ANALYSIS OF CAUSES OF DEATH AT HOME AND IN A PUBLIC HOSPITAL CAPRICORN DISTRICT OFLIMPOPO PROVINCE

by

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DECLARATION

I, Sam Thembelihle Ntuli declare that the work herein submitted as a thesis for Doctor of Medical Science resulted from my own investigation and that it has neither wholly nor partially been presented as a thesis for a degree at the University of Limpopo. Work by other authors who served as sources of information, have dully been acknowledged by references to the authors.

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DEDICATION

I dedicate this thesis to:

- My late father Jerry Simo Ntuli, my brother Thokozani Dunford Ntuli, my wife's father, who has also passed on, Nicolas Mashiya;

- My brother's son Bongani, my younger sisters Nomalanga, Tshadi and Mpho, my elder brother Thulani;

- Mylate mother, Jeannett Tshadinyana Ntuli, who took pride in the achievements of her children, and who taught us that the best gift you can give to a child is education and love;

- The families of those who passed on in the Pietersburg/Mankweng Hospital Complex (PMHC)and Dikgale Health and Demographic Surveillance Site (HDSS);

- My wife Constance, my three children: Thokozile, Masello and Sibusiso for their love, understanding and support throughout my study period.

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ABSTRACT

Objectives

The objectives of the study were to examine the demographic profile and causes of death of people dying in a hospital and community; and to determine mortality rates, specifically age- and gender-specific mortality rates in a community. The study also compared causes of death assigned to hospital records with causes of death obtained from verbal autopsy reports.

Methodology

The data used in this thesis were collected in two phases. The first phase involved a retrospective review of all deaths that occurred in the Pietersburg/Mankweng Hospital Complex from 1st January, 2011 to 31st December, 2012. The second phase involved a community-based study using a verbal autopsyto determine cause of death in Dikgale HDSS for the same period.

Results

A total of 5402 deaths were reported in the hospital and 625 in the community. The majority of deaths in the hospital involved adults in the 15 to 49 year old age group, while in the community more deaths were recorded amongst adults aged 15 to 49 years of age and those in the 65+ year old age group. There were more male deaths in the hospital, while in the community a higher proportion of deaths occurred amongst females.

In children less than1 year old, the cause of death in the hospital was predominantly due to perinatal conditions, particularly preterm birth, low birth weight and birth asphyxia; while in the community, of the 5 deaths in this age group, infectious diseases were recorded as the main cause of death. Amongst children in the 1 to 4 year old age groups causes of hospital deaths were dominated by infectious diseases, injuries and malnutrition; while in the community infectious diseases were the main cause of death.

Stillbirths were noted in the hospital with a stillbirth rate of 29.1/1000 deliveries. In the community no stillbirths were reported. More than half of the stillbirths were caused by unexplained intrauterine foetal causes followed by maternal hypertension in pregnancy and placenta abruption.

For adults in the 15 to 49 year old age groups infectious diseases, such as HIV/AIDS and tuberculosis, were the leading causes of death in both the hospital and in the community. The proportion of deaths due to HIV/AIDS and tuberculosis was significantly greater in the community than in the hospital.

Amongst adults in the 50+year old age group non-communicable diseases, particularly cardiovascular diseases and cancers were the most common causes of death. In this age group, the hospital recorded more cancer deaths than did the community; while the community recorded more cardiovascular deaths than did the hospital.

The overall mortality rate in the community was 8.4 deaths per 1000 person-year, with more deaths occurring amongst males (8.9 deaths per 1000 person-year). The mortality rate was high amongst adults in the 65+ year old age group (48.9 deaths per 1000 person-year).

When comparing cause-specific mortality between hospital cause of death notification forms and cause of death determined by verbal autopsy reviews, the same top five underlying causes of death were observed, namely: cardiovascular diseases, infectious diseases, diabetes mellitus, malignant neoplasms and respiratory infections. The agreement between causes of death reported on cause of death notification forms and cause of death as a result of a verbal autopsywas 48%.

For individual causes, agreement of more than 80% was achieved between cause of death recorded on cause of death notification forms and from verbal autopsy reviews for respiratory infections, diabetes, malignancies and injuries. Infectious diseases (68.5%) and cardiovascular diseases (74.1%) achieved the lowest agreement. In other words, in only 68.5% and 74.1% respectively was the cause of death as recorded on the “cause of death notification” forms the same as the cause of death when reviewed verbally.

Furthermore, 13 deaths were recorded as being due to cardiovascular diseases on the “cause of death notification” forms, however, in only 5 of these cases was the cause of death recorded as the same in the verbal autopsy report. In 21 cases cause of death was attributed to infectious diseases on the cause of death notification form,

while in only 13 of these cases was the cause of death similarly ascribed after verbal autopsy review.

Conclusion

This study showed that the verbal autopsy instrument has the potential to identify causes of death in a population where deaths occur outside of health facilities. Procedures for death certification and coding of underlying causes of death need to be streamlined in order to improve the reliability of registration data. This will be achieved if medical students and trainee specialists are trained in the completion of cause of death notification forms.

Foetal autopsies should be introduced at tertiary hospitals to determine the causes of stillbirths.Antenatal care education for pregnant women should be encouraged because the level of antenatal care has an influence on the health of mothers and their newborns.

The government should continue to focus on improving the socio-economic status of the population, while adequate foetal monitoring by health workers may reduce neonatal deaths resulting from preterm births, low birth weight and birth asphyxia. Innovative injury prevention strategies, interventions to control infectious diseases, cancer screening and lifestyle program may reduce adult mortality.

TABLE OF CONTENTS

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
CCVA	Computer Coded Verbal Autopsy
DHA	Department of Home Affairs
DCH	Department of Community Health
DHSD	Department of Health and Social Development
GBD	Global Burden of Disease
HDSS	Health and Demographic Surveillance Site
HIV	Human Immunodeficiency Virus
ICD-10	International Classification of Diseases
INDEPTH	International Network for the continuous Demographic Evaluation of Populations and Their Health
MRC	Medical Research Centre
MDG	Mellinium Development Goal
NCD	Non-Communicable Diseases
PMHC	Pietersburg/Mankweng Hospital Complex
PPV	Positive Predictive Value
TB	Tuberculosis
VA	Verbal Autopsy
WHO	World Health Organization

PAPERS PREPARED FROM THIS THESIS

The following papers resulted from this project and were used to form part of a pilot study to assess the feasibility and availability of information before the data collection for this study began:

- Ntuli ST, Malangu N. An investigation of the stillbirths at a tertiary hospital in Limpopo province of South Africa. Glob J Health Sci. 2012 Sep 24;4(6):141-7. doi: 10.5539/gjhs.v4n6p141.

- Ntuli ST, Malangu N, Alberts M. Causes of deaths in children under-five years old at a tertiary hospital in Limpopo province of South Africa. Glob J Health Sci. 2013 Feb 15; 5(3):95-100. doi: 10.5539/gjhs.v5n3p95.

- Malangu N, Ntuli ST, Alberts M. Causes of deaths in patients treated at a Tertiary Hospital in Limpopo Province of South Africa: A retrospective study from 2008 to 2010.Accepted for publication by South African Journal of Epidemiology and Infectious diseases

CHAPTER 1: INTRODUCTION

This introductory chapter provides a background to the study, the research question, research hypothesis and the rationale for the study. The purposeand the objectives of the study are also elaborated on in this chapter.

1.1 Background of the study

Consistent and reliable mortality statistics are essential for evaluating the effectiveness of health services and formulating local and global health policies (Lopez et al, 2006; Mathers et al., 2009; Lozano et al., 2012; Stats SA, 2013). Such data also provides a basis for investigating the occurrence of diseases and for identifying the magnitude, pattern and distribution of major disease problems (Mathers and Loncar, 2006; Stevens et al., 2008; Celine, 2013; Yang et al., 2013).

Civil registration systems remain the “gold standard” source of continuous mortality statistics worldwide (Lopez et al., 2006; Lozano et al., 2012; Phillips et al., 2013). However, the chance of a death being registered and the cause of death documented in a civil registration system depends on the socioeconomic status of the community and nation in which that death occurs (Byass, 2006).

Previous studies found that mortality statistics provided to World Health Organization (WHO) by high-income countries are of a higher quality when compared to mortality statistics provided by low-and-middle income countries (Mahapatra et al., 2007; Setel et al., 2007). In many low-and-middle income countries, especially those in

sub-Saharan Africa, cause of death data are inadequate or not readily available (Mahapatra et al., 2007; Setel et al., 2007; Ye et al., 2012, Phillips et al., 2013) for policy-making, public health programs and research (Johns et al., 2013).

Mortality registration and causes of death reporting system has existed for many years in South Africa (Stats SA, 2005). When a death occurs in a health facility the attending doctor or professional nurse issues a death certificate (Pieterse et al., 2009) according to the international standard recommended by the International Classification of Diseases 10th Revision (WHO, 2004a; WHO, 2004b; WHO, 2004c).

When a death occurs at home, the cause of death is certified by an attending doctor, if present. If a doctor or other healthcare professional is not present then the death will be recorded by a traditional headman or funeral undertaker, in which case the medically-determined cause of death is usually not recorded (Pieterse et al., 2009).

Despite recent improvements in the death registration system in South Africa (Joubert et al., 2013; Stats SA, 2013), the quality of cause of death statistics remains deficient and causes of death recorded are often “ill-defined” or “undetermined” and/or misclassified, especially HIV/AIDS related deaths (Burger et al., 2007; Nojilana et al., 2009; Bradshaw et al., 2010; Groenewald et al., 2010; Birnbaum et al., 2011; Stats SA, 2013). Deaths coded to these categories are of little use for decision-making.

Given the lack of reliable vital statistics in South Africa (Pillay-van Wyk et al., 2011; Joubert et al., 2013), there are substantial efforts underway to improve the civil

registration system. However, deaths in remote rural areas often occur at home and are not always recorded (Stats SA, 2013). Thus any survey of hospital records can often misrepresent mortality rates and causes of mortality.

The Verbal Autopsy (VA) method is the best available tool to complement the collection of vital statistics data in settings with weak civil registration systems (Baiden et al., 2007; Garenne and Fauveau, 2007; Kahn et al, 2007; Van Eijk et al., 2008; Herbst et al., 2011; Murray et al., 2011a; Olack et al., 2014).

VA involves interviewing a family member and/or caregiver of the deceased using a structured questionnaire to record signs, symptoms and the sequence of events seen during the illness that preceded death (Fantahum et al, 2006; Soleman et al, 2006). This is followed by a physician's review of the VA or the use of automated computer programs for assigning cause of death from VA contents (Fottrel and Byass, 2010; Lozano et al., 2011a, Lozano et al., 2011b;Flaxman et al., 2011b; James et al., 2011; Murray et al., 2011a; Byass et al., 2012; Desai et al., 2014; Jha, 2014).

Civil registration systems and verbal autopsies present their own challenges. In the case of verbal autopsies diverse practices in the implementation of VA field methodology such as variability of field procedures, questionnaire used, recall period by respondents and different methods in interpreting VA information to determine a probable cause of death present challenges (Garenne and Fauveau, 2006; Soleman et al., 2006; Thatte et al., 2009; Fottrell and Byass, 2010; Dharmaratne et al., 2011).

Civil registration systems, on the other hand, are difficult to establish, expensive to maintain and have problems with accuracy and coding of causes of death (Burger et al., 2007; Nojilana et al., 2009; Bradshaw et al., 2010; Groenewald et al., 2010; Birnbaum et al., 2011; Pillay-van Wyk et al., 2011). Despite their limitations, the two methods are accepted tools that are useful in estimating cause-specific mortality fractions in a large population (Sartorius et al., 2010; Lozano et al., 2012; Narh-Bana et al., 2012; Stats SA, 2013; Olack et al., 2014).

Stillbirths remain the most common adverse outcome of pregnancy, yet are not included in the international health agenda (Bryce et al., 2013). Globally, there were 2.65 million stillbirths in 2008, more than two-thirds (98%) occur in low and middle income countries (Lawn et al., 2011). In South Africa (SA), the national stillbirth rate for the year (2007/2008) was 23.0 per 1000 births, and two districts (i.e.rural and urban) of the Limpopo had a slightly higher rate than the national average (Day et al., 2009).

The Millennium Development Goal 4 (MDG-4) recommended a global reduction of under-5 mortality rate by two-thirds between 1990 and 2015. In South Africa, the under-five mortality rate was 53 per 1000 live births in 2010, which is higher than the international target of 20 per 1000 live births (Statistics South Africa, 2013).

There are many factors that contribute to under-5 mortality. In South Africa, preterm birth and low birth weight, birth asphyxia and infections - primarily pneumonia and sepsis - were the main causes of under-5 mortality (Nannan et al., 2012). Ntuli and co-authors found that prematurity/low birth weight, pneumonia, diarrheal diseases,

birth asphyxia, and severe malnutrition were the top five common causes of under-5 mortality in a tertiary hospital of the Limpopo (Ntuli et al., 2013).

In Limpopo Province, a community-based study reported an increase in mortality rates from 6.8 to 9.9 per 1000 person-years between 1996/1999 and 2004/2007 (Kanjala et al., 2010).The rate was relatively high amongst adults in this rural community; the explanation is multifactorial and could include the growing burden of chronic and lifestyle-related diseases and HIV/AIDS in adults (Malangu et al., 2014).

The statistics on cause of death require careful evaluation if they are to be useful for epidemiological research and health intervention policy or program.Comparison of cause of death reported on death certificates with clinical records or verbal autopsies are usually assessed by using the concepts of sensitivity, specificity or kappa statistics (Rao et al., 2007; Wang et al., 2007; Burger et al., 2012; Misganaw et al., 2012a; Khalili et al., 2012).

A number of studies have reported sensitivity of above 50%and specificity of more than 80% for most of the communicable diseases (Setel et al., 2006; Khademi et al., 2010; Khalili et al., 2012; Misganaw et al., 2012). However, there are studies that found a sensitivity of less than 50% (Wang et al., 2007). For non-communicable diseases, sensitivity and specificity of the verbal autopsy diagnoses was 69% and 78%, respectively (Misganaw et al., 2012). The studies reviewed illustrate the potential of verbal autopsy to provide cost-effective information to guide policy on communicable and non communicable diseases.

The absence of a reliable vital statistics system in South Africa limits the usefulness of measuring the impact of health interventions, particularly at periphery of the healthcare system. An analysis of the burden of disease needs more accurate cause of death data in order to make provision for a relevant health system in rural areas. In order to assist local health teams in planning relevant health systems in remote areas it is important to identify the correct causes of death in any given community.

1.2 Rationale and Problem Statement of the Study

There is a great deal of uncertainty regarding the causes of mortality in the Limpopo Province, a province with a population of more than 5 million people. Causes of mortality can be estimated by combining through information from vital statistics obtained from hospital records and verbal autopsy records of deaths in the community where patients were unattended by competent health professionals, however, this combination method has not been effectively studied in a rural setting. High quality mortality data is critical for the assessment of the health status of a given population and for health policy formulation or modification aimed at bringing about cost efficient and effective health services.

Medical certification of death depends on the availability of a doctor at the time of death. In remote rural areas of South Africa most deaths occur at home (Kahn et al, 2007; Clark et al, 2007; Kanjala et al., 2010), with limited contact between the patient and the health service during the time of illness preceding death (McLarenet al., 2013).

Given this background, an analysis of statistics of registered causes of death in the rural areas of South Africa requires careful evaluation if they are to be useful for epidemiological research and health service planning. Therefore, a community-based study using VA reporting and hospital data was undertaken to compare cause-specific mortality patterns according to the age of the deceased and to compare the cause of death as documented on hospital records with VA report.

1.3 Research Question

Are cause-specific mortality patterns in a public hospital different to those reported in anadjacentcommunity?

1.4 Research Hypothesis

The research hypothesis for this study is that the cause-specific mortality patterns in the hospital are different to adjacent communities.

1.5 Aim and Objectives

1.5.1 Aim

The aim is to determine the cause-specific mortality patterns in a public hospital and nearby community.

Objectives

- To examine the demographic profile of people dying in a hospital and in a community adjacent to that hospital;
- To determine mortality rates, age and gender-specific mortality rates in a community ;
- To determine the leading causes of death in a hospital and community;
- To compare cause of death assigned on the hospital death registration form to the cause obtained froma verbal autopsy report.

1.6 Summary

The introductory chapter explained the background of the study, research question, research hypothesis and the rationale for the study, as well as the aims and objectives of the study. A review of the literature follows in Chapter 2 in which what has already been done in this field of study will be examined.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature, focusing on previous studies relevant to the aims and objectives of this study.

Mortality statistics are widely used epidemiological data for determining the burden of disease in a population and for planning of health services. Globally, civil registration systems are the principal source of mortality data and are dependent on the cause of death reports based on the opinion of a medical doctor (Myer and Eden, 2007; Wetmore, 2007; Pieterse et al., 2009).

Several papers published by Lancet drew attention to the importance of civil registration systems for monitoring global health and its implementation in many countries (Mahapatra et al., 2007; AbouZahr et al., 2007). However, between one-third and two-thirds of the world's annual births and deaths are not registered, especially in low-and-middle income countries (Setel et al., 2007).

The lack of political will and coordination, limited analytical skills and insufficient technical resources in low-and-middle income countries impact negatively on the collection of civil registration data and vital statistics (Carter et al., 2012).

With population ageing and other possible factors, there is steady increase in the proportion of home deaths worldwide, which has negative implicationson the quality of documentation of causes of mortality.

An increasing body of evidence showed a decline in home deaths in the Brussels (Houttekier et al., 2011), England and Wales (Gomes and Higginson, 2008) in 1998-2007 and 1974-2003, respectively. In contrast, data from England shows an increase in home deaths between 2004 and 2010 (Gomes et al., 2012).

A comparison study of the location of deaths in Japan, England, France and USA found a greater proportion of home deaths in these countries (Broad et al., 2013). In Canada, 15% of deaths occur at home in rural settings comparable to 16% in an urban setting (Goodridge et al., 2010). In Singapore, most deaths amongst elderly people occur mainly in hospitals, while 31% die at home (Beng et al., 2009). In the rural areas of China (Yang et al., 2005), most of adult deaths occur at home, while in Brazil, home deaths accounted for 23% of all deaths (Franca et al., 2008).

In sub-Saharan Africa, home deaths is not a new phenomenon, Lazenby and co-authors showed that home deaths in Botswana accounted for 36% of all deaths (Lazenby et al, 2010). According to Stats SA, 30% of deaths in South Africa occurred at home (StatsSA, 2013). The HDSS data in Kenya (van Eijk et al., 2008; Philips-Howard et al., 2012), indicated that more than two-thirds of deaths occurred at home, while in Mpumalanga Province, South Africa, 23% of maternal deaths occurred at home (Weiner et al., 2007).

The reviewed studies show that home deaths are common globally which has an implact on the documentation of causes of death. There are various reasons that contribute to home deaths in high income countries such as patient preferences and improved caregiver support (Gomes and Higginson, 2008; Gomes et al., 2012), while

in low-and-middle income countries home deaths occurred as a result of distance, finance and local culture (Weiner et al., 2007; McLarenet al., 2013).

In high income countries home deaths do not have negative implication on the quality of mortality data, since when a person is in the process of dying or about to die, a family doctor will be called upon to participate in an end-of-life care of the patient (Myer and Eden, 2007; Wetmore, 2007). However, in low-and-middle income countries a large number of home deaths are recorded by an attending doctor if present, by the traditional headmen or funeral undertakers (Franca et al., 2008; Pieterse et al., 2009), which impact negatively on the quality of data.

2.2 Verbal Autopsy

In a situation where medical certification of death is limited and/or death occurs without medical attention, the World Health Organization (WHO) has urged the use of the verbal autopsy method to ascertain cause of death (Baiden et al., 2007).VA is an indirect method of determining cause of death based on an interview with a family member and/or caretakers of a deceased individual. The interview is carried out by a trained field worker using a structured questionnaire that records the sign, symptoms and sequence of events prior to death (Fantahum et al, 2006; Soleman et al, 2006). The collected information is used to establish the most probable cause of death.

There are two approaches for analysing the verbal autopsy questionnaire contents in order to reach a probable cause of death. The first method is the physician review, which uses two trained physicians who independently apply their professional knowledge and experienceto the verbal autopsy questionnaire to assign a probable

underlying cause of death in each case. The adjudication is done by reaching consensus between the two physicians or through an assessment by a third doctor. The physician verbal autopsy review is widely used; however, it has been shown to have the following limitations, inter and intra observer differences in coding and it is relatively costly and time consuming when dealing with a large number of questionnaires to be assessed (Fottrel and Byass, 2010).

To overcome these problems there has been an interest in using automated computer programs for interpreting VA data, which has been reported to be cheaper, faster and more consistent over time (Fottrel and Byass, 2010). The main purpose of these automated computer programs is the large-scale profiling of causes of death in a population for the purposes of evaluation of health programs and planning health interventions (Garenne, 2014).

There are various automated computer programs which can be either algorithmic or probabilistic, namely: (1) InterVA which is developed by UmeåUniversity (Byass et al., 2012), (2) Tariff (James et al., 2011) and (3) Random Forest methods developed by Population Health Metrics Research Consortium (Flaxman et al., 2011a) and (4) King-Lu method developed by Gary King and Ying Lu (King and Lu, 2008).

These methods have been validated against physician reviews and against each other (Lozano et al., 2011a, Flaxman et al., 2011a; James et al., 2011; Murray et al., 2011a; Desai et al., 2014; Jha, 2014). Leitao and co-authors concluded that none of the four automated computer program is superior to the other (Leitao et al., 2014).

The InterVA program has been available in the public domain for many years (Chandramohan et al., 1994; Lozano et al., 2011a). The program applies a Bayesian probability method which requires the extraction of a defined set of indicators (signs, symptoms, history, and circumstances) as the input to the model, which can be derived from both the open narrative and closed questions in the VA interview. Running the model on these indicators will then generate a database with up to three likely causes of death for each case, together with respective probabilities.

Byass and co-authors conducted a study in a rural community in Vietnam with the aim to validate the InterVA model. The findings of this study showed that the probability approach (InterVA) has great potential for VA interpretation (Byass et al, 2003). Similar studies were conducted in different parts of the world to show the validity of the model (Byass et al, 2006; Fantahum et al, 2006).

The UmeåUniversity designed a new public-domain probabilistic model (InterVA-3) for interpreting VA data which can be used for determining cause of death both in research settings and for routine registration of the cause of death (Byass et al., 2012). This modified InterVA-3 model has been shown to provide plausible results for stillbirths and newborn deaths when broadly comparable to a physician's review but with the added advantage of internal consistency (Vergnano et al., 2011). Internal consistency reliability is a measure of how well the items on the test measure the same construct or idea.

2.3 Gender and Age at Death

Knowledge about the distribution of death by age and gender can effectively inform health policy makers about the risk factors associated with diseases that contribute to deaths in a population. Since mortality risks vary by age and gender, it is important to understand the leading causes of death by age and gender to plan intervention strategies.

Globally, life expectancy for both males and females increased from 65 years in 1990 to 71 years in 2013. The improvement in life expectancy has shown a reduction in cardiovascular disease and cancer deaths in high income countries and reduction in child deaths from diarrhea, lower respiratory tract infections, and neonatal causes in low-and-middle income regions (Naghavi et al., 2015).

Important gaps exist in this global burden of disease study (2013) such as the quality of the underlying medical certification of causes of death and verbal autopsy, country-specific cause of death data show national variation in coding practices, uncertainty from garbade code is not incorporated for ill-defined causes of death and the clinical pathways to deaths such as heart failure, sepsis, fungal infection, and acute kidney injury were excluded (Naghavi et al., 2015).

In high income countries such as USA (Heron. 2012) and England and Wales (McLaren, 2011) a greater proportion of death occurred amongst females. In contrast, national reports from Stats SA showed that in South Africa (SA) there were slight more male than female deaths (Stats SA, 2013). In SA, male deaths have always been exceptionally large (Timaeus, 1999).

In industrialized countries, the socio-economic status is strongly associated with high mortality (Stringhini et al., 2010), and as more women enter and remain in the labor force, a large number are now involved in unhealthly behaviours such as smoking, alcohol use, unhealthy diet and physical inactivity which have negative impact on their health (Stringhini et al., 2011).

Similarly hospital-based studies in low-and-middle countries have shown a higher proportion of male deaths when compared to female deaths (Tariq et al., 2009; Adeolu et al., 2010; lliyasu et al., 2010; Preacely et al., 2012; Aziz et al., 2013; Ayoade et al., 2013; Abejew et al., 2014).

Similar findings of greater proportion of male deaths were reported in community-based studies in Kenya (Negin et al., 2010), India (Palanivel et al., 2013) and South Africa (Cook et al., 2008; Kahn et al., 2007; Mashego et al., 2007; Sartorius et al., 2010; Kanjala et al., 2010). In contrast, a study which explored deaths among young adults aged between 15 and 24 years of age in a rural community in Kenya found that females accounted for 67.3% of deaths (Phillips-Howard et al. 2012).

Unwillingness of men to use health services and report health problems together with aggressive behaviour (Roger et al., 2010) may account for some of the burden of male deaths (Signh-Manoux et al., 2008) in low-and-middle income countries.

Regarding age, the World Health Organization (WHO) found that globally most deaths (43%) occurred at age 70 years and older (Wang et al., 2012). In the USA

70% or more deaths were adults in the age group 65 years and above (Heron, 2012). In South Africa, most deaths were adults aged between 15 and 49 years old (Stats SA, 2013, Stats SA, 2014).

A hospital-based study in Nigeria indicated that two-thirds of deaths were young adults aged between 15 and 49 years old (Preacely et al., 2012). A study by Einterz and Bates (2011) in a district hospital in Cameroon indicated that the majority of all deaths (63.9%) involved children under-15 years old (Einterz and Bates, 2011).

A community-based study in India reported that more than half (59%) of deaths occurred in people aged 60 years and above（Palanivel et al., 2013). In rural communities in Kenya, more than two-thirdsof deaths occurred among adult's under-65 years old (van Eijk et al., 2008) and those above 65 years of age (Negin et al., 2010).

In South Africa, HDSS data shows high mortality rates in children under-5 years old (Kahn et al., 2007), in the age group 15 to 49 years of age (Kahn et al., 2007; Mashego et al., 2007; Sartorius et al., 2010; Kanjala et al., 2010; Herbst et al., 2011) and in those aged 65 and above (Cook et al., 2008; Kanjala et al., 2010; Herbst et al., 2011).

The high death rates among adolescents and young adults could be due to several factors, including behavioural risk factors such as unprotected sexual practice, which increases the chances of acquiring HIV infection and alcohol use which contributes to non-natural causes of deaths (Senn et al., 2006; Muula, 2008).

The involvement of parents and other family members, mass media programmes, sex education and HIV education have shown to influence HIV-related outcomes among young people (Monasch and Mahy, 2006; Bertrand et al., 2006; Kirby et al., 2006; Keeney and Palley, 2013).

2.4 Causes of Mortality

In this section the underlying causes of mortality will be discussed by age group. The first part discusses the causes of mortality in children under-5 years of age followed by a discussion on causes of mortality among adults aged 15 years old and above.

2.4.1 Causes of Stillbirth

Worldwide, stillbirths are considered a major public health problem with more than twomillion stillbirths occurring annually (Lawn et al., 2011). High income countries are also affected by the burden of stillborns.

The Lancet's Stillbirths Series showed a significant variation in stillbirth rates between high income countries (Cousens et al., 2011).In these countries, Finland and Singapore have the lowest stillbirth rate, while USA and UK were shown to have the highest rates of stillbirth (Cousens et al., 2011).

The differences in the rates could be ascribed to socio-economic differences between these countries (Smith et al., 2010; Seaton et al., 2012), smoking behaviour during pregnancy (Gray et al., 2009; Gardosi et al., 2013; Goldenberg et al., 2013; Gordon et al., 2013) and overweight and/or obesity of the mothers (Flenady et al., 2011; Gardosi et al., 2013).

The rate of stillbirths are higher in low and middle income countries when compared to the rate found in high income countries (McClure et al., 2006; McClure et al., 2007a; McClure et al., 2007b; McClure et al., 2011; Cousens et al., 2011). A comparative study of six low-and-middle income countries found a significant different in the stillbirth rates (McClure et al., 2011).

The high stillbirth rates in low and middle income countries could be attributed to inadequate access to appropriate maternal health care during the antenatal period and at the time of delivery (Shrestha and Yadav, 2010) and low socioeconomic status (Smith et al., 2010; Seaton et al., 2012).

Several studies have shown that hospital-based stillbirth rates are higher than the rates reported from community-based studies. Hospital-based studies in low-and-middle income countries reported stillbirth rates of 156/1000 births in Gambia (Jammeh et al., 2010); 59.8/1000 births in India (Bhattacharya, et al., 2010); 57/1000 births in Zimbabwe (Feresu, 2010) and 35.9/1000 births in Tanzania (Mmbaga et al., 2012). In SA, the hospital stillbirth rates range from 10.1 to 52.3 per 1000 births which continue to pose serious challenges (Pattinson, 2009).

Community-based studies reported stillbirth rates of 19/1000 births in Uganda (Nankabirwaet al., 2011); 33/1000births (Engmann et al., 2009), 34.2/1000 births in Ghana (Edmond et al., 2008) and 35.4/1000 births in Ghana (Lee et al., 2011). A community-based study in Zambia found that among 148 child deaths 34% were stillbirths (Ensor et al., 2014).

The reviewed studies have shown that the rate of stillbirths is lower in the community as compared to the hospital. Stillbirths in the rural communities are often hidden and disposed without recognition or rituals (i.e. funeral rites) because the evil spirit is to blame (Haws et al., 2010; Froen et al, 2011; Kiguli et al., 2015).

Causes of stillbirths are associated with both medical and non-medical risk factors. These risk factors are manifold, often unclear and vary by geographical region (Lawn et al., 2010). Obesity and excessive weight gain during pregnancy lead to adverse maternal and foetal outcomes (Athukorala et al, 2010; Crane et al., 2013). Studies in several low-and-middle income countries identified overweight and obesity among the major risk factors for stillbirths (Salihu et al., 2007; Flenady et al., 2011; Gardosi et al., 2013; Scott-Pillar et al., 2013).

Interventions to reduce stillbirths include antenatal dietary and lifestyle interventions in obese pregnant women to reduce maternal pregnancy weight gain and improve pregnancy outcome (Oteng-Ntim et al., 2012; Thangaratinamet al., 2012; McPherson, 2013).

Smoking behaviour during pregnancy has also been identified as a risk factor for stillbirths (Flenady et al., 2011; Gardosi et al., 2013; Goldenberg et al., 2013; Gordon et al., 2013). Recently Varner et al reported that exposure to second-hand smoke during pregnancy was associated with an increased risk of stillbirths (Varner et al., 2014). There is evidence that psychosocial interventions during pregnancy reduce smoking behaviour and thus stillbirths (Chamberlain et al., 2013).

Hypertensive disorders are the most common medical complications encountered during pregnancy and are associated with poor maternal and foetus outcomes (Roberts et al., 2008; Duley et al., 2009; Steegers et al., 2010; Bateman et al., 2012). Globally, the number of women entering pregnancy with established hypertension disorders is set to increase (Seely and Ecker, 2011).

A retrospective review of hospital maternity records in Gambia reported that hypertensive disorders are highly associated with stillbirth (Jammeh et al., 2010). Another Gambian study in three (3) obstetric referral hospitals found that hypertension in pregnancy was most common cause of stillbirth (Cham et al., 2009).

A community-based study undertaken in sub-Saharan Africa, Southern Asia and South America using verbal autopsy reporting indicated that hypertensive disorders were common causes of stillbirth (Engmann et al., 2012). In Nigerian mission hospital, Onyiriuka (2009) reported that hypertensive disorders are among the three leading risk factors resulting in stillbirths. Numerous case-control studies have identified hypertension in pregnancy as a risk factor for adverse events for mother and the foetus (Berg et al., 2009; Hossain et al., 2009).

Several risk factors that contribute to hypertension in pregnancy include obesity, older age and diabetes mellitus (Al-Jameil et al., 2013). Use of anticonvulsants(Acosta et al., 2012; King, 2013; Kassebaum et al., 2014; Say et al., 2014), aspirin, calcium supplementation in areas with low intake (Henderson et al., 2014) can reduce the incidence of hypertension disorders in pegnancy.Some studies suggested improvement in screening, prevention and treatment strategies and

developing hospital protocols for treatment of hypertension and eclampsia (Wagner et al., 2007; Lowe et al., 2009).

Obstructed labour is also among the major medical conditions that cause stillbirths in many health facilities (Onyiriuka, 2009; Mmbaga et al., 2012) and communities (Engmann et al., 2012; Alkali et al., 2014) in low-and-middle income countries.

Early and regular antenatal care visits improve the chances of identifying complications during pregnancy (Young et al., 2007; Di Mario et al., 2007; McClure et al., 201; Ensor et al., 2014). Several procedures, such as caesarean delivery, are done to relieve the obstruction in obstructed labour (Nwogu-Ikojo et al., 2008; Alkire et al., 2012).

In the Harare Maternity Hospital, lack of prenatal care contributed to a large number of stillbirths (Feresu, 2010). In four rural health districts in DRC, a correlation was found between lack of prenatal care and formal education, on the one hand (Engmann et al., 2009). In a Tanzanian hospital's non-adherence to an antenatal care program was found to correlate with high stillbirth rates (Schmiegelow et al., 2012).

2.4.2 Causes of Death in Children Under-1 Year of Age

The Millennium Development Goal 4 (MDG4) target is to reduce under-5 mortality rate by two-thirds between 1990 and 2015. There has been an impressive progress in reducing under-5 mortality globally, although few countries will reach target by 2015 (Bryce et al., 2013).

In 2010, there were 7.6 million recorded deaths of children under-5 years of age worldwide, of which more than two-thirds occurred in the neonatal period. Low-and-middle-income countries have the highest neonatal mortality rates, with two regions, namely sub-Saharan Africa and Southern Asia, together accounting for nearly 80% of the worldwide neonatal deaths (Liu et al., 2012).

Globally, the leading causes of deaths in the neonatal period were preterm births, intrapartum-related conditions (previously called birth asphyxia) and infections - mainly sepsis, meningitis and pneumonia (Liu et al., 2012; Oza et al., 2013).

Preterm deaths are the most common cause of deaths in all countries, congenital malformations cause more neonatal deaths in high income countries, while infection and intrapartumassociated disorders cause more neonatal deaths in low-and middle income countries (Liu et al., 2012; Oza et al., 2013). In SA, preterm birth and low birth weight, birth asphyxia and neonatal infections - primarily pneumonia and sepsis - were the main causes of neonatal deaths (Nannan et al., 2012).

Preterm birth, which is defined as being born less than 37 weeks after conception, and low birth weight, which is defined as a weight of less than 2500g at time of delivery (Gray et al., 2008) were the main causes of death in hospital-based studies in low-and-middle income countries (Grandin et al., 2006; Ngocet al., 2006; Huerga et al., 2009; Forae et al., 2014; Mmbaga et al., 2012). Similar findings were reported in community-based studies which show preterm birth and low birth weight as the leading causes of neonatal deaths in low-and-middle income countries (Manandhar et al., 2010; Okechukwu and Achonwa, 2009; Omoiqberale et al., 2010).

There are many factors that contribute to infant mortality such as the mother's level of education and environmental conditions. Improving sanitation, access to clean drinking water and hand washing could help to reduce the high rate of infant mortality.

Smoking cessation interventions and use of progesterone have been shown to reduce mortality related to low birth weight and preterm birth, respectively (Barros et al., 2010; Hassan et al., 2011; Slager et al., 2012).

In addition, poor maternal nutritional status during pregnancy has been shown to interfere with foetal growth and development resulting in newborns with low birth weight (Quigley et al., 2008; Belkacemi et al., 2010; Wu et al., 2012). The provision of micronutrients such as iron, folate and zinc to pregnant women who consume minimal vitamins and minerals in their daily diet has a significantly positive impact on low birth weight of newborns (Barros et al., 2010). The introduction of basic obstetric care, an improved referral system and neonatal resuscitation have shown to reduce asphyxiated deaths (Cowles, 2007; Lawn et al., 2007).

Neonatal deaths due to infections are also common in low-and-middleincome countries, whereas in high income countries infections rarely cause neonatal mortality (Black et al., 2010; You et al., 2010). In neonates infections normally occur either during pregnancy or at the time of delivery, causing sepsis, pneumonia or meningitis (Heath and Jardine, 2014).

Neonatal deaths could be reduced through appropriate antenatal care and timely referral of the mother to tertiary care facilities (Mmbaga et al., 2012; Ali et al., 2013). In addition, in areas where malaria is endemicthe use of anti-malarial drugs amongst primiparae and the use of insecticide-treated nets both result in a reduction in perinatal mortality (Barros et al., 2010).

2.4.3 Causes of Death in Children between the Ages of 1 and4 Years of Age

Whilst there has been some reduction in under-5 mortality rates globally, progress to reduce mortality in some regions of the world has been insufficient particularly in sub-Saharan Africa (Bryce et al., 2013).

Among children aged between 1 and 4 years old, infections - primarily pneumonia, diarrhoea and malaria - are the predominant causes of death which result in a substantial burden on a health-care system(Black et al., 2010; Boschi-Pintoet al., 2008; Johnson et al., 2010; Kassebaum et al., 2014). Infectious diseases are particularly common in sub-Saharan Africa and Southern Asia.

In low-and-middle income countries, hospital-based studies reported that infectious diseases - mainly pneumonia and diarrhoea - were the main causes of death in children aged between 1 and 4 years old (Grandin et al., 2006; lloh et al., 2011; Stephen et al., 2011; Misganaw et al., 2012b; Forae et al., 2014).Several authors noted that in rural communities in low-and-middle income countries pneumonia and diarrhoea were the predominant causes of death amongst these age group (Garrib et al., 2006; Sacarlal et al., 2009; Awqati et al., 2009; Byass et al., 2010; Johnson et

al., 2010; Huo et al., 2010; Liu et al., 2011; Checchi et al., 2011; Feng et al., 2012; Parcesepe et al., 2013).

Pneumonia- and diarrhoeal-related deaths are closely associated with factors such as poverty, under-nutrition and poor hygiene. It is wellknown that exclusive breastfeeding up to 6 months of age, rotavirus vaccination, *Haemophilus influenzae* (Hib) vaccination, oral rehydration solutions, zinc therapy and antibiotics for pneumonia reduce pneumonia and diarrhoealrelated mortality in children under-5 years old (Sayem et al., 2012; Bhutta et al., 2013; Chopra et al., 2013).

Malaria also continues to contribute many deaths amongunder-5s living in rural areas across sub-Saharan Africa and South Asia (Black et al., 2010; Liu et al., 2012; Kassebaum et al., 2014).

The major risk factors that contribute to high malaria mortality include low socio-economic status, poor access to healthcare services and low quality of health services (Belay et al., 2008; Dawit et al., 2012; Chirebvu et al., 2014).

In low-and-middle income countries, hospital-based data identify malaria as the main cause of death in children aged between 1 and 4 years old (Misganaw et al., 2012b;Einterz and Bates, 2011; Forae et al., 2014). A systematic review of community-based studies indicated that in low-and-middle income countries malaria caused most deaths among childrenaged between 1 and 4 years old (Johnson et al., 2010).

The use of insecticide-treated nets and anti-malarial spraying has contributed to a decrease in the incidence of malaria (Belay et al., 2008; Dawit et al., 2012; Chirebvu et al., 2014).

2.4.4 Causes of Death in Children between 5 and 14 Year of Age

The leading causes of death among children under-5 years of age in low and middle-income countries are well researched (Black et al., 2010; Liu et al., 2012; Kassebaum et al., 2014). However, little information is available on the causes of morbidity and mortality among children in the 5 to 14 year age group. The main reason is that the mortality rate is low and causes of death in this age group remained unchanged (Desai et al., 2014; Streatfield et al., 2014).

Injuries are a major global public health issues that contributesto morbidity and mortality among children,especially those in the 5 to 14 year age group (Peden et al., 2008; Harvey et al., 2009). A study in Perureported injuriesas the leading cause of mortality in children in the 5 to 14 year age group (Huicho et al., 2009). Similarly in Mozambique, the most frequent cause of mortality among children in the 5 to 14 year age group was injuries (Sacarlal et al., 2009).

In Agincourt, Byass and co-authors showed that among children in the 5 to 14 year age group, injuries were the common cause of death (Byass et al., 2010). Traffic accidents are the most important cause of child injury-related deaths (Huicho et al., 2009; Sacarlal et al., 2009; Byass et al., 2010; Imamura et al., 2012).

Road traffic injury deaths may be due tooverburdened informal urban settlements,a high degree of traffic law violation, poor traffic control and lack of adult supervision of children (Rizvi et al., 2006; Harvey et al., 2009; Mamady et al., 2012).

Infectious diseases are the next most common cause of death in this age group, especially in low-and-middle income countries (Huicho et al., 2009; Sacarlal et al., 2009; Byass et al., 2010; Morris et al., 2011). In rural India (Morris et al., 2011) and Peru (Huicho et al., 2009), infectious diseases such as diarrhea and pneumonia were found to be the leading causesof death in children aged between 5 and 14 years old. In Mozambique, infectious diseases, mainly malaria and anaemia, were the leading causes of death (Sacarlal et al., 2009).

Data collected by Byass and colleaques showed that among children in the 5 to 14 year age group, meningitis and HIV/AIDS were the leading infectious causes of death in the Mpumalanga Province of South Africa (Byass et al., 2010).

Socio-economic inequalities are a major public health problem in globally. Childhood mortality is higher in low-and middle income countries compared to high income countries. However, even in high income countries child mortality is high among lower socio-economic groups compared to higher income groups (Signh et al., 2007; Houweling and Kunst, 2010;Signh et al., 2013; Signh and Siahpush, 2014).

Improvements in living conditions, better nutrition, and access to clean drinking waterhave been cited as factors contributing for the decline in child mortality particularly from infectious diseases (Singh and Kogan, 2007).Moreover,

interventions, such as use of anti-malarial spraying, rotavirus vaccination, *Haemophilus influenzae* (Hib) vaccination, zinc therapy and antibiotics, have shown to reduce mortality due to malaria, pneumonia and diarrhoea (Sayem et al., 2012; Bhutta et al., 2013; Chopra et al., 2013).

2.4.5 Causes of Death in Adults (older than15 Years of Age)

The cause of death amongst adults is a neglected topic in the global health discussion (Accorsi et al., 2010; Lozano et al., 2011; Dye, 2014). In 2004, 46.9 million of the 58.8 million deaths worldwide occurred in people aged 15 years and older (WHO, 2008). Despite high adult mortality, for many years public health efforts have focused on reducing maternal and child mortality, as well as halting and reversing the spread of HIV and tuberculosis (United Nations, 2011).

Causes of death vary substantially by age. Amongst adults aged between 15 and 49 years old, infectious diseases such as HIV/AIDS and tuberculosis are the leading causes of death, particularly in sub-Saharan Africa and Asia (Lozano et al., 2012).

Similar proportion of HIV/AIDS and tuberculosis deaths in this age group occurred in the hospitals (Adeolu et al., 2010; Ohene et al., 2011; Etyang et al., 2013) and rural community-based studies (van Eijk et al., 2008; Byass et al., 2010; Herbst et al., 2011; Checchi et al., 2011; Dlodlo et al, 2011; Narh-Bana et al., 2012; Chihana et al., 2012; Kumar et al., 2012; Palanivel et al., 2013).

Behavioural risk factors, such as unprotected sexual practice is the most important factor associated with adolescents and young adults becoming infected with HIV

(Senn et al., 2006; Muula, 2008). However, antiretroviral (ARV) treatment has played a major role in reducing the death rate in people with HIV (Walensky et al., 2009; Ray et al., 2010; Saraceni et al., 2014; Yang et al., 2014).

A number of studies have shown that tuberculosis is closely linked to HIV/AIDS, overcrowding, smoking, diabetes and malnutrition (Chaisson and Martinson, 2008; Lawn and Zumla, 2011; Ferrara et al., 2012; Murthy et al., 2013; Narasimhan et al., 2013) are the risk factors. Therefore, these factors play a significant role at both the individual and population level. Aglobal threat to tuberculosis controlhas been the emergence and spread of multi-drug-resistant tuberculosis (MDR-TB) (Banerjee et al., 2008; Ramachandran et al., 2009; Grobusch, 2010).

The incorrect use of anti-TB drugs, either due to prescription errorsor to low patient compliance,has led to the widespread emergence of MDR-TB.Preventive strategies include prompt diagnosis and adequate TB treatment using the directly observed therapy, short-course (DOTS) strategy and drug-resistance programmes, preventive treatment of TB/HIV, and optimal use of antiretroviral therapy (Prasad, 2010; Yew, 2011; Chang and Yew, 2012).

Non-natural causes of death, such as road traffic accidents, are the second largest global cause of death in the 15 to 49 year age group (Lozano et al., 2012; WHO, 2013). In the USA Heron (2013) found that injuries, particularly road traffic accidents, are the leading cause of deaths in adult aged between 25 and 44 years old. In SA road traffic accidents and violent assault are among the leading causes of death in young adults (Stats SA, 2014).

Similar findings were found in hospital (Adeolu et al., 2010; Chukuezi and Nwosu, 2010; Ohene et al., 2011; Etyang et al., 2013) and community-based studies (Byass et al., 2010; Herbst et al., 2011; Narh-Bana et al., 2012) which reported road traffic accidents as the leading cause of death amongst young adults.

These studies found that there were twice as many deaths amongst young males due to injury than there were amongst young females, demonstrating the susceptibility of young males to external causes of death. Alcohol abuse and aggressive behaviour contributes greatly to external causes of death (Senn et al., 2006; Muula, 2008).

The Millennium Development Goal 5 (MDG-5) recommended a global reduction of the maternal mortality rate by three quarters between 1990 and 2015 (Bryce et al., 2013). Pregnancy-related deaths among females aged between 15 and 49 years old, continue to be a public health concern worldwide, particularly in sub-Saharan Africa and Asia (Koblinsky et al., 2012; Bhutta et al., 2013; Kassebaum et al., 2014).

Approximately 99% of all maternal deaths occur in low-and-middle income countries, with a maternal mortality ratio (MMR) of 233 per 100 000 births versus a MMR of 12 per 100 000 in high income countries in 2013 (Kassebaum et al., 2014).

As stated by WHO (2003 - 2009), over two-thirds of global maternal deaths are due to direct obstetric causes, mainly obstetric haemorrhage, hypertensive disorders, abortions and infections (Say et al., 2014). In contrast, indirect causes, mainly non-

pregnancy related infections are responsible for maternal deaths in South Africa (NCCEMD, 2012).

According to hospital-and community-based studies in low-and-middle income countries, an increase in maternal deaths due to direct causes include maternal haemorrhaging and hypertension, while anaemia, malaria and HIV/AIDS were the main indirect causes of maternal deaths (Igberase et al., 2007; Kongnyuy et al., 2009; Gupta et al., 2010; Lee et al., 2012; Dinyain et al., 2013; Der et al., 2013; Bukar et al., 2013).

In many low-and-middle income countries, lack of adequate healthcare, poor family planning,limited access to skilled birth attendants and the fact that patientsoften travel long distances to the nearest clinic to receive proper care contribute to maternal deaths(Ujah et al., 2005; Alvarez et al., 2009; Kassebaum et al., 2014; Say et al., 2014).

Basic emergency obstetric interventions, such as the provision of antibiotics, oxytocic's, anticonvulsants and the manual removal of the placenta and the prevention of anaemia, malnutrition and malaria during pregnancy, as well as the provision of calcium and micronutrient supplementation and the reduction in unsafe abortions have shown to improve pregnancy outcome (Nour, 2008; Bhutta et al., 2008; Acosta et al., 2012; King, 2013; Kassebaum et al., 2014; Say et al., 2014).

In adults aged 50 years and older, non-communicable diseases, particularly cardiovascular diseases (CVDs) and malignant neoplasms,were the predominant

causes of death worldwide (Lozano et al., 2012, WHO, 2013). CVDs are known to be a public health problem worldwide and to have a major impact, not only in high income countries, but also in low-and-middle income countries countries (Lopez et al., 2006; WHO, 2008; Mayosi et al., 2009).

With accelerating global trends in industrialisation, urbanisation and increase socio-economic status the prevalence of CVDs is set to increase if left unchecked.

In a high income country like the USA, Heron (2013) found that CVDs are the leading cause of death in adults aged 45 years and older. In low-and-middle income countriesCVDs were also found to cause many deaths in adults aged 50 years and above (Mayosi et al., 2009; Porapakkham et al., 2010; Stats SA, 2014).

Many hospital-based studies reported CVDs as the leading cause of death among adult aged 45 years and older (Tariq et al., 2009; Papazafiropoulou et al., 2010; lliyasu et al., 2010; Beharry et al., 2011; Preacely et al., 2012; Olarinde and Olatunji, 2014). Similarly, community-based studies found CVDs to be the leading cause of death among adults aged 50 years and above (Kynast-Wolf et al., 2010; Kumar et al., 2012).

Most of these deaths can be prevented by addressing risk factors such as tobacco use, unhealthy diets, overweight and obesity, physical inactivity, high blood pressure and the harmful use of alcohol (Pennant et al., 2010; Korczak et al., 2011;WHO, 2011b; van de Vijver et al., 2012; Nguyen et al., 2012).

Neoplasms account for the second most common non-communicable causes of death amongst adults aged 50 years and older and accounted for around eight million deaths in 2012 worldwide (de Martel et al., 2012; WHO, 2013). This age group has a much higher proportion of cancer deaths when compared to younger age groups, with two-thirds of all cancer deaths occurring in adults aged 50 years and above (WHO, 2013).

The causes of cancer deaths vary dramatically by gender, with cancer of the trachea, bronchus, lung, liver, and stomach accounting for 46% of cancer deaths in men, while in women, 38% of cancer deaths were caused by breast, trachea, bronchus, lung and colorectal cancers (WHO, 2013). Neoplasmsare already the leading cause of deaths in many high-income countries and are set to become a major cause of mortality and disability in developing countries (Bray et al., 2012).

In South Africa, neoplasm deaths are mainly caused by cancer of digestive organs in adults aged 50 years and above (Stats SA, 2014). In the USA neoplasmsaccounted for 13% of deaths in adults aged between 25 and 44 years old, 32% of deaths in adults aged between 45 and 64 years old and 34% of deaths in adults aged 65 years and older (Heron, 2013).

Psychosocial experiences such as stress and health behaviour including tobacco use, sun exposure, poor diets and a sedentary lifestyle, increase the risk of some cancers (Klein et al., 2014; Lugman et al., 2014).

2.4 CommunityMortality Rates

Mortality statistics are valuable measures for assessing the health status of a population and for planning healthcare priorities. A better understanding of mortality could contribute to a more effective approach to saving lives. In low-and-middle income countries a large number of people live in poor rural areas and face challenges in accessing quality health care (Peters et al., 2008; Kiwanuka et al., 2008).

An analysis of the data from six HDSSsshows high mortality rates, ranging from 8 to 20 deaths per 1000 person-year, in sub-Saharan African HDSSswhen compared to 6.0 and 6.9 deaths per 1000 person-year in Bangladeshi sites (Adjuik et al., 2006). In rural Tanzania (2003-2007) researchers found that the mortality rate was 7.3 per 1000 person-year (Narh-Bana et al., 2012), while in Kenya the mortality rates were between 5 and 15 per 1000 person-years (Negin et al., 2010; Olack et al., 2014).

In the Dikgale HDSS, although a cause of death data is not available, the mortality rate was found to be 7.5 deaths per 1000 person-year between and 1996 and 2003 (Cook et al., 2008). A follow-up study in the same rural area found mortality ratesto be 6.8 deaths per 1000 person-year during 1996-1999study period, which increased to 9.9 deaths per 1000 person-years in the 2004-2007 study period (Kanjala et al., 2010). In rural Kwa-Zulu Natal, with a high prevalence of HIV infections, the mortality rates were found to be between 15 and 30 deaths per 1000 person-year (Mashego et al., 2007; Herbst et al., 2011).

These studies show a wide regional variation in mortality rates. Various risk factors account for this variation, including socio-economic status, low education, lack of public infrastructure providingpotable water and sanitation services and the lack of access to healthcare facilities.

Understanding the pattern of deaths by age can effectively inform health policy makers when interventions for various age groups. In rural Tanzania the mortality rate was highest amongst adult aged between 45 and 59 years old (Narh-Bana et al., 2012). In contrast in Kenya, higher mortality rates were reported amongst infants and in adults aged 50 years old and above (Olack et al., 2014).

The HDSS sites in South Africa reported high mortality rates amongst children under-5 years old (Cook et al., 2008), in adults aged between 15 and 49 years old (Mashego et al., 2007; Herbst et al., 2011), in adults aged between 50 and64 years old (Mashego et al., 2007; Sartorius et al., 2010; Kanjala et al., 2010) and those aged 65 years and above (Mashego et al., 2007; Sartorius et al., 2010; Kanjala et al., 2010; Herbst et al., 2011).

The high rate of adult mortality in those aged 50 years and above is evidence of the increasing prevalence of chronic diseases in these rural communities (Kynast-Wolf et al., 2010; Kumar et al., 2012).

Regarding gender-differential, a number of studies show higher male death rates as compared to female death rates (Mashego et al., 2007; Cook et al., 2008; Sartorius et al., 2010; Kanjala et al., 2010; Negin et al., 2010; Narh-Bana et al., 2012; Olack et

al., 2014). In contrast, van Eijk and co-colleagues reported higher death rates amongst females when compared to male death rates (van Eijk et al., 2008).

An important explanation for high death rates among men may be the unwillingness of men to make use of health services and to report health problemsto the relevant healthcare professionals and aggressive behaviour which may lead to mortality related to non-natural causes (Signh-Manoux et al., 2008).

2.6 Agreement of Causes of Death between Hospital Recordsand Verbal Autopsy Reports

The planning of public health systems should be based on reliable and timely data on the leading causes of death and disability. Globally, civil registration systemsare important tools commonly used to ascertain population-based mortality; however, in low- and middle-income countries,problems with completeness and accuracy of causes of death persist(Mahapatra et al., 2007; Setel et al., 2007).

In many low- and middle-income countries, especially those in sub-Saharan Africa, cause of death data are inadequate or not readily available (Mahapatra et al., 2007; Setel et al., 2007; Ye et al., 2012, Phillips et al., 2013). In South Africa, the quality of cause of death data capturesin civil registration systems remains deficient, with many causes of death recorded as “ill-defined” and/or “undetermined” (Burger et al., 2007; Nojilana et al., 2009; Pillay-van Wyk et al., 2011;Birnbaum et al., 2011).Therefore, statistics on registered cause of death require careful evaluation if they are to be useful for epidemiological research and health service planning purposes.

Comparison of cause of death reported on death certificates with clinical records or verbal autopsies areusually assessed by using the concepts of sensitivity, specificity or kappa statistics (Rao et al., 2007; Wang et al., 2007; Burger et al., 2012; Misganaw et al., 2012a; Khalili et al., 2012).However, sensitivity and specificity are the most frequently used measure to quantify interrater agreement (Rao et al., 2007; Wang et al., 2007; Khalili et al., 2012).

Rao et al compared diagnoses recorded on medical records and those recorded on death registration systems for 2917 deaths that occurred in secondary and tertiary hospitals in China. The study reported the sensitivity of all causes of deaths identified by death notification forms to be on average 50%-75% (Rao et al., 2007). The study found an overall misclassification rate of 21.6%, with 12% of reported injury deaths (mostly from falling) attributed to natural causes on the medical records.

A comparative study between deaths recorded through the use of verbal autopsy reports and those recorded in death registry records for 2482 deaths in China found that injuries, such as fall and poisoning, ischaemic heart disease, chronic obstructive pulmonary disease and tuberculosis had sensitivity lower than 50% (Wang et al., 2007). A cause of death misclassification rate of 40.4% was reported in this study.

Another study in China where 3290 cause of death records were analysed reported a higher sensitivity for strokes, cancers and transport accidents, while low sensitivity was reported for ischeamic heart disease, chronic obstructive pulmonary disease, diabetes and tuberculosis (Yang et al., 2006).

In an Indonesia study, of the 446 deaths analysed, a greater proportion (66%)of deaths was attributed to cardiovascular disease recorded on death certificateswhen compared to 49%of deaths by verbal autopsy reporting (Pane et al., 2013). In a recent review Rampatige et al revealed massive misclassification of causes of death in hospitals in China, Iran, Mexico, Sri Lanka and Thailand (Rampatige et al., 2014).

In these studies most deaths from ischaemic heart disease were attributed to strokes, while HIV/AIDS deaths were attributed to septicaemia.Various forms of heart disease, diabetes and chronic constructive pulmonary diseases were often coded as ill-defined causes (Pane et al., 2013; Rampatige et al., 2014).

A cohort study in Tehran, Iran that compared deaths diagnosed by a panel of specialists and deaths recorded on death certification forms for 367 deaths found a sensitivity of greater than 60% in all natural causes of deaths, except for the disease of nervous system and genito-urinary system (Khalili et al., 2012). Another study in Iran found that VA reporting had a sensitivity of 80% or more and Kappa of 75% in determining the general cause of death (Khademi et al., 2010).

In a Tanzanian study that compared deaths diagnosed by verbal autopsy reporting and deaths recorded on medical records for 3123 deaths found a sensitivity of higher than 50% for HIV/AIDS, malaria, cerebrovascular disease, injuries and malignant neoplasm of the gastro-intestinal tract (Setel et al., 2006). In Uganda, Mpimbaza et al carried out a study of 719 deaths of under5 year old children with the aim of assessing the diagnostic accuracy of VA procedures compared to hospital medical records for determining malaria deaths (Mpimbaza et al., 2011). The sensitivity of VA

procedures for determining death from malaria was 50% or more, specificity 80% or more and the positive predictive value was between 30% and 80%.

In Ethiopia, a validation study amongst 335 adult deaths indicated that for communicable diseases the values of sensitivity, specificity and positive predictive value of VA diagnoses were 79%, 78%, and 68%, respectively, while for non-communicable diseases, sensitivity was 69%, specificity 78% and positive predictive value 79%. Injury sensitivity of the verbal autopsy diagnosis was 70%, specificity 98% and positive predictive value 83% (Misganaw et al., 2012a). The study showed a misclassification pattern of 40% or more for cardiovascular diseases and infectious diseases such as tuberculosis and HIV.

Burger et al (2003-2004), in their study, compared causes of deaths on the death notification forms (DNF) with diagnoses recorded in hospital records for 703 deaths in Cape Town, South Africa. This study found the sensitivity of DNF for identifying all natural causes of death studied was greater than 50%, except for infectious diseases, diabetes and cardiovascular disease (Burger et al., 2012). The overall disagreement was 45% between the underlying causes of death as coded in the medical records and on the death certificate (Burger et al., 2012).

2.8 Summary

Chapter 2 dealt with the review of literature dealing with the causes of death and mortality rates across the globe, in sub-Saharan Africa and South Africa in particular.The rates and causes of stillbirth werealso investigates.Studies using the

verbal autopsy instrument to assign causes of deaths were also cited. The materials and methods used to collect data for this study will be discussed in the next chapter.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in this thesis. The chapter begins with the study design, study setting in terms of the geography of the community and health facility. The chapter then details the sampling techniques, sample size, data collection, data management and analysis and ethical consideration.

3.2 Study Design

This study was divided intotwo phases: The first phase involved a retrospective review of all deaths that occurred at Pietersburg/Mankweng Hospital Complex (PMHC). The second phase involved a community-based study using a verbal autopsy instrument to determine cause of death in Dikgale Health and Demographic Surveillance Site (HDSS) in Limpopo Province.

3.3 Study settings

The first phase of the study was conducted at Pietersburg/Mankweng Hospital Complex (PMHC) which is the only tertiary referral hospital in Limpopo Province. It is a teaching hospital for the University of Limpopo (Medunsa Campus) and serves mostly rural communities. The complex is a combination of two hospitals - Pietersburg Hospital Campus and Mankweng Hospital Campus, which provide tertiary services to all Level 1 (district)and Level 2 (regional) hospitals in the Province. The PMHC had 900 beds and approximately 4500 staff members focusing

on (5) five main medical disciplines namely: general surgery, obstetrics and gynaecology, orthopaedic, radiology and paediatrics.

The second phase of the study included the Dikgale HDSS centre which is located in the central region of Capricorn District of the Limpopo Province (**Figure 1**). The area is predominantly rural, about 20 km from the University of Limpopo (Turfloop Campus) and 40 km from Polokwane city, the capital of Limpopo Province. There are three primary health clinics in Dikgale HDSS.

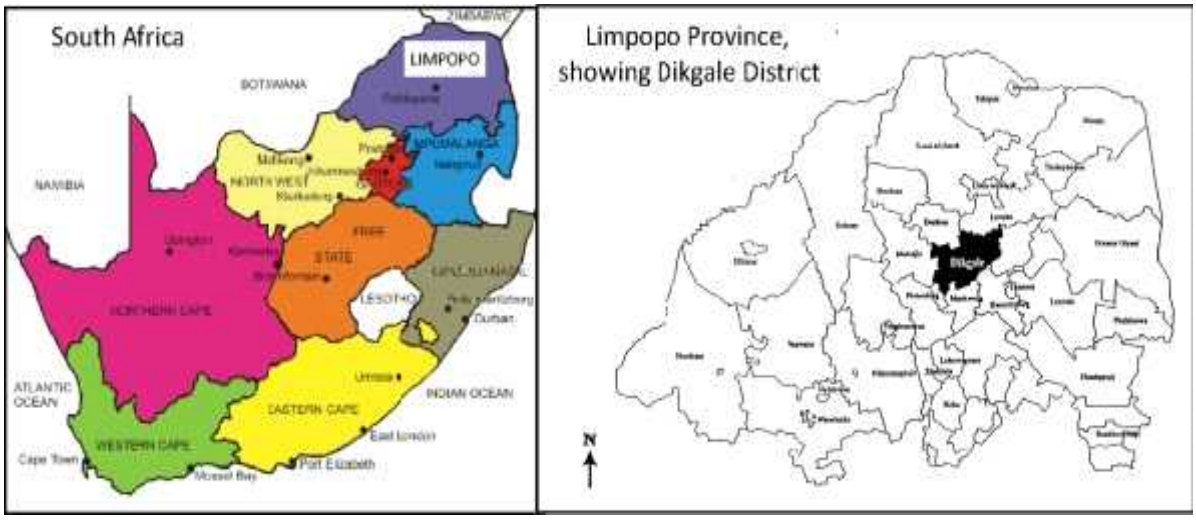

Figure 1: **Map of South Africa and Limpopo Province Showing the Location of Dikgale (Source: Kanjala et al., 2010)**

The Dikgale HDSS was established in 1995 and covers8 villages with a total population of approximately 8000. In 2010 Dikgale HDSS was expanded to include15 villages with a population of approximately 36000. A number of households have water taps in the yards; other households fetch water from taps situated at strategic points in the villages. The area is impoverished with high unemployment and poor infrastructure. Most households have pit latrines with no organized waste disposal (Mkhonto et al., 2012).

An update is conducted annually when each household is visited and changes have taken place since the last visits are recorded. Question on pregnancy is included in the census form. A full maternal historic of new women in the household is recorded. Date of birth, gender live or stillbirth, birth weight and site of delivery are recorded. Death forms are completed for each death that has occurred. Migration inquiries include information on origin or destination and reason for change of locality. Fieldworkers were trained in the administration of verbal autopsy questionnaire.

The prevalence of risk factors such as smoking obesity and diabetes are reported to be high in Dikgale HDSS (Alberts et al., 2005).Thedetail original study area and the population have been previously documented (Cook et al., 2008; Kanjala et al., 2010). The prevalence of HIV/AIDS in Limpopo provice among adult aged 15-49 years was 13.7% in 2008 (HSRC, 2009).

3.4 Sampling Technique and Sample Size

To determine the pattern of cause of death from both the hospital and community, all deaths that occurred between 1st January, 2011 and 31st December, 2012 were selected for the study. To assess the community mortality rates all deaths that occurredin the communityfrom 1 January to 31 December 2012, regardless of place of death, were included in a study.

3.5 Data Collection

The data in the hospital were obtained from Pietersburg/Mankweng Hospital Complexfor a period of 2years (January 1, 2011 to December 31, 2012). Data were collected using a data collection form designed for the study (**Annexure 3)**. The

researcher used the hospital deaths register as the starting point to collate the list of deaths that occurred during the study period. The relevant death notification forms were retrieved and reviewed by the researcher and a trained research assistant. The following datawere collected: date of death, sex and age at death and the cause of death. In order to find missing information, some patients records were also consulted where deemed necessary.

The number of deaths in the community was obtained from Dikgale HDSS database, while the causes of death data were obtained by a short VA questionnaire (Appendix 4) and processed into the already specified batchin.csv file format of InterVA-3.The short VA questionnaire covers all deaths in all age groups (Byass et al., 2010; Fottrell et al., 2010; Fottrell et al., 2011).

The information from the VA questionnaire was entered into a database and the researcherextracted the data into the InterVA-3 probabilistic model to establish the most likely cause of death.

Running the model on these indicators will then generate a database with up to three likely causes of death for each case, together with respective likelihoods. The HIV level for the InterVA model was set to "high" and malaria set to "low," based on existing knowledge of causes of death in this population, as discussed previously (Ntuli et al., 2013; Malangu et al., 2014).

The researcher then coded the diagnosis according to the 10th International Classification of Diseases, injury and Causes of Death(WHO, 2004).A list of specific causes of death with the corresponding ICD-10 is attached (**Annexure5**).

After every verbal autopsy interview the team leader (in the field) checked the questionnaires for completeness. The forms were checked at the University and passed on to the data capture team.

In addition, an independent ascertainment of cause of death from a medical records review was undertaken. It is well established that in South Africa about 60% of deaths are ascertained from the opinions of medical doctors and/or nurses (Stats SA, 2013; Stats SA, 2014).In this study, there were 54 linkable deaths – community deaths that occurred in the Pietersburg/Mankweng Hospital. The cause of death using VA was completed and compared to the causes of death recorded on the hospital medical records.

3.6 Data Analysis

The results of this thesis are presented as numbers and percentages for categorical data, and means, standard deviations (sd) for continuous variables. The following age groups were used in thee analysis, under5 (0 to 4 years old), children (5 to 14 years old), young adult (15 to 49 years old), adults (50 to 64 years old) and elders (65 years old and older).

From the community data, age and sex specific mortality rates were calculated using the maximum likelihood estimate by dividing the number of deaths in the given age

or sex category by the number of persons in that age or sex category with person-years of observation constituting the denominator.

Cross-tabulations were used to establish the percentage agreement between medical records and verbal autopsy reports. Cause specific mortality fractions were used to measure agreement at the population level.

Cohen's kappa statistic was used to assess the degree of agreement between the two methods of ascertaining cause of death.Viera and Garrett (2005) proposed the following as standards for strength of agreement for the kappa coefficient: 1 indicates perfect agreement, whereas a kappa of 0 indicates agreement equivalent to chance (Viera and Garrett, 2005). However, Landis and Koch categorized the standards for strength of agreement for the kappa coefficient into six groups: ≤0=poor, 0.01–0.20=slight, 0.21–0.40=fair, 0.41–0.60=moderate, 0.61–0.80=substantial and 0.81–1=almost perfect (Landis and Koch, 1977).

The validity of the methods was assessed using sensitivity and specificity. VA might be considered to have good validity for the diseases when the sensitivity and specificity excees 60% and 85%, respectively (Bauni et al., 2011).

Data entry and statistical analysis were performed using the Microsoft Excel and Statistical Software (STATA 9.0; StataCorp; College Station, TX), respectively. The verbal autopsy (VA) interviews were interpreted using the probability approach (InterVA-3) to determine the underlying cause of death.The analysis of data, tables and graphs were prepared by the researcher.

3.7 Validity, Reliability and Bias

The data were collected by trained field workers. The VA instrument developed, validated and widely used by numerous studies was used for assigning cause of death in the community (Baiden et al., 2007; Byass et al., 2010; Fottrell et al., 2011).

The questionnaire used to collect hospital data was piloted to assess the reliability.Selection bias was minimized by including all deaths that occurred during the study period. Information bias could occur in the hospital data as the variables were not meant for this study and some information unavailable or open to interpretation. Since most of the documentationswere available from reports and clinical notes the information was reconciled. The data abstractors were blinded to the purpose of the study and the research question to decrease reviewer bias.

3.8 Ethical Considerations

Ethical clearance for the community study and the hospital study was obtained from the Medunsa Research Ethics Committee (MREC) of the University of Limpopo, Medunsa Campus (**Annexure 6**). Permission to conduct the study in the complex was also obtained from the Provincial Research Committee of Department of Health and Social Development (DHSD) Limpopo Province (**Annexure 7**).

The village chiefs were informed of the study before data collection for community-based study began. No participants were identified by name in the final report. Participation in the community-based study was voluntary and participants could refuse to be interviewed. The interviewer explained what the survey was about and provided the necessary information to ensure that respondents understood the

implications of their involvement before giving their informed consent (**Annexure1 and 2**).

3.9 Summary

Chapter 3 summarised the materials and methods pertaining to this study. The findings of the study are presented in Chapters 4, 5 and 6.

CHAPTER 4: CAUSES OF MORTALITY

4.1 Introduction

In the previous chapter, study design, study settings, sampling methods, sample size, training of field workers, pilot study, data collection, data management and analysis were outlined. This chapter presentsthe age and gender of the deceased,together with the causes of deaththat occurred in Pietersburg/Mankweng Hospital Complex and Dikgale HDSS over 2-year period (2011-2012).

4.2 Gender and Age at Death

The gender and agedistribution at death of those who died in the hospital and the community during 2011-2012 were presented**.** Five different age categories were used for analysis: under–5 (0 to 4 years old), children (5 to 14 years old), young adults (15 to 49 years old), adults (50 to 64 years old) and elders (65 years old and older).

A total of 5402 deaths (excluding stillbirths) were reported in the hospital and 40% (2182 out of 5402) of these deaths occurred amongst young adultsin the 15 to 49 year old age group. In the community, 625 deaths were recorded and (39%) of deaths involved adults in the 65+ age group (**Table 1**).

The highest proportion of deaths in the hospital occurred in those aged 15-49 years (40%), followed by those aged 65 years and over (20%) and those aged 50-64 years (19%). In the community, the proportion of deaths in descending order occurred among adults aged 65 years and over (39%) and in the 15-49 age group (36%).

In the hospital most 83% (798/964) of the deaths in the under-5 year occurred in children under-1 year of age. In the community the deaths were higher in children aged between 1 and 4 years of age.

Table 1: **Age distribution at death, 2011-2012**

	Hospital deaths		Community deaths	
	No	**%**	**No**	**%**
Age (years)				
Under-5 (0-4)	964	18	22	4
Children (5-14)	164	3	12	2
Young adult (15-49)	2182	40	226	36
Middle aged adult (50-64)	1021	19	121	19
Elders (65+)	1071	20	244	39
All ages	**5402**	**100**	**625**	**100**

With regard to gender distribution, fifty two per cent of deaths in the hospital were males, while in the community 51% of deaths were females (**Figure 2**).

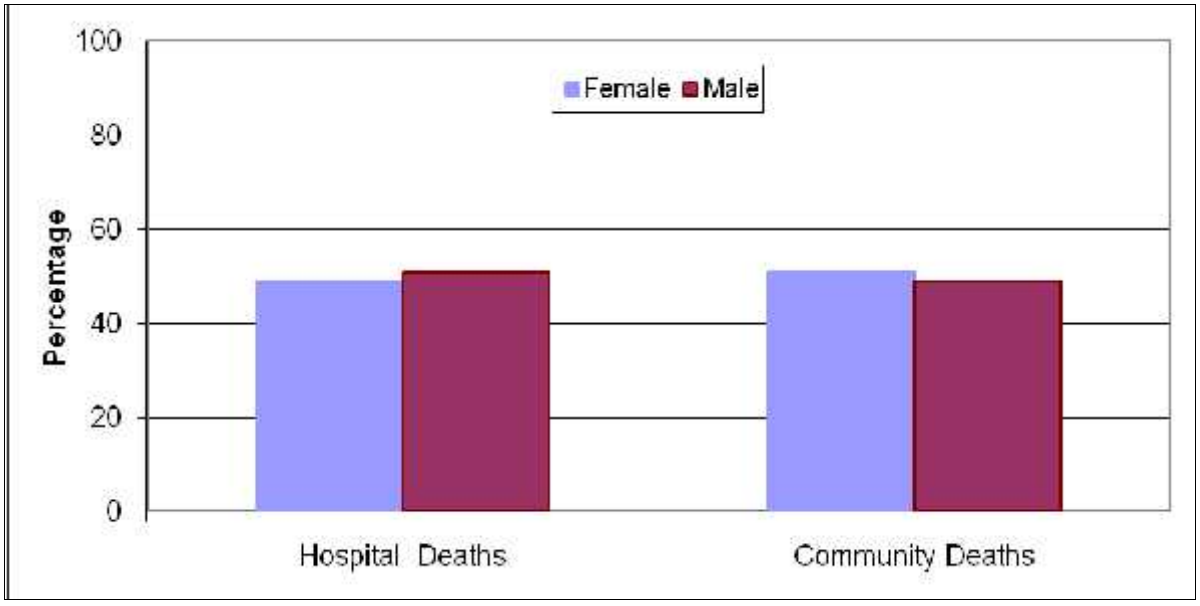

Figure 2:**Gender distribution of deaths in hospital and in the community**

4.3 Causesof Death

Four main causes of death categories were created. **Group I:**Comprise deaths attributable to communicable, maternal, perinatal and nutritional conditions, while **Groups II**and **III**represent deaths attributable to non-communicable diseases and injury-related deaths, respectively.

This classification conforms to the WHO's "Global Burden of Disease (GBD)" categorisation of causes of deaths (WHO, 2008).To include symptoms, signs and ill-defined conditions,a fourth category has been added,namely, undetermined cause of death.

The causes of death in the hospital and the community are presented in **Figure 3**. The proportion of deaths due to non-communicable diseases was 36% in the community and 30% in the hospital, while deaths due to injury were 10% in the hospital and 9% in the community. Ill-definedcauses of death were 11% in the hospital and 10% in the community.Communicable, maternal, perinatal and nutritional conditions listed as the cause of death were higher in the community (51%) than in the hospital (44%).

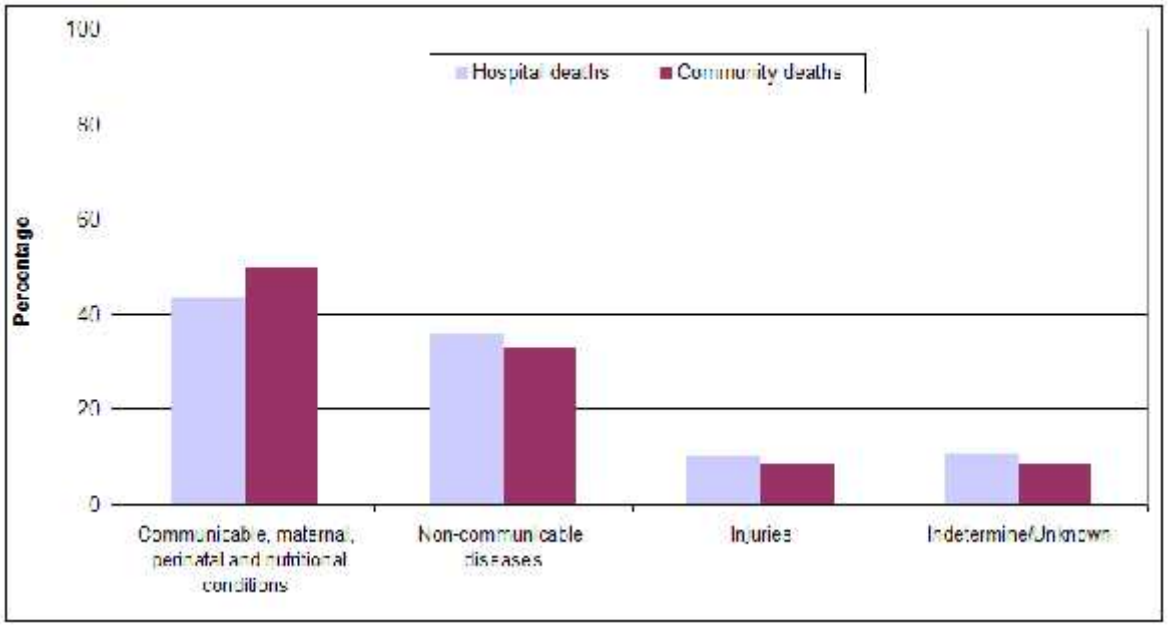

Figure 3: **Causes of death by major category and site, 2011-2012**

In **Group I**, the main causes of death in both the (26%) hospital and (37%) community deaths weredue to infectious and parasitic diseases.In **Group II**:deaths due to cardiovascular diseases was (18%) in the community deaths and (9%) in the hospital deaths and diabetes mellitus was (6%)in the community deaths and (2%) in the hospital deaths. Malignancies (11%) is higher in the hospital deaths, while in the community deaths cancer contributed (4%) of deaths (**Table 2**).

Causes of death in the hospital not found in the community included: perinatal conditions, endocrine disorders,digestive diseases and congenital abnormalities. Among the infectious and parasitic diseases, HIV/AIDS and tuberculosis contributed to over a third of deaths in both the hospital and in community, while preterm birth, low birth weight and birth asphyxia were predominant perinatal conditions observed in the hospital. Malaria was among infectious causes of death reported in both the hospital and in the community. However, few cases were reported. Common non-natural causes observed in the hospital were road traffic accidents, burns, homicide

and poisoning, while in the communityroad traffic accidents, homicide and poisoning were the main causes of non-natural deaths.

Table 2: Main causes of death in Group I and II

	Hospital deaths		Community deaths	
	No	%	No	%
GROUP I				
Infectious and parasitic diseases	1422	26.3	197	38.6
Perinatal conditions	380	7.0	-	-
Respiratory infections	404	7.5	53	10.4
Maternal conditions	53	1.0	2	0.4
Nutritional deficiencies	101	1.9	6	1.2
GROUP II				
Malignancies	609	11.3	21	4.1
Cardiovascular diseases	465	8.6	90	17.6
Digestive diseases	260	4.8	-	-
Respiratory diseases	138	2.6	4	0.8
Diabetes Mellitus	127	2.4	32	6.3
Genito urinary diseases	127	2.4	6	1.2
Neuropsychiatric conditions	77	1.4	1	0.2
Endocrine disorders	65	1.2	-	-
Congenital abnormalities	36	0.7	-	-
Other NCD	26	0.5	1	0.2
GROUP III	540	10.0	47	9.2
GROUP IV	572	10.6	50	9.8
All causes	**5402**	**100**	**510**	**100**

4.4 Causes of Death by Age-Group

This section presents the causes of death in different age groups. Five age groups were used: under5 year old age group (0 to 4 years old), children (5 to 14 years old), young adults (15 to 49 years old), adults aged between 50 and 64 years old and those aged 65 yearsold and above.

4.4.1 Causes of Childhood Death (<1 year, 1-4 years and 5-14 years)

There were few deaths (n=22) that occurred in the community among children in the under 5 year age group (**Table 3**). The causes of death in the hospital for children less than 1year old were dominated by perinatal conditions (46%), mainly preterm

births, low birth weight and birth asphyxia, while in the community of the 3 deaths in this age group 1 was due to infectious diseases and the other two deaths were undetermined.

Amongst children in the 1 to 4 year age group, hospital deaths were dominated by infectious diseases (32%), non-natural causes (16%) and malnutrition (11%), while in the community (42%) were attributed to ill-defined conditions,while infectious diseases caused (26%) of the deaths.

Table 3: **Causes of death among children aged <1 and 1-4 years**

	<1 year		1-4 years		Total	
	Hospital deaths n(%)	Community deaths n(%)	Hospital deaths n(%)	Community deathsn(%)	Hospital deaths n(%)	Community deathsn(%)
Congenital anomalies	36(5)	-	-	-	36(4)	-
Cardiovascular disease	17(2)	-	2(1)	-	19(2)	-
Digestive disease	28(4)	-	6(4)	-	34(4)	-
Genito-urinary	10(1)	-	7(4)	-	17(2)	-
Infectious/parasitic	88(11)	-	29(17)	5(26)	117(12)	5(23)
Injury	21(3)	-	27(16)	1(5)	48(5)	1(5)
Cancer	6(1)	-	8(5)	-	14(1)	-
Neuropsychiatry	4(1)	-	4(2)	-	8(1)	-
Malnutrition	18(2)	-	18(11)	3(16)	36(4)	3(14)
Perinatal conditions	369(46)	-	11(7)	-	380(39)	-
Respiratory disease	30(4)	-	2(1)	-	32(3)	-
Respiratory infections	95(12)	1(33)	25(15)	2(11)	120(12)	2(14)
Other NCD	7(1)	-	3(2)	-	10(1)	
Undermined	69(9)	2(67)	24(14)	8(42)	93(10)	10(45)
Total	**798(100)**	**3**	**166(100)**	**19**	**964(100)**	**22**

Other NCD: Skin diseases, Musculoskeletal and Endocrine disorders

With regard to stillbirths, from 11473 deliveries, 334 stillbirths were recorded in the hospital during the 2-year period of the study, giving a stillbirth rate of 29.1 per 1000 deliveries (data not shown). In the community, no stillbirths were reported.

A large proportion (59.6%) of the stillbirths was macerated. Of these, half (50%) were unexplained intrauterine foetal deaths, (18%) were due to maternal

hypertensive diseases and (14%) were as a result of placenta abruption. Among the fresh stillbirths group, (31%) were due to maternal hypertensive disease, (23%) placenta abruption and (5.8%) were due to foetal distress (**Table 4**).

Table 4: **Causes ofstillbirth in Pietersburg/Mankweng Hospital Complex**

	Fresh stillbirth		Macerate stillbirth		Total	
	No	**%**	**No**	**%**	**No**	**%**
Maternal						
Hypertensive disease	42	31.1	36	18.2	78	23.4
Diabetes mellitus	3	1.9	8	4.0	11	3.2
Cephalo-pelvic disproportion	4	2.9	2	1.0	6	1.8
Unspecified	7	4.9	6	3.0	13	3.8
Foetal						
Congenital anomalies	3	1.9	2	1.0	5	1.4
Foetal distress	8	5.8	-	-	8	2.4
Breaches	7	4.9	-	-	7	2.0
Infection	3	1.9	2	1.0	5	1.4
Placenta						
Placental abruption	31	23.3	28	14.1	60	17.8
Placenta praevia	-	-	2	1.0	2	0.6
Cord accidents	7	4.9	12	6.1	19	5.6
Unexplained IUFD	22	16.5	101	50.5	123	36.8

Amongst children in the 5 to 14 year old age group, infectious diseases(50%) and injuries (20%) were the most common causes of death in the community (n=10), while in the hospital (n=164)infectious diseases (23%), malignant neoplasms(21%) and injuries (13%) were the leading causes of death (data not shown). HIV/AIDS and tuberculosis were the most common causes of death from infectious diseases followed by gastroenteritis and meningitis.

4.4.2 Causes of Death in AdultsAged 15 to 49 Years Old

Amongst adults in the 15 to 49 year old age group, infectious and parasitic diseases were the most common cause of death in both the (43%) hospital and in the (57%) community (**Table 5**).

Table 5: **Causes of Death AmongstAdults 15 years Old and Older**

	15-49yrs		50-64yrs		65yrs	
	Hospital deaths n (%)	Community deaths n(%)	Hospital deaths n (%)	Community deaths n(%)	Hospital deaths n (%)	Community deaths n(%)
Infectious/parasitic diseases	929(43)	108(57)	240(24)	41(39)	98(9)	41(21)
Respiratory infections	122(6)	13(7)	56(6)	7(7)	94(9)	30(15)
Maternal conditions	53(2)	2(01)	-	-	-	-
Nutritional deficiencies	29(1)	1(0.5)	18(2)	-	15(1)	4(2)
Malignant neoplasms	177(8)	6(3)	187(18)	4(4)	196(18)	11(6)
Cardiovascular diseases	98(5)	10(5)	117(12)	21(22)	225(21)	59(30)
Digestive diseases	82(4)	-	73(7)	-	67(6)	-
Genito-urinary diseases	59(3)	-	27(3)	2(2)	16(1)	4(2)
Diabetes mellitus	18(1)	4(2)	46(5)	8(8)	63(6)	20(10)
Respiratory diseases	40(2)	2(1)	37(4)	1(1)	28(3)	1(1)
Endocrine disorder	19(1)	-	16(2)	-	24(2)	-
Neuropsychiatric disorder	40(2)	-	11(1)	-	7(1)	-
Other NCD	11(1)	-	6(1)	-	3(0)	1(1)
Trauma	327(15)	30(16)	71(7)	3(3)	72(7)	11(6)
Undetermined/Unknown	178(8)	14(7)	116(11)	10(10)	163(15)	14(6)
All causes	**2182**	**190**	**1021**	**97**	**1071**	**196**

Trauma was one of the main causes of death in both the (15%) hospital and in the (16%) community. There were 2 maternal deaths reported in the community, while in the hospital 53 deaths were reported. Causes of death in the hospital which were not found in the community included: digestive diseases, genitor-urinary disease, endocrine disorders and neuropsychiatry conditions.

4.4.3 Causes of Death in AdultsAged between 50 and 64 Years of Age

Amongst adults aged between 50 and 64 years old, common causes of death in both the hospital and in the community included infectious and parasitic diseasesas well as cardiovascular diseases.

The incidence of infectious and parasitic diseaseswas (39%) in the community deaths and (24%) in the hospital deaths.Deaths due to cardiovascular diseases were higher (22%) in the community deaths than in the hospital deaths (12%). However,

cancers were greater cause of death in the hospital (18%) than in the community (4%).

There were (11%) undetermined causes of death in the hospital deaths, while in the community deaths (10%) were recorded as undetermined causes. Causes of death recorded in the hospital which was absent from the community include: digestive diseases, endocrine disorders and neuropsychiatric conditions.

4.4.4 Causes of Death in Adults 65 Years of Age and Older:

Amongst adults aged 65 years old and older, cardiovascular diseases were by far the most common causes of death in both the (30%) hospital and in the (21%) community. The cause of death due to infectious and parasitic disease was (21%) in the community deaths and (9%) in the hospital deaths and respiratory infections was (15%) in the community deaths and (9%) in the hospital deaths.

In this age category undetermined causes of death were more common in the (15%) hospital deaths than in the (6%) community deaths. The proportion of deaths due to diabetes mellitus was (10%) in the community deaths and (6%) in the hospital deaths.However, malignant neoplasms caused more deaths in the (18%) hospital than in the (6%) community.

4.5 Summary

Chapter 4summarised the age and gender of the deceased and the leading causes of death that occurred in the hospital and in the nearby community. The mortality

rates in the Dikgale Health and Demographic SurveillanceCentre are presented in Chapter 5.

CHAPTER 5: COMMUNITY MORTALITY RATES

5.1 Introduction

This chapter presents the mortality rates in the Dikgale HDSSCentre for the years 2012. In 2011, verbal autopsy records were incomplete and could not be included in the cause-specific mortality rates in this chapter.

The chapter is subdivided into two sections: (1) population size, age and gender distribution in the community, (2) age and gender-specific mortality rates.

5.2 Population Size, Age and Sex Distribution in the Community

The total population of the Dikgale Demographic Health and Surveillance Site (HDSS) Centre was 36 572 during the period of the study. Overall, females constituted approximately 53% of the population (Figure 4).

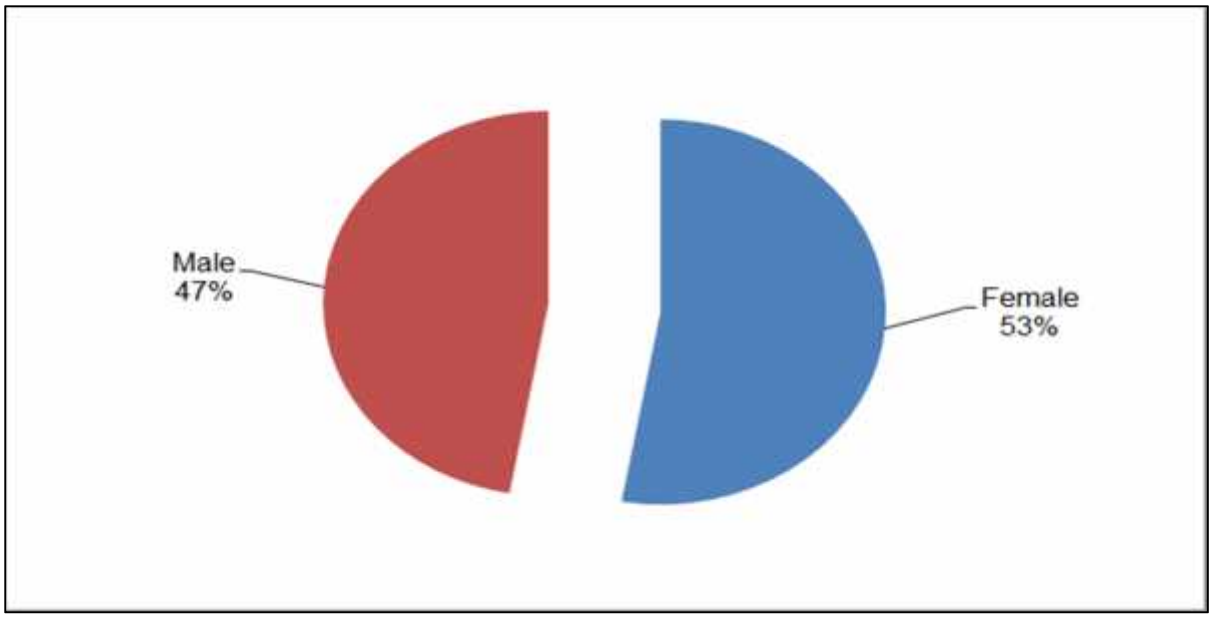

Figure 4: Gender distributionin the community

Young adults aged between 15 and 49 years of age comprised 54.5% of the total population and adults 65 years and older made up 6.9% (Figure 5).

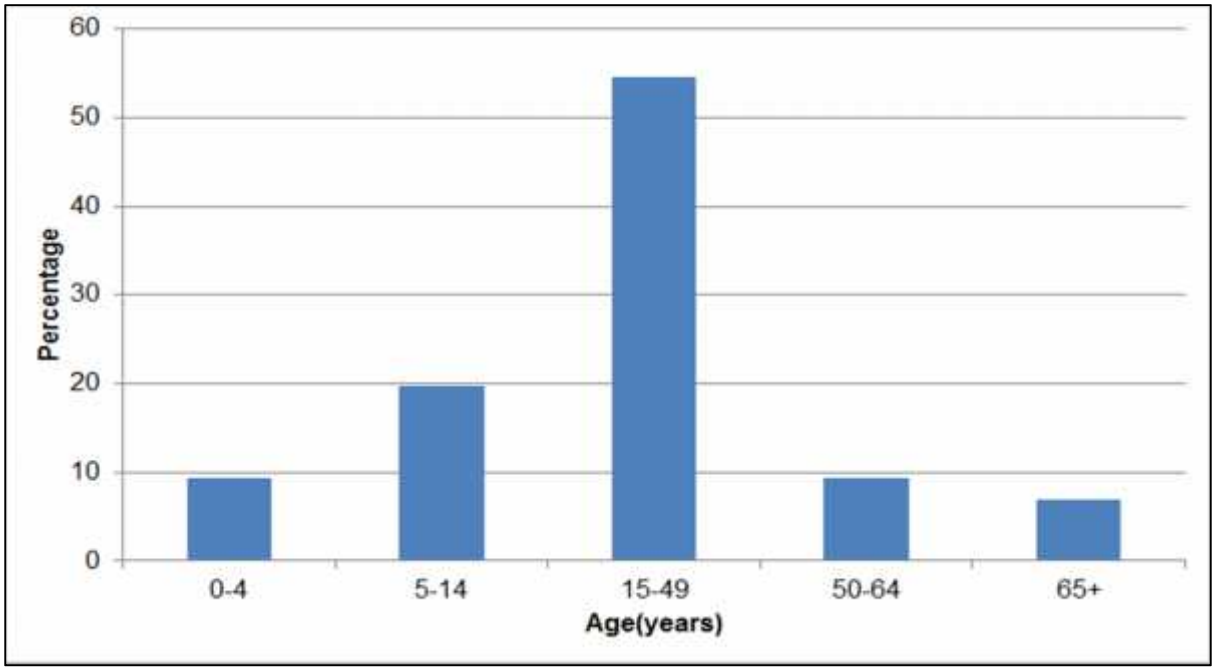

Figure 5: Age distribution in the community

5.3 Age and Gender Specific Mortality Rate in the Community

A total of 340 deaths occurred in Dikgale HDSS out of 36572person-years of observation, which gives an overall mortality rate of 9.3 deaths per 1000 person-years.Most (62%) of the deaths occurred at home with (38%) occurring in health facilities.

The mortality rates by gender are shown in **Table 6**. A higher mortality rate was observed among males (9.7 deaths per 1000 person-years) compared to females (8.9 deaths per 1000 person-years).

Table 6: **Mortality Rates (per 1000 person-years) in Dikgale HDSS**

	Deaths	Person years	Death rate
Male	168	17 273	9.7
Female	172	19 299	8.9
Total	**340**	**36 572**	**9.3**

Regarding age, overall the mortality rate was 3.5 per 1000 person-years in children in the 0 to 4year old age group and dropped to 1.1 per 1000 person-years in those aged between 5 and 14 years old (**Table 7**).

Table 7: **Crude Mortality Rates (per 1,000 person-years) by Age and Gender**

Age group	Overall			Females			Males		
	Deaths	Person years	Death rate	Deaths	Person years	Death rate	Deaths	Person years	Death rate
0-4 years	12	3438	3.5	4	1721	2.3	8	1717	4.7
5-14 years	8	7242	1.1	5	3651	1.4	3	3591	0.8
15-49 years	120	19938	6.0	63	10235	6.2	57	9702	5.9
50-64 years	63	3439	18.3	28	1956	14.3	35	1483	23.6
≥65 years	137	2516	54.5	72	1736	41.5	65	780	83.3

The highest mortality rates were observed amongst adults in the 50 to 64year old age group (18.3 deaths per 1000 person-years) and those in the 65+year old age group (54.5 deaths per 1000 person-years). The mortality rate was 6.0 deaths per 1000 person years in adult in the age group 15-49 years.

With regard to the mortality rate by gender, in both males (83.3 deaths per 1000 person-year) and females (41.5 deaths per 1000 person-year) a high rate of deaths occurred in adults in the 65+ year old age group. Mortality rate was lower among femalesin all age groups except in children aged 5-14 years.

5.5 Summary

Chapter 5 summarised the mortality rate in the community of Dikgale Health and Demographic Surveillance Site in Limpopo Province. In chapter 6, the causes of death assigned on the hospital death registration formsare compared to the causes obtained from a verbal autopsy reports.

CHAPTER 6: AGREEMENT OF CAUSES OF DEATH BETWEEN HOSPITAL RECORDS AND VERBAL AUTOPSY

6.1 Introduction

In the previous chapter the mortality rates in Dikgale HDSS centre were presented. This chapter compares the cause of death as it appeared on the death notification form with that derived using a verbal autopsy instrument. The results are presented by cause specific mortality fraction (CSMF's) and measures of agreement using sensitivity, specificity and Cohen's kappa statistics.

A total of 340 deaths occurred in Dikgale HDSS in 2012 and verbal autopsies were performed on 327 of these cases to determine the cause of death. Of these deaths, 36% (117 out of 327) occurred in the health facility. Out of 117 deaths that occurred in the health facility, 93% (109 out of 117) occurred in the Pietersburg/Mankweng Hospital Complex.

Of thelinkable deaths (community deathsthat occurred in the Pietersburg/Mankweng Hospital Complex), 49.5% (54/109) of the hospital records were retrieved. The rest of the hospital records were not available in the record room either due to destruction or the files did not have a cause of death included on the death notification form.

6.2 Demographic Profile of the Deceased

Of 54 available cause of deaths records more than half (52%) were males (data not shown). The distribution of age at death showed that (37%) of deaths were in the age group 15 to 49 years old, and (43%)were aged 65 years old and above. There

were few deaths in the age groups 0 to 4 years old (4%) and 50 to 64 years old (17%).

6.3 Causes of Death on Hospital Records and by Verbal Autopsy

The cause of death recorded on the death notification forms and the cause of death determined by verbal autopsies are shown in **Table 8**. The findings of this study show that infectious and parasitic diseases as well as cardiovascular diseases were the most common causes of death recorded on death notification forms and by verbal autopsy.

Of the 54 patient files retrieved, the death notification formcoded cardiovascular disease as the underlying cause of death for 24% of deaths, while VA ascribed cardiovascular disease to 20% of deaths. There was no statistical significant difference between the hospital records and the verbal autopsiesas far as cause of death due to cardiovascular diseases (p=0.817) was concerned. Infectious and parasitic diseases were said to have caused 39% of deaths in the hospital compared to 41%as determined by verbal autopsies (p=1.000).

Other causes of death which showed insignificant differences between hospital records and verbal autopsies included diabetes mellitus (4% versus 6%, p=0.270); injury (6% versus 6%, p=1.000); malignancies (9% versus 4%, p=0.437); maternal conditions (2% versus 2%, p=1.000); respiratory infections (7% versus 11%, p=0.742) and ill-defined conditions (6% versus 4%, p=1.000). Causes of deathson the death notification formsthat were not determined by verbal autopsies included: endocrine disorders and neuro-psychiatric diseases.

Table 8: **Causes of Death on Hospital Records and by Verbal Autopsies**

	Hospital Records		Verbal Autopsy	
	No	**%**	**No**	**%**
Cardiovascular disease	13	24	11	20
Diabetes Mellitus	2	4	6	11
Endocrine disorders	1	2	-	-
Infectious/parasitic disease	21	39	22	41
Injury	3	6	3	6
Malignant Neoplasm	5	9	2	4
Maternal	1	2	1	2
Neuropsychiatric disorders	2	4	-	-
Respiratory Infections	4	7	6	11
Undetermined	2	4	3	6
Total	**54**	**100**	**54**	**100**

6.4 Agreement of Causes of Death between HospitalRecordsand Verbal Autopsies

Due to the low number of deaths due to endocrine disorders, maternal conditions, and neuropsychiatric disorders and undetermined were not included in determining the agreement between hospital and verbal autopsy report. The agreement between causes of death derived from verbal autopsies and death notification forms for top six causes of death is presented in **Table 9**.

The overall agreement for all causes of death was 48.2%. A high percentage of agreement was achieved for respiratory infections (96.3%), diabetes mellitus (92.6%) malignant neoplasms (90.4%), and injuries (85.2%). Cardiovascular diseases (74.1%) and infectious and parasitic diseases (68.5%) achieved the lowest percentage of agreement.

The sensitivity (39%) was slightly higher among infectious and parasitic diseases, while the remaining causes of death the sensitivity ranged between 4% and 24%. The InterVA-3 had a specificity ranging between 80% and 96% with infectious and parasitic diseases and neoplasm scoring high.

Table 9: **Agreement of Causes of death between Death Notificationsand Verbal Autopsy**

Major disease	Hospital Records	Verbal Autopsy	Agreement Rate (%)	Sensitivity (%)	Specificity (%)	K(SE)
CVD	13(24%)	11(20%)	74.1	24	80	0.25(0.13)
Neoplasms	5(9%)	2(4%)	90.4	9	96	0.24(0.12)
I&P	21(39%)	22(41%)	68.5	39	96	0.34(0.14)
Respiratory infection	4(7%)	6(11%)	96.3	7	89	0.64(0.14)
Injury	3(6%)	3(6%)	85.2	6	94	0.12(0.13)
Diabetes mellitus	2(4%)	6(11%)	92.6	4	89	0.47(0.12)
All causes	54	54	48.2			0.33(0.06)

I&P: Infectious and parasitic disease; CVD: Cardiovascular diseases

The Cohen's kappa statisticalanalysis of the differences between death notification forms and verbal autopsies for all causes of death showed a fair agreement (0.33).For individual cause of death the agreement was fair for infectious and parasitic diseases (0.34), cardiovascular disease (0.25) and malignant neoplasm (0.24). The findings of this study, however, showed a moderate to substantial agreement between death notification form records and verbal autopsies for respiratory infections (0.64) and diabetes mellitus (0.47).

Table 10 presents the discrepancy pattern of the major causes of death with low agreement. The columns of the matrix indicate the number of deaths assigned to a

particular cause of death in the notification form records, while the rows show the cause of these deaths assigned as a result of a verbal autopsy.

Of the 13 deaths ascribed to cardiovascular diseases on the death notification forms, verbal autopsies agreedin only 5 cases, 8 cases were re-classified to other causes. In 21 deaths certified as due to infectious diseases on the death notification forms, 13 were classified as such after VA review, the remaining eight (8) were assigned to other causes.

Table 10: **Discrepancies Observed between VA Diagnoses and HospitalRecords**

	Death Notification Form									
Verbal Autopsy	CVD	Neoplasm	Diabetes Mellitus	Endocrine disorder	I&P	Injury	Maternal	Neuropsychiatric disorder	Respiratory infection	Undetermine
CVD	5	1	0	1	3	0	0	1	0	0
Neoplasm	0	1	0	0	1	0	0	0	0	0
Diabetes Mellitus	3	1	2	0	0	0	0	0	0	0
Endocrine disorder	0	0	0	0	0	0	0	0	0	0
I&P	2	2	0	0	13	1	0	1	2	1
Injury	0	0	0	0	1	2	0	0	0	0
Maternal	0	0	0	0	0	0	1	0	0	0
Neuropsychiatric	0	0	0	0	0	0	0	0	0	0
Respiratory infection	3	0	0	0	2	0	0	0	1	0
Undetermine	0	0	0	0	1	0	0	0	1	1
Total	**13**	**5**	**2**	**1**	**21**	**3**	**1**	**2**	**4**	**2**

CVD; Cardiovascular diseases; I&P: infectious and parasitic disease

6.5 Summary

Chapter 6 examined the agreement between causes of deathdetermined from death notification forms and cause of death derived from verbal autopsies. The discussion on the findings from chapter 4, 5 and 6 will be presented in the next chapter, with support from appropriate literature.

CHAPTER7: DISCUSSION AND CONCLUSION

7.1 Introduction

Lifestyle-and health-related behaviours are recognised as preventable risk factors of morbidity and mortality in both low and middle income and high income countries (Khaw et al., 2008; Stringhini et al., 2010; Stringhini et al., 2011). Mortality risk factors vary by age, gender and geographic region, thus it is important to understand the leading causes of death attributed to these variables so that relevant intervention strategies can be planned (Senn et al., 2006; Muula, 2008; Sayem et al., 2012; Bhutta et al., 2013; Chopra et al., 2013).

7.2 Gender and Age at Death

In 2010, the World Health Organization (WHO) reported that globally most deaths (43%) occurred at age 70 years and older (Wang et al., 2012). Similarly, in high-income countries like the USA, a large proportion of deaths occur amongst adults aged 70 years and older (Heron, 2012), whereas in South Africa, a middle-income country, more than 40% of all deaths occurred in adults in the 15 to 49 year old age group (Stats SA, 2013). These findings indicate that mortality patterns differ from country to country and depend on the availability of healthcare, lifestyle and wealth of a particular country (Stringhini et al., 2011). Thus preventable social and behavioural risk factors, such as excessive alcohol drinking and unprotected sexual practice, are linked to higher mortality among teenagers and young adults (Senn et al., 2006; Muula, 2008).

It is not surprising that in the present study, in both settings, a greater proportion of deaths occurred amongst young adults in the 15 to 49 year old age group, which concurs with the findings from other tertiary hospitals in Nigeria (Preacely et al., 2012) and Pakistan (Aziz et al., 2013) and HDSS sites in South Africa (Kahn et al., 2007; Mashego et al., 2007; Sartorius et al., 2010; Herbst et al., 2011). However, in contrast with HDSS sites in rural India (Palanivel et al., 2013) and Kenya (Negin et al., 2010) where it was found that a higher proportion of deaths occurred amongst adults aged 50 years and above.

It is worrisome to note that in this study a large number of deaths in both settings occurred amongst adolescents and young adults, which is the most economically active group. This has negative implications on households as well as for the economic development of the country (Carter et al., 2007; Hunter et al., 2011). Consistent with many studies in sub-Saharan Africa (Adeolu et al., 2010; Checchi et al., 201; Dlodlo et al, 2011; Ohene et al., 2011; Etyang et al., 2013), in this study HIV/AIDS was the dominant cause of death in these age groups.

For decades, the South African (SA) government was in denial of the HIV epidemic and lifesaving antiretroviral therapy (ART) was not provided to those in need (Simelela et al., 2014). Currently there are three million people in South Africa on ART which has increased life expectancy from 56 to 61 years in the period 2009-2012. However, there continues to be more new HIV infections especially in women age 15-24 years (Simelela et al., 2015).

There are many factors that make young people vulnerable to HIV infection. Social and economic factors put adolescents and young adults especially women at higher risk of infection (Kamndaya et al., 2014; Kunnuji, 2014). In addition, alcohol use, lack of knowledge, education about HIV and life skills, poor access to health systems and early sexual debut increase the risk of HIV infection (Monasch and Mahy, 2006; Oppong Asante et al., 2014; Nkosi et al., 2014).

The involvement of parents and other family member's, mass media programmes, sex education and HIV education interventions in schools have shown to influence HIV-related outcomes among young people (Monasch and Mahy, 2006; Bertrand et al., 2006; Kirby et al., 2006; Keeney and Palley, 2013).

With regard to gender differences, in the present study males experience slightly higher death rates than do females in the hospital. Similar findings of higher male death rates were found in other tertiary hospitals in Nigeria (Preacely et al., 2012; Adeolu et al., 2010; Sanya et al., 2011; Ayoade et al., 2013), Ethiopia (Abejew et al., 2014) and Pakistan (Tariq et al., 2009; Aziz et al., 2013).

In this study, the community deaths were dominated by females which is similar to the studies conducted in rural Kenya (Van Eijk et al., 2008; Phillips-Howard et al., 2012). In contrast, another study in Kenya (Negin et al., 2010) and in India (Palanivel et al., 2013) demonstrated that two-third of deaths in rural areas involved males. Similarly, the HDSS in Kwa-Zulu Natal Province (Mashego et al., 2007) and Mpumalanga Province (Kahn et al., 2007; Sartorius et al., 2010) also reported a higher proportion of male deaths.

Several national reports from Statistics South Africa have shown that there were slightly more male than female deaths in South Africa (Stats SA, 2013, Stats SA, 2014). The number of male deaths in South Africa has always been exceptionally large (Timaeus, 1999). Although the present study did not assess the causes of death by gender, the reasons for high mortality among males are not entirely certain, however, aggressive behaviours by young adult males (Roger et al., 2010) and the unwillingness of men to use health services and report health problems may account for some of this excessive burden of mortality (Signh-Manoux et al., 2008).

7.3 Causes of Death

7.3.1 Stillbirths

Stillbirths continue to be a public health crisis and account for a significant proportion of mortality burden in the neonatal period (Ananth et al., 2009; Lawn et al., 2011). The rates of stillbirths remain high (an estimated 98%) in low and middle income countries of sub-Saharan Africa and South Asia (McClure et al., 2006; Stanton et al., 2006; Cousens et al., 2011). In the present study, a greater proportion of stillbirths were found in the hospital deaths, while in the community deaths no stillbirths were reported. There is a lack of studies assessing factors that affect disclosure of stillbirth. However, studies found that most stillbirths and early neonatal deaths in the rural communities are hidden and disposed without recognition or rituals (i.e. funeral rites) because the blame is often on the witchcraft and other supernatural forces (Haws et al., 2010; Frøen et al., 2009; Frøen et al, 2011; Kiguli et al., 2015).

There are several medical and non-medical risk factors that are associated with stillbirths and these factors vary by geographical region. In developed countries the non-medical risk factors for stillbirths include: low socioeconomic status (Smith et al., 2010; Seaton et al., 2012), smoking behaviour during pregnancy (Gray et al., 2009; Gardosi et al., 2013; Goldenberg et al., 2013; Gordon et al., 2013), exposure to second-hand smoke during pregnancy (Varner et al., 2014) andoverweight and obesity (Flenady et al., 2011; Gardosi et al., 2013). In developing countries, high stillbirth rates could be related to inadequacies in accessing appropriate maternal health care during the antenatal period and at the time of delivery (McClure et al., 2006; McClure et al., 2007; Haws et al., 2009; Shrestha and Yadav, 2010).

Regarding medical risk factors, many studies have found that the most common risk factors associated with stillbirths in developed and developing countries were hypertension in pregnancy (Roberts et al., 2008; Duley et al., 2009; Berg et al., 2009; Hossain et al., 2009; Jammeh et al., 2010; Steegers et al., 2010; Bateman et al., 2012) obstetric haemorrhage (Walch et al., 2008; Engmann et al., 2009; Jammeh et al., 2010; Shrestha et al., 2010) and obstructed labour (Nwogu-Ikojo et al., 2008; Alkire et al., 2012; Engmann et al., 2012; Mmbaga et al., 2012; Alkali et al., 2014). Moreover, a few studies in low- and middle-income countries indicated that placenta/cord factors, congenital malformations, infections (Ngoc et al., 2006; Jammeh et al., 2010) and unexplained intrauterine foetal death were the common causes of stillbirths (Pattinson, 2009; Day et al., 2009; Shrestha and Yadav, 2010).

In the present study the findings from the hospital data confirm maternal hypertensive diseases and placenta/cord factors as common causes of stillbirth; however, unexplained intrauterine foetal deaths were documented as the most

common causes of death. Early and regular antenatal care visits have shown to improve the outcome of pregnancy for both the mother and the newborn (Di Mario et al., 2007; Young et al., 2007; Engmann et al., 2009; Feresu, 2010; McClure et al., 2011; Oteng-Ntim et al., 2012; Thangaratinam et al., 2012; ; McPherson, 2013; Schmiegelow et al., 2012; Ensor et al., 2014).

There is evidence that psychosocial intervention during pregnancy reduces smoking behaviour and reduces stillbirth (Chamberlain et al., 2013). Moreover, because of the high rate of unexplained intrauterine foetal deaths, it is recommended that interventions be made to introduce foetal autopsies to tertiary healthcare facilities and that an educational intervention aimed at teaching pregnant women be instituted.

7.3.2 Causes of Death in Children below 1 year Old

Infant mortality has been shown as an important contributor to under-five mortality. Globally, six million children die each year before their fifth birthday, of which more than two-thirds (71.1%) died in the neonatal period. More than (80%) of these deaths occur in low-and middle-income countries, particularly in sub-Saharan Africa and Asia (Liu et al., 2012).

As very few infant mortality are recorded in Dikgale HDSS is difficult to make a meaningful conculsion. Although the VA interviews in our setting are conducted annually, the low VA completion rate amongst this age group could be due to the parents not wanting to share information, because discussions of some deaths are

culturally prohibited and confidential or the parent and the family are still traumatised by their loss (Chapman, 2003; Winch et al., 2005; Aborigo et al., 2013).

Among the various recognised causes of neonatal deaths:preterm birth, low birth weight, birth asphyxia andneonatal infectionsremain the most common in developing countries, however, an increase in the proportion of neonatal death caused by congenital malformationshas been noted (Kassebaum et al., 2014). In South Africa, preterm birth, low birth weight, birth asphyxia and neonatal infections - primarily pneumonia, sepsisand malaria – are the main cause of neonatal deaths (Nannan et al., 2012).

A number of hospital-based (Grandin et al., 2006; Ngocet al., 2006; Huerga et al., 2009; Forae et al., 2014; Mmbaga et al., 2012) and community-based studies (Manandhar et al., 2010; Okechukwu and Achonwa, 2009; Omoiqberale et al., 2010) found preterm birth and low birth weight as main causes of neonatal mortality. In the present study, preterm birth and low birth weight were the most common causes of death among children less than 1 year old observed in the hospital, while in the community none of these conditions were reported. This could be as a result of methodologyused in Dikgale HDSS. Moreover, the hospital based study was conducted in a tertiary referral hospital which admits patients that could not be managed at district and regional hospitals; therefore, the situation may not be a real reflection of causes of child mortalitythroughout the province.

Smoking cessation interventions and use of progesterone have shown to reduce the mortality related to low birth weight and preterm birth, respectively (Barros et al., 2010; Hassan et al., 2011; Slager et al., 2012). Moreover, provision of micronutrients

such as iron, folate and zinc to pregnant women who consume less vitamins and minerals has been shown to significantly impact on low birth weight (Barros et al., 2010).

Birth asphyxia is one of the primary causes of neonatal mortality worldwide (Kassebaum et al., 2014). Studies from different settings have shown birth asphyxia to be the main cause of neonatal deaths. An analysis of data from hospitals(Grandin et al., 2006; Mmbaga et al., 2012; Chiabi et al., 2013; Jacinto et al., 2013; Forae et al., 2014) and from rural communities (Manandhar et al., 2010; Huo et al., 2010; Feng et al., 2012) in low and middle income countries found birth asphyxia to be the most frequent cause of perinatal death. In the present study asphyxiated deaths were common in the hospital, whereas in the community no birth asphyxia deaths were recorded.Theintroduction of basic obstetric care, an improved referral system, and neonatal resuscitation have shown to reduce asphyxiated deaths (Cowles, 2007; Lawn et al., 2007).

Neonatal deaths due to infections are also common in low and middle income countries, whereas in high income countries theseinfections are rare (Black et al., 2010; You et al., 2010; Kassebaum et al., 2013). A number of community-based studies in low and middle income countries reported infections as the leading cause of neonatal deaths (Okechukwu and Achonwa, 2009; Sacarlal et al., 2009; Manandhar et al., 2010; Omoiqberale et al., 2010; Chiabi et al., 2013). Similarly, data obtained from hospitals also showed infections amongstthe most common paediatric causes of death (Grandin et al., 2006; Huerga et al., 2009).

In the present study the hospital- and community-derived causes of death were remarkably similar for infectious diseases, primarily pneumonia and sepsis. This could be reduced by appropriate antenatal care and in-time referral to tertiary care facilities (Mmbaga et al., 2012; Ali et al., 2013). In addition, in malaria endemic areas the use of anti-malarial drugs among primiparae and insecticide-treated nets reduce perinatal mortality (Barros et al., 2010).

7.3.3 Causes of Death in Children Aged between 1 and 4 years Old

In children aged between 1 and 4 years old, preventable infectious diseases, mainly diarrhoea, pneumonia and malaria,constitute over 50% of deathsworldwide (Black et al., 2008; Boschi-Pintoet al., 2008; Johnson et al., 2010; Kassebaum et al., 2014).

Diarrhea is the most important public health problem and is associated with unsafe water and inadequate sanitation (Jasper et al., 2012; Tarrass et al., 2012), low income and poorenvironment (Gebru et al., 2014; Sinmegn Mihrete et al., 2014), being malnourished (O'Reilly et al., 2012); age of child (Siziya et al., 2009; Bbaale, 2011; Sinmegn Mihrete et al., 2014); mother's educational status (Siziya et al., 2009; Bbaale, 2011; Sinmegn Mihrete et al., 2014; Gebru et al., 2014); mother not washing handsbefore preparing foods (Gebru et al., 2014) and climate change (Bhandari et al., 2012;Alexander et al., 2013).

Diarrheal diseaseis a global crisis and prevalent in low and middle income countries, particularly in sub-Saharan Africa including South Africa (Black et al., 2008; Boschi-Pintoet al., 2008; Johnson et al., 2010; Kassebaum et al., 2014). Hospital-based (lloh et al., 2011; Stephen et al., 2011; Grandin et al., 2012; Misganaw et al., 2012b;Forae

et al., 2014) and community-based studies (Garrib et al., 2006; Sacarlal et al., 2009; Awqati et al., 2009; Byass et al., 2010; Johnson et al., 2010; Huo et al., 2010; Liu et al., 2011; Checchi et al., 2011; Feng et al., 2012; Parcesepe et al., 2013) founddiarrhoeato be the number one cause of death in children aged between 1 and 4 years old.

In the present studyonly a small number of deaths in children aged between 1 and 4 years old were reported in the community, which makes it difficult to make a meaningful comparison. Nevertheless, the findings illustrate that in the community no diarrhoeal deaths were reported, whereas in the hospital diarrhoeal diseases were found to be amongst the leading causes of death in this age group.

Strategies aimed to reduce the burden caused by diarrheal diseasesinclude exclusive breastfeeding for up to 6 months of age, oral rehydration solution, zinc therapy;use of safe water and good personal and domestic hygiene (Sayem et al., 2012; Bhutta et al., 2013; Chopra et al., 2013). However, diarrhoealdiseasesare still the leading infectious cause of morbidity and mortality in children under5 years old in sub-Saharan Africa and South Asia (Black et al., 2010; Boschi-Pintoet al., 2008; Johnson et al., 2010; Kassebaum et al., 2014).

Pneumonia is another condition which is prevalent in children under-5 years old. Globally, pneumonia is the single biggest cause of death in children aged between 1 and 4 years old(Ruban et al., 2008; Black et al., 2008; Boschi-Pintoet al., 2008; Johnson et al., 2010; Kassebaum et al., 2014). Most of these deaths occurred in low and middle income countries, especially in Saharan Africa and South Asia where

access to care is limited and the sort of interventions that have led to improved care in developed countries are scarce. Ruban and co-authors (2008)in their study, estimated and incidence of pneumonia in children under-5 years of age of 0.29 episodes per child-year in developing countries and 0.05 episodes per child-year in in high income countries.

In low and middle income countries hospital-based studies (lloh et al., 2011; Stephen et al., 2011; Grandin et al., 2012; Misganaw et al., 2012b) and community-based studies (Sacarlal et al., 2009; Awqati et al., 2009; Byass et al., 2010; Johnson et al., 2010; Huo et al., 2010; Liu et al., 2011; Checchi et al., 2011; Feng et al., 2012; Parcesepe et al., 2013) reported pneumonia as the main cause of death in children aged between 1 and 4 years old. In the present study, 3 out of 11 deaths in the community were due to pneumonia, whereas in the hospital pneumonia caused 15% of deaths.

Pneumonia and diarrhoeal deaths are closely associated (Walker et al., 2013), with preventable risk factors such as lack of exclusive breastfeeding, under-nutrition, indoor air pollution, low birth weight, crowding and lack of measles immunisation (Wichmann et al., 2006; Ruban et al., 2008; O'Reilly et al., 2012;Turneret al., 2013; Sinmegn Mihrete et al., 2014; Gebru et al., 2014).

There are inexpensive and effective measures available for both prevention and control of pneumonia in children. Use of antibiotics, improving case management at home and providing effective referral care for cases with severe pneumonia reduce

childhood pneumonia-related deaths (Ghimireet al., 2012; Sayem et al., 2012; Bhutta et al., 2013; Chopra et al., 2013).

Many studies have been conducted to investigate different aspects of malaria (Abdullah et al., 2007; Becher et al., 2008; Ndugwa et al., 2008), yet the disease remains a leading cause of death among children aged between 1 and 4 years old living in rural areas across sub-Saharan Africa (Black et al., 2010; Liu et al., 2012; Kassebaum et al., 2014). This is not surprising as hospital-based (Misganaw et al., 2012b; Einterz and Bates, 2011; Forae et al., 2014) and community-based studies (Johnson et al., 2010)reported malaria as the leading cause of death in children aged between 1 and 4 years old.Numerous interventions, including insecticide-treated nets and anti-malarial spraying, have shown to contribute to a decrease in the incidence of malaria (Belay et al., 2008; Dawit et al., 2012; Chirebvu et al., 2014).

No deaths due to malaria in children aged between 1 and 4 years old were found in the hospital, while in the community1 case was reported.This could be an imported case or an incorrect diagnosis as Dikgale HDSS is not within a malaria endemic area.

7.3.4 Causes of Death in Children Aged between 5 and 14 years of Age

In low and middle income countries the mortality rate is low and causes of death data amongst children in the 5 to 14 year old age group remained unchanged (Adjuik et al., 2006; Desai et al., 2014; Streatfield et al., 2014). Many studies have specifically investigated the causes of mortality in children under-5 years old but not

in the 5 to 14 year old age group (Black et al., 2010; Liu et al., 2012; Kassebaum et al., 2014). In this study, there were only ten deaths in children aged 5-14 years old in the community which makes it difficult to make a meaningful comparison.

However, the present study indicates that non-natural causes of death were found among the common causes of childhood deaths in both settings. Similarly, studies in low-and-middle-income countries have shown that non-natural causes, particularly road traffic accidents, are the leading causes of death in children in the 5 to 14 year old age group (Hyder et al., 2006; Bener et al., 2007; Hyder et al., 2008; Huicho et al., 2009; Sacarlal et al., 2009; Burrows et al., 2010; Byass et al., 2010; Imamura et al., 2012;Streatfield et al., 2014). Injuries need to be recognised as an important cause of child mortality in the 5 to 14 year old age group in developing countries, including South Africa.

There are numerous effective interventions for the prevention and control of injury morbidity and mortality among children. Parental education has shown to reduce unintentional childhood injury mortality in low-and middle-income countries (Klein et al., 2012; Kendrick et al., 2008; Kendrick et al., 2012; Kendrick et al., 2013).

Moreover, the WHO has recommended several interventions, including identifying a lead agency in governments to guide the national road traffic safety effort, assess the problem and institutional settings relating to road traffic injury and prepare a national road safety strategy and plan of action, allocate financial and human resources to address the problem. Minimize injuries and their consequences and

evaluate the impact of these actions, and support the development of national capacity (Peden et al., 2004).

In the present study HIV/AIDS was amongst the greatest contributors to child mortality, both in the hospital and in the community. Similar results were reported by Byass et al in children from 5 to 14 years of age in Mpumalanga Province, where up to 12% of deaths were attributed to HIV/AIDS (Byass et al., 2010). Most of these children acquired HIV from HIV-infected mothers during pregnancy, at the time of birth or through breastfeeding (Rollins et al., 2007; Rollins et al., 2009; Shetty and Maldonado, 2013; Sinunu et al., 2014).

Sacarlal et al in a study conducted in Mozanbique found that malaria was the single largest cause of death in this age group, accounting for 21.8% of cases (Sacarlal et al., 2009). In present study, no death due to malaria was reported in this age group, because the area is not malaria region.

Effective intervention for the prevention of mother to child transmission of HIV in developing countries exists (Suksomboon et al., 2007; Sturt et al., 2010; Sherman et al., 2014; Bhadwaj et al., 2014). However, such interventions are still not accessible or available in resource-limited countries where the burden of HIV is highest (Aizire et al., 2013; Gourlay et al., 2013; Lerebo et al., 2014).

7.3.5 Causes of Death in Adults (Older Than 15 years of Age)

There have been many community-based studies on causes of death in South Africa (Cook et al., 2008, Kanjala et al., 2010; Byass et al., 2010; Herbst et al., 2011);

however, none compared the causes of adult deaths occurring in a hospital to those occurring in an adjacent community.

Amongst adults in the 15 to 49 year old age group infectious diseases, mainly HIV/AIDS and tuberculosis, are the most common causes of death worldwide (Lozano et al., 2012). Mortality due to these infectious diseases is high in both the hospitals (Adeolu et al., 2010; Ohene et al., 2011; Etyang et al., 2013) and in the communities (van Eijk et al., 2008; Byass et al., 2010; Herbst et al., 2011; Checchi et al., 2011; Dlodlo et al, 2011; Narh-Bana et al., 2012; Chihana et al., 2012; Palanivel et al., 2013).

The results of the present study show very clearly the importance of infectious diseases, particularly HIV/AIDS and tuberculosis, as the leading causes of death amongst adults in the 15 to 49 year old age group. The infectious causes of death in this age group were lower in the hospital compared with the community. It is clear that in this rural community premature deaths as a result of HIV/AIDS could be prevented by effective programmes that provide care for HIV infected persons and programmes directed towards the prevention of HIV infection.

The introduction of antiretroviral therapy (ART) programmes in sub-Saharan African countries have shown to reduce HIV/AIDS mortality among all age groups (Floyd et al., 2012; Marston et al., 2012; Kasamba et al., 2012; Kanjala et al., 2014). In SA, 3 million people are on ART which has increased life expectancy from 56 to 61 years in the period 2009-2012 (Simelela et al., 2015).

Mortality due to injury among people in this age group was shown in the present study to be more common in males than in females. Most of these trauma-related deaths were due to road traffic accidents. These findings are supported by hospital (Juillard et al., 2011; Beharry et al., 2011; Chichom et al., 2013; Ayoade et al. 2013) and community-based studies (Narh-Bana et al., 2012; Palanivel et al., 2013).

Population-based studies have also drawn attention to the significant contribution of road traffic accidents to the death of young adults (Groenewald et al., 2010; Korhonen et al., 2011; Burrow et al., 2013; Zhang et al., 2014). In the present study violent assault and suicide were among the common causes of injury death in the hospital and in the community. The national mortality data reported road traffic accidents, homicide and suicide as the common causes of injury death in young adults (Statistics South Africa, 2014).

There are several preventable risk factors that contribute to deaths due to injuries. Studies have shown that the most common risk factors associated with injury deaths were excessive alcohol consumption, disregarding of traffic rules and regulations, driver rush and the lack of effective street lighting (Beyer et al., 2009; Bakhtiyari et al., 2014).

When considering deaths amongst women, pregnancy-related complications are known to be a public health problem worldwide, particularly in sub-Saharan Africa and Asia (Koblinsky et al., 2012; Bhutta et al., 2013; Kassebaum et al., 2014).

The MDG-5 recommended a global reduction of the maternal mortality rate by three quarters between 1990 and 2015 (Bryce et al., 2013). However, there are many

challenges such as maternal death definition (Mckee et al., 2010; Garenne et al., 2013), missing data, and their uneven distribution (Byass, 2009), lack of capacity to collect data and data collection varies in quantity and quality (Graham et al., 2008).In addition, different approaches are used to assess maternal mortality (Hill and Stanton, 2011). According to Hill and Stanton (2011) hospital maternal mortality data are unreliable as they do not represent the population and community based data are few to be statistically meaningful.

In the present study 53 maternal deaths were reported in the hospital, whereas in the nearby community only 1 death was recorded. Much emphasis had been placed on reduction of maternal mortality worldwide, however, many low and middle income countries, lack equipment and adequatehealthcare, family planning, early and appropriate referrals to health facilities, and access to skilled birth attendants and patients travel long distances to receive proper care(Ujah et al., 2005; Kassebaum et al., 2014; Say et al., 2014). Alvarez et al reported that socio-economic status, adult's literacy rate, access to clean water and government expenditure on health per capita is also associated with maternal mortality (Alvarez et al., 2009).

The predominant factors contributing to maternal deaths seen during this study included factors such as hypertension in pregnancy and maternal haemorrhage. Many hospital-based studies in developing countries reported maternal haemorrhageand hypertension in pregnancy as common causesof maternal death (Igberase et al., 2007; Kongnyuy et al., 2009; Lee et al., 2012; Dinyain et al., 2013; Der et al., 2013; Bukar et al., 2013).

Similarly, a community-based study in India also reported maternal haemorrhage and hypertension in pregnancy as the leading causes of maternal deaths (Gupta et al., 2010). Provision of antibiotics and oxytocics, manual removal of placenta and blood transfusion, if needed, have been shown to prevent maternal haemorrhage, while hypertension in pregnancy is commonly treated with anticonvulsants (Nour, 2008; Bhutta et al., 2008; Acosta et al., 2012; King, 2013; Kassebaum et al., 2014; Say et al., 2014).

Amongst adults in the 50 plus age group the World Health Organisation reported that non-communicable diseases, such as cardiovascular diseases and malignant neoplasms,were the most common causes of death worldwide (WHO, 2011a; Lozano et al., 2012, WHO, 2013). In developing countries hospital-based studies reported cardiovascular diseasesand neoplasms as the leading causes of death amongst adultsin the 45 years old and olderage group (Tariq et al., 2009; Papazafiropoulou et al., 2010; lliyasu et al., 2010; Beharry et al., 2011; Preacely et al., 2012; Olarinde and Olatunji, 2014). Cardiovascular diseases and neoplasmswere also found in the community to be the leading causes of death amongst adult aged 50 years old and older (Kynast-Wolf et al., 2010; Kumar et al., 2012).

The findings from this study show that cardiovascular diseasesand neoplasms were the most common causes of death in this age group. Deaths due to cardiovascular diseases were significantly higher in the community than the hospital, while the proportion of cancer-related deaths was greater in the hospital. These diseases are related to modern lifestyle risk factors such as tobacco use, unhealthy diet, overweight and obesity, physical inactivity, high blood pressure and the harmful use

of alcohol (Pennant et al., 2010; Korczak et al., 2011; WHO, 2011b; van de Vijver et al., 2012; Nguyen et al., 2012).

In the present study infectious diseases were found to be amongst the most common causes of death in adultsin the 50 year old and older age group. Among the infectious diseases, HIV/AIDS,tuberculosis, and gastro-enteritis continue to be the predominant cause of death in this age group and were significantly higher in the community than in the hospital. This is not surprising as tuberculosis has been reported to be the leading cause of adult deaths in South Africa (Stats SA, 2013). The results of this study emphasise the need to develop innovative strategies to address these communicable diseases, particularly with regard to the need to curtail transmissions from the infected people to those not yet infected, as well as to improve on successful treatment outcomes.

In the present, the causes of death in the hospital which were not recorded in the community included digestive diseases, genitor-urinary disease, endocrine disorders and neuropsychiatry conditions.

Mateen and Kalter (2012) found that verbal autopsy may or may not assist in providing data on neurological conditions in adults. Moreover, many VA studies did not record some of the non-communicable diseasesespecially digestive diseases, genitor-urinary diseases, and endocrine disorders (Yang et al., 2006; Wang et al., 2007; Khalili et al., 2012; Mossong et al., 2014), while others did record these conditions (Alam et al., 2014).

It is likely that some causes of deaths are less likely to occur in some geographical locations due to environment, social, and culture.Furthermore, it would be interesting to investigate why VA is unable to diagnosis neurological conditions.

7.4 Community Mortality Rates

Mortality statistics provide information which is of great importance in assessing the health and well-being of a population. In Dikgale HDSS data on mortality has been compiled since 1996, though causes of death data was not capturedfor many years.

The results of the present study indicated that 36 572 person-years were observed during the 12-months follow-up period, of which 340 deaths occurred over the 12 month period, resulting in an overall mortality rate of 8.4 deaths per 1000 person-years. This finding is consistent to the mortality rates observed in other surveillance sites in sub-Saharan Africa like Kenya (Negin et al., 2010; Olack et al., 2014), South Africa (Kanjala et al., 2010; Sartorius et al., 2010), Tanzania (Narh-Bana et al., 2012) and Bangladesh (Adjuik et al., 2006), which reported mortality rates ranging from 5-20 deaths per 1000 person-years. In the Kwa-Zulu Natal surveillance sites with high HIV prevalence the mortality rates were relatively high compared to our findings, ranging from 15 to 30 deaths per 1000 person-years (Mashego et al., 2007; Herbst et al., 2011).

The highest mortality rate in the present study occurred among adults in the 65 year old and older age group, followed by adults in the 50 to 64 year old age group, with 48.9 and 16.6 deaths per 1000 person-years, respectively. This finding is in

agreement with data from other surveillance sites in sub-Saharan Africa (Sartorius et al., 2010; Narh-Bana et al., 2012; Olack et al., 2014), however, it appears that the under-5 age group mortality rate in the present study is lower than the rates reported from other surveillance sites (Sartorius, 2013b; Olack et al., 2014; Weldearegawi et al., 2014).

The high mortality rate amongst adults in the present study is most likely because of the remoteness of health facilities, low education and low socio-economic status (Weiner et al., 2007; Ataguba et al., 2011; McLaren et al., 2013); while lower mortality in the under-5 year old age group seems to coincide with the introduction and roll-out of the national programme for preventing mother-to-child transmission of HIV (Sartorius et al., 2013a).

With regard to gender, the present study indicated that males experienced higher mortality rates than did females, which could be related to aggressive behaviours by young adult male (Roger et al., 2010) and an unwillingness on the part of men to report their health problems (Signh-Manoux et al., 2008). The predominance of male deaths has been documented in various surveillance sites in Kenya (Negin et al., 2010), India (Palanivel et al., 2013) and South Africa (Khan et al., 2007; Mashego et al., 2007; Sartorius et al., 2010; Sartorius et al., 2013a). In contrast in rural Kenya, a study which explored deaths among young adult in the 15 to 24 year old age group demonstrated that the death of females contributed to two-thirds of all deaths (Phillips-Howard et al. 2012).

In the present study about 60% of deaths took place outside of a health facility. This percentage is slightly lower than that found from other studies carried out in Kenya (van Eijk et al., 2008; Philips-Howard et al., 2012), however, this is higher than the national estimates for South Africa (Stats SA, 2013). It is worth noting that access to health facilities is not just a matter of distance as other factors such as poverty and inequality in socio-economic status may be even more important in defining the health-seeking behaviour pattern in rural communities (Weiner et al., 2007; Ataguba et al., 2011; McLaren et al., 2013).

Although the cause of death data has not been collected in Dikgale HDSS for many years, it is likely that the major causes of deaths in this rural area are due to infectious diseases, particularly HIV/AIDS, in all age groups and increases burden of non-communicable diseases amongst adults (Kahn et al., 2007; Mashego et al., 2007; Tollman et al., 2008; Sartorius et al., 2010; Herbst et al., 2011). Thus, an increase in non-communicable disease-related mortality in this rural population indicates a need for preparedness to deal with this potential double burden. Studies found that the introduction of antiretroviral therapy (ART) reduced HIV/AIDS mortality in sub-Saharan African countries (Floyd et al., 2012; Marston et al., 2012; Kasamba et al., 2012; Kanjala et al., 2014).

7.5 Agreement of Cause of Death between Hospital Records and Verbal Autopsies

Mortality statistics obtained from vital registration systems are a widely used source of epidemiological data for monitoring the healthcare services and for formulating health policies. Many studies have identified quality problems associated with

mortality data and suggested that the discrepancies be investigated so that improvements can be made (Burger et al., 2007; Nojilana et al., 2009; Bradshaw et al., 2010; Groenewald et al., 2010).

To compare the cause of death reported on death certificates with clinical records or verbal autopsies (Rao et al., 2007; Wang et al., 2007; Burger et al., 2012; Misganaw et al., 2012a; Khalili et al., 2012) areusually assessed by using the concepts of sensitivity, specificity or kappa statistics of agreement and these reliability measures are affected by inadequate sample size (Leitao et al., 2013).

Furthermore, comparative studies face the challenge of how to obtain a suitable reference diagnosis and many use medical records or death certificates as a “gold standard” (Kumar et al., 2006; Burger et al., 2007; Misganaw et al., 2012a). Use of medical records of diagnosis of cause of death as the “gold standard” has been considered to have limitations (Bradshaw et al., 2010; Groenewald et al., 2010). Recent evidence demonstrated that there are no “gold standard” definitions for reference diagnoses used for comparison (Byass, 2011).

In our study, the sample size was small compared to other studies (Setel et al., 2006; Yang et al., 2006; Wang et al., 2007; Rao et al., 2007) which make it difficult to make a meaningful comparison. Nevertheless, the cause-specific mortality fractions for all cause of death groups diagnosed by VA were similar to the causes of death obtained from the hospital records. This finding is in line with the finding of studies carried out in low- and middle-income countries (Kumar et al., 2006; Misganaw et al., 2012a; Pane et al., 2013).

In the present studythe sensitivity of individual causes of death ranges from 2% to 39%, which is lower compared to previous studies (Setel et al., 2006; Rao et al., 2007; Khalili et al., 2012). The specificity of most of the causes of death in the present study being more than 80% is consistent with other studies (Wang et al., 2007; Rao et al., 2007; Khalili et al., 2012).The InterVA model has been shown in many studies to have high sensitivity and specificity identifying the cause of death (Byass et al, 2003; Byass et al, 2006; Fantahum et al, 2006; Vergnano et al., 2011; Byass et al., 2012). In the present study, a small sample size might have influence the results.

With regard to overall agreement, in the present study the overall level of agreement between hospital records and the verbal autopsy report to establish all cause of death was fair (kappa= 0.33)with level of agreement for individual diseases ranging from 60% to 96%. Similar findings were reported in Kilifi Health Demographic Surveillance System in Kenya (Bauni et al., 2011). Wang and co-authors found a kappa score of more than 40% for all causes of death except for tuberculosis, hypertensive disease and poisoning (Wang et al., 2007).

Although the sample size was small the findings of the present study show that certain direct causes of death in the hospital can be determined by means of verbal autopsies with a reasonable level of confidence.

Afinding in the present study is that infectious diseases, mainly HIV/AIDS-related deaths, are often misclassified on the hospital record as being due to other conditions. This finding concurs with the findings of several quality studies in low-and

middle income countries (Burger et al., 2007; Nojilana et al., 2009; Yudkin et al., 2009; Birnbaum et al., 2011, Misganaw et al., 2012a; Haque et al., 2013).

The explanation probably is that clinicians received inadequate training in completing the death notification form or are reluctant to certify HIV/AIDS as the underlying cause of death due to concerns about confidentiality of the information on the death notification form (Nowels, 2004; Nojilana et al., 2009).

Moreover, there has been an improvement in the quality of mortality data, especially in high income countries (Mahapatra et al., 2007; Setel et al., 2007).A number of studies have shown that educational intervention can dramatically improve the accuracy of the completion of death certificates by clinicians, leading to the production of high quality mortality data for epidemiological research and public health policy determination (Villar and Pérez-Méndez, 2007; Selinger et al., 2007; Pandya et al., 2009; Aung et al., 2010; Azim et al., 2014).

7.6 Limitations of the Study

This study suffered from some limitations: Firstly, the hospital mortality data was retrospectively collected and was limited to a two-yearperiod; a longer study period may show a different pattern of causes of death. Moreover, the hospital data was collected in a tertiary referral hospital which admits severely ill patients that could not be managed at lower level of care due to complications; therefore, the situation may not be a real reflection of cause of death throughout the Province.

Secondly, the causes of death recorded in the hospital were based on the clinical assessment of the attending medical doctor, no autopsies were performed on any of the deceased and no post-mortem records could be used to verify the correctness of the causes of death recorded in the register and on death notification forms.

Thirdly, comparing the community mortality rate with similar studies from other indepth HDSS locations (Khan et al., 2007; Floyd et al., 2010; Negin et al., 2010;Herbst et al., 2011; Olack et al., 2014), the present study is somewhat compromised by the relatively small sample size.Finally, for comparison of causes of death recorded on a hospital record with verbal autopsy reports, the present study failure to find or retrieved some of the patient files from the hospital, which resulted to small sample size is also cause for concern.

7.7 Recommendations

Accurate and timely information on the causes of death are essential for understanding the magnitude and distribution of the disease burden so that programs can be developed to address the health needs of a given population (Setel et al., 2007).

Based on the results of this study, the following recommendations are proposed:

- The present study found that the mortality rate in Dikgale (HDSS) is similar to other HDSS and a high proportion of deaths occurred at home. Evidence showed that deaths that occurred at home in rural communities are as a result of distance, socio-economic status and local culture (Weiner et al., 2007; Ataguba et al., 2011;

McLaren et al., 2013). The government efforts in improving the community social and economic status might reduce inequalities in healthcare access. In addition, evidence from Free State province showed that effective and prompt inter-facility transport of patients with pregnancy complications to an appropriate facility resulted in a reduction of maternal mortality (Schoon, 2013).

- Deaths that occur at home have a devastating impact on the quality of causes of death data because most deaths occur without contact with health services during the illness preceding death. This study has demonstrated the potential of the verbal autopsy instrument to identify the causes of death in populations where a large proportion of deaths occur outside hospitals. This is in line with what AbouZahr et al (2012) observed in their study, that is, when properly applied, the verbal autopsyinstrument can yield population-based causes of death data of comparable quality to that typically collected in hospitals in developing countries.

- Ahigh rate of stillbirths was observed in the hospital with unexplained intrauterine foetal causes, which are of particular concern. It is recommended that interventions be made to introduce foetal autopsies at this tertiary referral hospital to determine the cause of stillbirths.In addition, educational intervention aimed at pregnant women should be encouraged because inadequate antenatal care, smoking behaviour during pregnancy and overweight and obesity has influence on newborn and maternal outcome. Moreover, pregnant women in the community should be identified and followed until the baby is delivered.

- Amongst children less that1 year old, preterm birth, low birth weight and birth asphyxia were identified as the main causes of death in the hospital, while in the community infectious diseases were identified as the main cause of death. Causes of preterm birth and low birth weight are multi-factorial and are closely related, therefore this study recommends that the government must continue to focus on tackling the socio-economic status of the population. Also suggestedis that early recognition of these complications and adequate foetal monitoring by health workers may reduce the perinatal deaths from these diseases.

- In children in the 1 to 4 year old age groups infectious diseases,mainly diarrhoea and pneumonia,were the most common causes of death in both the hospital and in the community. Pneumonia and diarrhoeal deaths are closely associated with preventable risk factors such as poverty, under-nutrition and poor hygiene. It is well-known that exclusive breastfeeding up to 6 months of age, oral rehydration solution, zinc therapy and antibiotics for pneumonia reduces pneumonia and diarrhoeal related mortality.

- A great potential for the reduction of impact on adult health lies in education aimed at changing personal behaviours. Most of the leading causes of death amongst adults, such as HIV/AIDS, tuberculosis, cancers, cardiovascular diseases and injuries can be linked to a handful of personal behaviours.
- Innovative injury-prevention strategies and interventions to control the spread of infectious diseasesare urgently required. Cancer screening services and culturally appropriate lifestyle programs are needed to address the burden of non-communicable diseases.

- Finally, medical students and trainee specialists should be trained in the completion of death notification forms and much more research is required on comparing the causes of death obtained in the health facility and those from the community nearby.

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ANNEXURE : Informed consent form Sepedi

Setatamente mabapi le go tsea karolo ka go Protseke.

Leina la Protseke: Analysis of Causes of Death at Home and in a Public Hospital, Capricorn District of Limpopo Province.

Ke badile ka ga tsedimoso mapabi le maikemisetso le merero wa dinyakisiso tseo di sisintswego gomme ke ile ka fiwa monyetla wa go botsisa dipotsiso gomme ka fiwa nako yeo e lekanego gore ke naganisise ka ga taba ye. Ke tloga ke kwesisa maikemisetso le merero wa dinyakisiso tse gabotse. Ga se ka gapeletswa go kgatha tema ka tsela efe goba efe.

Ke a kwesisa gore go kgatha tema Protsekeng keg a boithaopo gomme nka tlogela go kgatha tema nako efe goba efe ntle le gore kef e mabaka. Se se ka se be le khuetso efe goba efe go kalafo yaka ya ka mehla ya maemo a ka gape e ka se huetse le ge e ka aba tlhokomelo yeo ke e humanago go ngaka yaka ya ka mehla.

Ke a tseba gore Protseke di dumeletswe ke Medunsa Campus Research and Ethics (MCREC), Yunibesithi ya Limpopo (Khamphase ya Medunsa). Ke tseba gabotse gore dipoelo tas Protseke d ital dirisetswa merero ya saense gomme do ka pkatlalatswa. Ke dumelela le se, ge fela bosephiri bja ka bo ka tiisetswa.

Mo ke fa tumelelo ya go kgatha tema Protsekeng.

Leina la moithaopi				Mosaeno wa moithaopi
Lefelo		Date		Tlhatse

Setatamente ka Monyakisisi

Ke fana ka tshedimoso ka molomo le/goba yeo e ngwadilwego mabapi le Protseke ye.
Ke dumela go araba dipotsiso dife goba dif etas ka moso mabapi le Protseke ka bokgoni ka moo nka kgonago ka gona. Ke tla latela melao yeo e dumeletswego.

Leina la Monyakisis		Mosaeno		Letsatsikgwedi		Lefelo

ANNEXURE: Informed consent form English

Statement concerning participation in the Research Project

Name of project: Analysis of Causes of Death at Home and in a Public Hospital, Capricorn District of Limpopo Province.

I have been informed about the aims and objectives of the proposed Study and was provided the opportunity to ask questions. I declare that the aim and objectives of the present study are sufficiently clear to me and that I was given adequate time to rethink and understand the issue.

I understand that participation in this Study is completely voluntary and that I may withdraw from the study at any time without supplying any reasons. I equally understand this will have no consequences on me personally or members of this household.

I know this Study has been approved by the Provincial Department of Health & Welfare and the Provincial Research Committee, and I am fully aware that the results of this Study will be used for scientific purposes and as such may be published in scientific journals. I agree to this, provided there will be no breach in confidentiality and my privacy will be guaranteed.

I hereby consent to participate in this Project.

Name of Respondent		Name of Respondent
Place		Date

Statement by the researcher

I have provided verbal information regarding the aims and objectives of this Project.

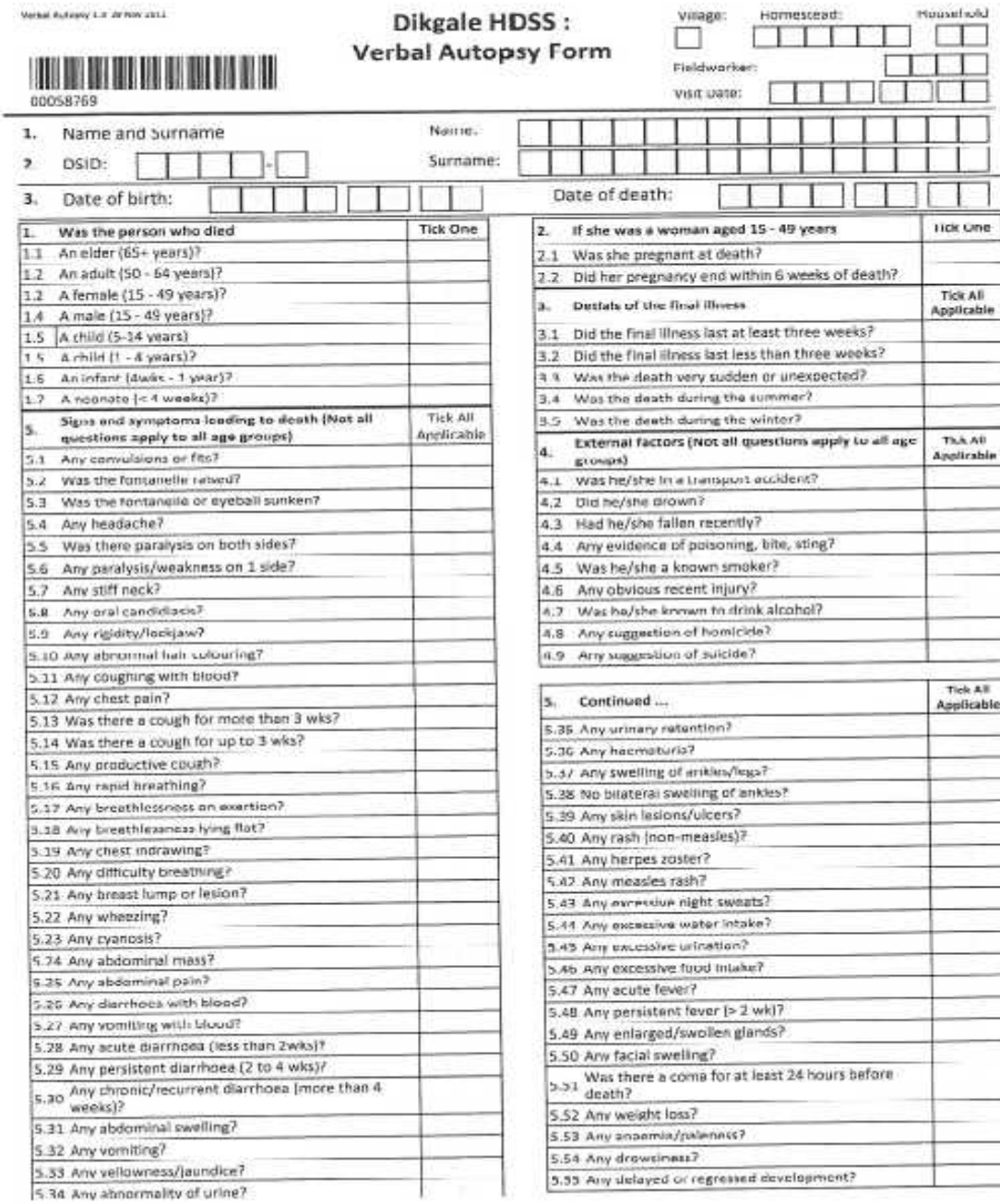
I agree to answer any future questions concerning the study to the best of my knowledge and I will adhere to the approved protocol.

Name of researcher		Signature		Date		Place

ANNEXURE : Data Abstraction Form for Health Facility

NO.	PATIENT REG.	DATE OF DEATH	AGE	GENDER	CAUSE OF DEATH

ANNEXURE : Verbal Autopsy Questionnaire



Dikgale HDSS : Verbal Autopsy Form

Village: Homestead: Household

Fieldworker:

Visit Date:

00058769

1. Name and Surname — Name:

2. DSID: — Surname:

3. Date of birth: Date of death:

1. Was the person who died	Tick One
1.1 An elder (65+ years)?	
1.2 An adult (50 - 64 years)?	
1.2 A female (15 - 49 years)?	
1.4 A male (15 - 49 years)?	
1.5 A child (5-14 years)	
1.5 A child (1 - 4 years)?	
1.6 An infant (4wks - 1 year)?	
1.7 A neonate (< 4 weeks)?	

5. Signs and symptoms leading to death (Not all questions apply to all age groups)	Tick All Applicable
5.1 Any convulsions or fits?	
5.2 Was the fontanelle raised?	
5.3 Was the fontanelle or eyeball sunken?	
5.4 Any headache?	
5.5 Was there paralysis on both sides?	
5.6 Any paralysis/weakness on 1 side?	
5.7 Any stiff neck?	
5.8 Any oral candidiasis?	
5.9 Any rigidity/lockjaw?	
5.10 Any abnormal hair colouring?	
5.11 Any coughing with blood?	
5.12 Any chest pain?	
5.13 Was there a cough for more than 3 wks?	
5.14 Was there a cough for up to 3 wks?	
5.15 Any productive cough?	
5.16 Any rapid breathing?	
5.17 Any breathlessness on exertion?	
5.18 Any breathlessness lying flat?	
5.19 Any chest indrawing?	
5.20 Any difficulty breathing?	
5.21 Any breast lump or lesion?	
5.22 Any wheezing?	
5.23 Any cyanosis?	
5.24 Any abdominal mass?	
5.25 Any abdominal pain?	
5.26 Any diarrhoea with blood?	
5.27 Any vomiting with blood?	
5.28 Any acute diarrhoea (less than 2wks)?	
5.29 Any persistent diarrhoea (2 to 4 wks)?	
5.30 Any chronic/recurrent diarrhoea (more than 4 weeks)?	
5.31 Any abdominal swelling?	
5.32 Any vomiting?	
5.33 Any yellowness/jaundice?	
5.34 Any abnormality of urine?	

2. If she was a woman aged 15 - 49 years	Tick One
2.1 Was she pregnant at death?	
2.2 Did her pregnancy end within 6 weeks of death?	

3. Details of the final illness	Tick All Applicable
3.1 Did the final illness last at least three weeks?	
3.2 Did the final illness last less than three weeks?	
3.3 Was the death very sudden or unexpected?	
3.4 Was the death during the summer?	
3.5 Was the death during the winter?	

4. External factors (Not all questions apply to all age groups)	Tick All Applicable
4.1 Was he/she in a transport accident?	
4.2 Did he/she drown?	
4.3 Had he/she fallen recently?	
4.4 Any evidence of poisoning, bite, sting?	
4.5 Was he/she a known smoker?	
4.6 Any obvious recent injury?	
4.7 Was he/she known to drink alcohol?	
4.8 Any suggestion of homicide?	
4.9 Any suggestion of suicide?	

5. Continued ...	Tick All Applicable
5.35 Any urinary retention?	
5.36 Any haematuria?	
5.37 Any swelling of ankles/legs?	
5.38 No bilateral swelling of ankles?	
5.39 Any skin lesions/ulcers?	
5.40 Any rash (non-measles)?	
5.41 Any herpes zoster?	
5.42 Any measles rash?	
5.43 Any excessive night sweats?	
5.44 Any excessive water intake?	
5.45 Any excessive urination?	
5.46 Any excessive food intake?	
5.47 Any acute fever?	
5.48 Any persistent fever (> 2 wk)?	
5.49 Any enlarged/swollen glands?	
5.50 Any facial swelling?	
5.51 Was there a coma for at least 24 hours before death?	
5.52 Any weight loss?	
5.53 Any anaemia/paleness?	
5.54 Any drowsiness?	
5.55 Any delayed or regressed development?	

6.	Details of medical history	Tick All Applicable
6.1	Been discharged from hospital very ill?	
6.2	Any surgery just before death?	
6.3	Was he/she adequately vaccinated?	
6.4	Any diagnosis of TB?	
6.5	Any diagnosis of asthma?	
6.6	Any diagnosis of diabetes?	
6.7	Any diagnosis of heart disease?	
6.8	Any diagnosis of HIV/AIDS?	
6.9	Any diagnosis of hypertension?	
6.10	Any diagnosis of liver disease?	
6.11	Any diagnosis of cancer?	
6.12	Any diagnosis of stroke?	
6.13	Any diagnosis of measles?	
6.14	Any diagnosis of kidney disease?	
6.15	Any diagnosis of haemoglobinopathy?	
6.16	Any diagnosis of malaria?	

7.	If the was a woman who died shortly before or after childbirth	Tick All Applicable
7.1	Any delivery complications?	
7.2	Any heavy bleeding before/after delivery?	
7.3	Was there prolonged labour > 24 hrs?	
7.4	Were there convulsions during delivery?	

8.	If this was a baby who died within a month of birth	tick all applicable
8.1	Was the baby born early < 34 wks /	
8.2	Was the baby small < 2500 g?	
8.3	Was there difficulty breathing at birth?	
8.4	Any congenital malformations?	
8.5	Was this a multiple birth?	
8.6	any umbilical infection?	

Please write here any further information coming from the interview, which you think might not have been well covered in the questions above

ANNEXURE : List of ICD 10 codes used

Cause name	ICD-10 code
Communicable, maternal, perinatal and nutritional conditions	A00-B99;G00-G04;N70-N73;J00-J06;J10-J18;J20-J22,H65-H66;O00-O99;P00-P96; E00-E02;E40-E46;E50;D50-53;
A. Infectious and parasitic diseases	
Tuberculosis	A15-A19; B90
HIV/AIDS	B20-B24
STI's excluding HIV	A50-A64
Syphilis	A50-A3
Chlamydia	A55-A56
Gonorrhoea	A54
Other STI's	A57-A64;N70-N73
Diarrheal disease	A00;A01;A03;A04;A06-A09
Meningitis	A39; G00; G03
Hepatitis A, B & C	B15; B16-B19
Malaria	B50-B54
B. Respiratory Infections	
Lower respiratory infections	J10-J18; J20-J22
Upper respiratory infections	J00-J06
Otitis media	H65-H66
C. Maternal Conditions	O00-O99
Maternal haemorrage	O44-O46;O67;O72
Maternal sepsis	O85-O86
Hypertensive disorders of pregnancy	O10-O16
Obstructed labour	064-O66
Abortion	O00-O07
D. Perinatal Conditions	
Prematurity and low birth weight	P05;P07;P22;P27-P28
Birth asphyxia and birth trauma	P03;P10-P15;P20-P21;P24-P26;P29
Neonatal infections and other conditions	P00-P02;P04;P08;;P23;P35-P96
E. Nutritional deficciencies	
Protein-energy malnutrition	E40-E46
Iodine deficiency	E00-E02
Vit A deficiency	E50
Iron-deficiency anaemia	D50-D64.9
Other nutritional disorders	D51-D53;E51-E64
Non-communicable diseases	
Malignant neoplasm	C00-C97;D00-D48
Mouth and orapharynx	C00-C14
Oesophagus	C15
Stomach	C16
Colon and rectum	C18-C21
Liver	C22
Pancreas	C25
Trachea/bronchus and lung	C33-C44
Melanoma and other skin	C43-C44
Breast	C50
Cervix	C53
Corpus uteri	C54-C55
Ovary	C56
Prostate	C61
Bladder	C67
Lymphoma and myeloma	C81-C90;C96
Other neoplasm	D00-D48

Diabetes mellitus	E10-E14
Endocrine disorder	D55-64(- D64.9); D65-89;E03-07;E15-16;E20-34;
Neuropsychiatric disoders	F01-F99; G06-G98
Sense organ disease	H00-H61; H68-H93
Glaucoma	H40
Cataracts	H25-H26
Refractive errors	H524
Cardiovascular disease	I00-I99
Rheumatic heart	I01-I09
Hypertensive	I10-I13
Ishaemic heart	I20-I25
Cerebrovascular	I60-I69
Inflammatory heart	I30-133;I38.I40;I42
Respiratory infections	J30-J98
Chronic obstructive pulmonary	J40-J44
Asthma	J45-J46
Other respiratory	J30-J39; J47-J98
Digestive disease	K20-K92
Peptic Ulcer	K25-K27
Cirrhosis of Liver	K70-K74
Appendicitis	K35-K37
Genitourinary diseases	N00-N64; N75-N98
Nephritis and nephrosis	N00-N19
Benign prostatic hypertrophy	N40
Other genitor-urinary	N20-N39;N41-N64;N75-N98
Skin diseases	L00-L98
Musculoskelatal diseases	M00-M99
Rhematoid arthritis	M05-M06
Ostearthritis	M15-M19
Gout	M10
Low back pain	M45-M48;M54 (-M54.2
Congenital anomalies	Q00-Q99
Oral conditions	K00-K14
Dental caries	K02
Periodontal	K05
Injuries	V01-Y89
A. Unintentional	
Road traffic accidents	
Poisoning	
Burns	
Drowning	
Falls	
B. Intentional	
Self-inflicted	
Violence	

ANNEXURE : Approval letter from Ethics Committee

UNIVERSITY OF LIMPOPO
Medunsa Campus

MEDUNSA RESEARCH & ETHICS COMMITTEE

CLEARANCE CERTIFICATE

P O Medunsa
Medunsa
0204
SOUTH AFRICA

Tel: 012 - 521 4000
Fax: 012 - 560 0086

MEETING: **06/2010**

PROJECT NUMBER: **MREC/P/146/2010: PG**

PROJECT :

Title:	Analysis of causes of death at home and in a public hospital, Capricorn District of Limpopo Province
Researcher:	Mr S Ntuli
Supervisor:	Prof M Alberts
Co-supervisor:	Prof P Byass
Hospital Superintendent:	Dr RS Khoabane
Department:	Chemical Pathology
School:	Pathology - Turfloop Campus
Degree:	PhD

DECISION OF THE COMMITTEE:

MREC approved the project.

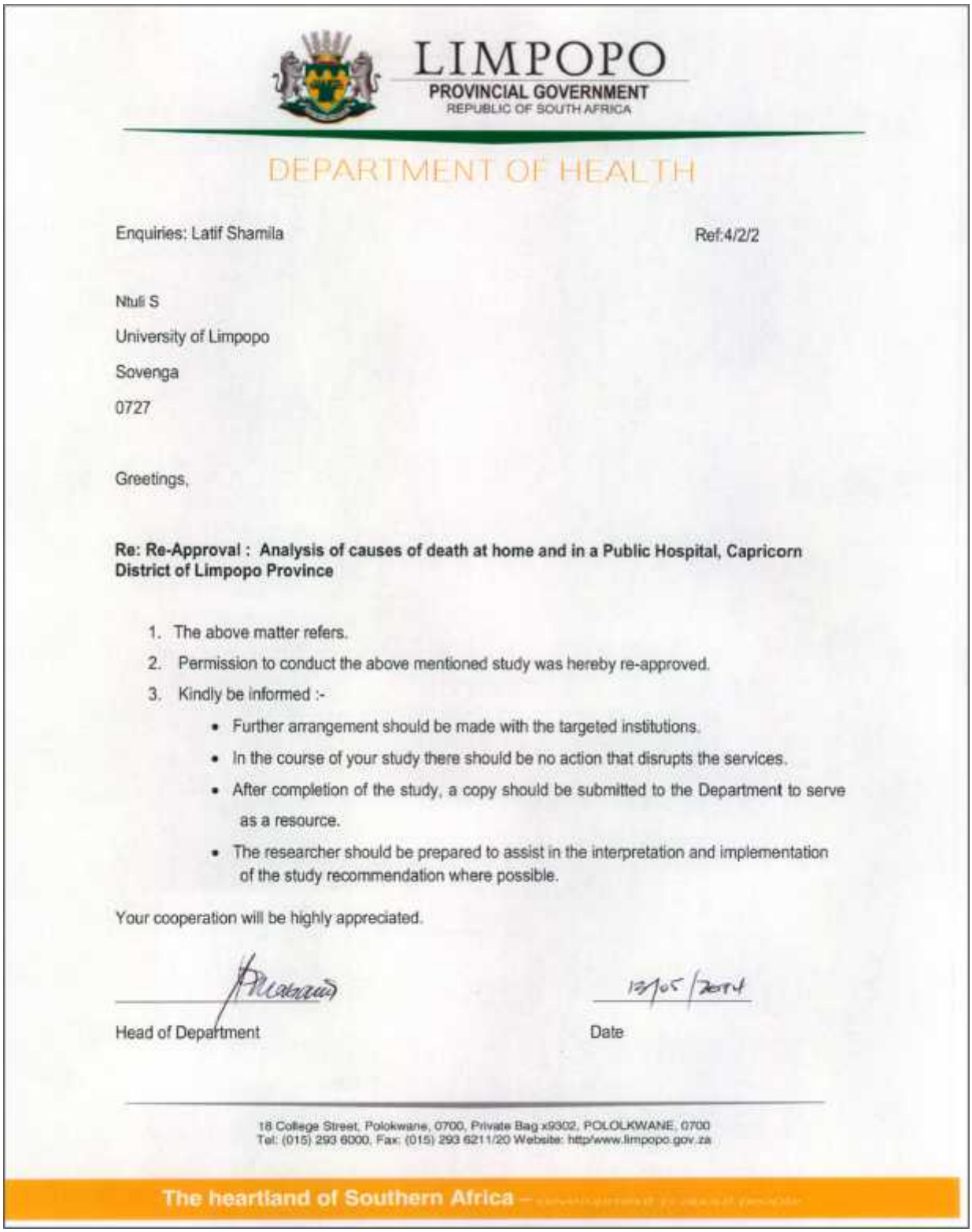
DATE: 06 August 2010

PROF GA OGUNBANJO
CHAIRPERSON MREC

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

African Excellence - Global Leadership

ANNEXURE: Approval Letter from Provincial Office



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH

Enquiries: Latif Shamila

Ref:4/2/2

Ntuli S
University of Limpopo
Sovenga
0727

Greetings,

Re: Re-Approval : Analysis of causes of death at home and in a Public Hospital, Capricorn District of Limpopo Province

1. The above matter refers.
2. Permission to conduct the above mentioned study was hereby re-approved.
3. Kindly be informed :-
   - Further arrangement should be made with the targeted institutions.
   - In the course of your study there should be no action that disrupts the services.
   - After completion of the study, a copy should be submitted to the Department to serve as a resource.
   - The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.

Your cooperation will be highly appreciated.

Head of Department

13/05/2014
Date

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An Investigation of the Stillbirths at a Tertiary Hospital in Limpopo Province of South Africa

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Abstract

Objective: To determine the stillbirth rate and identify the causal factors associated with it in a tertiary hospital.

Methods: A retrospective review of records of women who had stillbirths at a tertiary hospital of the Limpopo Province was conducted. The study period was two years from January 1, 2009 to December 31, 2010. The hospital maternity registers were used to identify the women who gave birth during the study period. Data were collected using a data collection form designed for the study. The data collected included maternal age, parity, gestation, mode of delivery, obstetric complications, infant or foetal's gender and weight; whether the birth was fresh stillbirth or macerated and cause of stillbirth.

Results: There were 5597 deliveries during the two years period of the study. The hospital-based stillbirth rate was 38.4 per 1000 births, with 71% being macerated. The majority of women with stillborn infant in this study were in the age group (24%) 20-34 years, followed by (23%) aged 35 years and older. Nulliparity was associated with stillbirth. Unexplained intrauterine foetal death, hypertensive disease, placenta abruptio was the leading causes of stillbirth.

Conclusion: In this study stillbirth rate seems to be unacceptably high, though less than those reported in other settings. The causal factors associated with it were identified as nulliparity, unexplained intrauterine foetal deaths, hypertensive disease, and placenta abruptio. Because of the high rate of stillbirths reported in this study, it is recommended that interventions be made to introduce fetal autopsies at the tertiary healthcare facilities and that an educational intervention aimed teaching pregnant women be instituted.

Keywords: stillbirth, prematurity births, South Africa

1. Introduction

Stillbirth continues to pose serious challenges in both developed and/or developing countries. In the recent years, a significant decline in stillbirths has occurred in many developed countries due to improvement in antenatal and delivery care, while rates in developing countries remain high. A number of studies have reported a stillbirth rate of less than 10 per 1000 delivery in developed countries (Shankar et al., 2002; O'Leary et al., 2007; McClure et al., 2007; Archibong et al., 2003), while other studies indicated rates of 10 to 40 per 1000 in developing countries (Shrestha & Yadav, 2010; Ngoc et al., 2006; Elhassan et al., 2009; Onyiriuka, 2009; Engmann et al., 2009; Chigbu et al., 2009; Saving Babies, 2009). However, there are few studies with a stillbirth rate of more than 40 per 1000 delivery in developing countries (Hossain et al., 2009; Jammeh et al., 2010; Onadeko & Lawoyin, 2003; Stanton et al., 2006).

There are different medical and nonmedical factors that result in pregnant women given birth to a stillborn baby. The most common medical factors reported are pre-eclampsia/eclampsia, obstetric haemorrhage and prolonged/obstructed labour (Elhassan et al., 2009; Engmann et al., 2009; Jammeh et al., 2010; McClure et al., 2009; Walch et al., 2008). A few studies reported placenta/cord factors, diabetes mellitus and congenital malformation as the commonest conditions (Shrestha & Yadav, 2010; Zupan, 2005). Maternal or foetal infection as possible cause of stillbirth has been reported in developing countries, whereas in developed countries lower proportion is attributable to infection (Gibb, 2002; Cham et al., 2009). Some studies reported advanced maternal

age and multipara as high risk factors of stillbirth (O'Leary et al., 2007; Jammeh et al., 2010; Stanton et al., 2006). Hossain et al. (2009) in their study shows that gender of the baby was not associated with stillbirth.

Several studies reported nonmedical factors such as referral from peripheral health facility, delay in receiving appropriate management, lack of skilled birth attendants and antenatal care as the commonest conditions that lead to stillbirths (Shrestha & Yadav, 2010; Hossain et al., 2009; Onadeko & Lawoyin, 2003; Zupan, 2005). Jammeh and colleagues (2010) in their study reported caesarean section delivery as the risk factor of stillbirth, while other studies showed no relationship between the caesarean section delivery and stillbirth rate (WHO, 2004). Cham et al. (2009) from their study conducted in Gambian hospitals, reported vaginal delivery as a risk factor of stillbirth in women with severe obstetric complications.

The studies reviewed illustrated the variation in rates and the risk factors associated with stillbirths in developed and developing countries. Tertiary health centers usually admit more risk obstetric patients. There is a need to understand the distribution of fresh and macerated stillbirths and deaths within the immediate postpartum period in order to identify factors contributing to them and relevant interventions. This study was conducted to determine the rates and the documented causal factors of stillbirths among neonates at Pietersburg provincial referral hospital, South Africa.

2. Methods

A retrospective descriptive study was conducted at a provincial tertiary hospital in the Limpopo Province, South Africa. The study was performed over 2-years period (January 1, 2009 to December 31, 2010). The hospital maternity registers were used to identify the women who gave birth during the study period. Data were collected using a data collection form designed for the study. Births without information on vital status were excluded in this study. Stillbirth in this study was defined, in accordance with the World Health Organization's International Classification of Disease (ICD-10) recommendation for international comparison, as the death of a foetus weighing at least 1000 g occurring after 28 weeks of gestation (WHO, 2004).

The Ethics Committee of the University of Limpopo (Medunsa Campus) approved the study; anonymity and confidentiality of patient personal information were protected through several mechanisms. Data for the study were collected using a pre-designed data collection form by trained nurse assistants. The data collected included maternal age, parity, gestation, mode of delivery, maternal obstetric complications, infant or foetal's gender and weight, whether the birth was fresh stillbirth or macerated and cause of stillbirth. A stillbirth was defined as an intrauterine death of a fetus weighing at least 500 grams, whose gestation was over 20weeks, occurring before the complete expulsion or extraction from its mother. A fresh stillbirth was defined as the intrauterine death of a fetus during labor or delivery; while a macerated stillbirth was defined as an intrauterine death of a fetus occurring before the onset of labor and the fetus shows degenerative changes (WHO, 2001). The numbers of fresh and macerated stillbirths are presented as a proportion of all deliveries. Categorical data (i.e. referral status, mode of delivery, baby's gender and weight) was displayed as percentages. Continuous data (i.e. maternal age and parity) was reported as mean ± SD. Comparison was performed using student t-test for continuous variables and chi-square test for categorical variables. The analysis was performed with Statistical software (STATA 9.0; StataCorp; College Station, TX). The p-values of less and/or equal to 0.05 were considered statistically significant.

3. Results

A total of 5597 deliveries were recorded during the period of the study (January 1, 2009 to December 31, 2010). Of these, 218 were stillbirths given a stillbirth rate of 38.9 per 1000 deliveries. The average age of the mother was 28.4 ± 6.9 years (range: 16 to 44 years). More than half (55%) of women were less than 30 years of age. Seventy four mothers (34%) were primigravida, 49(23%) primiparous, 66(31%) had parity between ranging from 2 to 4 children, 8(4%) had parity of 5 or more children, and the remaining 18(8%) parity was unspecified. Ninety-four women (43%) were referred from district, regional hospitals and private sector. The majority of these women were from district hospitals - 73/94(78%). Seventy five patients (34%) delivered by caesarean section and of these 46(61%) were macerated. The stillborn infants had the following characteristics. Fifty-one percent were female and 71% were macerated stillbirths. Their mean weight was 2178g ± 0.84 (Table 2). Of hundred and forty-one (65%) stillborn babies had a low birth weight (birth weight less than 2500g), the majority of them were macerated. There were some differences with regard to the profile of their mothers. The age of women who had fresh stillbirths was significantly lower than those of women who had macerated stillbirths ($p<0.05$). Additionally, the parity of the mothers with macerated stillbirths was significantly higher than those with fresh stillbirths ($p<0.05$). However, no significance difference was observed with regard to distance travelled to tertiary care services ($p>0.05$), although, of the 218 stillbirths, 94(43%) had been referred from other health care facilities. Although the

difference was not statistically significant, referrals were slightly higher among women with fresh stillbirths than those with macerated stillbirths (Table 3).

Table 1. Maternal demographic characteristics

	N	%
Maternal age		
<20	20	9
20-24	51	24
25-29	47	22
30-34	36	17
35+	49	23
Unspecified	12	6
Parity		
0	74	34
1	49	23
2	30	14
3	24	11
4	12	6
5+	8	4
Unspecified	18	8

Table 2. Stillbirth characteristics

	N	%
Gender		
Male	108	49
Female	110	51
Birth weight		
1000-1449	61	28
1500-1999	39	18
2000-2499	41	19
≥2500	77	35

Table 3. Demographic characteristics between mothers with fresh and macerated stillborn babies

	Fresh Stillbirth	Macerated stillbirth	Test statistics	p-value
Maternal age, mean ±SD	25.9 ± 6.1	29.4 ± 6.9	-3.524*	<0.01
Parity, mean ±SD	1.03 ± 1.3	1.5 ± 1.6	-2.081*	0.04
Distance to facility, mean ±SD	84.7 ± 65.2 km	73.6 ± 66.3 km	1.132*	0.25
Referred				
Yes	32(50%)	62(40%)	1.749**	0.19
No	32(50%)	92(60%)		
Mode of delivery				
Caesarean section	29(45%)	46(30%)	4.778**	0.03
Normal vaginal delivery	35(55%)	108(70%)		
Baby's gender				
Male	32(50%)	76(49%)	0.008**	0.93
Female	32(50%)	78(51%)		
Baby's Weight				
<2500g	41(64%)	100(65%)	0.015**	0.90
≥2500g	23(36%)	54(35%)		

* Student t-test; ** Chi-square test

There were 154(71%) macerated stillbirths documented during the study period. Of these, half (50%) were unexplained intrauterine foetal deaths, 28(18%) were due to maternal hypertensive disease, and 21(14%) were as a result of placenta *abruptio*. Among the fresh stillbirths group, 20(32%) were due to maternal hypertensive disease, 15(24%) placenta *abruptio*, and 4(6%) were due to foetal distress (Table 4).

Table 4. Etiology of stillbirths

	Fresh Stillbirth	Macerated stillbirth	Total
	N(%)	N(%)	N(%)
Maternal			
Hypertensive disease	20(32%)	28(18%)	48(22%)
Diabetes mellitus	1(2%)	6(4%)	7(3%)
Cephalo-pelvic disproportion	2(3%)	2(1%)	4(2%)
Unspecified	3(5%)	5(3%)	8(4%)
Foetal			
Congenital anomalies	1(2%)	1(1%)	2(1%)
Foetal distress	4(6%)	0(0%)	4(2%)
Breaches	3(5%)	0(0%)	3(1%)
Infection	1(2%)	2(1%)	3(1%)
Placenta			
Placental *abruption*	15(24%)	21(14%)	36(17%)
Placenta *previa*	0(0%)	2(1%)	2(1%)
Cord accidents	3(5%)	10(6%)	13(6%)
Unexplained IUFD	11(17%)	77(50%)	88(40%)

4. Discussion

In our study, the stillbirth rate was 38.9 per 1000 delivery. The findings is similar to those studies which range between 30 and 40 per 1000 delivery (Shrestha et al., 2010; Ngoc et al., 2006; Elhassan et al., 2009; Onyiriuka, 2009; Engmann et al., 2009; Chigbu et al., 2009). Although in other studies the rates were reported to be less than 10 per 1000 delivery (Shankar et al., 2002; O'Leary et al., 2007; McClure et al., 2007; Archibong et al., 2003). The latter were exclusively conducted in developed countries where antenatal and obstetric care at peripheral referring hospitals is much improved compared to developing countries. In South Africa, few studies have estimated national and provincial stillbirth rates. The current perinatal care survey of South Africa (2006/07) recorded a national stillbirth rate of 24.4 per 1000 deliveires (Saving Babies, 2009). According to the District Health Barometer (2007/2008), the average stillbirth rate for South Africa was 23.0 per 1000 births, and two districts (i.e. rural and urban) of the Limpopo Province had a slightly higher rate than the national average (Day et al., 2009). It is important to note that the stillbirth rate reported in our study is higher than the national average. This finding suggests that the rate of stillbirths may be increasing in this rural province. However, the reported rate is less than the rates reported from other settings in developing countries (Bhattacharya et al., 2010; Ugboma & Onyearugha, 2012; Euzebus et al., 2011).

Previous studies reported that pre-eclampsia/eclampsia, obstetric haemorrhage, prolonged/obstructed labour were the most common risk factors for stillbirths (Shrestha et al., 2010; Elhassan et al., 2009; Onyiriuka, 2009; Engmann et al., 2009; Jammeh et al., 2010; Walch et al., 2008; Begum et al., 2010), while few studies indicated that placenta/cord factors, congenital malformation and infections were the most common cause of stillbirth (Ngoc et al., 2006; Jammeh et al., 2010; Zupan, 2005; Stanton et al., 2006). However, other studies have reported unexplained intrauterine foetal death as the commonest cause of stillbirths (Shankar et al., 2002; Shrestha et al., 2010; Zupan, 2005; Saving Babies, 2009; Day et al., 2009). The findings of our study confirm pre-eclampsia/eclampsia and placenta/cord factors as the common causes of stillbirth, although unexplained intrauterine foetal deaths were the most common.

In our study, younger mother's age between 20 and 24 years and those women aged 35 years and older had high proportion of stillbirths. This finding is in contrast to studies conducted elsewhere (Katz et al., 2008), which found higher rates of stillbirth among adolescents. Others have found stillbirths in older women (O'Leary et al., 2007,

Shrestha et al., 2010; Stanton et al., 2006), while some reported no difference in stillbirths rates by maternal age (Goldenberg et al., 2007).

Specifically, in our data women who had never had prior live births were at higher risk for stillbirths. Hossain and colleagues (2009) as well as Jammeh and co-workers (2010) indicated that both nulliparity and grand multiparity were significantly associated with stillbirths. A similar study reported higher parity as risk factor for stillbirths (Stanton et al., 2006). Several studies reported caesarean section as a risk factor for stillbirth (Onadeko & Lawoyin, 2003), while other studies reported no relationship between caesarean section and intrapartum stillbirth (Hossain et al., 2009; WHO, 2004). One study conducted in Gambian hospitals, reported vaginal delivery as a risk factor for stillbirths (Walch et al., 2008). In the present study, 55% of fresh stillbirths occurred among women who had normal vaginal delivery.

There are many other factors that contribute to higher stillbirth rates in a community. Previous studies have indicated that socioeconomic status and literacy also influence pregnancy outcomes (Bhattacharya et al., 2010; Engmann et al., 2009; Korde-Nayak & Gaikward, 2008). In our study, the socioeconomic status and educational level of the study participants were not assessed, however, a large number of these women came from rural villages with poor socioeconomic backgrounds.

In our study, the majority (71%) of the stillbirths were macerated. This finding is in contrast to several recent studies which found higher proportion of fresh stillbirth (McClure et al., 2007; Chigbu et al., 2009; Hossain et al., 2009; Stanton et al., 2006); while some older studies found similar results (Shankar et al., 2002). The average age of mothers with macerated stillbirths were significantly high than those mothers with fresh stillbirths. The high number of stillbirths in our study can be explained by the lack of proper antenatal care, late referrals, poor transport facilities, limited specialist obstetrician support, long distances to the referral hospital and inadequate emergency obstetric care at referring centers close to patient residences. To reduce this high macerated stillbirth rate, it will be necessary for the provincial health department to implement audit processes to identify areas for improvement in obstetric care at the district and regional referral hospitals.

This study suffered from some limitations including the fact that it was limited to two years only; a longer study period may have resulted in either a higher or lower stillbirth rates as calculated. Moreover, the study was conducted in a tertiary referral hospital which admits patients that could not be managed at lower level of care due to complications; therefore, the situation may not be probably a real reflection of the obstetric performance in the province as a whole. In addition, some of the patients admitted might have been in labour for a prolonged period of time and ran into difficulties at a peripheral facility well before being referred to the tertiary hospital, this could partly explain the occurrence of fresh stillbirths.

As with retrospective studies, any missing data from patient files affects the reliability of the data but this was minimized by reviewing the maternity delivery registers and the patient files over the study period. The history of antenatal care was not documented in most of the patient files; therefore, this was not included in the final analysis. The causes of stillbirth were based on clinical assessment of the attending medical doctor not on *post-mortem*. Fetal autopsy is the useful diagnostic procedure for information on the cause of deaths (Sliver et al., 2007; ACOG, 2009). More accurate data could have been available if fetal autopsies were conducted to determine the cause of deaths. However, the review assisted in addressing the research questions adequately and in providing data that can be used for further studies and in training healthcare providers.

5. Conclusion

In this study stillbirth rate seems to be unacceptably high, though less than those reported in other settings. The causal factors associated with it were identified as nulliparity, unexplained intrauterine foetal deaths, hypertensive disease, and placenta abruptio. Because of the high rate of stillbirths reported in this study, it is recommended that interventions be made to introduce fetal autopsies at the tertiary healthcare facilities and that an educational intervention aimed teaching pregnant women be instituted.

Acknowledgements

We thank the staff of the Maternity Division and Records Division of the Pietersburg Hospital especially K.L Mohlake and T. Esterhuyse for their assistance during this study. Thanks to Joseph Wamukuo and Professor Daniel Ncayiyana for providing useful comments and suggestions.

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Causes of death in patients treated at a tertiary hospital in the Limpopo province: a retrospective study from 2008-2010

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Keywords: causes of death, mortality rate, chronic disease, noncommunicable disease, lifestyle disease, HIV/AIDS

The aim of this study was to determine mortality rates and identify associated causes at a tertiary hospital situated in the Limpopo province of South Africa. Death notification forms from Pietersburg Mankweng Hospital Complex were retrieved and reviewed for the period 1 January 2008-31 December 2010 in this cross-sectional study. Data were collected using a data collection form designed for the study. There were 5 232 deaths, on which there was complete information for 5 147, which was then analysed. The average death rate was 6.8 deaths per 1 000 patients, based on the number of patients admitted during the study period. The age of the deceased ranged from 15-104 years, with a mean of 49.1 ± 18.6 years. While only 2.4% of deaths occurred in teenagers, over two thirds occurred in people aged 20-59 years. Human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS), cancer, cardiovascular disease, trauma and tuberculosis were the top five most common causes of death, and were responsible for 61.2% of all recorded deaths. Trauma was the most common cause of death in teenagers, and HIV/AIDS the most common cause in young adults and adults. Cardiovascular disease was the main cause of death in the elderly. Overall, the triple burden of infectious diseases, noncommunicable diseases (NCDs) and injury remain the leading causes of death in patients at the study site. Innovative injury prevention strategies and interventions to control the spread of infectious diseases are urgently required. Cancer screening services and culturally appropriate lifestyle programmes are needed to address NCDs.

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Introduction

Death affects all age groups worldwide. However, deaths occurring in adults are of significant importance because of the societal role that adults play in the well-being of both children and the elderly.[1] In South Africa, an increase in adult mortality rates from 6.8 per 1 000 adults in the 1990s to 9.9 per 1 000 adults by 2007, was reported following a community-based study in the rural areas.[2] The explanation for such an increase is multifactorial, and includes the growing burden of chronic and lifestyle-related diseases, and human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) in adults.[3-6] Current projections by the World Health Organization indicate that by 2020, infectious diseases will be the leading cause of death in low-income countries, while noncommunicable diseases (NCDs), including heart and cerebrovascular disease, will predominate in middle- and high-income countries.[7]

Several studies have reported on causes of death at provincial and national levels in South Africa. However, little information is available on specific causes of death at institutional level.[8-12] Yet, it important for local healthcare teams to know which health conditions are responsible for the largest burden of death, so that they can plan interventions to address them. The aim of this study was to determine death rates in patients aged 15 years and older, and to identify causes of death at Pietersburg Mankweng Hospital Complex, a tertiary hospital.

Method

This was a retrospective descriptive study, based on the review of records at Pietersburg Mankweng Hospital Complex, the only tertiary referral hospital in the Limpopo province. It is a teaching hospital for the University of Limpopo (Medunsa Campus) that mainly serves rural communities, with a maximum capacity of 1 000 beds. There are 20 beds in the intensive care unit.

The data for this study were collected for a period of 36 months from 1 January 2008-21 December 2010. Data were collected using a data collection form designed for the study. This study included the deaths of people aged 15 years and older who had been treated at the facility. The hospital deaths register was used as the starting point in the collation of a list of deaths that occurred during the study period. The relevant death notification forms were retrieved and reviewed. The following data were collected: date of death, gender and age of the deceased and the cause of death. In order to access missing information, some patient records were also consulted, when deemed necessary.

The recorded causes of death were classified according to the International Classification of Disease version 10.[13] Although the death notification form contains information about which method was used to ascertain the cause of death, it is well established in South Africa, approximately 60% of deaths are determined from the opinion of medical doctors and nurses.[9]

Table I: Mortality rates per year at Pietersburg Mankweng Hospital Complex from 2008-2010

Year	Recorded deaths			Recorded admissions			Calculated death rates		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
	F	F	F	F	F	F	Rate per 1 000	Rate per 1 000	Rate per 1 000
2008	933	873	1 806	11 664	14 845	26 509	8	5.9	6.8
2009	953	892	1 845	11 167	14 213	25 380	8.5	6.3	7.3
2010	772	724	1 496	10 687	13 602	24 289	7.2	5.3	6.2
Total	2 658	2 489	5 147	33 518	42 660	76 178	7.9	5.8	6.8

F: frequency

The statistical software, Stata® version 9, was used for data analysis. Comparison was performed using the chi-square test for categorical variables. A p-value of less than 0.05 was considered to be statistically significant. Ethical clearance was granted by the Medunsa Campus Research Ethics Committee of the University of Limpopo.

Results

Rate of death

Five thousand two hundred and thirty-two adult deaths were recorded during the study period, on which there was complete information for 5 147 patients, which was then analysed. Overall, of the deceased 5 147, the absolute number of deaths decreased slightly from 2008 to 2010. Based on the number of patients admitted during the study period, the average death rate was 6.8 deaths per 1 000 patients, and ranged from 6.2-7.3 deaths per 1 000 patients. The death rate in males was consistently higher than that in females (7.9 vs. 5.8 deaths per 1 000, p-value 0.86), but the difference was not statistically significant (Table I).

Over the three-year period, over 50% of deaths occurred in males (Figure 1). Based on age category, it is interesting to note that although only 2.4% of deaths occurred in teenagers, over two thirds (67.8%) of deaths occurred in people aged 20-59 years (Table II). The age of the deceased ranged from 15-104 years, with a mean of 49.1 ± 18.6 years. The mean age of the deceased did not change significantly by gender (mean age of 49.1 ± 17.4 years in males vs. 49.09 ± 19.6 years in females, p-value 0.76), and over the study period. The mean age of all of the deaths was 48.9 ± 18.6 years in 2008, 49.15 ± 18.3 years in 2009 and 49 ± 18.8 years in 2010.

Age and sex differentials with respect to the proportion of deaths

The absolute number of deaths showed that female deaths exceeded those for young adults and the elderly. The highest percentage of male deaths occurred in adults aged 40-59 years, while the highest percentage of deaths in females occurred in those aged 20-39 years (Table II).

The proportion of male deaths exceeded that of female deaths in teenagers and adults aged 40 to 59 years old, but the difference was not statistically significant in teenagers (p-value > 0.05). Similarly, the proportion of female deaths was higher than that of male deaths in young adults aged 20-39 years old.

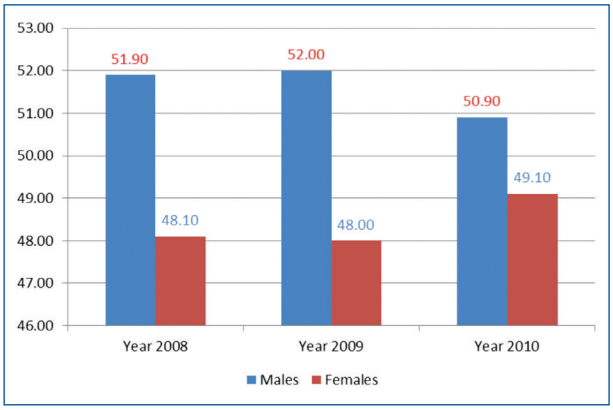


Figure 1: Percentage of deaths per sex at Pietersburg Mankweng Hospital Complex from 2008-2010

Table II: Death by age and sex in adults at Pietersburg Mankweng Hospital Complex from 2008-2010

Age category	Females		Males		Total	
	n	%	n	%	n	%
Teenagers, aged 15-19 years	57	2.3	66	2.5	123	2.4
Young adults, aged 20-39 years	932	37.4*	794	29.9	1 726	33.7
Adults, aged 40-59 years	722	29	1 042	39.2*	1 764	34.1
Elders, aged ≥ 60 years	778	31.3	756	28.4	1 534	29.8
Total	**2 489**	**100**	**2 658**	**100**	**5 147**	**100**

*:p-value < 0.05

Categories of causes of deaths

In this study, both natural and non-natural causes of death were identified. Notwithstanding the 3.6% of deaths due to undetermined causes, 88% of deaths were caused by identified natural causes. External and non-natural causes of death were responsible for 12% of deaths. Infectious and parasitic diseases, cancer and diseases of the cardiovascular, digestive and respiratory systems were the leading causes of natural death, while trauma was the leading non-natural cause of death (Table III).

Of the identified infectious and parasitic diseases, HIV/AIDS, tuberculosis, malaria, respiratory infections and other infectious diseases constituted over a third of the deaths reported in this study. Moreover, cardiovascular disease, diabetes and cancer represented over a quarter of deaths. Other important natural causes of deaths included endocrine, digestive, neuropsychiatric and maternal conditions (Table IV).

Table III: Distribution of death by causes of death at Pietersburg Mankweng Hospital Complex from 2008-2010

Causes of death	Frequency	%
Natural causes of death		
Infectious and parasitic diseases	1 084	21.06
Diseases of the respiratory system	918	17.84
Neoplasm and cancer	607	11.79
Diseases of the circulatory system	605	11.75
Diseases of the digestive system	404	7.85
Endocrine, nutritional and metabolic disorders	324	6.29
Diseases of the genitourinary system	205	3.98
Diseases of the nervous system	102	1.98
Maternal, pregnancy and puerperium disorders	96	1.87
Diseases of the skin and subcutaneous tissue	15	0.29
Diseases of the musculoskeletal system	3	0.06
External and non-natural causes of mortality		
Trauma	597	11.60
Undetermined causes of death		
Undetermined symptoms and signs not classified elsewhere	187	3.63
Total	**5 147**	**100**

Table IV: Identified causes of death at Pietersburg Mankweng Hospital Complex from 2008-2010

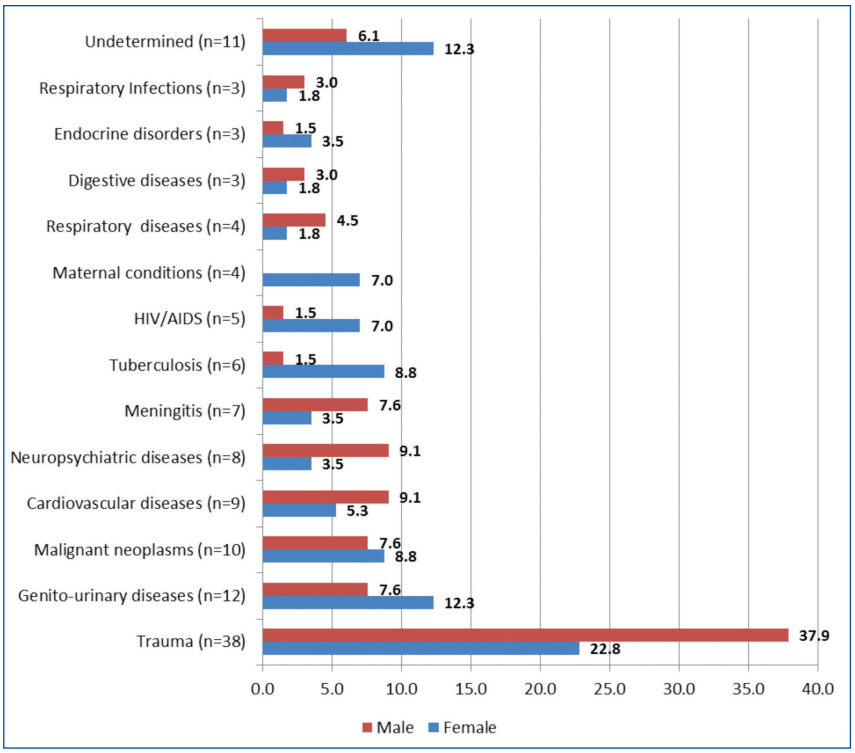
Identified causes of death	Frequency	%
HIV/AIDS	847	16.5
Malignant neoplasm	607	11.8
Cardiovascular disease	605	11.8
Trauma	597	11.6
Tuberculosis	487	9.5
Respiratory infection	304	5.9
Digestive disease	265	5.1
Genitourinary disease	205	4
Diabetes mellitus	168	3.3
Meningitis	155	3
Diarrhoeal disease	136	2.6
Respiratory disease	127	2.5
Endocrine disorders	112	2.2
Neuropsychiatric disease	102	2
Maternal conditions	96	1.9
Other infectious disease	65	1.3
Nutritional deficiencies	44	0.9
Malaria	17	0.3
Skin disease	15	0.3
Musculoskeletal disease	3	0.1
Oral conditions	3	0.1
Undetermined	187	3.6
Total	**5 147**	**100**

AIDS: acquired immune deficiency syndrome, HIV: human immunodeficiency virus

Age and sex differentials with respect to causes of death

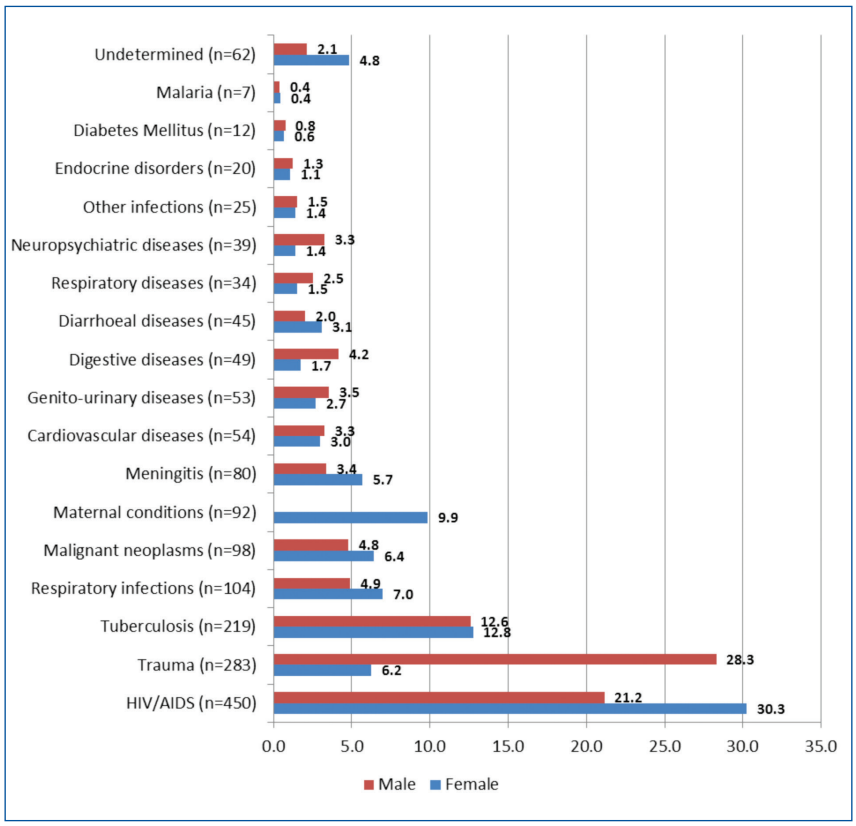
HIV/AIDS, cancer, cardiovascular disease, trauma and tuberculosis were the top five most common causes of death in patients at Pietersburg Mankweng Hospital Complex, and were responsible for 61.2% of all recorded deaths. Their distribution varied significantly based on the age and the sex of the patients. Trauma was the leading cause of death in teenagers, and affected significantly more males than females (37.5% vs. 21.5%, p-value < 0.04). Head injuries were the only recorded traumatic cause of death in this study. Moreover, more males died from cardiovascular, neuropsychiatric and respiratory diseases, and meningitis, than females. By contrast, females succumbed more significantly to HIV/AIDS, tuberculosis and genito-urinary diseases than males, in addition to maternal conditions (Figure 2).

HIV/AIDS was the leading cause of death in young adults, and affected significantly more females than males (30.3% vs. 21.2%, p-value < 0.00002). Moreover, respiratory infections, meningitis and cancer caused more deaths in females than in males (p-value < 0.05), but deaths due to tuberculosis affected females and males equally (p-value 0.35). Deaths due to childbearing conditions were responsible for approximately 10% of all deaths. As in



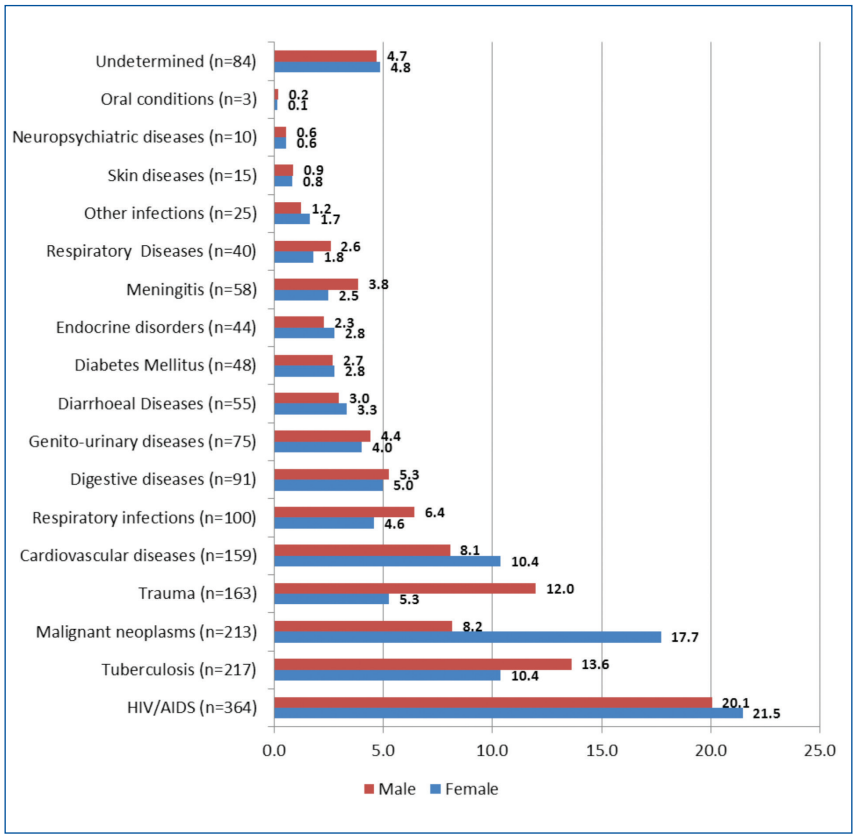
AIDS: acquired immune deficiency syndrome, HIV: human immunodeficiency virus

Figure 2: Distribution of causes of death in teenagers per sex at Pietersburg Mankweng Hospital Complex from 2008-2010



AIDS: acquired immune deficiency syndrome, HIV: human immunodeficiency virus

Figure 3: Distribution of causes of death in young adults per sex at Pietersburg Mankweng Hospital Complex from 2008-2010



AIDS: acquired immune deficiency syndrome, HIV: human immunodeficiency virus

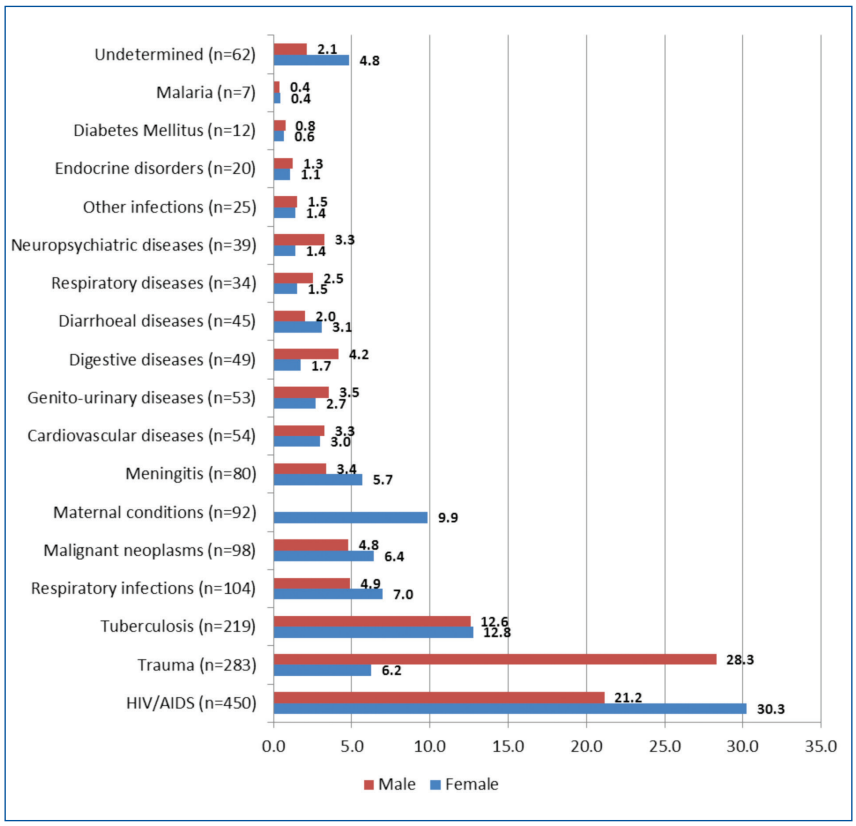
Figure 4: Distribution of causes of death in adults by sex at Pietersburg Mankweng Hospital Complex from 2008-2010

teenagers, deaths due to trauma occurred significantly more in males than in females (28.3% vs. 6.2%, p-value 0.00001). In addition, deaths due to digestive and neuropsychiatric and respiratory diseases affected significantly more males than females (Figure 3).

Once again, HIV/AIDS was the leading cause of death in adults aged 40-59 years, and equally affected males and females. Tuberculosis was the second most common cause of death in this group, and it affected significantly more males than females (13.6% vs. 10.4%, p-value 0.047). By contrast, death due to cancer (17.7% vs. 8.2%, p-value 0.00001) occurred more significantly in females than in males. Cancers of the cervix, breast and oesophagus were the most common cancers in adult women, while oesophagus and lung cancer were more prevalent in men. Similarly, deaths due to cardiovascular disease affected more females than males. In this group, as in the previous age categories, deaths due to trauma occurred significantly more in males than in females (12% vs. 5.3%, p-value 0.00001). In contrast to the situation in young adults, respiratory infections caused more deaths in males than in females (Figure 4).

Cardiovascular disease was the leading cause of death in the elderly, and affected more females than males (27.8% vs. 22.1%, p-value 0.01). Diarrhoeal disease (3.2% vs. 1.5%, p-value < 0.01), diabetes (9.3% vs. 4.8%, p-value 0.003) and cancer (19.9% vs. 17.3%, p-value 0.052) caused more deaths in females than in males. Prostate, oesophagus and lung cancer were the most common cancers in elderly men, while breast and cervical cancer was the predominant cause of death in women. By contrast, digestive, genitourinary, respiratory disease and respiratory infections caused significantly more deaths in males than in females (p-value < 0.05). Additionally, HIV/AIDS, neuropsychiatric disease, nutritional deficiencies, trauma and tuberculosis caused more deaths in elderly men than in elderly women, but the difference was not statistically significant (Figure 5).

Overall, based on the age category of the patients, different death trend patterns were revealed with respect to the five most common causes of death. Hence, death due to HIV/AIDS was less than 5% in teenagers, but increased



AIDS: acquired immune deficiency syndrome, HIV: human immunodeficiency virus

Figure 5: Distribution of causes of death in the elderly per sex at Pietersburg Mankweng Hospital Complex from 2008-2010

to over 20% in patients aged 20-59 years, before decreasing to less than 2% in the elderly. This trend was seen also with deaths resulting from tuberculosis. Death due to tuberculosis levelled off at 12% in young adults and adults, and then decreased to less than 3% in the elderly. Death due to cancer doubled from less than 9% in teenagers to approximately 18% in the elderly. Similarly, death from cardiovascular disease increased from less than 7% in teenagers, to being the leading cause of death in the elderly; responsible for a quarter of all deaths in this group. By contrast, trauma-related death peaked in teenagers; trauma causing over 30% of deaths, then started to decrease with increasing age, before reaching less than 8% in the elderly (Table V).

It is noteworthy that the identified top five most common causes of death, namely HIV/AIDS, cancer, cardiovascular disease, trauma and tuberculosis, were together responsible for over 50% of deaths in adults aged 40-59 years. Three of the most common causes of death were responsible of over 50% of deaths in young adults and the elderly. These conditions were HIV/AIDS, trauma and tuberculosis in young adults aged 20-39 years; and cardiovascular disease, cancer and trauma in the elderly. In addition to trauma, genitourinary disease, cancer and cardiovascular disease led to over half of all deaths in teenagers.

Discussion

This study has presented the rates and causes of adult deaths at Pietersburg Mankweng Hospital Complex. The average death rate of 6.8 deaths per 1 000 patients, calculated from the data from this institution, is lower than the national crude death rate that has been estimated to range from 11.7-12.4 deaths per 1 000 people.[9] The findings of this study confirm the trend that the female death rate is lower than that for males; and that the death rate in children and teenagers is lower than that in adults.[9,14] Additionally, while the findings of this study concur with the established fact that the proportion of deaths was highest in people aged 35-39 years in 2009, it also demonstrates that females in this age group died more than males. Moreover, the finding that 50.9-52% of deaths occurred in males is consistent with the national figure of 51.4% for male deaths, reported in 2009.[9] The above trends have also been reported by other investigators.[3,10,15-17]

The finding that the average age of patients at the study site was 49 ± 18.6 years concurs with the observation made by Abdool Karim, Churchyard, Karim and Lawn that South Africans are dying during the most economically active period of their lives.[17] It is sad to note that the proportion of death in females was highest in the period when they could be bearing children. Similarly, it appears that deaths were highest in males when they are expected to be most productive in their careers. These trends call for more efforts to address causes of death, in order to mitigate the associated negative implications.

The findings of this study show that the identified top five most common causes of death, namely HIV/AIDS, cancer, cardiovascular disease, trauma and tuberculosis, were together responsible for over 50% of all deaths. Their distribution, based on age and sex, clearly suggests that an epidemiological transition is taking place. Non-natural causes of death were responsible for 12% of deaths in the sample, but this proportion was highest in teenagers, where they caused over 30% of deaths. This finding concurs with national data that show that 40.3% of deaths in teenagers were due to non-natural causes.[9] Injury prevention strategies, that target the South African youth, are needed to avert causes of premature death, e.g. from road traffic accidents and violence, which are responsible for head injuries.[9,11,12] The increased proportion of deaths from NCDs, e.g. cardiovascular disease, diabetes and cancer (that caused over a quarter of deaths, particularly in adults and the elderly), is worrying. The findings reported here concur with results from a recent systematic review that showed that infectious and parasitic disease and disorders of the circulatory and digestive system were the leading causes of death in sub-Saharan Africa.[18]

Of the infectious diseases, HIV/AIDS and tuberculosis continue to be predominant causes of death in patients aged 20-59 years. Although national data suggest that HIV/AIDS was the seventh leading cause of death in 2008 and 2009, our findings concur with reports that tuberculosis was the leading cause of death from 2007-2009; responsible for at least 12% of all deaths each year.[9] Our findings

Table V: Identified causes of deaths per age category at Pietersburg Mankweng Hospital Complex from 2008-2010

Causes of death	Overall		Teenagers		Young adults		Adults		Elderly	
	F	%	F	%	F	%	F	%	F	%
HIV/AIDS	847	16.5	5	4.1	450	26.1	364	20.6	28	1.8
Malignant neoplasm	607	11.8	10	8.1	98	5.7	213	12.1	286	18.6
Cardiovascular disease	605	11.8	9	7.3	54	3.1	159	9	383	25
Trauma	597	11.6	38	30.9	283	16.4	163	9.2	113	7.4
Tuberculosis	487	9.5	6	4.9	219	12.7	217	12.3	45	2.9
Respiratory infection	304	5.9	3	2.4	104	6	100	5.7	97	6.3
Digestive disease	265	5.1	3	2.4	49	2.8	91	5.2	122	8
Genitourinary disease	205	4	12	9.8	53	3.1	75	4.3	65	4.2
Diabetes mellitus	168	3.3	0	0	12	0.7	48	2.7	108	7
Meningitis	155	3	7	5.7	80	4.6	58	3.3	10	0.7
Diarrhoeal disease	136	2.6	0	0	45	2.6	55	3.1	36	2.3
Respiratory disease	127	2.5	4	3.3	34	2	40	2.3	49	3.2
Endocrine disorders	112	2.2	3	2.4	20	1.2	44	2.5	45	2.9
Neuropsychiatric disease	102	2	8	6.5	39	2.3	10	0.6	45	2.9
Maternal conditions	96	1.9	4	3.3	92	5.3	0	0	0	0
Other infectious disease	65	1.3	0	0	25	1.4	25	1.4	15	1
Nutritional deficiencies	44	0.9	0	0	0	0	0	0	44	2.9
Malaria	17	0.3	0	0	7	0.4	0	0	10	0.7
Skin disease	15	0.3	0	0	0	0	15	0.9	0	0
Musculoskeletal disease	3	0.1	0	0	0	0	0	0	3	0.2
Oral conditions	3	0.1	0	0	0	0	3	0.2	0	0
Undetermined	187	3.6	11	8.9	62	3.6	84	4.8	30	2
Total	**5 147**	**100**	**123**	**100**	**1 726**	**100**	**1 764**	**100**	**1 534**	**100**

AIDS: acquired immune deficiency syndrome, F: Frequency, HIV: human immunodeficiency virus

emphasise the need for innovative strategies to address communicable diseases, and particularly on how to curtail HIV transmission, as well as to improve successful treatment outcomes.

The first South African National Burden of Disease Study reported that cervical and breast cancer in women, and lung cancer in men, were the main causes of cancer deaths in adults aged 45 years and older.[19] Since then, reports by other investigators concur with our findings that breast, cervical and oesophagus cancer in adults and elderly women, on the one hand; and oesophagus, lung and prostate cancer in adults and elderly men, on the other; were the predominant causes of cancer deaths in South Africa and other African countries.[4,9,14,20] These findings suggest that cancer screening services should be widely distributed, and the promotion of these services actively promoted.[21]

Death resulting from cardiovascular disease is known to be a problem worldwide.[7] Bradshaw et al reported that hypertension, strokes and ischaemic heart disease were causing many adult deaths in South Africa.[8] These trends have been reported elsewhere in Africa, and underline the existence of the triple burden of infectious disease, NCDs and injury as major causes of morbidity and death, as the demographic transition is being experienced by African populations.[2-3,15,16,18] Several interventions are needed to address NCDs. Besides screening services, appropriate and well equipped centres for diagnosis and treatment need to be established.[22] In addition to lifestyle programmes, cohort studies are required to determine important risk factors that could be targeted in further interventions.

As a cross-sectional investigation, this study was limited by the short period in which the data were collected. It is possible that a period longer than three years might have yielded different results. Moreover, because the study was conducted in a tertiary referral hospital which admits patients who cannot be managed at a lower level of care, the computed death rates may not have reflected the situation throughout the province. Additionally, the recorded causes of death were based on a clinical assessment of the attending medical doctors. In the absence of post-mortem autopsy records, the correctness of the causes of death could not be verified.

In conclusion, based on the number of patients admitted during the study period, the average death rate was 6.8 deaths per 1 000 patients. While only 2.4% of deaths occurred in teenagers, over two thirds of deaths occurred in people aged 20-59 years. The proportion of male deaths exceeded that of females, in teenagers and in those aged 40-59 years, while the proportion of female deaths was higher than that of males, in those aged 20-39 years and in the elderly. HIV/AIDS, cancer, cardiovascular disease, trauma and tuberculosis were the top five most common causes of death, and were responsible for 61.2% of all recorded deaths.

Overall, the triple burden of infectious diseases, NCDs and injury remains the leading cause of death in patients at the study site. Innovative injury prevention strategies and interventions to control the spread of infectious diseases are urgently required. Cancer screening services and culturally appropriate lifestyle programmes are needed to address NCDs.

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Causes of Deaths in Children under-Five Years Old at a Tertiary Hospital in Limpopo Province of South Africa

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Abstract

Objective: Accurate and timely information on the causes of child deaths is essential in guiding efforts to improve child survival, by providing data from which health profiles can be constructed and relevant health policies formulated. The purpose of this study was to identify causes of death in children younger than 5 years-old in a tertiary hospital in South Africa. **Methods:** Death certificates from the Pietersburg/Mankweng hospital complex, for the period of January 1, 2008 through December 31, 2010, were obtained for all patients younger than 5 years and were retrospectively reviewed. Data were collected using a data collection form designed for the study. Information abstracted included: date of death, age, sex, and cause of death. **Results:** A total of 1266 deaths were recorded, the sex ratio was 1.26 boys per girl. About 611 (48%) of deaths were listed as neonatal deaths (0-28 days), 387 (31%) were listed as infant deaths (29 days-11 months), and 268 (21%) as children's death (1-4 years). For neonates the leading causes of death were: prematurity/low birth weight, birth asphyxia and pneumonia. For the infant death group, the leading causes of death were pneumonia, diarrhea, and HIV/AIDS; and in the children's group, the leading causes were injuries, diarrhea and pneumonia. There was no statistical significant difference in the proportions of causes of death based on the sex of children. **Conclusion:** The top 10 leading causes of death in children under-5 years old treated at Pietersburg/Mankweng Hospital Complex were in descending order: prematurity/low birth weight, pneumonia, diarrheal diseases, birth asphyxia, and severe malnutrition, HIV/AIDS, hydrocephalus, unintentional injuries, meningitis and other infections. These ten conditions represent 73.9% of causes of death at this facility. A mix of multi-faceted interventions is needed to address these causes of death in children.

Keywords: causes of death, neonates, mortality, Limpopo Province

1. Introduction

Accurate and timely information on the causes of child deaths is essential in guiding efforts to improve child survival, by providing data from which health profiles can be constructed and relevant health policies formulated (Bradshaw et al., 2003). Such data are not only crucial for monitoring the causal factors that lead people to die, but also to establish the patterns of medical causes of death. In doing so, such data are helpful for targeting where, when, and how public health resources should be channeled to address these issues and avoid untimely deaths.

In the case of South Africa, data from the Death Notification Forms (DNF's) as compiled by Statistics South Africa conform to the World Health Organization (WHO) guidelines; they are good sources of information on death and its causes. Moreover, it is established that about 48.6% of deaths in South Africa occur within a healthcare facility (Statistics South Africa [Stats SA], 2011a). Hence, institutional death registers are valuable repository of data that could be analyzed and used for local decision-making purposes. This is important because in order to achieve the Millennium Goal 4, that is to reduce child mortality, a concerted effort is needed from local to national institutions.

Nationally, the most recent data on child mortality come from the 2007 Community Survey which reported that under-five mortality rate was 104 per 1000 live births which is higher than the international target of 20 per 1000 live births (Stats, 2011b). In order to assist local healthcare teams in knowing which health conditions to focus on, there is a need to identify the causes of death prevalent in their settings. Therefore, a retrospective descriptive study was undertaken to establish the common causes of death of children under-five year old at a tertiary hospital of the Limpopo Province.

2. Material and Methods

This was a retrospective descriptive study based on the review of records at Pietersburg/Mankweng Hospital Complex (PMHC), the only tertiary referral hospital in Limpopo Province of South Africa. It is a teaching hospital for the University of Limpopo (Medunsa Campus) that mainly serves rural communities. The neonatal unit at PMHC has a maximum capacity of 54 beds and a small Neonatal Intensive Care Unit with 9 beds. The unit has a total admission of 800 patients per annum. The data for this study was collected for a period of 36-months from January 1, 2008 to December 31, 2010. Data were collected using a data collection form designed for the study. For the purpose of this study, a neonatal death was defined as a death occurring on or before 28 days of life, infant death as a death occurring between the 29th day of life and the 11th month of life, and children's death as a death occurring between the 1st year of life and the 4th year of life.

The hospital death register was used as the starting point to collate the list of deaths that occurred during the study period. Then the relevant death notification forms were retrieved. In order to increase the reliability, the patients' register and the files were also consulted. Using the register, patient files and the death notification forms, the following data were collected: date of death, gender and age of the deceased, and the cause of death. Although the death notification form contains the information about which method was used to ascertain the cause of death, it is well established that in South Africa about 60% of deaths are ascertained from the opinions of medical doctors and nurses (Stats, 2011a).

The recorded causes of death were classified the according to the International Classification of Disease version 10 (ICD-10). Stillbirths were excluded from the study. The statistical software, STATA version 9.0 (StataCorp; College Station, Texas) was used for the data analysis. Comparison was performed using chi-square test for categorical variables. The p-values of less and/or equal to 0.05 were considered statistically significant. Ethical clearance was granted by the Medunsa Campus Research Ethics Committee of the University of Limpopo.

3. Results

A total of 1266 deaths in children under-5 years old were reported during the study period. Of this group, 55.8% (706/1266) were males; with a male to female ratio of about 1.26 boys per girl. Neonatal deaths accounted for about half of the deaths recorded (48.3%); while infant and children deaths accounted for 31% (387/1266) and 21% (268/1266) of total deaths respectively. There was no statistical significant difference (p=0.884) in the proportions of causes of death based on the sex of children (Table 1).

Table 1. Deaths by age and sex among under-five year's old children at PMHC 2008-2010

Age category	Male		Female		Total	
	N	%	N	%	N	%
Neonatal (0-28 days)	345	48.9	266	47.5	611	48.3
Infant (29 days-11mths)	214	30.3	173	30.9	387	30.6
Children (1-4 years)	147	20.8	121	21.6	268	21.2
Total	**706**	**100.0**	**560**	**100.0**	**1266.0**	**100.0**

With regard to the causes of deaths, there were noticeable differences among the three groupings. Among neonates, just over half of the deaths were due to prematurity/low birth weight; the other most prevalent causes in this group were birth asphyxia and pneumonia. In the infant group, pneumonia was the most prevalent cause of death (31.8%) followed by diarrhea and HIV/AIDS. The three causes constituted over a 50% of all causes recorded in this group. In children, unintentional injuries contributed 14.2% (38/268) of deaths. Together with diarrhea, pneumonia, meningitis and severe malnutrition, they constituted over 50% of all deaths recorded in this group (Table 2). Of the injuries recorded, 52.6% (20/38) of them were burns, 31.6% (12/38) were poisoning, while 15.8% (6/38) were road traffic accidents. During the period of the study, there were no changes in the pattern of deaths along the years in relation to the total death by age group and cause of death (data not shown).

Table 2. Causes of death in under-five years old children at PMHC 2008-2010

Neonates (<29 days)			Infant (29 days -11 months)			Children (1 - 4 years)		
Causes	**N**	**%**	**Causes**	**N**	**%**	**Causes**	**N**	**%**
Prematurity/low birth weight	319	52.2	Pneumonia	123	31.8	Unintentional injuries	38	14.2
Birth asphyxia	79	12.9	Diarrhoea	51	13.2	Diarrhoea	34	12.7
Pneumonia	30	4.9	Undetermined/unknown	31	8.0	Pneumonia	29	10.8
Undetermined/unknown	29	4.7	HIV/AIDS	25	6.5	Severe malnutrition	26	9.7
Congenital anomalies	27	4.4	Hydrocephalus	24	6.2	Meningitis	21	7.8
Neonatal Sepsis	25	4.1	Severe malnutrition	24	6.2	Other infection	18	6.7
Meconium aspiration	13	2.1	Prematurity/low birth weight	20	5.2	Hydrocephalus	16	6.0
Renal failure	11	1.8	Meningitis	14	3.6	Undetermined/unknown	16	6.0
HIV/AIDS	9	1.5	Bowel obstruction	10	2.6	HIV/AIDS	12	4.5
Respiratory failure	7	1.1	Other infection	10	2.6	Malignancies	12	4.5
Diarrhoea	7	1.1	Sepsis	7	1.8	Tuberculosis	11	4.1
Other infection	6	1.0	Respiratory failure	4	1.0	Bowel obstruction	5	1.9
Miscellaneous	49	8.0	Miscellaneous	44	11.4	Miscellaneous	30	11.2
Total	**611**	**100.0**	**Total**	**387**	**100.0**	**Total**	**268**	**100.0**

Overall, as shown in Table 3, the top 10 leading causes of death in children under-5 years were in descending order: prematurity/low birth weight, pneumonia, diarrheal diseases, birth asphyxia, and severe malnutrition, HIV/AIDS, hydrocephalus, unintentional injuries, meningitis and other infections. These ten conditions represent 73.9% of causes of death at the study site.

Table 3. The leading causes of deaths in under-five year's old children at PMHC 2008-2010

Causes	**N**	**%**
Prematurity/low birth weight	339	26.8
Pneumonia	182	14.4
Diarrhea	92	7.3
Birth asphyxia	79	6.2
Severe malnutrition	50	3.9
HIV/AIDS	46	3.6
Hydrocephalus	40	3.2
Unintentional injuries	38	3.0
Other infection	34	2.7
Meningitis	35	2.8
Sepsis	32	2.5
Congenital abnormalities	27	2.1
Bowel obstruction	15	1.2
Meconium aspiration	13	1.0
Malignancies	12	0.9
Renal Failure	11	0.9
Tuberculosis	11	0.9
Respiratory failure	11	0.9
Miscellaneous	123	9.7
Undetermined/unknown	76	6.0
Total	**1266**	**100**

4. Discussion

This study shows that several health conditions are the causes of death in under-five year's old children. As discussed below the distribution of these causes varies with the ages of the children. The male to female ratio reported in this study is slightly higher than the national figure of 1.12 boys per girl (Nannan et al., 2012). It is worth noting that 48% of all deaths among under-5 years old occurred during the neonatal period. This finding concurs with the reports from a study conducted in KwaZulu-Natal Province that reported that more than 48% of deaths among children under-5 years old occurred in infants aged 29 days to 11 months old (Stats, 2009; Stephen et al., 2009; Garrib et al., 2006). In contrast, a population-based study in rural area of Limpopo Province of South Africa reported that 46% of deaths among children under-5 years old were among those aged 1 to 4 years old (Agincourt health and socio-demographic surveillance site [AHDSS], 2002). Another population-based study in Maputo Province of Mozambique indicated that 41% of under-five deaths were among children aged 1-4 years (Sacarlal et al., 2009). These findings are again in contrast to reports by Stephen and Patrick (2008) that 59% of deaths were among infants. It seems that the aggregation of death data at provincial and national levels masks important local or institutional disparities.

With regard to the causes of death, this study found that the most common causes reported in neonates were prematurity or low birth weight, birth asphyxia, upper respiratory infections such pneumonia, and neonatal sepsis. These findings concur with reports by other investigators (Garrib et al., 2006; Liu et al.,2011; Mmbaga et al., 2012; Nannan et al., 2012; Pattinson, 2009; Rashid et al., 2010; Roy et al.,2008; Stephen et al., 2009). Given the fact that over half of deaths were due to prematurity and circumstances surrounding the birth such as asphyxia and neonatal sepsis, there is a need for special attention to be paid to environmental and socioeconomic factors that affect prematurity as well as working conditions that may led the onset of sepsis in neonates.

In infants, this study shows that upper respiratory infections such as pneumonia, HIV/AIDS and diarrheal diseases constituted over half of causes of death. These findings concur with reports by Garrib and co-workers (2006) as well as Nannan and collaborators (2012). Given the infectious nature of these three dominant causes of death, it points out to the need for timeous diagnosis and appropriate treatment to be given. It is important that local Pharmacy and Therapeutics Committees be involved in ensuring that appropriate care and treatment protocols are adhered to and that the relevant medicines are available to treat these infections.

In children aged 1-4 years, unintentional injuries together with diarrhea, pneumonia, meningitis and severe malnutrition constituted over 50% of deaths. This finding is consistent with reports by previous investigators who stated that infections such as HIV/AIDS, diarrheal diseases, upper respiratory infections such as pneumonia as well as malnutrition were the most common causes of death (Nannan et al., 2012; Stephen et al., 2009; Garrib et al., 2006). However, in this rural setting, this study shows that unintentional injuries are the leading causes of death in this group of children. This finding is consistent with previous findings by Malangu (2005) that acute poisoning was responsible for 17% of admissions to wards in a rural hospital of Limpopo Province. Moreover, the proportion of deaths due to injuries as reported in this study is higher than the national average of 12.5% of deaths due to unnatural causes in this group (Stats, 2011a). Because deaths through injuries are avoidable, a public health education campaign is needed to raise the communities' awareness on prevention strategies.

Taken together the above findings suggest that congenital conditions, infections, malnutrition and unintentional injuries contribute significantly to the deaths of under-five year's old children. It is clear therefore that to address the Millennium Goal 4, in particular, to reach the targeted under-five mortality rate of 20 per 1000 live births, a mix of multi-faceted interventions is needed in addition to what was stated above. These interventions include the improvement in the care of and the environment for children; the support to home caregivers to children; the provision of safe and secure playgrounds; the strengthening of healthcare aspects relating to children. For instance, the majority of deaths reported in this study were due to prematurity/low birth weight. To manage neonates suffering from this condition specialised care such as intensive care units are needed together with highly trained personnel. Previous studies have reported that the establishment of neonatal intensive care units and the use of mechanical ventilation and exogenous surfactants improve the outcomes of neonates suffering from prematurity (Hack et al., 1996; Draper et al., 1999; Richardus et al., 2003; Velaphi et al., 2005). These reports suggest the need for upgrading the infrastructure of rural hospitals in order to decrease unnecessary deaths among children.

The above findings must be considered taking into account the following limitations. This study was limited to three years; a longer study period may show a different pattern of causes of death. Moreover, the study was conducted in a tertiary referral hospital which admits patients that could not be managed at lower level of care due to complications; therefore, the situation may not be probably a real reflection of causes of child mortality

throughout the province. Secondly, the recorded causes of death were based on clinical assessment of the attending physicians. Because no autopsies were performed on any of the deceased children, no post-mortem records could be used to verify the correctness of the causes of deaths recorded in the register and death notification forms. Finally, this study was a retrospective hospital record review; therefore the results cannot be extrapolated or generalized to the whole province or the whole country of South Africa.

In conclusion, the top 10 leading causes of death in children under-5 years old treated at Pietersburg/Mankweng Hospital Complex were in descending order: prematurity/low birth weight, pneumonia, diarrheal diseases, birth asphyxia, and severe malnutrition, HIV/AIDS, hydrocephalus, unintentional injuries, meningitis and other infections. These ten conditions represent 73.9% of causes of death at this facility. A mix of multi-faceted interventions is needed to address these causes of death in children.

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