 4 times. Those women were 0.05 times less risk of dying compared to women who do not attend antenatal care visits when pregnant. Hence, women were less likely to die with higher antenatal care visits.

The analysis also indicated that complication during delivery was another important predictor of maternal death. The risk of maternal death was significantly associated with delivery complication. It was observed that women who had caesarian section and other complication

were 10.2 times more likely to die compared to women who had no complication during delivery. Hence, women with complication were more likely to die during delivery.

In addition, this study revealed that there was a significant association between household socio-economic status and maternal death. Women with low socio-economic status were 0.12 times less likely to die compared to women with lowest socio-economic status. Though not significant, women with highest socio-economic status were 0.12 times less likely to die compared to women with lowest socio-economic status.

No interaction issue was significant in the model. The final multivariate model did not violate the assumption of linearity and that the overall “correctly classified” rate was 99.78%. Goodness of fit of the model was assessed using the Hosmer–Lemeshow goodness of fit test. A p-value of 0.8866 for the Hosmer–Lemeshow test suggests the model has a good fit. A receiver operator characteristic (ROC) curve was plotted to assess the area under the curve for this model. The area under the curve for the model was 91.21%.

Table 10: Univariate and Multivariate logistic models for maternal death in Agincourt sub-district, 1993-2006

Variable	Univariate (Unadjusted) Odd ratio (95%CI, P-value)	Multivariate (Adjusted) Odd ratio (95%CI, P-value)
Maternal Age at delivery		
15-24	1	1
25-39	2.80 (1.55, 5.04) 0.001	3.56 (1.37, 9.22) 0.009
40-49	4.09 (1.66, 10.10) 0.002	4.21 (0.87, 20.19) 0.072
Parity		
1	1	1
2	2.22 (1.34, 3.68) 0.002	1.23 (0.57, 2.66) 0.590
3	0.63 (0.15, 2.64) 0.534	-
4+	2.71 (0.83, 8.83) 0.096	0.87 (0.18, 4.20) 0.868
Education		
Primary level	1	
Secondary and above	0.88 (0.54, 1.43) 0.623	
Nationality		
South African	1	
Mozambican	0.94 (0.57, 1.56) 0.837	
Other	-	
Antenatal clinic attendance		
No	1	
Yes	0.21 (0.06, 0.71) 0.012	
Number of antenatal visits		
0	1	1
1-4	0.12 (0.04, 0.34) <0.001	0.12 (0.03, 0.37) <0.001
5+	0.07 (0.02, 0.21) <0.001	0.05 (0.01, 0.19) <0.001
Delivery Attendant		
Nobody	1	1
Unskilled Personnel	2.08 (0.27, 16.07) 0.481	1.93 (0.19, 19.29) 0.573
Skilled Personnel	0.88 (0.11, 6.62) 0.908	0.43 (0.04, 4.60) 0.487
Unknown	8.59 (1.17, 62.87) 0.034	0.26 (0.01, 3.80) 0.328
Place of Delivery		
Health facility	1	1
Outside health facility	2.07 (1.03, 4.13) 0.039	0.88 (0.41, 1.85) 0.739
Complication		
None	1	1
Caesarian Section & Other	6.87 (3.22, 14.62) <0.001	10.21 (4.23, 24.59) <0.001
Unknown	3.93 (2.25, 6.87) <0.001	5.30 (1.47, 19.09) 0.011
Distance from health unit	1.04 (0.89, 1.20) 0.582	
Socio-economic status		
Lowest	1	1
Low	0.31 (0.15, 0.66) 0.002	0.12 (0.02, 0.56) 0.007
Middle	0.74 (0.36, 1.51) 0.418	1.16 (0.47, 2.87) 0.740
High	0.80 (0.40, 1.62) 0.549	0.81 (0.28, 2.30) 0.700
Highest	0.30 (0.12, 0.76) 0.011	0.21 (0.04, 1.04) 0.057
Household Nationality		
South African	1	
Mozambican	0.89 (0.54, 1.47) 0.676	
Other	-	
Household Gender		
Female	1	
Male	1.18 (0.69, 2.00) 0.529	

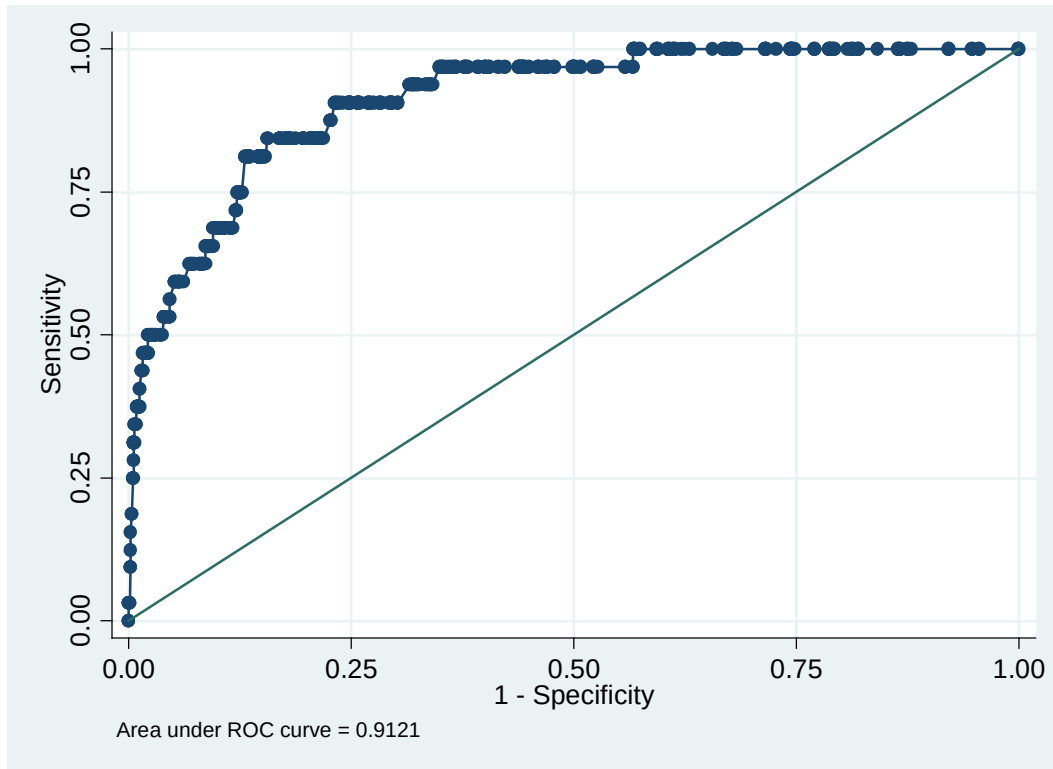


Figure 7: ROC curve for the multivariate logistic model predicting maternal death in Agincourt sub-district, 1993-2006

CHAPTER FOUR: DISCUSSION AND CONCLUSION

This study focused longitudinally on maternal deaths over a 14-year period and examined factors that were associated with maternal mortality in the rural Agincourt sub-district of Mpumalanga province between 1993 and 2006.

4.1: Maternal Mortality Level

Maternal mortality ratio (MMR) is an important health status indicator as well as a critical measure of human development that is internationally comparable. The MMR is defined as the annual number of maternal deaths per 100,000 live births (52). This study found maternal mortality ratio in Agincourt sub-district to be 287 per 100,000 live births over the 14-year study period. Trends in maternal mortality from 1993-2006 have increased in Agincourt sub-district and a trend test showed that the difference was statistically significant. Likely explanations for this increased trend are the HIV/AIDS epidemic and associated infectious diseases such as respiratory tuberculosis (52-54). Also to some extent, poverty can play a role up to 11% of the South Africa population spent below one dollar a day from 1990 to 1999 (53). Poor people have increased risk of exposure to health risks, and at the same have reduced access to both preventive and curative health services or interventions (55).

The most recent estimate of MMR for South Africa in 2003 is 123.7 per 100,000 live births (56). Also, according to UNICEF, the maternal mortality ratio for South Africa was estimated at 170 per 100,000 live births between the period 2000 and 2007 (57). Maternal mortality in the Agincourt sub-district increases with progressive age and parity, confirming other reviews (58-61). This finding agree with reports from the 1998 SADHS that showed that women of 30 years and older or of a parity of 5 or more were at a greater risk of death during pregnancy and the puerperium (54). The increased risk of death during pregnancy and the puerperium for older

women and for those with higher parity are not new findings. Most studies on risk factors for maternal death find the same thing. It is surprising therefore that there is a significant lack of knowledge in South African women over 34 years of any risk to themselves during their third pregnancy. The vast majority (92%) of women over 34 years who were pregnant and interviewed thought they were at no increased risk for their pregnancy. Even women, over 34 years who were not pregnant, but using contraceptives, were also ignorant of their risks (61-63). Women often die of infections not directly related to pregnancy, but that are aggravated in pregnancy. This is particularly so in the era of HIV/AIDS. Deaths in this category are those resulting from HIV/AIDS, pneumonia, tuberculosis, urinary tract infection, meningitis, and malaria. (55).

In 2000, the maternal mortality ratio for sub-Saharan Africa was estimated to be nearly 1000 per 100,000 live births; almost twice that of South Asia, four times as high as in Latin America and the Caribbean, and nearly 50 times higher than in industrialized countries. (64).

4.2: Causes of Deaths

According to UNICEF (2009) state of the world's children report, it was found that women in the world's least developed countries are 300 times more likely to die in childbirth or from pregnancy-related complications than women in developed countries. At the same time, a child born in a developing country is almost 14 times more likely to die during the first month of life than a child born in a developed one. The UNICEF Executive Director, elaborated that in every year, more than half a million women die as a result of pregnancy or childbirth complications, including about 700,000 girls and young women aged 15-19. She went ahead to say that since 1990, complications related to pregnancy and childbirth have killed an estimated 10 million women (57). Maternal mortality still remains a significant issue facing pregnant women, their families and health care professionals in sub-Saharan Africa.

In South Africa, within the period 1997-2002, the number of maternal deaths classified as underlying cause of death was 4,402. When broken down by year of death, it exhibits a gradual rise from 635 in 1997 to 855 in 2002 (56;65).

This study showed that 70 maternal deaths occurred in the study site during the study period. Late deaths that occurred between 42 days and beyond were excluded in the analysis. Nearly half of these seventy deaths, (49%) were due to indirect obstetric causes with HIV/AIDS the most common cause of indirect obstetric death in Agincourt sub-district. This finding is not a surprise as South Africa is a country that is severely affected by HIV/AIDS. The top five causes of death of women of reproductive age in the Agincourt sub-district also showed that HIV/AIDS is the highest across all age groups. This finding has been confirmed by other reviews (10). Other ill-defined conditions was the second leading cause of indirect obstetric death. Other causes were maternal infectious and parasitic diseases, malaria, respiratory tuberculosis, pneumonia and malignant neoplasm of other female genital organs. Eclampsia was the commonest cause of direct obstetric death in Agincourt sub-district, as elsewhere (66). Other causes were postpartum haemorrhage, puerperal sepsis, excessive vomiting during pregnancy, gestational hypertension and complications of the puerperium. Studies elsewhere had similar findings (40;44;46). The 1998 SADHS report showed the 'big five' causes of maternal deaths were complications of hypertensive conditions in pregnancy, AIDS, obstetric haemorrhage, pregnancy related sepsis and pre-existing medical conditions, mainly pre-existing cardiac disease. These five causes of deaths accounted for 73.3% of all the maternal deaths reported in South Africa (54). Maternal deaths are grouped around labour, delivery and the immediate postpartum period, with obstetric haemorrhage being the main medical cause of death and HIV/AIDS is becoming a leading cause of pregnancy-related death where HIV-related mortality rates are high (64;67-69). Even though,

maternal deaths take place in regions where HIV is prevalent, the exact contribution of HIV/AIDS to maternal death is not known. There is growing evidence that countries like South Africa, Malawi and Zimbabwe with a high prevalence of HIV as cause of death (70-72), the AIDS epidemic is thought to have reversed gains in maternal mortality (70;73).

Causes of death in women of reproductive age is also posing a very problem especially considering the top five main causes where AIDS toppled the list, and if effective mechanism is put in place to treat HIV with effective ART, this will lead to reduction in maternal mortality in Agincourt sub-district and other places where HIV tends to be the major cause of death in women of reproductive age.

4.2.1: Communicable and Infectious Causes of Death

Communicable diseases remain a major health issue in sub-Saharan African countries. In this study, over 79.7% of the deaths in women of reproductive age were due to infectious diseases which are potentially preventable. This may relate to low socio-economic status and poverty in this rural setting. South Africa is classified as a middle income country with a GDP per capita average annual growth rate of 1% (1990-2007) (57). However, inequality in personal and household wealth puts most persons living in rural communities into a developing and low-income category where infectious diseases are prevalent as a major cause of morbidity and mortality (52). Other major causes of communicable diseases were ill-defined conditions and respiratory tuberculosis.

4.2.2: Non-Communicable Diseases and Accidents and Violence as Causes of Deaths

This study showed that cancer of the cervix was the most common malignancy causing mortality. Other causes are heart failure and breast cancer. Other studies found non-communicable diseases the most common causes of death of women of reproductive age (66).

Accidents and violence contributes less to death of women of reproductive age in Agincourt sub-district. In South Africa, accidents and injuries are important cause of morbidity and mortality in the general population with traffic accidents as an important cause of death after HIV/AIDS (74).

4.3: Risk Factors Associated with Maternal Deaths

Study findings showed that factors that were positively associated with maternal death include increasing maternal age, complication during delivery, high number of antenatal care visits and low socio-economic status. Other reviews had similar findings (18;21;47;48). The World Health Organization reported that risk factors for maternal deaths operate at several levels. For instance, the social status of women in low income countries limits their access to economic resources and basic education, thus decreasing their ability to make decisions related to their health (17). Another study (24) found increased distance to the nearest clinic to receive care to be associated with increased maternal death. In this study, distance to the nearest clinic was not associated with maternal death possibly because of relatively easy accessibility to health care and better transport system in the Agincourt sub-district. There were other factors that were not associated in this study but were associated in other studies including mother's educational level and marital status. Possible reason why no association was found in this study was the extent of missing data. The majority of women who died in pregnancy/delivery were aged between 20-39 years, which was confirmed by a study in Ghana (44).

4.4: Limitations of the Study

1. Since causes of death were verified using verbal autopsy, the possibility of recall bias from close relatives could affect the quality of verbal autopsy findings.
2. Undercount of mortality deaths in the early period of developing the HDSS recording system could account for the unexpectedly low level of maternal mortality seen in 1993. This was during the period when the HDSS system was being strengthened and structures were being put in place.
3. The rise of the prevalence of HIV/AIDS in this area can lead to limitations in interpretation and analysis of the data. This could cause misclassifications in the determination of causes of death, for example, deaths due to diarrhoeal diseases and tuberculosis could have been attributed to HIV/AIDS. There is no evidence that maternal deaths that were attributed to HIV/AIDS were first tested positive before the death of the woman.
4. Small sample size of maternal deaths did not permit rigorous multivariate analysis.

Conclusion

The number of maternal deaths increased between 1993 and 2006, likewise maternal mortality ratio, but this was due to indirect causes of maternal deaths.

Deaths of women of reproductive age also increased across the period. The causes of death of women of reproductive age across rural settings in South Africa remain largely communicable and infectious diseases. It can be expected that in other regions with high HIV/AIDS prevalence, HIV/AIDS will increasingly be a major cause of death.

Increasing maternal age, more antenatal care visits, complication during delivery and low mother's socio-economic status were associated with increased risk of maternal death in Agincourt HDSS Site.

To reduce maternal mortality greater efforts must be directed towards effective coordination of preventive interventions and treatment. Scaling up preventive programmes such as Highly Anti-Retroviral Therapy (HAART) would be an important step in controlling HIV/AIDS. Also, it is important that government should support demographic surveillance sites because HDSS provide information on maternal deaths in the community-these are missed by Confidential Enquiry into Maternal Deaths which is only facility based. Intensive education should be given to pregnant mothers on the importance of good maternal care and therefore any existing maternal policy should be strengthened.

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APPENDICES

Appendix 1.0



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10 September 2009
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Mr R Nagai
C/O Cecilia Amevor
P.O. Box 35
Dodowa Gar

Dear Mr Nagai

Master of Science in Medicine (Epidemiology & Biostatistics): Approval of Title

We have pleasure in advising that your proposal entitled "*Predictors and factors associated with maternal death in Agincourt, a rural sub-district of Mpumalanga Province*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

A handwritten signature in cursive script, appearing to read 'S Benn'.

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 2.0

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

R14/49 Mr Richard A Nagai

CLEARANCE CERTIFICATE

M090950

PROJECT

Predictors and Factors Associated with
Maternal Death in Agincourt, A Rural Sub-
District of Mpumalanga Province

INVESTIGATORS

Mr Richard A Nagai.

DEPARTMENT

School of Public Health

DATE CONSIDERED

2009/10/02

DECISION OF THE COMMITTEE*

Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE

2009/10/02

CHAIRPERSON


(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr K Kahn

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

.....