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RELATIVE RISK OF WOMEN DYING FROM MATERNAL, INFECTIOUS OR NON-COMMUNICABLE CAUSES IN KINTAMPO, GHANA: A COMPETING RISKS ANALYSIS

BY

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DECLARATION

I, SULEMANA ABUBAKARI, hereby declare that except for references to other people's work, which have been duly acknowledged, this is the result of my own research and it has neither in part nor in whole been presented for another degree.

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SULEMANA ABUBAKARI DATE

DEDICATION

This thesis is dedicated to my three children: Zainab, Abdalla and Abubakari Tijani for their sacrifice while I undertook this study. It is also dedicated to my lovely wife, Zuwera for the love and encouragement, and for the preservation of the memory of my deceased mum, Hawa Musah and dad, Abubakari Seidu who all passed on in the course of this work. May Allah have mercy on their souls. Amen!

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LIST OF ABBREVIATIONS

CVDs	Cardio-vascular Diseases
DHS	Demographic and Health Survey
DSA	Demographic Surveillance Area
EEM	Eco-epidemiological Model
GDHS	Ghana Demographic and Health Survey
GHS	Ghana Health Service
GMHS	Ghana Maternal Health Survey
GSS	Ghana Statistical Service
HDSS	Health and Demographic Surveillance System
HICs	High Income Countries
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HPV	Human Papilloma Virus
HRB	Household Record Book
ICD-10	the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems
INDEPTH	International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries
JHS	Junior High School
KHDSS	Kintampo Health and Demographic Surveillance System
KHRC	Kintampo Health Research Centre
KMHD	Kintampo Municipal Health Directorate
KNM	Kintampo North Municipality
KSD	Kintampo South District
LMICs	Low and Middle-Income Countries
MDGs	Millennium Development Goals
MDLT	Multiple Decrement Life Table
MHS	Maternal Healthcare Services
MOH	Ministry of Health
MRP	Maternal Risk Period
MMR	Maternal Mortality Ratio
NCDs	Non-Communicable Diseases
PCA	Principal Component Analysis
PCVA	Physician Coding Verbal Autopsy
PGLE	Potential Gains in Life Expectancy
PHC	Population and Housing Census
PYO	Person Years of Observation
RALE	Reproductive Aged Life Expectancy
RIPS	Regional Institute for Population Studies
RRR	Relative Risk Ratio
SDGs	Sustainable Development Goals
SES	Socio-economic Status
SSA	Sub-Saharan Africa
STIs	Sexually Transmitted Infections

TB	Tuberculosis
UN	United Nations
UNDP	United Nation Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Emergency Fund
VA	Verbal Autopsy
WEP	World Economic Programme
WHO	World Health Organization
WRA	Women of Reproductive Age

ABSTRACT

Maternal, infectious and non-communicable causes of death combine to be simultaneously a major health problem for women of reproductive age (WRA) in low and middle-income countries (LMICs), particularly, sub-Saharan Africa (SSA). Yet, little is known about the relative risk of each of them when considered together and their demographic impacts. Consequently, the focus of research and funding has been on maternal health. However, the evolving demographic and health transitions in LMICs suggest a need for a comprehensive methodology to resolving women's health challenges beyond maternal causes. Drawing on the eco-epidemiological model, this study examines the relative risks of women of reproductive age dying from the respective causes using competing risks analysis.

Deaths and person-years of exposure were calculated by age for WRA (15-49) in the Kintampo Health and Demographic Surveillance area from January 2005 to December 2014. Causes of death were diagnosed by means of physician coding and the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) using the verbal autopsy questionnaire. Identified causes of death were categorised into three broad groups: maternal, infectious and non-communicable diseases. The relative risk ratio was used to compare the likelihood of dying from infectious and non-communicable causes relative to the maternal cause of death and vice versa. Determinants of the causes of deaths were established using multinomial logistics regression. Furthermore, the gains in life expectancy as well as the decomposition of the total gains were estimated using multiple decrements together with the associated single decrement life table methods.

There were 1,259 deaths that occurred among WRA during the study period. Out of this, 846 deaths from maternal, infectious, and non-communicable causes, representing 67.2 percent of the total deaths were used for this study. The causes of death for the rest were mostly either unknown or there was no suitable respondent for the verbal autopsy interview and a few of the deaths were due to injuries. Infectious diseases were responsible for most of the causes of death (61.3%). Non-communicable diseases (29.9%) were the second highest and maternal (8.8%) causes contributed the least. The top five specific causes of death were malaria, HIV/AIDS, septicaemia, cardiovascular diseases and intestinal infection. There was an increased and worsening risk of dying from both infectious and NCD causes relative to maternal causes of death throughout the study period. Determinants of causes of death among WRA were complex and cut across distal and proximate factors. These included age, marital status, district of residence, season, and place of death as well as admission in the last 12 months before death, surgical operation in the last 24 months and the nature of death, whether sudden or not.

Averting any of the causes of death leads to improved life expectancy but eliminating infectious causes of death leads to the highest number of years gained. Infectious causes of death affected all ages and the gains in life expectancy assuming they were eliminated, were greatest among under-five-year-old female children but diminished with increasing age. In contrast, adult females, 60 years and above accounted for the greatest gains in life expectancy if mortality from non-communicable causes of death were eradicated from the population. With respect to the elimination of maternal mortality, the oldest group, 45-49, had the greatest gain in reproductive aged life expectancy.

This study has demonstrated the existence of a triple burden of maternal, infectious and non-communicable causes of death among the WRA in the two Kintampo districts of Ghana.

Infectious causes of death are persistently high whilst deaths from non-communicable causes are rising and the level of maternal mortality is still unacceptably high. A cost-effective approach to screening and treating all WRA using the existing structures of the maternal health programme is recommended.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Cause of death among women of reproductive age (WRA) is reportedly due to maternal causes and sexual and reproductive risks despite over three decades of campaigns by the World Health Organization (WHO) and the global health community in general to reduce maternal mortality (Kassebaum et al., 2014; Scrafford & Tielsch, 2016). Approximately, 800 women die every day due to maternal-related complications globally and 99 percent of them occur in low and middle-income countries (LMICs), especially in sub-Saharan Africa (SSA) (World Health Organization, 2015). The majority of the countries in the SSA Region have maternal mortality ratios (MMR) of over 300 maternal deaths per 100,000 live births (Desai et al., 2013). According to WHO estimates, the risk of maternal death is greatest in the WHO African Region, where there were 900 maternal deaths per 100 000 live births; compared to 27 per 100 000 live births in the WHO European Region (WHO, 2010a).

The general health risks faced by WRA affect maternal mortality (Mane et al, 2013). Therefore, efforts to reduce maternal mortality should consider identifying and addressing other causes of death among WRA together with maternal mortality. However, research and funding have focused mainly on maternal health while other threats to women of this age group are neglected (Rajaratnam et al., 2010). Meanwhile, available research evidence suggests that infectious diseases including HIV/AIDS, tuberculosis and malaria continue to be the leading causes of death across all ages in many LMICs and contribute substantially to deaths among WRA (Narh-Bana, Chirwa, Mwanyangala, & Nathan, 2012). Analysis by Scrafford and Tielsch (2016) of 38 countries in three regions including SSA, showed that

deaths from maternal causes contribute between six (6) to forty (40) percent of all deaths occurring among WRA (Scrafford & Tielsch, 2016). Beside this, some studies have estimated the proportion of communicable diseases among adult deaths to be 40 percent (Narh-Bana et al., 2012) whilst others have estimated it to be as high as 74 percent (Van Eijk et al., 2008). Despite the high contribution of infectious diseases to deaths among WRA and adult mortality in general, studies on women have mainly focused on maternal health (Labrique et al., 2013; Norton, Peters, Jha, Kennedy, & Woodward, 2016).

In addition, studies in recent times have argued for the need to expand maternal health to cover women's health in general and to address the rising causes of death from non-communicable diseases (NCDs) among women. Labrique et al. (2013) reported that 48 percent of deaths among WRA in Bangladesh were due to NCDs (Labrique et al., 2013). Another study in Ethiopia reported that infectious diseases and NCDs were the top causes of death (Melaku et al., 2014). Other studies have also shown that NCDs are going to contribute most to causes of death due to the unfolding demographic and epidemiological transitions across LMICs and such studies have emphasized the need to re-set priorities on women's health beyond reproduction (Bawah et al., 2016; Bustreo, Knaul, Bhadelia, Beard, & de Carvalho, 2012).

From the foregoing, it is evident that maternal, infectious and non-communicable diseases could be described as triple causes of death among WRA since they combine to pose a major health problem to WRA in LMICs and SSA in particular. However, what is not clear is the relative risk of each of them when taken together. For instance, are WRA more likely to die from infectious, maternal or NCDs? In addition, what are the factors that are more likely to predispose WRA to each of those causes of death?

It is argued that the levels, patterns and trends in the causes of death provide a summary of whether a society is making progress or not in reducing the burden of premature

and avoidable mortality and indicate where attention needs to be focused (Murray et al., 2014). Furthermore, the rates and numbers of the population or sub-group who die, at what age they die, where they die and from what are vital inputs into policy, planning interventions, and prioritisation of research (Lozano et al., 2012). Yet, in many LMICs, information on causes of death is a major challenge and Ghana is no exception. Nonetheless, with the ever-increasing challenge posed by the triple burden of causes of death among WRA, where significant causes of death from maternal factors co-exist with infectious and increasing numbers of NCD causes, there is the need to find innovative methods of examining the causes of death within this population sub-group.

Therefore, the current study uses health and demographic surveillance (HDSS) data, to provide empirical evidence to examine the situation in the two Kintampo districts of Ghana among WRA. It fills the gap created by the paucity of data and lack of understanding of maternal, infectious and non-communicable causes of death. It employs competing risks analysis to measure the demographic impact of three broad causes of death namely: maternal, infectious and non-communicable causes among the study population.

1.2 Statement of the problem

Globally, there is growing advocacy for the expansion of research and policy focus on maternal health to consider all other aspects of women's health (Requejo & Bustreo, 2016; Scrafford & Tielsch, 2016). This is in response to the observation of the evolving epidemiological and demographic changes in various LMICs that present new challenges to health systems. Whilst NCDs constitute a rising threat of disability and causes of death among the WRA (Bustreo et al., 2012; Langer et al., 2015), simultaneously, the challenge posed by deaths from infectious diseases and maternal mortality to public health persist. A situation within which a focus is placed on one cause of death category has the potential to

derail efforts aimed at achieving the health-related targets of the sustainable development goals (SDGs) and any other national or local health policy.

SSA currently reports more deaths from infectious diseases compared to NCDs (Young et al., 2009). Infectious, maternal, perinatal and nutritional conditions are reported to account for 42 percent of total deaths (WHO, 2014). An earlier estimate reported the proportion of infectious diseases to be 53 percent of total deaths (Bloom et al., 2011). Some of the infectious diseases such as malaria have their heaviest toll on women, particularly pregnant women. Malaria is estimated to cause 10,000 maternal deaths each year in SSA. It is also estimated that malaria contributes up to 25 percent of maternal deaths in areas where it is endemic (Schantz-Dunn & Nour, 2009).

Although, infectious causes of death continue to present significant health challenge in SSA, the number of NCD cases in the region is rising rapidly and is expected to cause almost three-quarters as many deaths as infectious diseases by 2020, and to exceed infectious causes of death to become the leading cause of mortality by 2030 (Marquez & Farrington, 2013). A WHO (2010) publication estimates that globally, cardiovascular disease, cancer, chronic respiratory disease and diabetes contribute almost 60 percent of deaths. LMICs account for 80 percent of these deaths. It is estimated that NCDs will account for 73 percent of deaths and 60 percent of the disease burden in LMICs by 2020 (Islam et al., 2014).

Also, treatments for NCDs are expensive and women may find it difficult if not impossible to afford the high cost of treatment. This is partly because women are mostly at the lowest level of the socio-economic ladder in the communities. The results of the most recent Ghana Demographic and Health Survey (GDHS) conducted in 2014, indicate that subsistent agricultural production is the predominant economic activity of women in Ghana (GSS, GHS & ICF International, 2015). Thus, research indicates these changing trends in health conditions that have implications for the survival of WRA; however, the current

literature has not identified the competing aspects of these various causes and tends to fixate on maternal causes of death.

Meanwhile, maternal mortality continues to be unacceptably high. Almost 800 WRA die each day from pregnancy or childbirth and nearly all of these deaths occur in developing countries (Salam et al., 2014; World Health Organization, 2014). It is estimated that one out of every 13 WRA dies of pregnancy-related causes during her lifetime in SSA relative to one in 4,085 WRA in industrialised countries (McAlister & Baskett, 2006).

A WHO estimate in 2012 put the MMR estimate for Ghana at 350 deaths per 100, 000 live births (WHO, UNICEF, UNFPA and The World Bank, 2012). The Ghana Statistical Service also earlier estimated the MMR to be 560 death per 100 000 live births (Ghana Statistical Service, 2009) compared to 27 deaths per 100 000 live births in the WHO European Region (WHO, 2010b).

Despite the public health threat simultaneously posed by maternal, infectious and non-communicable causes of death among the WRA, studies among this group tend to focus on pregnancy and delivery-related health challenges instead of comprehensively examining all the major health problems that confront this population sub-group (Labrique et al., 2013). Also, among the few studies that have investigated the risks of dying from maternal and other causes of death, there is no consensus on whether WRA are more likely to die from maternal deaths compared to other causes of death (Garenne et al., 2013). There is also a need for a study that examines the impact of separately eliminating maternal, infectious and non-communicable causes of death on life expectancy since such analysis is very useful for targeting programmes and policies where life expectancy returns are highest.

Even though there is abundant literature on maternal causes of death for adult females, the literature is rare on the non-maternal causes of death for this population sub-group (GHS, 2007). It is important to observe that literature on the risk of women dying from

maternal, infectious and non-communicable causes together is scanty. However, these medical conditions constitute the main causes of death among the WRA in LMICs. There is, therefore, the need for research to address this gap in the literature and this is what this present study partly seeks to accomplish by using various methods including multiple decrements together with the associated single decrement life table techniques as well as decomposition and relative risks analyses.

Furthermore, information on causes of death is not readily available in most LMICs due to lack of vital and civil registration systems (Byass et al., 2013). As a result, studies on causes of death are based on demographic and health survey (DHS) and census data. However, studies using data from censuses are limited because of long inter-censal periods (Byass et al., 2013; Ye et al., 2012). Therefore, interventions and policies based on such findings tend not to achieve the desired results because the vulnerable groups supposed to be the targets are missed or hidden behind large population averages (Ye et al., 2012). Longitudinal data can best provide the information needed to understand consequences of women's health outcomes.

Moreover, it is important to indicate that studies such as the demographic and health survey (DHS) are mainly limited to cross-country, regional or rural-urban classification. Currently, there is an emphasis on the need for local data to set priorities for reducing maternal mortality (Kinney et al., 2010). Efforts to reduce adult female mortality, continue to be elusive because of the lack of appreciation of the effects of the underlying socio-demographic, economic, physical, behavioural and health-related conditions that women are exposed to within their various communities. This study uses data with the needed socio-demographic and economic information that can ensure that these important variables are also considered in mortality analysis among the WRA.

It is important to emphasise that reliable data for monitoring morbidity and mortality and in particular, maternal mortality was a major challenge in tracking the MDG 5A. Reliable data are still crucial for achieving the targets of the health indicators of the Sustainable Development Goals (SDGs). This study is therefore timely and justified because the Kintampo Health Research Centre has over two decades of data. The cause of death data collected using the Kintampo HDSS is longitudinal, local, detailed and continuous so provides the opportunity to understand who, where, when and how adult female deaths occurred. Therefore, this study will make it possible to fashion out feasible and cost-effective interventions to achieve the SDG target of reducing MMR to less than 70 maternal deaths per 100, 000 live births among women in Ghana, in addition to achieving other targets by 2030 (Murray, 2015).

Finally, this study is justified because the settings for most of the reviewed studies so far were mainly health facility-based studies. However, health facility data may not represent the general population since in low-income settings, most deaths occur in the homes thereby making it difficult to obtain medically certified cause of death (Mahapatra et al., 2007; Ye et al., 2012). Fortunately, the verbal autopsy method used by the HDSSs provides valuable information on patterns of causes of death (Murray et al., 2014; Setel et al., 2004) and this is utilised by the present study. In addition, institutional data is fraught with several challenges such as ineffective record system and inability to know the denominator of the study population. The present study used population-based data that is devoid of such data challenges.

1.3 Research questions

In view of the gaps identified in the literature, this study examined the relative risk of WRA dying from maternal, infectious and non-communicable causes of death by addressing the following research questions:

i. Are WRA in the two Kintampo districts more likely to die from maternal causes than infectious or NCD causes?
ii. What are the changes in the relative risks of dying from maternal, infectious and non-communicable causes among the WRA from 2005 to 2014 in the Kintampo districts?
iii. How are the socio-demographic and economic determinants of maternal deaths different from infectious or NCD causes of death in the Kintampo districts?
iv. What is the effect of separately eliminating maternal, infectious or non-communicable causes of deaths on life expectancy among the WRA in the Kintampo districts?
v. Which age group will benefit more from improvements in life expectancy?

1.4 Objectives

The general objective is to examine the relative risk of women in reproductive age dying from maternal, infectious and non-communicable causes as well as the determinants of these causes of death in the Kintampo North Municipality and Kintampo South District.

The specific objectives are:

i. To examine the relative risk of dying from maternal, infectious or non-communicable causes among WRA in the Kintampo districts from 2005 to 2014;
ii. To determine the socio-demographic and economic determinants of maternal, infectious or non-communicable causes of death among WRA from 2005 to 2014;

iii. To estimate the effect of separately eliminating maternal, infectious or non-communicable causes of death on life expectancy among WRA; and

iv. To decompose the total change in life expectancy by age separately for maternal, infectious or non-communicable causes of death among WRA.

1.5 Hypotheses

The study is further guided by the following hypotheses.

i. WRA are more likely to die from infectious than maternal causes of death

ii. WRA are more likely to die from NCD than maternal causes of death

iii. Elimination of maternal death will lead to a lower improvement in life expectancy among WRA than elimination of infectious causes of death

iv. Elimination of maternal death will lead to a lower improvement in life expectancy for WRA than that of NCD causes of death

1.6 Rationale

This study examined the relative risks of WRA dying from maternal, infectious or non-communicable causes of death in addition to the demographic impacts of these causes of death together. This is an area lacking in the literature. The study used multiple-decrement and associated single-decrement life-table techniques to assess separately the overall number of person-years that will be discounted had maternal, infectious or NCD causes of death been hypothetically removed from the population given the mortality conditions of the period. This study may be the first attempt at investigating these major health challenges together among the WRA.

The study is also both timely and crucial for the following reasons. The first reason is the fact that the double burden of infectious and non-communicable causes of death is real in

Ghana (Agyei-Mensah & de-Graft Aikins, 2010; de Graft Aikins et al., 2012; The World Bank, 2006). The current study argues that in the case of WRA, a triple burden of maternal, infectious and non-communicable causes of death is emerging with a combination of persistent, new and re-emerging infectious diseases and growing NCDs and maternal deaths as well as morbidity. This is resulting into changes in the nature and number of people that need healthcare and leading to more expensive and complex cases. This research is, therefore, important as it seeks to bring to the fore the various dimensions of the problems on the dynamics and the need to seek increased government and non-governmental attention and funding. The relevance of this study can therefore not be underestimated.

About fifty percent of international assistance from private sources is used in funding global health (Merten 2008). The bulk of funds is used for vertical funding that confines development financing to targeted diseases or services in the health sector. In Ghana, vertical funding is targeted at a few infectious causes of death, mainly malaria and HIV/AIDS whilst chronic diseases are neglected. A study by de-Graft Aikins (2007) observed that non-communicable causes of death in Ghana are major public health and developmental threat. The study, therefore, argued that chronic diseases require the same intellectual and financial commitments as infectious diseases. The author also recommended that there should be an effective response to the multi-dimensional causes and consequences of NCDs and so research, interventions and policies on NCDs have to consider a multi-disciplinary approach that includes social science methods (de-Graft Aikins, 2007). Part of the present study is intended to address the social science aspect of this recommendation by analysing the socio-demographic, economic, behavioural and health-related determinants of maternal, infectious and non-communicable causes of death among WRA in the study area.

The study concentrates on women because it is known that women occupy the lowest position on the socio-economic ladder and are relatively more disadvantaged compared to

their male counterparts, whether in urban or rural settings. This situation has made them relatively poorer in the community and since studies have shown that the phenomenon of the double burden of disease tends to correlate with poverty (Agyei-Mensah & de-Graft Aikins, 2010), it is relevant to study how women are affected by the risks of dying from maternal, infectious and non-communicable causes of death. The bias of this study towards women is also justified within the context of ongoing efforts at improving the socio-economic and health conditions of women in Ghana through affirmative actions.

Furthermore, women may have to seek permission from their spouses and significant others and may have to depend on them for the medical expenses. This situation tends to make women either delay in or not report medical conditions, resulting in their prolonged health challenges and/or death (Somé, Sombié, & Meda, 2013). The study is, therefore, timely because of efforts by the Ghana Health Service and the global community in forestalling the potential of NCDs becoming an epidemic in the country. This is because NCDs are increasing and cases such as cervical and breast cancers are on the rise. The level of maternal mortality is also unacceptably high and many of the deaths have been linked to infectious causes of death such as malaria, HIV/AIDS and tuberculosis as the underlying causes of maternal mortality. In view of the foregoing, a research of this nature, and the findings thereof could assist a great deal in offering concrete recommendations for the implementation of policies with special reference to women to address this problem in Ghana.

Finally, the justification for this study is further borne out of the fact that although public health research has identified risk factors for adult female and maternal morbidity and mortality, such studies have focused more on individual or micro-level factors and a few have examined the macro-level factors. Some studies (Abel & Frohlich, 2012; Cockerham, 2005; Marmot, Friel, Bell, Houweling, & Taylor, 2008) have questioned the lesser emphasis on

social and structural conditions in favour of individual level factors since the social and structural conditions influence access to important resources and thus affect multiple health outcomes through various mechanisms. This current study examines the socio-demographic, economic, physical, behavioural and health-related determinants at three levels (i.e. individual, household and community level factors).

1.7 Chapter outline

The study is organised into nine chapters. Chapter one covers the background to the study, statement of the problem, research questions, objectives, rationale and the outline of the study chapters. Chapter two reviews the literature on the causes of maternal, infectious and non-communicable deaths among women of reproductive age and a presentation of the theoretical and conceptual frameworks adopted for the study. Chapter three presents on the profile of the study area as well as research methodology. Chapter four is dedicated to the broad and specific causes of death among women of reproductive age in the Kintampo districts. Chapter five focuses on the relative risk of dying from maternal, infectious and non-communicable causes of death among women of reproductive age from 2005 to 2014. Chapter six examines the socio-demographic and economic determinants that influence maternal, infectious and non-communicable causes of death among women of reproductive age. Chapter seven estimates the effect of separately eliminating maternal, infectious and non-communicable causes of death on life expectancy for the study women. Chapter eight investigates decomposition of the total change in life expectancy by age separately for maternal, infectious and non-communicable causes of death among WRA. Finally, chapter nine presents the summary, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter reviews the available literature on competing risks as well as the literature on the causes of maternal, infectious and non-communicable deaths among women of reproductive age within the global, regional, national and study area specific contexts where available and appropriate. In addition, major determinants including the socio-demographic and economic determinants of these causes of death are reviewed. Finally, the theoretical and conceptual frameworks guiding the study are also presented in this chapter.

2.2 Competing risks analysis and causes of death

Competing risk analysis is a special type of survival analysis that aims to accurately estimate the marginal probability of an event in the presence of competing events (Mailman School of Public Health, n.d.). Since death is not a repetitive event and is normally ascribed to a single cause, the causes of death compete with one another for the life of a person (Chiang, 1991). With respect to the present study, it is conceptualised that maternal, infectious and non-communicable causes of death compete with one another for the life of WRA in the Kintampo HDSS Area. Traditionally, methods such as Kaplan-Meier have been used to describe survival processes. However, such methods tend to produce incorrect estimates when analysing the marginal probability for cause-specific events since they are not designed to consider the competing nature of multiple causes to the same event (Mailman School of Public Health, n.d.).

The analysis of the competing risks involves multiple-decrement and associated single-decrement life table procedures. Multiple decrement life tables (MDLT) are situations

where a member of a cohort can be terminated by two or more exits (Bawah & Binka, 2007). MDLT is appropriate for this analysis because maternal, infectious and non-communicable causes of death are considered as competing risks. Multiple decrement life table analysis allows cause attribution or "removal" of deaths attributed to a particular cause (Ferguson, Restrepo, & Villamarín, 2010).

Azeko et al. (2013) proposed a modification to the MDLT but they adopted Minitab Model 15, Princeton, New Jersey, USA for their analysis. However, using a model life table such as Minitab Model 15, Princeton, New Jersey, USA, may not be suitable for a given population (Adlakha, 1972). The current study adopted a procedure by Preston et al. (2000) for the analysis. From MDLT, the associated single decrement life table (ASDLT) is calculated, whereby a cause of death *i* is removed. The ASDLT is employed to compute the change in life expectancy as a result of hypothetically eliminating a cause of death *i* (Ferguson et al., 2010). With respect to WRA, reproductive-aged life expectancy (RALE), analogous to life expectancy at birth is computed from 15 to 49 years (Canudas-Romo, Liu, Zimmerman, Ahmed, & Tsui, 2014).

More recently, advances in the area of competing risks have mostly used the concept of potential lifetimes (Chiang, 1991; Moeschberger & David, 1971). The potential gain in life expectancy (PGLEs) is the added years of life expectancy the population receives when the deaths from a specific cause were removed as a competing risk of death (Lai & Hardy, 1999). PGLEs appropriately consider competing risks by assuming that if a person does not die of cause *j*, that individual is still at risk of dying from other causes during his or her life time and may eventually die of cause *k*. By considering other mortality risks existing within the population, PGLEs correctly determine the accurate effect of a mortality risk as far as the overall life expectancy is concerned (Ferguson et al., 2010). Computation of life years to be gained by removal of particular causes of death offer invaluable summary of the comparative

significance of these causes of death, in addition to the potential benefits of interventions (Mackenbach, Kunst, Lautenbach, Oei, & Bijlsma, 1999; S. H. Preston, Keyfitz, & Schoen, 1972).

The cause-elimination life table calculation's main assumption is that individuals who are saved from dying as a result of the eradicated cause, are still at risk of death from other causes that are equivalent to the average risks of death from all causes of death observed in the whole population (Chiang, 1991; Cornfield, 1957). This assumption is unrealistic, especially where common risk factors are involved in the analysis. For example, many persons dying from ischaemic heart disease would be at a greater than average risk of death from several other causes of death, such as chronic respiratory conditions, lung cancer, hypertension and other cardio vascular diseases. In this way, gains in life expectancy after removal of ischaemic heart disease are likely to be over-estimated (Mackenbach et al., 1999). The present study considered the various causes of death at their broad level to minimise such effects.

Furthermore, independence of risks is generally assumed since there is no simple statistical method available for cause-specific mortality analysis when risks are dependent. However, some scholars have disagreed with the validity of the assumption, which has been the subject of debate since there is no unique answer to the problem of risk independence. The independence assumption may not be valid for closely related causes of death, but it may be true between distant disease types (Arriaga, 1984; Chiang, 1991). The present study used the broad categorization of causes of death, which are distant disease categories.

Most of the studies on increases in life expectancy due to removal of major causes of death have been conducted in the high-income countries (Lai & Hardy, 1999; Phetsitong & Soonthorndhada, 2016). It is observed that a few studies have estimated the major cause of death in LMICs (Phetsitong & Soonthorndhada, 2016). The nature of causes of death found

in the global north is different from those found in low income settings. Preston et al. (1972) observed that the greatest improvement in life expectancy for 1964 was 13 and 17 years for males and females respectively in the United States of America. The authors reported that this greatest increase in life expectancy occurred from the elimination of causes of death due to circulatory diseases. They further observed the same pattern across high-income countries where causes of death due to circulatory diseases resulted in most of the large gains in life expectancy (Preston et al., 1972).

In contrast, it is reported that the elimination of causes of death due to circulatory diseases in LMICs leads to the lowest improvement in life expectancy relative to other causes of death. A study in Pakistan to examine the gains in life expectancy after eradication of specific causes of death reported that removal of causes of death due to circulatory system diseases resulted in only 1.29 years gained compared to 3.9 years gained if malaria were eliminated (Ali, Nasir, & Farooqui, 1988). Yet, in a more recent study in another Asian country with a relatively higher income, cardio-vascular diseases (CVDs) contributed most years gain in life expectancy. Mohammadpour et al. (2014) conducted a study in Iran to estimate the gain in life expectancy of 28 provinces by the elimination of specific causes of death. The authors observed that elimination of CVDs led to most years gained in life expectancy. The foregoing discussion, suggests that causes of death are context and time specific. In addition, the authors in the Iranian study reported that improvements in life expectancy were different for various causes of death and age groups (Mohammadpour, Khanali, Yazdani, Mahmodi, & Khosravi, 2014).

In most high-income countries, the occurrence of infectious causes of death is so low that elimination of such causes contributes little to improvement in life expectancy. For instance, in the United States of America, for both males and females, only 0.1 year was added to life if infectious causes of death were averted (Preston et al., 1972). Nevertheless, in

the LMICs such as Ghana, infectious causes of death such as malaria resulted in gains in life across all ages (Bawah & Binka, 2007). Bawah and Binka (2007) reported that in the absence of malaria, life expectancy increased at every age. Furthermore, a study that examined 165 populations observed a marked difference in added years of life gained as a result of elimination of infectious diseases, neoplasm and CVDs between high and low mortality populations (Preston, 1976).

Moreover, Canudas-Romo et al. (2014) used the human mortality and the DHS data for some selected countries to assess the changes in the effects of maternal mortality on life expectancy. The authors' goal was to estimate the improvement in reproductive-aged life expectancy in high-income and African countries by eliminating maternal mortality. They observed that the values of the RALE vary from 27.9 to 33.4 years across countries in SSA. According to the authors, the possible gain by eliminating maternal mortality was lowest in Namibia and highest in Chad (Canudas-Romo et al., 2014).

In addition, it is possible to decompose the overall change in life expectancy by different age groups after a particular cause of death is removed using life table techniques (Arriaga, 1984; Martikainen, 2001). Bawah and Binka (2007) in their study to assess the number of years that will be discounted if malaria were removed from the population also ascertained the age groups that will contribute most to the overall change in life expectancy at birth because of the eradication of malaria. They found that children under five years had the greatest gain in life expectancy of about 45 percent after elimination of malaria. They concluded that the highest improvement in life expectancy was expected for children under the age of 5 years since the highest percentage of the deaths (36%) occurred in the under-five-year old and the highest percentage of deaths (27%) were as a result malaria.

2.3 Maternal causes of death

2.3.1 Overview of maternal causes of death

Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes (WHO, 2010b). Maternal causes of death usually have been defined as direct and indirect obstetric causes, but not including external deaths such as deaths from accidents, violence or suicide (Chou, 2013).

Globally, maternal mortality has been acknowledged as a major public health challenge and discussed over three decades ago (Scrafford & Tielsch, 2016). Maternal mortality has been the focus of discussions or at least a major part of the discussions at several international fora to date. These include, but are not limited to the 1987 Safe Motherhood Conference in Nairobi, Kenya, the 1994 International Conference on Population and Development in Cairo, Egypt, the 1995 Fourth World Congress on Women in Beijing, China, the 1997 Safe Motherhood Technical Consultation in Colombo, Sri Lanka, the MDGs in 2000 and currently, the 2015 SDGs both in New York, USA. Despite all this attention, causes of death among WRA are reportedly due to maternal mortality (Kassebaum et al., 2014; Scrafford & Tielsch, 2016; United Nations, 2009).

Maternal mortality declined by 1.5% per year between 1990 and 2015 (WHO et al., 2015) largely as a result of global efforts in the last three decades (Scrafford & Tielsch, 2016). It is reported that improvement in maternal mortality accelerated after the introduction of MDG 5A in 2000 which aimed to reduce the global MMR by at least 75% by 2015 (Alkema et al., 2016; Say et al., 2014). However, the WHO estimated a cumulative decrease in global MMR of 44 percent that fell short of the target. In addition, the MMR declined

across all regions during the period but the level of the reduction varied substantially between regions (WHO, UNICEF, UNFPA & The World Bank, 2015).

According to a technical report submitted to the WHO (WHO, UNICEF, UNFPA & The Word Bank, 2010), in low-income settings, the annual rate of MMR reduction during the 1990-2000 period was 1.3 percent. However, during the 2000-2015 period, progress more than doubled to an annual rate of 3.1 percent due mainly to global efforts aimed at maternal deaths (Scrafford & Tielsch, 2016). These rates translate to an estimated 2.4 percent overall yearly average reduction from 1990 to 2015. Eastern Asia experienced the highest estimated annual rate of decline of 5.0 percent between 1990 and 2015 whilst the lowest estimated annual rate of decline of 2.2 percent per year happened in Western Asia for the same period.

Furthermore, almost 99 percent (302 000) of maternal deaths is estimated to have occurred in developing regions in 2015. SSA alone contributed about 66 percent (201 000). Southern Asia followed with 66 000 and the developing region with the fewest maternal deaths of 500 was Oceania. In addition, poor-resource settings in 2015 experienced 239 deaths per 100,000 live births compared to 12 in the developed region. This is about 20 times higher than that of high-income settings.

SSA compared to other developing regions of the world has a very high MMR (Wilmoth et al., 2012). It has a point-estimate of 546 compared to 187 in Oceania, 176 in Southern Asia and 110 in South-eastern Asia. Moreover, the lifetime risk of maternal mortality is estimated at one in 36 in SSA compared to one in 2300 in Eastern Asia and one in 1100 in Caucasus and Central Asia. In the high-income settings, the lifetime risk is estimated at one in 4900 which contrast sharply with the risk in SSA. In addition, among the 20 countries with the highest maternal mortality ratios, only Afghanistan is not in the SSA Region (Alvarez, Gil, Hernandez, & Gil, 2009). According to estimates, using the 1990 to 2013 global burden of disease (GBD) data, there would be 184, 100 maternal deaths globally

in 2030. SSA accounted for 38 out of 53 countries expected to have MMR of more than 100 which fall short of the SDG target 3.1 (Kassebaum et al., 2014).

From the foregoing, the causes of maternal mortality are several and differ from one setting to another depending on prevailing factors. There are variations across developing countries and regions (United Nations, 2015). Therefore, efforts to reduce maternal mortality need to be tailored to local conditions to achieve the desired and maximum impact. A WHO systematic analysis using both specialised and general bibliographic databases for published articles between January 2003 and December 2012, reported that the main cause of maternal mortality globally is haemorrhage (27.1%) followed by hypertensive diseases (14%) and sepsis (10.7). The remaining causes were abortion (7.9%), embolism (3.2%), other direct causes (9.6%) and indirect maternal causes (27.5%). However, the review highlighted regional differences (Say et al., 2014).

2.3.2 Determinants of maternal causes of death

The reviewed literature on maternal causes of death shows correlations between maternal causes of death and, indeed, other causes of death, and some distal, intermediate and proximate level factors. These factors include socio-demographic (age, parity, marital status); socio-economic and cultural (educational level attained, occupation, religion, ethnicity), as well as lifestyle and behavioural (alcohol and tobacco use) factors among others.

One demographic factor that featured in most of the reviewed literature on maternal causes of death is age. Most of the studies reviewed showed that maternal mortality increases with age. For example, Scrafford and Tielsch (2016) used the sisterhood method to estimate maternal and non-maternal deaths by using DHS data with maternal mortality module for 38 countries in three regions among WRA 15–49 years. The findings revealed an increasing trend of up to 30-35 years old followed by a decline, with a sharp fall above 40 years. Also, an analysis of aggregated DHS data to examine age patterns for maternal deaths established

that the highest cases of maternal mortality happens from 25 to 29 years, the greatest maternal mortality rate happens from 30 to 34, and the highest risk (MMR) happens after 40 years (Scrafford & Tielsch, 2016). The observed pattern may be because of the occurrence of the greater number of childbirth within this age group.

In addition, a study in Ghana by Asamoah et al. (2011) used the Ghana maternal health survey data for WRA 12-49 to examine the socio-demographic distribution of causes of maternal deaths. The study found that haemorrhage was the main cause of maternal deaths and it mostly occurred among the 35-39 year age-group (Asamoah et al., 2011). Some studies in high-income settings have indicated also that older women were at greater risk of haemorrhage relative to WRA who are younger (Al-Zirqi, Vangen, Forsen, & Stray-Pedersen, 2008; de Vienne, Creveuil, & Dreyfus, 2009). Several studies conducted in Africa and Asia including Ethiopia, Tanzania, Bangladesh and Nepal similarly found that pregnancies are significantly riskier in WRA above 35 years old compared to those who are younger (Evjen-Olsen et al., 2008; Gidey, Bayray, & Gebrehiwot, 2013; Jahromi & Husseini, 2008; Kang, Liao, Wester, Leeder, & Pearce, 2010; A. R. Khan, Jahan, & Begum, 1986).

However, some studies reported that mortality risk from abortion declines as maternal age rises and others found that the risk of dying from abortion is higher among WRA less than 25 years old. Still, other studies have pointed out that the toll of maternal mortality is heaviest among the youngest age group 15-19. For example, Garenne et al. (2013) used HDSS data to examine the variations in risk of mortality for WRA within and without the maternal risk period (MRP), which are pregnancy, delivery and puerperium in Agincourt, South Africa. Conceptually, the idea was to calculate the relative risk (RR) of death within and without the MRP. A value of RR=1 showed a higher risk of death due to pregnancy, and RR<1 indicates a protective influence of pregnancy. The MRP was defined as 46 weeks (40 weeks of pregnancy, the delivery and 6 weeks post-partum).

The study used information on mortality for all WRA (15–49) years old between 1992 and 2010 and a validated VA questionnaire was used to estimate the causes of death. The analysis involved 2,170 deaths, of which 137 happened during the MRP. The results generally showed that WRA significantly had lower mortality in the course of the MRP than outside it (RR = 0.75; 95% CI = 0.63–0.89). Apart from adolescents (15–19 years old) whose risk of death was greater (RR = 2.07; 95% CI = 1.19–3.61; p= 0.009), for all other age groups the RR was lower. Lower mortality during the MRP may be due to the selection of healthy women for pregnancy and childbirth (Garenne, 2011; Garenne et al., 2013). However, the authors noted that this higher mortality for the adolescents was because of eight out of 15 deaths that were due to obstetrical causes during the MRP. This is because apart from obstetrical causes, the RR was less than one among the adolescents for other causes.

Another demographic factor commonly used in the reviewed literature is parity. Many of the studies reviewed reported that higher parity correlates with higher maternal deaths. Several studies including the study by Asamoah et al. (2011) have documented that women who had a parity of five or more accounted for the highest parity-specific mortality rate (Asamoah et al., 2011; Ganatra, Coyaji, & Rao, 1998; M Garenne, Mbaye, Bah, & Correa, 1997; Mbizvo et al., 1993). Many of the studies that associated increasing parity with maternal causes of death also reported higher mortality with primiparas. For instance, Asamoah et al. (2011) found that most (68.3%) women who died from hypertension-related diseases, had a parity of two or less. However, some studies including one by Christian et. al (2008) and another by Evjen-Olsen et al. (2008) observed that higher parity resulted in greater protection (Evjen-Olsen et al., 2008).

The literature on marital status and maternal causes of death generally showed some inconsistency. This is because Asamoah et al. (2011) reported that married women died most (93.7%) from maternal causes of death (Asamoah et al., 2011). This may be because of a

greater proportion of married women likely to get pregnant or experience childbirth. However, Illah et al. (2013) used HDSS data from Rufiji, a rural setting in Tanzania to examine levels, causes and risk factors that correlate with maternal causes of death. They reported that marital status suggested that WRA who were ever married had a protective influence of 62 percent relative to those who were never married (HR=0.38, 95% CI=0.176-0.839). They further observed that this correlation continued to be significant after accounting or adjusting for maternal age (Illah, Mbaruku, Masanja, & Kahn, 2013). A case-control study using health facility data from a hospital in Dakar, Senegal reported that women who had never been in a union were 150 percent more likely to die from maternal causes relative to women who had ever been married (Garenne et al., 1997). This observation of protection for those in union is partly because women who were healthy to begin with were more likely to marry and remained in marriage and partly because marriage provides an alternative source of income and social protection (Waldron, Hughes, & Brooks, 1996).

Most of the literature on maternal mortality and education show an inverse relationship. Several studies using institutional data in SSA countries, including Senegal, Tanzania and Nigeria found that lower levels or no maternal formal education increase the risk of maternal mortality (Evjen-Olsen et al., 2008; Garenne et al., 1997; Olopade and Lawoyin, 2008). Similarly, population-based studies and in particular studies using HDSS data have also reported inverse correlations between formal education and maternal deaths (Hill, Tawiah-Agyemang, & Kirkwood, 2009; Melaku et al., 2014; Mills, Williams, Wak, & Hodgson, 2008; Rosário et al., 2016).

Melaku et al. (2014) used HDSS data to estimate mortality rates and causes of death in a cohort of the female population in Ethiopia. They found that approximately, four out of five deaths (n= 578; 79.9%) happened among illiterates (Melaku et al., 2014). Another study to examine the correlations between cause-specific mortality in adults aged 20 years and

above and their socio-economic status in rural Vietnam reported that those with lower educational statuses experienced higher mortality rates including maternal mortality than the better-educated. They observed that even after controlling for age and household socio-economic status (SES), education was observed to strongly positively correlate with mortality. They explained that women's education is an essential long-term health factor, as women play a very significant role in the care of the family, particularly their children (Rosário et al., 2016).

Several other reasons have been advanced regarding the relationship between maternal education and mortality. One reason is the fact that education of women tends to affect their use of all types of health facilities such as ante-natal care (ANC). These services especially, the use of prenatal services have a positive effect on maternal survival (Aggarwal, Pandey, & Bhattacharya, 2007; Ganatra et al., 1998). Another reason supporting the relationship is the influence that maternal education has on their use of contraception (Fawole, Hunyinbo, & Adekanle, 2009). In addition, women without formal education lack awareness regarding the seriousness of maternal health issues, and so they are unlikely to understand health messages and making decisions regarding their pregnancy and childbirth care (Gidey et al., 2013). Some studies have also shown that literacy affects the place of delivery and the skill level of health personnel chosen for attendance at delivery. Women with high educational attainment levels prefer delivering at health facilities where there is skilled personnel (Buor & Bream, 2004).

On the contrary, the findings of some studies did not appear to associate low maternal education with a higher risk of maternal mortality (Ganatra et al., 1998; Mbizvo et al., 1993). Also, a case-control study to investigate the determinants of maternal mortality in a rural Tanzania by comparing the WRA dying of maternal mortality with those from similar populations but who attended antenatal clinics during the same time period reported an

association between high maternal deaths and high formal education. However, the authors attributed the finding to the fact that the study participants were very few to identify an actual association (Evjen-Olsen et al., 2008).

A lot of the reviewed literature associated religion with the four-delay model in seeking medical attention. Most especially the first two delays regarding recognising the danger signs of maternal mortality and taking the decision to take the woman to the health facility for medical attention. Kenneth et al. (2016) used qualitative methods to explore apostolic beliefs and practices on maternal health in five purposively selected districts of Zimbabwe and reported that religious heads were usually the first point of call for parturient women who experienced complications (Kenneth, Marvellous, Stanzia, & Memory, 2016). Some studies including Kerber et al. (2007) and Pasha et al. (2010) have observed that emergency obstetric care could minimise maternal deaths (Kerber et al., 2007; Pasha et al., 2010). However, by reporting first to pastors not only delays the time in getting to emergency obstetric care services but may perhaps also raise the number of fatalities if the pastors do not immediately send the cases to health facilities.

Another factor associated with the delay model is physical distance. Gidey et al. (2012) during a hospital-based case-control study to assess patterns of maternal mortality and associated factors found that out of the 310 study subjects, 99 controls and 44 cases had to travel over 5km to reach nearby health institutions. They also demonstrated a significant association between maternal death and women whose residence were a rural area which was ≥5km far from any nearby hospitals (Gidey et al., 2013). The result showed that 71% of the deceased women resided in the rural area. This finding was supported with the result observed in Pakistan which showed 61.7% for maternal deaths due to a 5km or more distance far away from the health facility to the residence in a health facility-based maternal death audit in Tigray between December 2005 and May 2006 (Iqbal, Shaheen, & Begum, 2014).

Numerous studies in the past several decades have established a link between poverty and maternal health. It is well documented in the maternal mortality literature that the difference in maternal deaths between the poor and the rich is mainly due to an uptake of ante-natal care (ANC) and delivery services most especially in fee-paying settings. A study in Peru estimated that the poorest quintile recorded higher than 800 maternal deaths per 100, 000 live births whilst the richest group recorded less than 130 maternal deaths per 100, 000 live births which constitute a six-fold difference (Ronsmans & Graham, 2006). Another study in Indonesia found that 32 to 34 percent of maternal mortality happened among WRA from the poorest segment of the community (Graham, Fitzmaurice, Bell, & Cairns, 2004).

Furthermore, the familial technique, which is a proxy for the wealth index at the individual level, has been used to determine poverty status of WRA. Variables such as the level of education, the water source, toilet type and material of the building floor are included in the index. The familial technique measures the poverty level of the women and by linking it to maternal deaths showed that as poverty increased, the percentage of death from non-maternal causes also raised, and the number of WRA dying of maternal mortality raised steadily (Graham et al., 2004). This method is akin to the principal component analysis (PCA) that is used in the current study.

The PCA that uses property ownership inside households has been used by other studies in African settings to examine the influence of socio-economic status on mortality and morbidity in general in several HDSS sites. Findings from these studies have indicated that poorest households have worse healthcare indices relative to those in the least poor households (Bawah et al., 2012; Khan et al., 2006). This observation has been explained to be because of socio-economic position of women in LMICs restrict their access to basic education or economic resources, thereby limiting their capacity to take decisions that affect their health (Parris, 2008).

In addition, the literature on maternal mortality shows associations between maternal mortality and behavioural characteristics such as alcohol and tobacco consumption. Many studies have established a positive correlation between alcohol consumption and maternal mortality. Most of these studies were conducted in high-income countries (HICs) and focused mainly on spontaneous abortion with a few studies investigating alcohol consumption and induced abortion (Gil Lacruz, Gil Lacruz, & Bernal-Cuenca, 2012; Raatikainen, Heiskanen, & Heinonen, 2006; Sen, 2003). Studies on alcohol and maternal mortality are rare in SSA where the burden of maternal deaths is highest but accessing and consuming alcohol is less controlled (Asamoah & Agardh, 2012).

Similarly, Asamoah and Agardh (2012) used the Ghana Maternal Health Survey 2007 to examine the correlation between consuming alcohol and maternal death from induced abortion. Their study showed a positive correlation between consuming alcohol and risk of maternal mortality from induced abortion. They observed that maternal educational level and age were probable factors influencing the patterns of alcohol consumption. They reported that women who drank alcohol were over two times more likely to die from abortion than their counterparts who did not consume alcohol after adjusting for the effect of maternal educational level, age, marital status and rural–urban residence status. Consumption of alcohol was also reported to have a strong correlation and the association increased as women grew older (Asamoah & Agardh, 2012).

A number of studies have proposed possible mechanisms that consuming alcohol could lead to a greater risk of maternal mortality, particularly induced abortion and subsequently death due to induced abortion. One suggestion that has been put forward is that consuming alcohol leads to an impaired judgment which increases the risk of non-contracepted sexual intercourse and thereby making abortion become an option due to unwanted pregnancy (Grossman, 2002; Sen, 2002). Yet, Weinhardt and Carey (2000) in their

review of literature many of which were on college students and adults, reported that there was no evidence that consuming alcohol leads to unprotected sex (Weinhardt & Carey, 2000). Another related pathway that has been suggested is that alcohol consumption leads to a situation where one cares very little about the future including the consequences of unprotected sex such as pregnancy which may be considered as minor (Sen, 2003).

Health status is a proximate determinant of a cause of death (Defo, 2014). Because of factors explained by the delayed model as earlier presented, many studies have associated hospital admission to maternal mortality. A study that combined systematic review and meta-analysis in SSA reported that the proportion of skilled birth attendance and type of health facility accounted for 44 percent of the total variation of the MMR between studies (Montoya, Calvert, & Filippi, 2014). In addition, a study in Pakistan to examine the risk factors of maternal mortality observed that 53 percent of maternal deaths happened in less than 24 hours of hospital admission with only 28 percent of women remaining alive for 72 hours (Iqbal et al., 2014). Another study in Asia reported that a high proportion of maternal deaths occurred in hospitals with 48.9 percent of the admitted women dying within 24 hours of admission (Aggarwal et al., 2007).

Several hypotheses may explain this paradox. One reason is probably that the deliveries were conducted at home by untrained persons and were rushed to a hospital when they became too complicated resulting in the women dying at the hospital. Other reasons could be that there were no skilled attendants and/or no required equipment to attend to the women. In addition, a study in Ethiopia reported that maternal death was less likely to occur in WRA whose labour pain were less than 24 hours from admission relative to WRA whose labour pain was more than 24 hours (Gidey et al., 2013).

One intervention under hospital settings is a surgical operation. Caesarian sections (CS) continue to grow in the last four decades throughout the world (Althabe et al., 2006;

Gebremedhin, 2014; Volpe, 2011). Nevertheless, a study in Pakistan that analysed postoperative complications and CS concluded that compared to vaginal delivery, maternal mortality is increased with caesarian delivery (Khaliq, Mehmood, & Zakia, 2005). Yet, an ecological study of 119 low-middle-high income countries examined the effects of a 10 percent CS threshold on maternal and neonatal mortality. The authors observed that 76 percent of LMICs recorded CS rates lower or equal to 10 percent and showed a maternal mortality of over five times greater than countries with CS rates higher than 10 percent. Alternatively, high-income countries with 97 percent of CS recorded CS rates of over 10 percent and presented quite similar maternal mortality rates amongst them (Althabe et al., 2006). One reason that has been suggested for this observation is that in LMICs, less number of CS is done than the number required for their population at risk. Conversely, in most HICs, the required number of CS is done for their population at risk, and the higher rates of CS may be a measure of the use of unwarranted CS in healthy populations and also the use of CS to prevent non-severe morbidity in their populations (Althabe et al., 2006; Gebremedhin, 2014; Volpe, 2011).

2.4 Infectious causes of death

2.4.1 Overview of infectious causes of death

Infectious diseases are spread directly or indirectly, from one person to another by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi (WHO, n.d.-b). A WHO estimate shows that one billion people globally are directly affected by one or more infectious diseases (Nunn, Fonseca, Bastos, Gruskin, & Salomon, 2007). According to Hotez et al. (2009), infectious diseases together contributed to the death of more than 8.7 million people globally in 2008 (Hotez, Fenwick, Savioli, & Molyneux, 2009). Most of these deaths were of poor populations living in LMICs. The social and economic circumstances of these

populations are characterised by poverty that directly or indirectly affects health status and health outcomes. It is suggested that the effects of poverty are two folds. It produces the conditions that aid the spread of infectious diseases. It also inhibits the affected populations from gaining access to prevention and care (WHO, 2012b).

Studies also using HDSS data in SSA have reported that communicable diseases are the leading causes of death among WRA although there are notes of increasing trends for the non-communicable causes of death (Kone et al., 2015; Lulu & Berhane, 2005; Melaku et al., 2014). Kone et al. (2015) used the InterVA-4 model to examine Taabo HDSS data in La Cote d'Ivoire from 2009 to 2011 for the whole HDSS population and found that generally, 58.9 percent of the mortality from the InterVA-4 output were as a result of infectious diseases, leading to a mortality rate of 4.0 deaths per 1,000 person years of observation (PYO). Similarly, Melaku et al. (2014) using the physician coding to analyse the Kilite-Awlealo HDSS data in Ethiopia between 2010 and 2012 among all female population found out that maternal causes of deaths were few (0.8 percent or 0.03 deaths per 1000 PYO) and the top broad cause of death was infectious diseases accounting for 37.2 percent or 1.40 deaths per 1000 PYO. An earlier study by Lulu and Berhane (2005) using the Butajira HDSS data among the adult population 15-49 reported that infectious causes of death accounted for 60.8 percent of the total causes of death.

2.4.2 Determinants of infectious causes of death

The literature on infectious causes of death is very rare for non-pregnant WRA. There is some consensus that efforts to reduce maternal deaths among WRA should be re-focused on the reduction of non-obstetric or indirect causes as direct maternal mortality decreases mainly because of targeted interventions (Say et al., 2014; Scrafford & Tielsch, 2016). Pregnancy and vulnerability to infectious diseases have been investigated for several diseases, which are major causes of mortality in WRA in LMICs. These include malaria, HIV

and AIDS, and other sexually transmitted infections (STIs) such as gonorrhoea and syphilis, TB, listeria, cholera and other diarrheal diseases, listeria and viral diseases such as hepatitis, influenza, measles, mumps and rubella. All these infections apart from HIV and AIDS are categorised as indirect causes of maternal death by the ICD-10 (Garenne, 2011).

Both pregnant and non-pregnant women of WRA are expected to have the same mortality risk for malaria. This is because malaria is transmitted to human beings by an infected female anopheles' mosquito bite irrespective of whether the woman is pregnant or not. However, malaria in pregnancy could cause cerebral malaria or lead to severe anaemia with several health outcomes such as heart failure and postpartum haemorrhage (Garenne, 2011). In view of this, it is expected that malaria in pregnancy may lead to an increased risk. It has been suggested that additional research on malaria and pregnancy is required since the literature in this regard is contested and the health outcomes of malaria in pregnancy is influenced by several factors that include maternal age, gravidity, and parity (Garenne et al., 2013). Other factors are the malaria profile of the community such as the strain of the plasmodium and transmission patterns, nutritional status, genetics (both host and parasite), treatment and prophylaxis, natural immunity and previous exposure as well as co-morbidity with other infections that include hookworm infestations, and infections from viruses for instance, HIV (Garenne, 2011; Garenne et al., 2013).

Recently, scholarly works on malaria and pregnancy have undergone tremendous review in a number of studies (Campion, Kourtis, Read, & Jamieson, 2014; Tonga et al., 2013; Uneke, 2007). It has well been established that WRA are highly vulnerable to Plasmodium falciparum in pregnancy (Garenne, 2011; Garenne et al., 2013). Asamoah et al. (2011), found that malaria accounted for 53.6% of pregnancy-related deaths due to infectious diseases in a study using the Ghana Maternal Health Survey data among WRA between 12-49 years. Garenne et al. (2013) used HDSS verbal autopsy data to examine the differences in

risk of death for 15-49-year-old WRA within and outside of the maternal risk period in South Africa. They observed that the four malaria deaths to pregnant women happened at ages less than 35 years, whilst the malaria deaths that occurred in non-pregnant women were spread evenly. For the non-pregnant women, there were 18 malaria deaths for WRA less than 35 years old and 11 deaths were beyond 35 years old. This pattern of distribution of malaria deaths indicates an interaction amongst malaria, pregnancy and age. The authors also suggest that there is a greater risk linked to the first pregnancy (Michel Garenne et al., 2013).

However, the demographic influence of malaria and pregnancy on maternal mortality is still poorly researched and contentious. For example, Hounton et al. (2008) reported an increased maternal mortality in the dry season, which is characterised by little malaria transmission compared to the wet season, which is the highest period of malaria transmission in Burkina Faso, which has seasonal malaria and high mortality. Nonetheless, in Senegal, which also has seasonal malaria, Etard et al. (2003) reported the reverse. They found an increased maternal mortality as a result of obstetric causes in the wet season, but not from non-obstetric or indirect causes of maternal mortality (Etard, Kodio, & Ronsmans, 2003). Within the current study area, Dery et al. (2010) examined the effect of seasons on malaria transmission and observed that malaria transmission occurred all over the year even though there are differences in inoculation rates in the rainy and dry seasons. The authors, therefore, concluded that malaria transmission in the Kintampo area of the Brong Ahafo Region of Ghana during 2004 and 2005 was high and occurred all-year round (Dery et al., 2010).

Furthermore, Menendez et al. (2008) found that 10.1 percent of maternal mortality in a Maputo Central Hospital in a two-year period were due to malaria. Granja et al. (1998) in an earlier study for the same facility reported 16 percent of maternal mortality during a five-year period were due to malaria. In both studies, the proportion of malaria-related maternal deaths was higher within adolescents and primigravidae (Granja, Machungo, Gomes,

Bergström, & Brabin, 1998; Menendez et al., 2008). However, both studies did not consider the relative risk of death since there was no comparison with non-pregnant WRA of the same characteristics (Granja et al., 1998). On the other hand, a study from 1992 to 2008 in Agincourt Health and Demographic Surveillance System (HDSS), South Africa, showed that the relative risk of malaria deaths in pregnancy was not significantly different from that of non-pregnant WRA (Garenne et al., 2013).

Moreover, Bawah and Binka (2007) used the life table techniques to evaluate the impact of eliminating malaria on life expectancy. Using the Navrongo HDSS data for 1995, the authors observed that at every age, life expectancy is increased if malaria were averted. In addition, their findings show that about a third of all the deaths is attributable to malaria and life expectancy was likely to be increased by over six years if hypothetically, malaria were removed as the main cause of death in the population (Bawah & Binka, 2007).

There is also an abundance of literature on the influence of HIV and AIDS and pregnancy. It has been established that pregnancy does not increase the progression of HIV (McIntyre, 2003). This means that deaths from HIV in pregnancy are unlikely to be significantly different from non-pregnant women of the same age. For instance, the age-adjusted proportion maternal (PM) for each of 29 countries in SSA ranked by the prevalence of HIV indicated a negative relationship between prevalence of HIV and PM with SSA countries that have highest and lowest HIV prevalence, respectively at the lowest and highest ends of the PM distribution (Scrafford & Tielsch, 2016). This finding could be explained by the fact that it has been shown that HIV infection reduces fertility (Garenne, 2011). This is due to the selection effect, as HIV sero-positives are less likely to get pregnant than others of the same age. An association with lower maternal mortality during pregnancy could exist as a result of the selection bias resulting from lower fertility as well as possible changes in sexual

behaviour since WRA in the last stages of AIDS may possibly have less sexual contacts (Garenne, 2011; Garenne et al., 2013).

However, HIV could have an influence on indirect causes by favouring the development of opportunistic infections that include miliary, TB, pneumonia, chronic diarrhoea or exacerbated malaria. Hospital studies or confidential inquiries have documented the comparatively high percentage of AIDS mortality among pregnant WRA (Kongnyuy, Mlava, & van den Broek, 2009; van der Spuy, 2009). Yet, after controlling for age, AIDS-related deaths are not greater during the maternal risk period compared to outside it and there is no evidence in available literature of high risk of AIDS-related mortality in the maternal risk period (MRP) (Garenne et al., 2013).

In the case of pregnancy and tuberculosis (TB), the former has frequently been seen as a probable risk for TB. This is as a result of the associated immune suppression due to pregnancy could reenergise dormant TB. However, literature review on TB and pregnancy concluded, "pregnancy on its own has not been found to be associated with an increased risk of TB" (Mnyani & McIntyre, 2011, 227). This means that a rise in pregnancy-related mortality may not automatically mean that the risk of death from TB is greater within pregnant WRA compared to those who are non-pregnant WRA with the same characteristics. It is essential to consider that TB is closely connected to HIV and in recent years, mortality from TB in pregnancy has risen due to the increasing incidence of TB. It is also worthy of note that selection bias might have an effect. This is because WRA in the last stages of TB-related infection have lower chances of becoming pregnant thereby resulting in an apparent lesser risk of death during the MRP. However, a study in Agincourt, South Africa showed that HIV/AIDS and TB are the main causes of death amongst WRA, 15–49 years old. Together, they accounted for 71 percent of established causes of death among non-pregnant WRA (Garenne et al., 2013).

Furthermore, Melaku et al. (2014) used the Kilite-Awlealo HDSS VA data to examine causes of death in Ethiopia over a three-year period among all females and established that HIV/AIDS and TB were the main causes of death in WRA. This suggests that other causes of death among WRA such as HIV/AIDS and TB, at least, deserve equal attention in addition to maternal causes. Several other researches have also documented the public health importance of HIV/AIDS and TB within the female populations in SSA countries (Herbst, Mafojane, & Marie-Louise, 2011; Kahn, Tollman, Garenne, & Gear, 1999; Misganaw, 2012; Phillips-Howard et al., 2012)

There is limited and occasionally contradictory literature on cholera and other diarrheal diseases such as shigella and pregnancy. A Nigeria study found a lower level of mortality within pregnant WRA after comparing cholera mortality among pregnant and non-pregnant WRA (Ayangade, 1981). Listeria, though has a lower demographic effect as a result of its rarity is reported to be more lethal in pregnancy (Poulsen & Czuprynski, 2013). Similarly, there is limited literature on viral infections such as measles, rubella and mumps. The impact of these viral conditions on mortality among pregnant and non-pregnant WRA remains poorly documented, and perhaps small (Garenne, 2011; Garenne et al., 2013).

On the other hand, it has been found that all the three viral infections could lead to adverse pregnancy effects such as foetal loss, prematurity, and neonatal sepsis especially if the infection happens during the third trimester. For instance, rubella could lead to congenital defects (White, Boldt, Holditch, Poland, & Jacobson, 2012). However, the impact of influenza on maternal deaths has been recognised from the time of the influenza epidemic between 1918 and 1919. In addition, there has been a comprehensive documentation of the effect of influenza in the recent past influenza A (H1N1) epidemic that affected the general population including non-pregnant WRA (Creanga et al., 2010; Laibl & Sheffield, 2005).

Moreover, it has been shown that hepatitis E is more contagious in pregnancy, and could even cause death (Krain, Atwell, Nelson, & Labrique, 2014).

2.5 Non-communicable causes of death

2.5.1 Overview of non-communicable causes of death

NCDs, unlike infectious diseases, are not spread from one person to another, mostly not acute, and cannot be cured in a short time, but usually progress slowly and are likely to remain lifelong (WHO, 2010c). The four major non-communicable diseases are CVDs such as heart failure and stroke, cancer, diabetes, and chronic respiratory diseases for example, asthma and chronic obstructive pulmonary disease (WHO, 2010c). Together, these four categories of diseases contribute about 80 percent of NCD mortality. They also have four common risk factors namely, unhealthy diet, tobacco use, low physical activity and excessive alcohol use (Roura & Arulkumaran, 2015).

Globally, NCDs are the number one causes of death, causing 60 percent of all deaths (WHO, 2010c). It is estimated that every year NCDs account for an approximately 35 million deaths (NCD Alliance, 2011). According to a WHO projection, deaths attributed to NCDs will grow from 36 million in 2008 to 52 million by 2030 (WHO, 2012a). It is estimated that LMICs account for 80 percent of deaths attributed to NCDs (Dye et al., 2013). It is reported that NCDs constitute the greatest threat to women's health globally, causing 18 million deaths among women (Tunstall-Pedoe, 2005). Thus, more than half of NCD deaths, every year are women (NCD Alliance, 2010).

It has recently been observed that NCDs are no more diseases of the affluent and elderly only, they are a major cause of deaths among WRA in LMICs (Dalal et al., 2011; Tunstall-Pedoe, 2005). In 2011, the World Economic Forum (WEF) ranked NCDs among the most important threats to global economic development (Bloom et al., 2011). This assertion

took cognisance of the significant social and economic impacts of NCDs on society. Moreover, over nine million NCD deaths equivalent to one fourth of NCD deaths, happen in persons less than 60 years old. These are "premature" deaths and 90 percent of them occur in LMICs (WHO, 2010c). It is increasingly affecting women in LMICs in their most productive years (NCD Alliance, 2010). Women are especially susceptible to NCDs because of biology, gender, and other social determinants (Langer et al., 2015).

NCDs in SSA mirror the global situation particularly that of the LMICs. It is a rising epidemic that includes cardiovascular diseases (CVDs), cancers and metabolic diseases such as diabetes and obesity (Ezzati et al., 2005; Parkin et al., 2008). This situation is partly because of the focus on maternal and child health as well as infectious causes of death in the region and as a result, there has been relatively little research that has been done on NCDs. Yet, individuals in SSA suffer from the dual burdens of causes of death from both infectious diseases and NCDs just as in other LMICs (Mathers & Loncar, 2006; Peer, 2015). The unacceptable level of maternal causes of death in LMICs, make the case of WRA, to be a triple burden.

NCD epidemic in SSA has several root causes. It is partly due to the demographic and epidemiological transitions that have led to reductions in infectious diseases that hitherto predominantly affect children. This has relatively resulted in the ageing of the population because of an increased survival into adulthood. The evolving demographic profile of the SSA population is an essential factor affecting the future occurrence of NCDs in the region. The epidemiological transition from mainly infectious to non-communicable causes of death is already occurring in many SSA countries as it is in LMICs (Agyei-Mensah & de-Graft Aikins, 2010). The fact that women live longer, as well as other socio-economic and cultural factors, means they will die more from NCDs (NCD Alliance, 2011).

The most common cancer among women worldwide is breast cancer. In 2008, 1.4 million estimated new cases were diagnosed and almost half of these cases occurred in LMICs (American Cancer Society, 2011). Breast cancer is the primary cancer cause of death in women globally notwithstanding the fact that it is largely treatable through early detection. However, early detection and affordable treatment continue to be a major challenge in LMICs (NCD Alliance, 2010). The public health burden of the disease is shifting considerably to susceptible populations in LMICs. It is projected that 1.7 million adult females mostly in LMICs with disease in 2015 will double to 3.4 million women in 2030 (The Lancet, n.d.).

The second major cancer cause of death for women globally is lung cancer although this type of cancer is easily preventable. It is estimated that cigarette smoking contribute to 50 percent of lung cancer diseases in adult women globally (American Cancer Society, 2011). It is projected that in 20-30 years, lung cancer may be the most common cancer in adult females globally as the rate of smoking amongst them rapidly rises. This is expected to happen if the current situation is allowed to continue without effective action to control it (American Cancer Society, 2011).

Health in LMICs is essentially an inter-related and inter-dependent mix of infectious and chronic illnesses. Evidence from the literature suggests that human papilloma virus (HPV) disease, one of the commonest STIs, is a major catalyst for cervical cancer. There are cost-effective processes to identify and treat cervical pre-cancer condition as well as HPV vaccines that are safe and effective and could prevent up to 70 percent of cervical cancer. Yet, 85 percent of mortality from cervical cancer happen in LMICs because of the virtual absence of screening and treatment services, and for this reason, WRA are not provided with the crucial HPV vaccines (NCD Alliance, 2011).

Globally, CVD causes more death than any other disease (WHO, n.d.-a). CVD is also the world's number one cause of death of women. CVD is characterised by sudden death

(Shanmugam, Sampath, & Kumar, 2015). Each year, CVD causes 9.1 million deaths among women. CVD caused 1.2 million deaths among women aged between 20 and 59 years in 2008 (American Cancer Society, 2011). This age group is the most productive period of life. In addition, CVD caused disability and morbidity to millions of people, especially in LMICs. It is estimated that among adult females who are likely to die from coronary heart conditions, LMICs account for 80 percent of the deaths.

It is projected that the average deaths each year from CVD will increase from 17.1 million to 23.6 million by 2030 (NCD Alliance, 2010). However, there is still a major difference between perceived and actual risk of CVD among women because of misconceptions that it is a male disease. Simple health interventions such as educating women on healthy lifestyle could be very useful in decreasing CVD death rates and the risk factors connected to it. However, the capacity of women to make healthy life choices is limited by poverty and other social conditions. As a result of this, women in LMICs living in poverty are especially vulnerable to CVD (NCD Alliance, 2010).

There is evidence to show that women are at a higher risk of suffering from adverse respiratory effects at lower levels of smoke exposure (Po, FitzGerald, & Carlsten, 2011). As a result, women are at a higher risk of developing the chronic obstructive pulmonary disease (COPD). In 2005, COPD caused more than three million people worldwide (NCD Alliance, 2010). In addition, COPD was ranked as the number five cause of death amongst women in LMICs in 2001. There is a gender difference in prevalence, severity, risk factors and death rates of COPD (American Cancer Society, 2011). This is because COPD strongly correlate with tobacco usage and usage of biofuels for cooking, lighting and heating which are mainly the responsibilities of women. In addition, women and sometimes with their young children spend time indoors where the biofuels are burnt. It is reported that 50 percent of the world's population particularly, in LMICs uses solid biofuels for cooking, lighting and heating. Each

year, COPD is estimated to cause 1.5 million premature deaths mostly among women and their young children since the length of exposure and the concentration of solid biofuels increase the COPD risk (Po et al., 2011).

Asthma is a type of COPD. Globally, about 300 million individuals are reported to be living with asthma. A number of studies have shown that a high percentage of confirmed asthma cases are women (NCD Alliance, 2011). Although, asthma could be reduced through proper control, a high percentage of cases, mostly women, continue to face lifestyle restrictions throughout their lives and sometimes require emergency care. The onset of asthma among women is more common and tends to be severe, yet it is usually underdiagnosed and undertreated in females than in males (NCD Alliance, 2011). One major cause of poorly controlled asthma that could lead to disability, absenteeism and poverty as well as death is the difficulty of accessing essential drugs (WHO, 2007).

Diabetes is ranked the number nine leading cause of death among women globally. There are more than 300 million persons with diabetes, and about half of this number are women (WHO, 2010b). The number of women with diabetes was estimated to be 143 million in 2010. It is projected that by 2030, this number will rise to 222 million (NCD Alliance, 2011). Each year 2.1 million women die of diabetes and a large proportion of these are between 40 and 60 years, which is their most productive years (NCD Alliance, 2011). The proportion of diabetes cases among women is rising because of increasing lifespan. It is reported that the all-cause mortality as well as the CVD mortality rates in the last three decades have declined for men with diabetes but that of women has not. It is suggested that this is because women are likely to receive less education on prevention and management of CVDs and type 2 diabetes compared to men.

The burden of NCD causes of death in Ghana is similar to that of SSA. Causes of death from NCDs in Ghana are estimated to rise because of ageing and urbanisation as well

as low physical activity, poor diet, tobacco and alcohol use. The GDHS conducted over the years show that the proportion of women between the ages of 15 and 49 years who are overweight or obese between a twenty-one-year period from 1993 to 2014, has more than tripled from 13 percent to 40 percent (GSS, GHS & ICF International 2015). According to a WHO study in 2008, it was estimated that each year 78,000 persons die of NCDs in Ghana. This represents 354 deaths per 100,000 population (WHO, 2010c). In addition, the report estimated NCDs account for 39 percent of deaths in Ghana (WHO, 2010c). However, according to the Ministry of Health, Ghana, each year, an estimated 86,200 persons die as a result of NCDs in Ghana. Of these deaths, 55.5 percent were less than 70 years old and 42 percent of females are affected (Ministry of Health, 2011).

CVD is reported to be the main NCD cause of death in Ghana (Bosu, 2013). According to a WHO estimate, it is one of the top two causes of death after diarrheal diseases (WHO, 2010c). Also, based on limited institutional data (excluding teaching hospitals) in 2003, CVD contributed 8.9% of institutional deaths whilst malaria contributed 17.1 percent. Five years later, CVDs became the top cause of institutional deaths in 2008. It accounted for 14.5 percent of institutional deaths whilst malaria contributed 13.4 percent of the deaths (Saleh, 2012; WHO, 2010c). It has been observed that CVD increases with age, rises steeply in mid-life and peak in the very old (Sanuade, Anarfi, de-Graft Aikins, & Koram, 2014). Recent studies are showing rising burden among the youth (Ogeng'o, Gatonga, & Olabu, 2011).

Wiredu and Nyame (2001) conducted a health facility study at the Korle Bu Teaching Hospital in Accra, Ghana to determine stroke-related mortality and patterns over a five-year period (1994-1998). Their findings reveal that stroke accounted for 11 percent of mortality (Wiredu & Nyame, 2001). In another health facility study to estimate stroke morbidity and mortality among adults on admission at the Komfo Anokye Teaching Hospital, Agyemang et

al. (2012) found that stroke accounted for about nine percent of the total adult admission. In addition, stroke accounted for 13 percent of all adult deaths that occurred in a period of 24 months starting from January 2006 to December 2007 (Agyemang et al., 2012).

Hypertension prevalence among adults in Ghana is increasing (Ofori-Asenso & Garcia, 2016). The proportion of adults in Ghana with hypertension is reported to range from 19 percent to 48 percent (Bosu, 2010). In addition, up to 70 percent of persons diagnosed with hypertension are not on any treatment. Furthermore, only up to 13 percent of persons with hypertensive conditions have well-controlled blood pressure. Moreover, approximately 50 percent of individuals with hypertension have target end organ damage. This suggests that such individuals have had the condition, for a long period without suitable treatment (Addo, Smeeth, & Leon, 2009).

Several modifiable risk factors such as bad eating habits, low physical activity, tobacco and alcohol consumption found elsewhere in the world and particularly in SSA, are found to be associated with NCDs in Ghana (Bosu, 2013; Bosu, 2010; Ofori-Asenso & Garcia, 2016). The 2008 GDHS reported that about five percent of adults eat satisfactory quantities of fruits and vegetables (GSS, GHS & Macro International Inc 2008). The 2014 GDHS also reported that usual adult females and males eat fruit three out of the seven days of the week and vegetables on four out of seven days of the week. The GDHS also reported variations by background characteristics in the average number of days that respondents ate fruit and vegetables in the past week were minimal (GSS, GHS & ICF Internaltional 2015).

The 2008 GDHS also showed that 41 percent of adult women and men had not involved themselves in vigorous physical activity in the last seven days prior to the survey. In addition, the GDHS 2014 reported that about one percent of adult women between the ages 15 and 49 smoke cigarettes and about one percent use other tobacco although three percent of

adult women in the Northern Region use tobacco (GSS, GHS & ICF Internaltional 2015). This suggests that tobacco use is context specific.

2.5.2 Determinants of non-communicable causes of death

In addition, WRA suffer from non-communicable causes of death apart from the scourge of the infectious causes. However, the literature on non-communicable causes of death is also very rare for non-pregnant WRA as observed for the infectious causes of death. The literature also tends to focus more on individuals who are 40 years and above. Many diseases such as anaemia including sickle-cell, obesity, cerebrovascular, diabetes, cancers, hypertension, and kidney disorders tend to increase the mortality risk within and outside pregnancy. These diseases lead to indirect causes of maternal mortality among pregnant WRA and their public health importance are expected to continue increasing. (Centre for Maternal and Child Enquiries, 2011; Nevis et al., 2011). Furthermore, among non-communicable causes of death, diabetes, cardiovascular, respiratory disorders, and cancers are of concern among WRA due to their potential contribution to indirect causes of maternal mortality. Therefore, focusing attention on understanding the actual burden of these causes of death in and outside pregnancy, and on the evolving demography and epidemiology of causes of death patterns, is necessary (Say et al., 2014).

The available literature on anaemia in pregnancy is as contentious as the literature on some of the infectious causes of death (Fleming, 1989). Anaemia is not an independent risk of pregnancy but often a consequence of it (Garenne et al., 2013). This is as a result of the higher need for iron and folate during pregnancy. In several developing countries, the situation could be detrimental due to women's lack of adequate diet. However, anaemia in pregnancy also occurs in developed countries. Apart from nutritional deficiencies, anaemia in pregnancy may result from parasites and viruses including malaria, hookworm and HIV besides various hemoglobinopathies and genetic factors. In addition, severe anaemia may

result in cardiac failure, haemorrhage, and some other adverse health outcomes in pregnancy (Garenne, 2011; Garenne et al., 2013).

Yet, whether anaemia is a maternal mortality risk factor at the demographic level, is still debated (Garenne, 2011; Garenne et al., 2013). This controversy is mainly because the values of about 40 percent of maternal mortality attributed to anaemia and frequently cited in the available literature are not much higher than the 42 percent anaemia prevalence within the overall population found in the DHS or quoted by the WHO. It could be deduced from this that anaemia is not a risk factor overall (Sanghvi, Harvey, & Wainwright, 2010). Moreover, many clinical trials that provided pregnant WRA with supplements of iron and folic acid have reported mixed findings with sometimes adverse effects (Pena-Rosas & Viteri, 2006). It is important to also note that classifying anaemia as an indirect cause of maternal mortality could be challenging if the specific pathology and aetiology in each case is not considered (Garenne, 2011).

Currently in majority of African countries, the population pyramid is conical in shape, depicting the large young people at the base with a median age of less than 20 years, juxtaposed with HICs where the shape is typically close to a cylinder and the median age is more than 40 years. From the dynamics of the population of HICs and LMICs, there is the likelihood for the population at risk of NCDs to rise significantly in sub-Saharan Africa compared to high-income countries (WHO, 2009b).

Drivers of the NCD epidemic are urbanisation and lifestyle adaptations related to economic improvement (American Cancer Society, 2011; WHO, 2007). These lifestyle factors include unhealthy diet, physical inactivity, obesity, tobacco and alcohol use. In HICs, about 90 percent of all new cases of diabetes mellitus and between 70 to 80 percent of all new cases of CVDs are contributed by relatively little changes in these factors (Po et al., 2011; Roura & Arulkumaran, 2015). Likewise, the INTERHEART study involving nine African

states and 43 other countries reported that five risk factors namely smoking, hypertension, diabetes mellitus, abdominal obesity, elevated Apolipoprotein B/Apolipoprotein A-1 ratio contributed 90 percent of the risk in the African locations for a first experience of myocardial infarction (Steyn et al., 2005; Yusuf et al., 2004).

Tobacco use is one of the most avoidable but serious risk factor for premature death in adult females (WHO, 2010d). Current evidence shows that smoking rates among men have peaked and are currently declining slowly (WHO, 2015). Conversely, the rate of smoking is growing among young women in many parts of the globe. A WHO projection shows that the percentage of adult females who smoke will increase from 12 percent in 2010 to 20 percent by 2025 (WHO, 2010c). Similarly, tobacco-related deaths among adult females are estimated to rise from 1.5 million in 2004 to 2.5 million by 2030. In addition, second-hand smoke endangers the health of women, particularly in nations and cultures where several women are powerless to ensure smoke-free places, even in their various homes (WHO, 2015). A case-control study in India that examined the influence of chewing tobacco on adult mortality involving 22,000 cases and 429,000 controls found significant excess relative risks of mortality among those who have ever chewed tobacco for TB, other respiratory infections, stroke and cancer relative to those who had never chewed tobacco. The authors observed that tobacco chewing resulted in 7.1 percent of mortality from all-causes (Gajalakshmi & Kanimozhi, 2015).

Another behavioural risk factor of NCD affecting WRA and adult women, in general, is alcohol consumption. Globally, alcohol consumption has increased especially in LMICs recently (UNESCO, UNODC, & WHO, 2011). Studies including meta-analyses and systematic reviews examining lifetime, current and past alcohol consumption for both women and men revealed consistently a J-shaped association with mortality for all-causes. This means that low levels of alcohol consumption is associated with low mortality and vice versa

(Di Castelnuovo et al., 2006; Jayasekara et al., 2014; O'Keefe, Bhatti, Bajwa, DiNicolantonio, & Lavie, 2014). Many societies expect or assume women drink less compared to men. In view of this perception, detecting and treating alcohol-related syndrome among adult females are difficult. Therefore, interventions for treating alcohol-related problems are male-oriented, thereby leaving women at a higher risk of dying from alcohol-induced NCDs compared to men (NCD Alliance, 2010).

It has been observed that the nutrition transition that has resulted in unhealthy diet with high fat, sugar and salt content especially in the urbanised centres serve as risk factors for NCDs. These changes in dietary patterns are stimulating high rates of obesity and overweight that are negatively affecting the health of women. According to WHO estimates in 2014, on average about 39 and 13 percent of adults globally were overweight and obese respectively, and of those, 40 and 15 percent women were overweight and obese respectively (WHO, 2016). Conversely, under-nutrition among WRA is equally dangerous with regard to the NCD epidemic globally (NCD Alliance, 2010). This is because according to the prenatal programming hypothesis, low levels of nutrition in pregnancy period raises the risk level of the child developing chronic diseases including diabetes and CVD during adulthood. This is extremely significant in most SSA countries, where under-nutrition co-exist with increasing levels of overweight and obesity in adults (WHO, 2010c).

Furthermore, physical inactivity predisposes WRA to the risk of dying from NCDs especially for those living in urban centres. This is because living in urban areas is typically linked to low levels of physical activity or inactivity compared to living in rural areas. Such a life style has the tendency to increase the risk of dying from cardiovascular disease, diabetes, cancers, overweight and obesity. There is evidence globally that suggests that there are differences between women and men in terms of the level of physical activity, especially during schooling hours. Young women in many LMICs are physically less active compared

to young men. This is because young women do not attach much importance to participating in physical activity (WHO, 2009b).

Apart from the risk factors, there are other significant barriers that tend to affect causes of death among WRA and females in general. The risk of WRA dying from NCDs is also driven by poverty (WHO, 2010c, 2011). Poverty increases the exposure of WRA to modifiable risk factors of NCDs and the economic burdens associated with it. Unhealthy lifestyle behaviours including consumption of alcohol and tobacco as well as unhealthy eating habits are relatively higher among poor populations (UNESCO et al., 2011).

In addition, low socio-economic status among women is increasing their exposure and vulnerability to the risk factors of NCDs (WHO, 2010c). It is estimated that 60 percent of the global poor are adult females, about two times as many adult females as males suffer from malnutrition; in addition, two out of three adults without formal education are adult females (NCD Alliance, 2010). These fundamental factors have placed adult females at a disadvantaged position to be able to protect themselves from dying of non-communicable, maternal and infectious causes since their capacity to afford healthcare services is limited by lack of access to and control over resources (NCD Alliance, 2010; WHO, 2010c).

It is reported that even in situations where cheap healthcare services exist, the socio-cultural status of adult females in several LMICs results in limited access health services as well as health literacy (WHO, 2009b). In addition, many women in LMICs are not able to decide for themselves and their children about healthcare without prior approval from their husbands and/or significant others in their family (Yaya, Bishwajit, & Ekholuenetale, 2017). Many women are discriminated and sometimes rejected by their community or even their family due to their disease thereby resulting in management challenges and leading to life-threatening conditions that are often preventable. Again, higher illiteracy rates among women compared to men translate into lower access to written material on non-communicable

disease prevention, risk factors in addition to treatment to avoid deterioration of their condition or death (NCD Alliance, 2010; WHO, 2010c).

Geographical distance could also serve as a major obstacle to accessing healthcare services for women. Physical distance is especially significant for women living in rural settings due to the bad nature of the road network and unavailability of transport. Women also are less mobile compared to men. This is because women due to their low socio-economic status have lower likelihood of owning a means of transport, and they may not even be able to afford public transport. Such limitations are normally re-enforced by social norms requiring that women remain indoors and only travel with a male company to avoid any harassment or violence in public. Besides, women are mainly responsible for household chores as well as childcare. Therefore, they are unable to afford the opportunity cost of travelling far away to seek healthcare services until the condition deteriorates and such delays may result in their death.

Health systems in many communities in LMICs especially in SSA are not quite friendly to the healthcare needs of women. Yet, in both the formal and the informal healthcare sectors as well as in the homes, women provide the bulk of healthcare worldwide. Nonetheless, women's healthcare requirements are usually poorly recognised and not provided with the needed attention with regard to access and responsiveness to needs of women (WHO, 2009b). Cultural taboos in many communities partly contribute to the causes of death among women. This is because, in some settings, it is practically not possible for adult females to get medical attention from male healthcare professionals even though female healthcare providers are scarce (NCD Alliance, 2010; WHO, 2010c).

Besides, the reality for millions of deaths from non-communicable causes is because programmes and services for NCDs are inadequate or non-existent (WHO, 2010c). Healthcare systems in LMICs are still preoccupied with infectious causes of death and

providing care for acute cases, therefore, there is the need to re-orient the healthcare system to incorporate NCDs (Allotey, Davey, & Reidpath, 2014; NCD Alliance, 2010). By integrating NCDs into the healthcare systems of LMICs, it is expected that there would be a different healthcare delivery system that focuses on health promotion and prevention (Allotey et al., 2014). Such changes to the health delivery system will be cost effective and of benefit to patients having all kinds of conditions; as this paradigm shift in the healthcare system will go a long way to reducing the increasing causes of death from NCD and others (NCD Alliance, 2010; WHO, 2010c).

2.6 Gaps in the literature

There is extensive literature on maternal causes of death. The literature on infectious and non-communicable causes of death is also quite extensive for the pregnant WRA. However, studies on maternal, infectious and non-communicable causes of death among WRA are virtually focused on pregnancy and delivery-related health challenges instead of comprehensively examining all the major health challenges that confront both pregnant and non-pregnant WRA. Therefore, the first gap in this review is the paucity of research on non-pregnant WRA. The focus of the current study is on both pregnant and non-pregnant WRA. The approach of this study is essential in view of the epidemiological transition where there are increasing cases of non-communicable causes of death among adult females including WRA in recent times (Labrique et al., 2013; Scrafford & Tielsch, 2016). In addition, the global effort aimed at reducing maternal mortality over the last three decades has seen significant reductions in maternal causes of death especially since 2000 (Alkema et al., 2016; Say et al., 2014).

Furthermore, despite the achievement in reducing maternal causes of death particularly in the last decade, it is clear from the reviewed literature that maternal death

remains a key public health challenge in LMICs, particularly SSA. The levels of maternal deaths are still unacceptably high in Ghana and the MDG 5A target was missed. Therefore, maternal, infectious and non-communicable causes of death simultaneously combine in what could be termed as a triple burden of causes of death among WRA. In view of this observation, the second gap that this study fills is examining the relative risk of WRA dying from maternal, infectious and non-communicable causes of death. The argument here is that such analysis will contribute to the literature on the epidemiological transition in respect of the relative importance of the different causes of death among WRA. It will also provide policy makers with clear options on which causes of death contribute most to mortality among the study population and for that matter where scarce resources should be spent.

The third gap identified in this review is the lack of data on causes of death in LMICs. This is mainly due to lack of civil registration systems. Most of the data for the studies in this review were from health facilities or cross-sectional studies. However, many women do not use health facilities and facilities tend to attract mainly complicated cases. The health facility as a result is unable to collect information on deaths that happened at home or within small health units. Therefore, health facility data are not sufficient and cannot be used reliably for examining causes of death. The value of HDSS data as used in this current study lies in the fact that it is population-based and longitudinal in nature and allows more precise tracking of changes over time as reporting of deaths is more complete compared to cross-sectional surveys or health-facility studies.

Finally, no study has examined the demographic impact of separately eliminating maternal, infectious or non-communicable causes of death on life expectancy though such analyses are very useful for targeting programmes and policies where life expectancy returns are highest. In addition, no study with respect to the three broad causes of death under study has determined the age or age-group that will make the greatest impact on life expectancy

because of a decrease in mortality from maternal, infectious or non-communicable causes of death would make the greatest impact on survival. Again, this will further provide policy makers with clear options on which age-group should be the target of interventions in the light of scarce resources.

2.7 Theoretical and conceptual considerations

The conceptual framework of this study is adapted from the eco-epidemiological model (EEM) of the multilevel eco-epidemiological life course framework for the health, disease and mortality cross-continuum in human populations (Defo, 2014). The framework draws on the strengths of trans-disciplinary causal models that include economics, climatology, physical and environment sciences, social and biomedical sciences as well as the transition models particularly, the epidemiological transition theory (ETT) as shown in Figure 2.1.

2.7.1 The epidemiological transition theory (ETT)

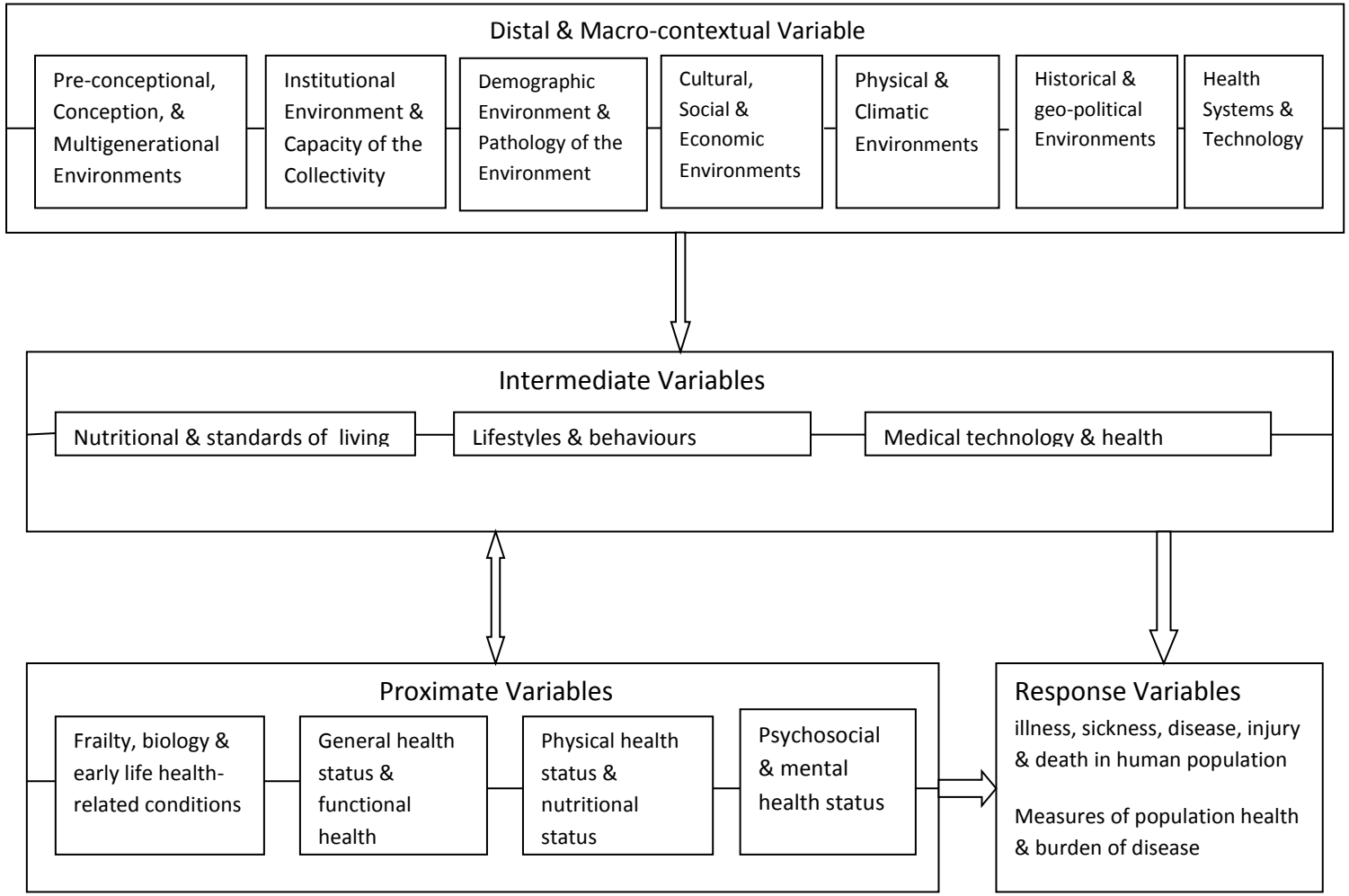
The ETT was originally proposed in 1971 by Abdel R. Omran to describe the shift in demographic and disease profiles experienced by populations in Europe and North America from 1750 to 1950s. Since the last four decades, the ETT has been used as the main conceptual model for examining changes in the cause of death from mainly infectious causes to chronic non-communicable causes. The applicability of the ETT in LMICs has been challenged because valid and reliable data on morbidity and mortality over long period are usually lacking or incomplete in low and middle-income settings. The framework has also been questioned for its failure to recognise and analyse the significance of culture, social beliefs and values, politics, and health policy when considering the epidemiological profiles of LMICs.

According to the ETT, there is a significant shift from one major cause of death to another at any given period. Therefore, one major criticism of the ETT among others is its inability to differentiate the risk of dying from a given cause from the relative contributions of different causes of death to the total death (McKeown, 2009). In view of this limitation, Defo (2014) argues that there is the need for new thinking that goes beyond the ETT. This is because results from HICs cannot be applicable to the African context due to the co-existence of infectious and NCD causes of death in the region (Dalal et al., 2011; Defo, 2014).

Over the last two decades, there has been growing debate on whether current theoretical frameworks in global health could offer some general guidance in LMICs. This is because of the unprecedented changes in morbidity and mortality trends in populations across LMICs. These changing morbidity and mortality patterns are attributed to the unique experience in LMICs. Countries in the Global South are experiencing increases in survival at the early ages of life and concurrently increasing growth of the adult populations. New infectious diseases including HIV/AIDS are emerging and others including dengue fever, TB, cholera and polio are re-emerging, particularly in LMICs.

In addition, countries in low and middle-income settings lack data for health policy and planning. Moreover, they are experiencing the double burden of infectious and non-infectious sicknesses, and yet, the health systems are largely not prepared to confront the problems of quality but affordable healthcare services (Allotey et al., 2014). Furthermore, a large percentage of their populations are living in abject poverty and without basic needs including inadequate or no access to clean water as well as non-existent or sub-standard sanitation systems (Alvarez et al., 2009; WHO, 2009b).

Figure 2.1: Multilevel eco-epidemiological life course framework for the health, disease and mortality cross-continuum in human populations



Source: Defo (2014)

2.7.2 The eco-epidemiological model (EEM)

Defo (2014), proposed the EEM to take into consideration the unique situation of the LMICs. The EEM is similar to the ecological model and it has enhanced the understanding of differential patterns of mortality within and across populations as well as sub-populations. This is because the EEM integrates multiple levels of determinants that cut across genetic, personal, socio-political and economic contexts. The EEM, therefore, reflects the concept of health that is more than the absence of diseases.

The EEM argues that the rising infectious and non-communicable diseases mainly take place in a state of continuous interactions between and among infectious diseases and NCDs through the life course of persons and communities in LMICs. A multilevel eco-epidemiological model using a life course approach that considers the health and disease cross-continuum perspectives is more appropriate for health studies in most LMICs' environments (Defo, 2014).

This approach recognises multiple and inter-related levels of causation and offers the opportunity for integrated models (Defo, 2014). The EEM provides three sets of significance for research and practice designed to improve health. The first is the need to consider the life course approach when examining health and disease trends within human populations. The second significance of the EEM is the emphasis on the need to allow for multiple levels of determinants because of the interactions among causes of death. The third importance of the EEM to research is that it considers that although death or disease happens to persons, interventions could take place at various levels including the individual, family, households and community levels to result in healthy individuals in healthy societies (Defo, 2014).

The EEM considers that several levels and multifactorial causes influence social production of health and diseases. It emphasises the multi-dimensional factors that affect the lives of individuals, their relationships and environments, leading to either wellness or

disease as well as disability or death along the health, disease and mortality cross-continuum in human populations. It considers all the determinants of health as integral to individual, family, community and national health and well-being (Defo, 2014).

The model as shown in Figure 2.1 contends that there are four levels namely: distal and macro-contextual variables (multilevel 4), intermediate variables (multilevel 3), proximate-level variables (multilevel 2) and response or outcome variables (multilevel 1) that influence the risk of illness, injury and death. A distal factor is distant in time to the event outcome (Defo, 2014). Distal variables are stable dispositional variables and environments that precede the intermediate and the proximate variables. It is reported that environmental processes that induce diseases in adulthood is influenced by factors in the pre-conceptional, conceptional or fetal stages of life as well as factors that operate during the course of life. Distal variables consist of the several environments that protect from or expose to different health-related consequences. They include: (i) pre-conceptional, conceptional, and multigenerational environments; (ii) institutional environment and capacity of the collectivity; (iii) demographic environment and pathology of the environment; (iv) cultural, social, and economic environments; (v) physical and climatic environments; (vi) historical and geo-political environments; and (vii) health systems and technology.

An intermediate variable influences the response or outcome variable and the intermediate variable is also influenced by the distal variables (Defo, 2014). Intermediate variables according to Defo (2014) consists of (i) nutrition and standards of living; (ii) lifestyle and behaviours; and (iii) medical technology and health knowledge. In contrast, the proximate variables are the immediate factors responsible for the occurrence of the observed outcome. Again, according to Defo (2014), proximate variables comprise (i) frailty, biology, and early life health-related conditions; (ii) general health status and functional health; (iii) physical health status and nutritional status; and (iv) psychosocial and mental health status.

On the other hand, the response or outcome variables consist of both individual-based measures such as illness, injury and death in addition to measures of population health and disease burden.

The EEM considers all prevailing factors from the time of conception to death for human life or for a population health burden using a probability scale from 0 to 1 (Defo, 2014). It takes into account various health states ranging from complete absence of ill-health to death as part of the continuum of health burden. The health state of an individual or population is the consequences of multilevel factors and outcomes at the micro, meso, and macro levels for every society. Therefore, an individual or population health state is a reflection of social, cultural, bio-behavioural, economic, physical, and medical influences within the broad context of risk, protective and resilience factors forming a continuum of multilevel states and renewal processes in the non-linear and dynamic epidemiology of population change (Defo, 2014).

According to the EEM, as patterns of causes of death change with time, there are variations in the relative influence of various causes of death to the total mortality, which may not represent variations in actual risk. This means that if the risk of dying from a specific cause of death drops, the relative risk of other causes may rise although the actual risk of these other causes of death remains unchanged. The actual risk of a given cause of death can even drop though the proportion of deaths ascribed to that cause increases, if the risk of death from other causes falls faster. Therefore, the EEM can explain the relative risk of dying from maternal, infectious and non-communicable causes that this current study seeks to examine.

2.7.3 Conceptual framework

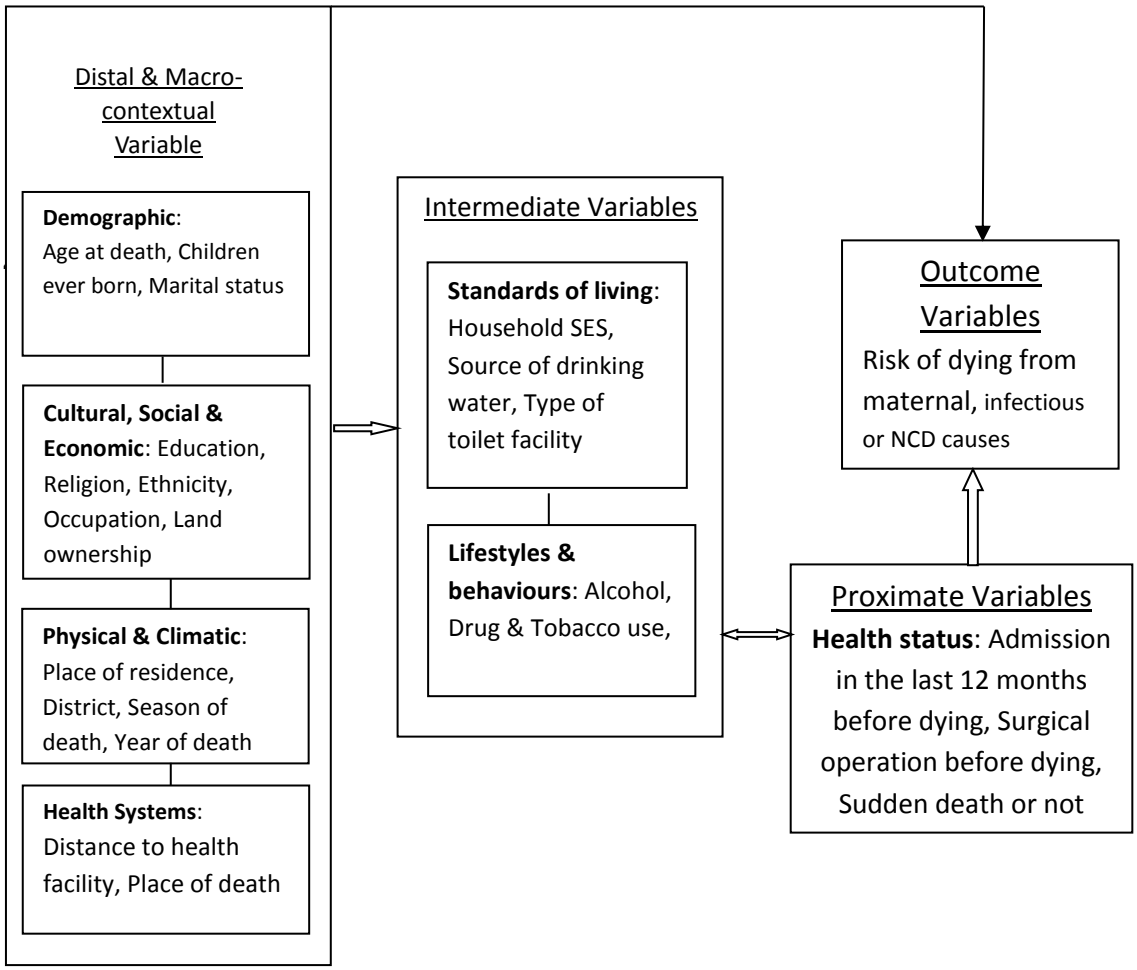
The conceptual framework of the present study as shown in Figure 2.2 excludes some of the factors at each level of the original model (Figure 2.1). This is because of two reasons. The first reason is that this current study relies on secondary data, which do not capture these

excluded variables. The other reason is that some of the variables particularly, some of the outcome or response variables fall outside the scope of this study.

The first two and the last but one distal and macro-contextual variables at multilevel 4 namely: pre-conceptional, conceptional, and multigenerational environments; institutional environments and capacity of the collectivity; and historical and geo-political environments are excluded. At the intermediate level, medical technology and health knowledge are also excluded. In addition, at the proximate level, frailty, biology, and early life health-related conditions; general health status and functional health; physical health status and nutritional status; and psychosocial and mental health status were lumped together as 'health status'. Finally, at the response or outcome level, only death was considered in the present study although the original model includes other outcome measures namely: illness, sickness, disease and injury.

The model for the current study drawing from the original framework contends that a set of distal, intermediate and proximate variables influence the risk of dying from maternal, infectious and non-communicable causes of death as shown in Figure 2.2. Distal level factors encompass the following: demographic; cultural, social and economic; physical and climatic; and health system and technological factors. The intermediate level factors include standards of living as well as lifestyles and behaviours whilst the proximate level covers health status.

Figure 2.2: Conceptual Framework of Factors Associated with Dying from Maternal, Infectious or Non-communicable Causes of Death



Source: Adapted from Defo (2014)

Among the distal factors, the socio-demographic variables comprise age, parity and marital status. The cultural, social and economic factors involve education, religion, ethnicity, occupation and land ownership. The physical and climatic variables, on the other hand, include place of residence, district and season of death. Finally, the health-related variables cover the place of death, and distance to a health facility. Although these factors are described as distal and are farthest away from the outcome variables, they are known to directly affect the outcome variables. For example, age in the distal variable can directly influence the outcome variables as shown by the arrow flowing from the distal factors to the

outcome variables. This is because several studies have found that increasing age correlates with higher risk of dying from maternal, infectious and non-communicable causes (Al-Zirqi et al., 2008; Gidey et al., 2013; Scrafford & Tielsch, 2016).

Within this study, intermediate level factors are conceptualised to cover standards of living as well as life styles and behaviours. Standards of living comprise household socio-economic status, drinking water source and toilet facility type. Life style and behaviours, on the other hand, include tobacco, alcohol and drug use. Changes in intermediate variables including access to and quality of health services are mostly responsible for the improvements in survival and longevity in modern societies just as they accounted for most of the mortality reductions and increases in life expectancy in Europe and North America. The technological advances in prevention and treatment of maternal, infectious and non-communicable conditions responsible for most deaths have significantly impacted the role of these factors in mortality declines and health improvements over time.

The conceptual framework also takes into consideration proximate factors, which are conceptualised as the health status of the deceased WRA before dying. The health status in this current study includes admission in the last twelve months before dying, and if the deceased woman had a surgical operation in the last 24 months before dying as well as whether the death was sudden or not. The proximate factors are the most immediate variables that influence the risk of dying from maternal, infectious and non-communicable causes of death as shown in Figure 2.2.

The framework also acknowledges interaction between the intermediate and proximate factors. For example, alcohol, tobacco and drug use may increase the risk of dying or negatively affect health status. On the other hand, poor health status may lead to substance use.

CHAPTER THREE

PROFILE OF STUDY AREA AND METHODOLOGY

3.1 Introduction

This chapter partly focuses on a description of the study area. This is intended to provide some context within which the present study is situated. In view of this, the economy, population and distribution of health facilities of the study area have been outlined. The chapter also discusses, in detail, the methodology of this study. The chapter provides information on the source, management and analysis of data, and limitations of the study.

3.2 The study area

The study area is part of the catchment area of the Kintampo Health Research Centre (KHRC) that administers the Kintampo HDSS. The Kintampo HDSS covers both the Kintampo North Municipality and the Kintampo South District of the Brong Ahafo Region of Ghana (Abubakari et al., 2015). The two districts are mainly rural; Kintampo South District was created in 2003. Their capitals, Kintampo and Jema are semi-urban. Together, the two districts recorded a population of 143,287 and 31,276 households as at December 2011 (KHRC, 2012). However, the 2010 Population and Housing Census (PHC) estimated a population of 176,480 for the two districts (Ghana Statistical Service, 2013b). The difference in population sizes is due to the different methods used by the HDSS and PHC (Wak et al, 2017). The Bono and the Mo are the main indigenous ethnic groups but there is a large immigrant population mainly from northern Ghana. Settlements are mainly concentrated in the southern parts of the districts and along the trunk road linking the district capitals and the Northern Region of Ghana.

3.2.1 Health facilities and research

There are 12 sub-districts in the study area. Seven of them are in the Kintampo Municipality and five in the Kintampo South District. In each of the sub-districts, there are either government or privately-owned health facilities or both. The Kintampo North Municipal has one municipal hospital, four health centres, three private clinics, one maternity home and 35 functional community health planning services (CHPS) compounds (Kintampo North Municipal Health Directorate, 2017) as well as a tertiary health educational institution, College of Health and Well-being at Kintampo. The Kintampo South District also has one district hospital, four health centres, one private clinic and one maternity home as well as 29 functional CHPS compounds (Kintampo South District Health Directorate, 2017). There are also a number of traditional health facilities within the study area. Apart from these, the nearby district hospitals are easily accessible geographically by some of the people of the sub-districts in the study area.

Since the creation of KHRC in 1994, it has carried out several health intervention research activities involving WRA and their new-borns. The study area has been the site for various research activities. For example, the Maternal Mortality Vitamin A trial (Obaapa Vita Project) from 2000 to 2009 directly targeted women of the reproductive age group which is the population of interest for this study (Kirkwood et al., 2010). The clinical personnel of the Centre supported the health facilities within the area of operation. In addition, the Centre has built some infrastructure and donated various health equipment to health facilities within its catchment area. Some of the studies provided ambulance services to ensure maximum health care for study participants who were invariably WRA.

The choice of the study area is appropriate because the Centre has conducted several studies on maternal, infectious and non-communicable diseases among the WRA. The study area is also appropriate as the Kintampo Health and Demographic Surveillance System

(HDSS) administered by the Centre has been monitoring the entire population of the study area since 2003. The current study, therefore, offers an opportunity to investigate the relative risk as well as the socio-demographic, economic, physical, behavioural and health-related determinants of women dying from maternal, infectious and non-communicable causes using the rich set of data gathered over a period of about one and half decades.

3.2.2 Economic activities

The main economic activities within the study area are in the agricultural and service sectors. The majority of the working class are farmers or combine farming with other activities and/or sell of agricultural products. The farmers are mostly peasant and cultivate mainly maize, yam and cassava (Ghana Statistical Service, 2013a). Small merchandising and dressmaking form the bulk of the workers in the service sector. Civil servants and teachers dominate workers in government employment. Most of these groups find it necessary to engage in farming, especially during weekends. Kintampo has Wednesdays as the general market day, but trading in yams, maize and charcoal goes on almost every day. Seasonally, fruits such as mangoes and watermelon as well as bush meat, especially grass cutters are traded. People come from all the sub-districts or elsewhere in Ghana and West Africa to trade. Some of the people from the sub-districts use the market day to visit the district hospitals. This is because it is easier to get transport to the Kintampo town on market days. In addition, it is on this day that most of the farmers generate income to enable them to pay for the cost of health services.

3.3 Methodology

3.3.1 Study design

This study used a quantitative research approach. The study sample consists of a prospective open cohort of women aged between 15 and 49 years living in the Kintampo HDSS area during the period from 1st January 2005 to December 31st, 2014.

3.3.2 Data source

Data for this study came from the Kintampo Health and Demographic Surveillance System (KHDSS) of the KHRC. KHDSS is made up of field and computing operations to manage the longitudinal follow-up of persons and their households as well as their residential units and all their demographic and health characteristics within the Kintampo North Municipality and the Kintampo South District of the Brong Ahafo Region of Ghana (Owusu-Agyei et al., 2012; Nettey et al., 2010).

The KHDSS area has been mapped by geo-referencing of residential units, using geographic information system (GIS) technology; global positioning system (GPS) coordinates are assigned as location attributes of the residential units within the database (Owusu-Agyei et al., 2012; Nettey et al., 2010). It is one of the three Ministry of Health/Ghana Health Service health research centres, strategically located in the middle belt of Ghana, with the other two located in the northern belt (Navrongo) and southern belt (Dodowa). It is also one of the 49 HDSS sites across 19 countries in Africa, Asia and Oceania and they typically engage in monitoring the population dynamics of their respective areas of operation (INEPTH-Network, n.d.).

The initial census for the KHDSS in 2003 defined and registered the target population within the KHDSS area. After the enumeration and data cleaning, registers referred to as household record books (HRBs) were printed according to clusters. A cluster consists of a number of houses within a defined geographical area. These HRBs have been the main documents for the updates of the demographic profile of the population. Following the completion of the baseline data preparation as well as the printing of the registers, sixth-monthly intervals of data collection by field workers allow registration of all new persons and their households as well as their residential units to update their key characteristics. Data collected during each round of fieldwork are not restricted to key demographic events but

also include the various attributes of the primary subjects. These attributes may be fixed (for example, ethnicity and gender) or change over time (for example, marital or residential status).

During the update visits, the field workers move with HRBs containing the names of houses and their numbers in a cluster. In each house, the names of all registered individuals are mentioned according to their respective households. The household head or any adult member of the household provides information on the presence or absence of each member. If an individual household member is temporarily absent, such as gone to school, farm or market, an indication of temporarily absent is made in the HRB to that effect.

The core system provides for monitoring of population dynamics by routinely collecting and processing information on births, deaths, and migrations. This core system is complemented by various other data sets such as the module on socio-economic status, education status and immunisation status that provide important social and economic correlates of population and health dynamics. The KHDSS also provides a platform for other studies within the same geographic area. This support varies from one study to another and may include the provision of an initial sampling frame, adjustment for confounding variables, provision of additional explanatory variables, and measurement of the health, social and demographic impact of interventions.

One of the key characteristics of the KHDSS is its longitudinal approach measurement of demographic and health variables. This is achieved through repeated visits at 6-monthly regular intervals to all residential units in the KHDSS area to collect a prescribed set of attribute data on registered subjects, who are consistently and uniquely identified. This and recording events affecting these subjects during the interval between visits allow one to construct their history and differentiate KHDSS data from data collected in multi-round

surveys and other prospective studies that allow comparison over time only on an aggregated level.

The KHDSS surveillance population includes all individuals who were registered at baseline census or have in-migrated and have continuously stayed in the demographic surveillance area (DSA) for at least 90 days. Children born to women who are already members of the HDSS are registered as soon as they are born and become members of the DSA for surveillance.

Pregnancies and their outcomes are recorded for all registered women in the KHDSS during routine update visits. Every live birth is then recorded as a member of the KHDSS, independent of subsequent survival. In KHDSS, field workers take note of live births to visitors to the KHDSS area to notify the field worker in the following round to register the eligible mother and her child or children. This practice is very useful, as it improves the precision of dates of birth for new-borns. In addition, it improves the reporting of births for mothers with repeated in- and out-migration. Furthermore, observation of pregnancy is used to improve the reporting of the outcomes of pregnancies. This is achieved by following up on a notification of pregnancy outcome for each registered pregnancy in the subsequent visit.

Deaths of all registered and eligible members of the KHDSS are recorded, irrespective of where the death occurred. Within the KHDSS, usually deaths are widely known compared to births so deaths are not commonly underreported. However, the deaths of under-five-year children, particularly neonates (eligible and not yet registered) are hardly known, especially, if cultural beliefs do not encourage reporting them. The KHDSS conduct verbal autopsies (VA) on all deaths that occur in the study area to ascertain the causes of deaths among the population.

Under the Kintampo HDSS operations, two types of migration events occur: external migration — where individuals change residence from or to an area outside the HDSS area of

operation. The other type of migration is internal migration — where individuals change residence within the HDSS area of operation. Internal migration does not influence the data in any way since the movement is within the HDSS area. On the other hand, external migration affects the data to some extent.

A 90-day period is used as inclusion or exclusion criterion for migrants. An individual who moves outside the HDSS Area for 90 days or more is considered to have out-migrated. On the other hand, an individual who enters the HDSS Area and stays for 90 days or more is considered to have in-migrated.

The Kintampo HDSS is a net exporter of people in the working age group (15-60) through out-migration. However, women of reproductive age group (15-49) rarely migrate mainly because of marriage and child-bearing. Moreover, WRA who migrate out are likely to be compensated by those who migrate in and expected to have similar characteristics as those who have moved out. In view of this, migration among WRA is not expected to significantly influence the results of the present study.

An innovative component of the KHDSS is the Community Key Informants (CKI) system where well-known individuals in the various communities are trained to enable them to record any pregnancy, birth and death that occur in their respective communities for a little fee. Their activities are important because some respondents do not report particularly pregnancy loss through miscarriage or abortion and neonatal deaths during the fieldworkers' visits. However, with the presence of the CKIs in the communities who record such events and in turn report them to the fieldworker, this challenge is largely reduced or overcome completely. In addition, the KHDSS has a number of mechanisms in place such as field supervisors checking questionnaire for completeness and consistency, automated range and consistency checks, double entry system as well as 5 percent re-interviews for all scheduled interviews to make sure the data quality standards are maintained.

3.3.3 Verbal autopsy data collection tool

Women in the reproductive ages in LMICs, especially SSA suffer from the triple burden of dying from maternal, infectious and non-communicable diseases (Gulati et al., 2015). However, precise and reliable estimates of causes of death for the population or sub-population in many SSA countries are difficult because of the limited access and utilization of health services and most of the deaths occur outside health facility (Dalal et al., 2011; Ramroth et al., 2012). This situation is further compounded by the lack of comprehensive population-based studies and incomplete or non-existent civil and vital registration systems in many LMICs (Ye et al., 2012). In view of these challenges, studies in SSA use estimates by the WHO that are mostly created from very scanty data (Mathers & Loncar, 2006). Lack of or inadequate data makes the understanding of the causes of death that may reveal the sickness load more complex (Gulati et al., 2015).

Verbal autopsy (VA) has been shown by several studies to be the best available tool for data collection on cause of death in low and middle-income countries (Moyer et al., 2016; Narh-Bana et al., 2012; Sankoh & Byass, 2012; Setel et al., 2004; Ye et al., 2012). In view of this, the VA approach has been used in recent times to ascertain the probable cause of death at the community level in many LMICs (Sankoh & Byass, 2012; Ye et al., 2012). Currently, interest in VA for monitoring causes of death is increasing (Murray et al., 2014). Several LMICs, including China, India, Brazil, Mozambique, Zambia and Tanzania have used different types of VA in collecting health data in their various jurisdictions (Murray et al., 2014). The WHO is advocating the extensive use of VA particularly to monitor the NCD epidemic in many LMICs with inadequate death registration and medical certification (Baiden et al., 2007).

Wider usage of VA for mundane national health information systems could potentially enhance the availability of essential and reliable data on causes of death for

disease control programmes. However, there are debates on the reliability of symptom-based data obtained from families and the practicality of depending on clinicians to evaluate unidentified symptom-based forms. Physician Coded Verbal Autopsy (PCVA) is the commonest method of determining the probable cause of death. PCVA is the only available method in the Kintampo HDSS Setup. Two physicians independently review VA questionnaire and assign a single cause using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). A third clinician examines the case if a consensual cause of death is not reached between the first two. No final cause of death is entered when consensus cannot be reached (Sankoh & Byass, 2012; Ye et al., 2012). The PCVA is associated with some challenges such as it is costly and it takes so much time (Murray et al., 2014). In the recent past, computerised algorithms have been created for establishing cause of death, to minimise the difficulties with the PCVA method (Houle et al., 2015; Murray et al., 2014). However, this study used the physician coding verbal autopsy certification to identify maternal, infectious and non-communicable causes of deaths.

This study mainly used the data from the verbal autopsy (VA) component of the KHDSS, which uses a standard VA tool (questionnaire) for the data collection. The KHDSS has four different VA tools for the different segments of the population. The infant VA questionnaire is used to collect information on deaths that occur to persons who are aged 0 to 2 years, inclusive. The children's VA questionnaire is for those over 2 years to 11 years. The women's VA questionnaire is for women aged 12 to 50 years. The fourth VA questionnaire covers women aged over 50 years as well as men from ages 12 years and above.

The main VA tool for this study was the women's VA questionnaire. It was used to collect data from the households where deaths for women aged 12 to 50 years occurred. The tool comprised eight sections. The first section collected background information on the deceased. The second section captured the deceased woman's illnesses that led to death. The

third partly captured open narration of the circumstances surrounding the death in question by the respondent. This section also partly captured duration of illnesses or symptoms or whether it was an injury death. Section four of the questionnaire contained specific questions on symptoms and signs during pregnancy, labour, delivery and six weeks after delivery. The fifth section covered symptoms of other illnesses such as heart, lung and malaria that are indirect causes of maternal deaths as well as medical care sought. Section six captured socio-economic information such as marital status, highest educational level, occupation, religion and ethnicity of the deceased person and her head of household. The seventh section covered fertility and obstetric history while the last section captured the deceased woman's lifestyle including tobacco and alcohol use (Appendix IV).

3.3.4 Data management

When completed registers and accompanying forms are brought from the field, field supervisors check them for blanks, inconsistencies, and any other type of errors, content or coverage prior to submission to the data management centre. The HRBs and their event forms are sent to the data management centre where they are received by filing clerks who log and keep the records. There is strict recording system to ensure that HRBs and their event forms are tracked and accounted for at every stage of the data collection, processing and storage. The HRBs and their event forms are passed on to the data entry clerks for data processing.

During data processing, each of the events recorded in the HRBs and their forms is captured on separate tables in the database. These different tables are linked to each other during data analysis by using each individual's unique identification that was assigned at the point of the initial registration. Similarly, prior to data processing, the main data collection tool for this study, the VA questionnaires were checked for completeness and consistency by research officers with a minimum of first-degree university education. The VA questionnaires

were double entered on computers using Microsoft Visual FoxPro (version 9.0) data management software. Automated range and consistency checks were performed. Discrepancies were resolved by referring to the original questionnaire and the field manual that was used for training the field workers.

3.3.5 Study population

A total of 1,259 deaths and 329,505 person-years of observation (PYO) were recorded among WRA aged 15-49 years during the 10-year study period. However, 162 (12.9%) WRA had no respondent. The two main reasons accounting for this were: (i) the difficulty in getting a family member that will be able to provide the required information; and (ii) the refusal to either take part in or to complete a VA interview. Some of the VA interviews were done but there were insufficient information or specific information were missing for 196 (15.6%) of them. In view of this challenge, the Physicians could not assign any cause of death to them or the cause of death was unknown. Accidents contributed 55 (4.4%) cases which were excluded because they fell outside the scope of the current study. The remaining 846 (67.2%) were used as the population for all analyses of the present study.

3.4 Key variables and measures

The selection of both outcome and explanatory variables for this study was guided by the reviewed literature in the preceding chapter. Some of the factors as discussed in the conceptual framework were not included in the analysis mainly because this study is a secondary data analysis and data on those variables were not collected. But this situation did not significantly have limitations on the study.

3.4.1 Outcome variables

The outcome variables for this study were deaths due to maternal, infectious or non-communicable causes among WRA in the two Kintampo districts from 2005 to 2014.

Maternal causes of death were operationally defined to include only direct (obstetric) deaths as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy. Infectious causes of death were also defined to include deaths from all infections and parasitic diseases whilst non-communicable causes of death were operationally defined as non-maternal and non-infectious and non-external or injury causes of death. These outcome variables are broad categories of causes of death, details of which are presented in Table 4.1 in the next chapter. The cause of death was arrived at after physicians have diagnosed and assigned a probable cause of death to each death that occurred in the Kintampo HDSS area during the death coding process.

3.4.2 Explanatory variables

The age at death for each adult female is arrived at by linking the death dataset to the individual dataset that contains the basic demographic data including the date of birth and sex of the person. The age at death is computed by finding the difference between the date of birth and the date of death. For this analysis, all adult females who died and were resident in the study area between 1st January 2005 and 31st December 2014 were included. Age was categorized into seven five-year groups namely: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49 years. This division made it possible to explore age-related differences associated with maternal, infectious and non-communicable causes of death including comparing adolescents and their older counterparts in the analysis.

Similarly, other demographic variables were selected and categorised according to the literature and also to ensure that there are enough cases in each cell for analysis. As per the reviewed literature, primigravidae and higher order parity are associated with higher mortality. Therefore, parity was categorised into three (3): 0, 1-3 and 4 and above to further examine the discussions in the literature. Some aspects of the literature indicate that marriage confers some protection on the individual as far as the risk of dying is concerned. However,

this assertion is disputed by others. In view of this contention, marital status was grouped into two (2): never married and ever married to explore the differences in this other demographic variable. It was also to allow for enough cases in the cells especially at the multivariate level of analyses.

Some socio-economic and cultural factors were also considered in this present study. Education was a key variable discussed in the literature on socio-economic determinants of causes of deaths. Therefore, the deceased adult female highest educational level attained was re-categorized into three to allow for enough cases in all the cells. The three categorizations were those who never had any formal education as 'none', those who attained up to primary school level as 'primary' and those who got up to middle or junior high school or senior high school or tertiary as 'JHS and above'. Ethnicity was also re-categorized into 'migrants' and 'non-migrants' to measure the effects of the ethnic groups who came from elsewhere to settle in the study area and those who did not on the outcome variables. Theories of migration suggest that migrant group tend to be disadvantaged compared to the indigenes of a place. In addition, ethnicity was measured conventionally by categorizing the ethnic groups in the study area into four: Northern ethnic groups, Akan, Mo and Other ethnic groups. Religion was also re-categorised into Catholic, Protestants, Pentecostal, Muslim and Other religions but at the multivariate level, it was re-categorised again into three: Christians, Muslims and Other to allow for enough cases in the cells especially for the maternal causes of death. For the same reasons, occupation was put into two categories: unemployed and employed at the multivariate level but grouped into six at the bivariate level as no occupation, trader/food seller, labourer/domestic worker, seamstress/hairdresser, professional (teacher, nurse, accountant) and other.

In order to explore the cultural dimension of mortality further, this study considered a measure of female level of independence in the community. The reviewed literature discusses

autonomy as very important as far as adult female mortality is concerned. This is because several studies have linked autonomous women with low mortality and vice versa. In view of this observation in the reviewed literature, farmland ownership was used as a proxy to measure the level of female independence in the community. This is quite appropriate because culturally, the head of the family who is mostly a male owns the land in trust for all. Therefore, a woman owning a farmland is an indication of how independent she is in the community. Land ownership was categorised into two in terms of whether the deceased woman owned land or not (yes or no).

The physical and climatic factors, including the household level factors were also considered in this study. The place of residence variable is a household characteristic and it was determined by the location of the compound in which the household is found. The household is either rural or urban. The study area is predominantly rural. There are only three communities namely Kintampo, Jema and Babato with a population of over 5,000 that were classified as urban. The Kintampo HDSS covers two administrative districts. Based on this, the district was also categorised into 2 namely Kintampo North and Kintampo South. Another physical and climatic factor considered in this analysis was the season of death. Malaria is the most dominant cause of death in the study area and it has been documented that its prevalence is highest in the rainy season as per the reviewed literature of the present study. Season of death was classified into two: wet and dry whilst the year of death was categorised into ten, from 2005 to 2014.

In addition, factors related to the health system were considered to reflect the conceptual framework adapted for this study. Distance is one key factor identified in the literature as affecting health service utilisation. Several studies have established a positive correlation between health facility use and a 5-km radius. In contrast, studies have shown that health facilities beyond 5-km radius tend to reduce health service utilisation. This has the

tendency to affect the health status and incidence of death eventually. Therefore, distance to the health facility was dichotomized into 5 km or less and more than 5 km by using the GIS data. Another health-related factor considered is the place where the deceased died. This variable is categorised into two: hospital and other to represent WRA who died in and outside hospital respectively. The health facilities have the clinicians and skill birth attendants as well as the equipment needed during emergency situations but these facilities are not available outside the hospital. Therefore, the 'place of death' is used in this study as a proxy measure for health service utilisation.

Intermediate level factors in this analysis were living standards and lifestyles. These factors were conceptualised to include both individual and household level variables. At the household level, the Principal Component Analysis (PCA) method was used to categorise households into three socio-economic statuses (SES) of most-poor, poor and least-poor. Household assets such as television, radio, refrigerator, telephone, lighting type, type of roofing material, type of floor material, vehicles, motorbikes and livestock were used in the PCA. Other household level variables considered in this study to reflect the importance of sanitation were source of drinking water and type of toilet facility, which were categorised separately as improved or unimproved. At the individual level, tobacco, alcohol and drug use were measured as to whether it was used or not. No drug use was reported in the data collected. In addition, they were put together in a composite as 'substance use' at the multivariate level and classified into two groups in terms of whether the deceased woman used any of the substance or not to allow for enough cases in all the cells for analysis.

Finally, proximate level variables were considered in this current study. These variables sought to measure the health status of the deceased WRA. The proximate level variables are the most immediate factors that influence the outcome of interest, which are the risk of dying from maternal, infectious and non-communicable causes of death. The health

status in this current study includes admission in the last twelve months before dying, whether or not the deceased woman had some surgical operation 24 months before dying and whether or not the deceased woman died suddenly. Responses to each of these variables were categorised into two (2): yes or no.

3.5 Analytical methods

Several analyses were conducted to answer the research questions to achieve the objectives of the study after some preliminary investigations including checking for multicollinearity and missing data were done. There was no multicollinearity for any of the variables. No data was imputed for any of the variables considered in this present study. In addition, all variables had responses and therefore, there was no missing data for any of the variables.

The first part of the analysis involved the generation of frequencies by way of univariate statistics to describe the number and distribution of the distal, intermediate and proximate variables. The second part of the analysis was a series of cross-tabulations between the outcome variables and each of the explanatory variables. This was done with the chi-square statistical test to examine the statistically significant association between the outcome variables and each of the explanatory variables. P-values of less than 0.05 were considered statistically significant.

The third phase of the analysis examined the relative risk of dying from maternal, infectious, non-communicable causes of death. To calculate the relative risk, the risk of dying for each of the three-broad causes of death (maternal, infectious and non-communicable) were calculated by dividing the number of deaths for each cause by the person-years of observation for WRA (15-49). This was done by year for the respective causes of death. After calculating the risk of dying for each cause, the relative risk for infectious and non-

communicable causes of death was calculated separately by using the risk of dying from maternal causes to divide each of them. By using this approach, a relative risk, which is more than 1.0 indicates that there is an increased risk of infectious or non-communicable causes of death, conversely, a relative risk, which is lower than 1.0 shows that there is a lesser risk of infectious or non-communicable causes of death.

A reverse approach was also used where the risk of dying from maternal cause was divided with that for infectious and non-communicable causes separately to arrive at the relative risks of dying from maternal causes with respect to infectious and non-communicable causes of death. With the latter approach, a relative risk of less than 1.0 illustrates that there is an increased risk of infectious or non-communicable causes of death. On the contrary, a relative risk, which is more than 1.0 shows that there is a decreased risk of infectious or non-communicable causes of death.

At the fourth stage of the analysis, STATA 14.2 S.E. (Stata Corporation, College Station, Texas) was used to analyse four multinomial logistic regression models. The choice of this method is due to the several competing outcomes. Assumptions behind the multinomial logistic regression included the following: (i) outcome follows a categorical distribution, which is linked to the covariates through a link function as in ordinary logistic regression; (ii) independence of observational units; and (iii) linear relation between covariates and expectation of the outcome. Maternal cause of death was used as the reference group or base outcome. The first model was a regression of each variable on the outcome variables. This was done to examine the separate effect of each of the variables on the outcome variables. From the second to the fourth models, hierarchical analysis was done where each of the components of the conceptual frame was entered cumulatively one after the other to account for their separate effects. This was done to deepen the understanding of the maternal, infectious and non-communicable causes of death in the study area.

With the hierarchical model, the distal variables were the first to be regressed on the outcome variables to examine its separate effect on the outcome variables. The intermediate variables were then entered cumulatively to study the separate effect of the intermediate variables on the outcome variables. During the final model, the proximate variables were also entered cumulatively to investigate this effect on the outcome variables when the distal and intermediate variables are controlled for. The R^2 is determined after each addition. P-values of less than 0.05 were considered statistically significant.

A series of further analyses were conducted to achieve other objectives of the study. Life-table techniques were employed to examine a situation of competing risks that involve the risk of dying from multiple causes of death. This is based on a hypothetical situation that uses life table methods to estimate by how much life expectancy would increase if any of the causes of death (maternal, infectious or non-communicable) were eliminated. This is done by estimating separately for each of the causes of death the expected reduced mortality and the consequent increases in life expectancy that could result in the hypothetical elimination of a specified cause of death (maternal, infectious or non-communicable). Appendix II has detailed explanation of the procedure. In addition, the total change in life expectancy was decomposed to determine which age group is likely to contribute most of the overall change in life expectancy because of the eradication of any of the causes of death (maternal, infectious, or non-communicable). Appendix III has detailed explanation of the procedure.

3.6 Limitation of the study

The influence of mortality from the various causes may not have been estimated accurately since not all deaths recorded by the Kintampo HDSS had successful verbal autopsy interviews but this is expected to be random and therefore, should not have major effects on the present study. In addition, a proportion of the cases with successful interviews

were coded as "cause of death not determined". This is also expected to be random. In addition, ethnicity was used as a proxy for migration status but this is not the usual convention. Furthermore, health system variables (Distance to health facility and Place of death) do not fully consider availability and quality of health services. Moreover, it is well established in the literature that NCDs affect older persons more. Therefore, by restricting this study to WRA, the effect of NCD causes of death may not be well accounted for. However, the analyses in this study were done based on the observation that the three categories of causes of death were recorded among the WRA. Finally, this study used secondary data and other key factors such as pre-conceptional, conceptional, geo-political contextual variables that may affect maternal, infectious and non-communicable causes of death were not included in the analysis.

CHAPTER FOUR

BROAD AND SPECIFIC CAUSES OF DEATH AMONG WOMEN OF REPRODUCTIVE AGE

4.1 Introduction

This chapter presents the broad and specific causes of death among WRA during the study period (2005-2014) that are of interest to this study. This is aimed at providing a general overview of the causes of death in the Kintampo HDSS area. In addition, this chapter presents the distribution of broad causes of death by socio-demographic, economic, physical, behavioural, and health-related factors as considered in this study.

4.2 Broad and specific causes of death

Table 4.1 shows the broad and specific causes of death for all the deaths that were considered in the present study. Infectious diseases were responsible for most of the causes of deaths (61.3%), with malaria contributing 16 percent of all the causes of death whilst HIV/AIDS accounted for 14.7 percent and septicaemia recorded 10.4 percent of all the causes of deaths during the period. Non-communicable diseases (29.9%) were the second highest cause of death among the WRA in the Kintampo HDSS, with cardiovascular diseases (CVDs) contributing to 7.2 percent of all the causes of death. Finally, maternal causes of death accounted for 8.8 percent with maternal haemorrhage, pregnancy with an abortive outcome and other direct maternal causes recording less than three percent each of the total causes of death considered for the present study.

Table 4.1: Broad and Specific Causes of Death

Infectious Causes of Death	Cases	Percent	NCD Causes of Death	Cases	Percent
Malaria	135	16.0	Cardio-vascular diseases	61	7.2
HIV and AIDS	124	14.7	Neoplasm	41	4.8
Septicaemia	88	10.4	Nutritional-related diseases	37	4.4
Intestinal infection	52	6.1	Cirrhosis of liver	28	3.3
Acute respiratory infections	32	3.8	Disorders of the nervous system	25	3.0
Tuberculosis	28	3.3	Genito-urinary disorders	23	2.7
Meningitis	26	3.1	Other abdominal conditions	16	1.9
Other infectious diseases	23	2.7	Other non-communicable diseases	9	1.1
Viral Hepatitis	11	1.3	Chronic respiratory diseases	8	0.9
Sub-total	**519**	**61.3**	Diabetes mellitus	5	0.6
Maternal Causes of Death			**Sub-total**	**253**	**29.9**
Other direct maternal cause	22	2.6	**Total**	**846**	**100.0**
Pregnancy with abortive outcome	21	2.5			
Maternal haemorrhage	19	2.3			
Hypertensive disorder of pregnancy	6	0.7			
Puerperal sepsis	6	0.7			
Sub-total	**74**	**8.8**			

Source: Kintampo HDSS (2005-2014)

4.3 Broad causes of death by socio-demographic, economic, physical, behavioural and health-related factors

From Table 4.2, it is observed that the highest percentage of maternal causes of death was recorded among the 25-29-year-olds (33.8 percent). In addition, the second highest percentage of maternal deaths occurred among the 20-24 age category (18.9 percent). Furthermore, the third highest percentage of maternal deaths occurred among the 15-19 age category (14.9 percent). In contrast, the highest percentage of death from NCD was recorded among the 35-39-year-olds (19.8 percent) whilst the second highest from NCD was reported

among the 30-34-year-olds (16.6 percent) and the third highest of 14.2 percent among both 40-44-year-olds and 25-29-year-olds. Similarly, the highest percentage of death from infectious causes was recorded among the 35-39-year-olds (19.1 percent) whilst the second highest occurred among the 25-29-year-olds (18.5 percent) and the third highest was reported among the 30-44-year-olds (18.3 percent). From the results of the study, a higher proportion of younger WRA died from maternal causes of death relative to infectious and non-communicable causes of death. This observation is expected as pregnancy usually involves relatively younger WRA.

It is further observed that the highest proportion of deaths from NCD causes was among women who had given birth to more than four children (39.1 percent) at the time of death. The second highest percentage of deaths from infectious causes occurred among women who had given birth to more than four children (34.3 percent) at the time of death. However, in the case of maternal causes, this category had the least percentage of mortalities (23 percent). Women who had given birth to four or more children are more likely to be older compared to those that had less than four children at the time of death. Therefore, this observation collaborates that of the age at death where younger WRA died more from maternal causes.

For all the three causes of death under examination, the proportion of deaths among those who were ever married was 89.2 percent, 79.4 percent and 77.1 percent for maternal, infectious and NCD causes respectively. The high proportion of the ever-married women of reproductive age is expected as marriage is still generally held in high esteem within the study area.

Moreover, for all the three causes of death, the highest proportion of deaths occurred among women who had no formal education. In order of magnitude, for maternal, infectious and non-communicable causes, 70.3, 64.4 and 62.1 percent respectively had no formal

education. For NCD and infectious causes, those with primary education recorded the second highest percentage of deaths – 18.2 percent and 16 percent respectively, followed by those who attained middle/JHS education. However, for maternal causes, the second highest percentage (17.6 percent) was among those who attained middle/JHS education, while the third highest (12.2 percent) was among those who had primary education. For all the three causes of death, those with senior secondary education or higher recorded the lowest proportion of deaths, with zero for maternal causes and 5 percent and 3.6 percent for infectious and NCDs respectively.

With regard to migration status, each of the three causes of death had over 50 percent of deaths among migrants. Specifically,73 percent of maternal causes, 55.5 percent of infectious and 55.3 percent of NCD deaths occurred among migrants. This observation from the study is expected. This is because it is well-documented that in some context, migrants are likely to be at a disadvantage in terms of health and resources in general compared to the indigenes of a given place.

For all three causes of death, majority of deaths occurred among women from the northern ethnic groups. That is 51.4 percent of maternal, 40.8 percent of infectious and 37.2 percent NCD deaths occurred among those from the northern ethnic groups. On the other hand, the least number of deaths for infectious causes occurred among women from other ethnic groups (14.6 percent) whilst for both NCD (10.7%) and maternal (5.4%), the least cases of death were reported among the Mo ethnic group. This observation is largely expected as people of the northern extraction are relatively poor which may impact on their health compared to other groups.

Table 4.2: Percentage distribution of broad causes of death by socio-demographic, economic, physical, behavioural and health-related factors

Factors	Infectious (n=519)	Non-communicable (n=253)	Maternal (n=74)	Total (N=846)	Pearson's chi square
Age at death	**%**	**%**	**%**	**%**	***
15-19	7.3	10.7	14.9	9.0	
20-24	10.8	12.6	18.9	12.1	
25-29	18.5	14.2	33.8	18.6	
30-34	18.3	16.6	14.9	17.5	
35-39	19.1	19.8	9.5	18.4	
40-44	14.8	14.2	5.4	13.8	
45+	11.2	11.9	2.7	10.6	
Children ever born					***
0	23.3	29.6	36.5	26.4	
1-3	42.4	31.2	40.5	38.9	
4+	34.3	39.1	23.0	34.8	
Marital status					
Never-married	20.6	22.9	10.8	20.4	
Ever-married	79.4	77.1	89.2	79.6	
Highest educational level attained					
No Education	64.4	62.1	70.3	64.2	
Primary	16.0	18.2	12.2	16.3	
Middle/JHS	14.7	16.2	17.6	16.6	
SHS+	5.0	3.6	0	2.9	
Migration status					**
Non-settler	44.5	44.7	27.0	43.0	
Settler	55.5	55.3	73.0	57.0	
Ethnicity					
Northern ethnic groups	40.8	37.2	51.4	40.7	
Akan	27.9	34.0	21.6	29.2	
Mo	16.6	10.7	5.4	13.8	
Other	14.6	18.2	21.6	16.3	

Table 4.2 CONTINUATION

Factors	Infectious (n=519)	Non-communicable (n=253)	Maternal (n=74)	Total (N=846)	Pearson's chi square
Religion					
Catholic	14.1	11.1	17.6	13.5	
Protestant	19.8	24.9	18.9	21.3	
Pentecostal	19.8	19.4	8.1	18.7	
Muslim	29.1	26.5	33.8	28.7	
Other religion	17.1	18.2	21.6	17.8	
Employment status					
Unemployed	36.8	47.8	50.0	41.3	
Employed	63.2	52.2	50.0	58.7	
Occupation					
No occupation	36.8	47.8	50.0	41.3	
Trader/food seller	36.6	29.6	25.7	33.6	
Labourer/domestic worker	13.9	9.9	10.8	12.4	
Seamstress, hairdresser etc	7.9	6.3	6.8	7.3	
Professional – teacher, nurse, accounts, administrative	2.1	3.6	0.0	2.4	
Other	2.7	2.8	6.8	3.1	
Land ownership		0.0			*
Yes	12.9	7.5	0.0	10.2	
No	87.1	92.5	100.0	89.8	
Place of residence					
Rural	62.8	63.2	67.6	63.4	
Urban	37.2	36.8	32.4	36.6	
District of residence					**
North |	63.2	54.5	44.6	59.0	
South	36.8	45.5	55.4	41.0	
Season of death					
Wet	48.4	51.4	62.2	50.5	
Dry	51.6	48.6	37.8	49.5	

Table 4.2 CONTINUATION

Factors	Infectious (n=519)	Non-communicable (n=253)	Maternal (n=74)	Total (N=846)	Pearson's chi square
Place of death					***
Other	64.9	64.4	41.9	62.8	
Health facility	35.1	35.6	58.1	37.2	
Year of death					**
2005	9.2	14.6	17.6	11.6	
2006	8.3	12.6	10.8	9.8	
2007	12.1	8.7	9.5	10.9	
2008	9.1	9.5	20.3	10.2	
2009	7.3	8.3	10.8	7.9	
2010	13.9	10.3	10.8	12.5	
2011	13.1	7.9	5.4	10.9	
2012	11.2	10.7	6.8	10.6	
2013	8.5	10.7	6.8	9.0	
2014	7.3	6.7	1.4	6.6	
Distance to facility					
<5km	57.4	60.1	52.7	57.8	
5km+	42.6	39.9	47.3	42.2	
Household socio-economic status					
Most Poor	26.6	19.0	24.3	24.1	
Poor	45.7	52.6	43.2	47.5	
Least Poor	27.7	28.5	32.4	28.4	
Source of drinking water					***
Improved	65.5	59.7	41.9	61.7	
Unimproved	34.5	40.3	58.1	38.3	
Type of toilet facility					
Improved	33.7	27.7	27.0	31.3	
Unimproved	66.3	72.3	73.0	68.7	

Table 4.2 CONTINUATION

Factors		Infectious (n=519)	Non-communicable (n=253)	Maternal (n=74)	Total (N=846)
Alcohol use					**
Yes	11.4	8.3	2.7	9.7	
No	88.6	91.7	97.3	90.3	
Tobacco use					
Yes	0.8	0.4	0.0	0.6	
No	99.2	99.6	100.0	99.4	
Drug use					
Yes	0.0	0.0	0.0	0.0	
No	100.0	100.0	100.0	100.0	
Admission in last 12 months before death					***
Yes	36.2	35.6	10.8	33.8	
No	63.8	64.4	89.2	66.2	
Surgical operation in last 24 months before death					***
Yes	2.3	6.3	12.2	4.4	
No	97.7	93.7	87.8	95.6	
Sudden death					***
Yes	60.7	64.0	77.0	63.1	
No	39.3	36.0	23.0	36.9	

***** p<0.001; ** p<0.01; *p<0.05** **Source: Kintampo HDSS (2005-2014)**

Majority of those who died from all the three causes of death were Muslims. That is, for maternal, infectious and NCD deaths, 33.8 percent, 29.1 percent and 26.5 percent respectively occurred among Muslims. In contrast, the least number of deaths for infectious causes were among Catholics (14.1 percent), whereas the least number of deaths from NCDs also occurred among Catholics (11.1 percent). Also, the least cases of death for maternal causes were reported among Pentecostals. This finding is also expected as Muslims are relatively poor compared to those of the Christian faith and this may negatively affect their health.

Concerning the employment status of the women of reproductive age in the study area, for those who died of infectious and NCD causes, 63.2 percent and 52.2 percent respectively were employed, whilst 50 percent of those who died of maternal causes were employed. These results are unexpected since the unemployed are generally expected to be negatively affected health-wise.

Regarding the occupational status of the study population, for all the three causes of death, the highest proportion of deaths occurred among women with no occupation in order of magnitude as follows: maternal causes (50 percent), NCD (47.8 percent) and infectious (36.8 percent). This finding is not expected to be different from the one about employment status. On the other hand, for all the three causes of death, less than 10 percent of death occurred among the occupational groups namely, seamstress/hairdresser, professional/administrative and other worker, in order of magnitude.

More than four fifth of the WRA who died from any of the three causes did not own any land at the time of death. Specifically, 81.7 percent, 92.5 percent and 100 percent of infectious, NCD and maternal death respectively were among WRA who did not own any land at the time of death. Traditionally, land is held in trust by the family head, who is invariably a male, and for this reason this finding is expected.

Furthermore, 67.6 percent, 63.2 percent, and 62.8 percent of WRA who died from maternal, NCD and infectious causes lived in rural areas, as such for each of the three causes of death, lower proportion of women were residents in urban areas. People living in rural areas are at a disadvantage in terms infrastructure, including health and for that matter, this observation is expected.

Moreover, 63.2 percent of all infectious causes of death occurred among women who lived in the Kintampo North Municipality, whereas 54.5 percent of all NCD deaths were from residents of Kintampo North Municipality. However, for maternal causes of death, 44.6

percent were recorded among women who lived in the Kintampo North Municipality. As expected, more maternal deaths were recorded in Kintampo South than Kintampo North Municipality. This is because the Kintampo South was recently created and depends on the Kintampo North Municipality for emergency obstetric care and other specialised care.

In terms of season of death, for maternal, NCD and infectious causes, 62.2 percent, 51.4 percent and 48.4 percent respectively occurred in the rainy season. This finding is unexpected as rainy season increased the risk of infections such as cholera and malaria, which was the top specific causes of death in the present study. However, the result could be partly because infections in the rainy season linger on in the dry season as the incubation period for malaria could take a month or more.

For infectious and NCD deaths, 64.9 percent and 64.4 percent respectively occurred outside a health facility. However, less than half (41.9 percent) of all maternal deaths occurred outside a health facility. The high proportion of maternal death within health facilities may probably be the effect of the free maternal care intervention which was introduced in all ten regions of Ghana in 2005, and as result, more WRA are relatively using health services for maternal care compared to other conditions.

The highest number of infectious causes of death occurred in the year 2010 and accounted for 13.9 percent of all deaths recorded over the 10-year study period. There has been a continuous decline in the contribution of infectious causes of death from 2011 to 2014. However, the number of NCD causes of death has been high from the beginning of the study period, 2005, and the number of cases has remained relatively high for most of the years. On the other hand, maternal causes reported the highest cases of death in the year 2008. The number of maternal cases remained relatively low and generally declined from 2009 to 2014.

With respect to distance from health facility, the proportion of deaths among women who lived less than 5km to a health facility were 60.1 percent, 57.4 percent and 52.7 percent

for NCD, infectious and maternal causes respectively. It is unexpected for those closer to a health facility to record more deaths than those further away but this may be because there are disproportionate number of WRA who live within 5km radii of health facilities in the study area.

For all the three causes of deaths, majority of deaths occurred among women who lived in poor households. Specifically, 52.6, 45.7 and 43.2 percent of NCD, infectious and maternal causes of deaths respectively occurred among women who lived in poor households. Also, for all three causes of deaths, the least percentage of deaths were recorded among women who lived in most-poor households. This finding is also not expected and there is the need for further investigation into this.

A higher proportion of infectious causes of deaths (65.5%) occurred among women who had access to improved source of drinking water. Similarly, a higher proportion of deaths from NCD causes (59.7%) were among WRA who used improved source of drinking water. However, for those who died of maternal causes, a lower proportion (41.9%) had access to improved source of drinking water. This observation means that most of the deaths from infectious and NCD causes occurred among women with access to improved source of drinking water. It is unexpected for WRA who use improved sources of drinking water to record more deaths than those who do not but this may be because there are disproportionate number of WRA who used improved water sources. It could also mean that the improved water sources are contaminated, probably because they are not properly stored or preserved.

Unlike the source of drinking water, for all the three causes of death under examination, the highest proportion occurred among women who used unimproved toilet facilities. In numerical terms, 73 percent of maternal cause, 72.3 percent of NCD causes and 66.3 percent of infectious causes of deaths were among women who used unimproved toilet

facilities. This observation is expected as women of reproductive age and the population in general, are expected to die more from exposure to unimproved toilet facilities.

Substance use among the study population is quite minimal, and this observation is consistent with what is reported nationally. For those who died of NCD and maternal causes, 8.3 percent and 2.7 percent respectively consumed alcohol, whilst for infectious causes about one out of ten deaths (11.4 percent) of those who died consumed alcohol. In the case of tobacco, 0.8 percent and 0.4 percent of those who died of infectious and NCD respectively used tobacco. However, none of those who died of maternal causes used tobacco. Also, none of those who died from the three causes reported using drugs.

For those who died of infectious and NCD causes, 36.2 percent and 35.6 percent respectively were admitted in the last 12 months before dying, whilst 10.8 percent of those who died of maternal causes were admitted in the last 12 months before dying. This suggest that a higher proportion of the WRA who died from infectious and NCD causes were admitted in the last 12 months before death.

A little over one out of ten (12.2 percent) of maternal causes of deaths were among women who had undergone surgical operation in the last 24 months before dying. For those who died of NCD and infectious causes, 6.3 percent and 2.3 percent respectively had undergone surgical operation in the last 24 months before dying. This finding suggests that women who undergo surgical operation in the last 24 months before dying are more likely to die from maternal causes than NCD or infectious causes. This is quite expected as delivery and abortion are likely to result in surgical operations that may end up as maternal deaths.

Finally, 77 percent, 64 percent, and 60.7 percent of maternal, NCD, and infectious causes of deaths respectively occurred suddenly. These results suggest that a higher proportion of WRA die suddenly from maternal than infectious or NCD causes. This is quite

expected since maternal deaths usually occur during delivery or surgical operations which are untimely and sudden.

4.4 Discussion

This chapter sought to describe the broad and specific causes of death as well as the distribution of broad causes of death by the explanatory variables among the WRA in the Kintampo HDSS area from 2005 to 2014. The bivariate analysis shown in Table 4.2 indicated that age at death, children ever born, migration status, land ownership, district of residence, place of death, year of death, source of drinking water, alcohol use, admission in the last 12 months before death, surgical operation in the last 12 months and sudden death have statistically significant influences on the causes of death whilst the remaining ones were not. Therefore, from the theoretical framework, all the three proximate factors were significant. In addition, two out of the six intermediate factors were significant whilst seven out of the sixteen distal factors were also significant.

The results of this study indicated that infectious causes of death were the main broad causes of death among the WRA in the Kintampo HDSS during the study period. This finding is similar to other studies in SSA that have established infectious causes of death as the top causes of death (Kone et al., 2015; Lulu & Berhane, 2005; Melaku et al., 2014). The current study found that infectious causes of death were responsible for 61.3 percent of all the causes of death among WRA. This finding is comparable to that of Lulu and Berhane (2005) who used the Butajira HDSS data among the adult population 15-49 and reported that infectious causes of death accounted for 60.8 of the total causes of death in Ethiopia.

Similarly, Kone et al. (2015) used the InterVA-4 model to examine Taabo HDSS data in Cote d'Ivoire and established that overall, 58.9 percent of the deaths subjected to InterVA-4 were due to infectious diseases. Melaku et al. (2014) also used the physician coding to

analyse the female population within the Kilite-Awlealo HDSS in Ethiopia and the top broad cause of death was infectious diseases accounting for 37.2 percent. Conversely, Labrique et al. (2013) found that NCD, maternal, infectious, injury and other causes contributed 48, 22, 17, 9 and 4 percent of causes of death respectively among WRA. However, the current study found NCD to be the second largest broad cause of death among WRA in the Kintampo districts during the study period. NCD causes of death were responsible for 29.9 percent of all the causes of death in the current study. This suggests that the causes of death are context-specific.

Malaria was found in this current study to be the main specific cause of death among WRA in the Kintampo North Municipal and Kintampo South District. Malaria accounted for 16 percent of all causes of death among WRA and more than one-quarter of infectious causes of death. Malaria transmission in the study area is reported to be throughout the year (Dery et al., 2010). In addition, Asamoah et al. (2011) reported that malaria accounted for 53.6 percent of pregnancy-related deaths due to infectious diseases in a study using the Ghana Maternal Health Survey data among WRA aged between 12 and 49 years.

The results of the present study show that HIV/AIDS was the second highest specific cause of death among WRA in the Kintampo districts during the study period. HIV/AIDS contributed 14.7 percent of all causes of death among WRA and more than one-fifth of infectious causes of death. A study in Ethiopia by Melaku et al. (2014) reported that HIV/AIDS and TB were the main causes of death amongst WRA. Another study in South Africa by Garenne et al. (2013) reported that the main causes of death among WRA (15–49 years) were HIV/AIDS and TB. The authors reported that both HIV/AIDS and TB accounted for 71 percent of causes of death for non-pregnant WRA (Garenne et al., 2013). In addition, several other researches have reported the public health importance of TB and HIV/AIDS

within the female populations in sub-Saharan African countries (Herbst et al., 2011; Kahn et al., 1999; Misganaw, 2012; Phillips-Howard et al., 2012). However, the present study did not find TB to be relatively a major cause of death among WRA in the study area.

The present study also found NCD causes of death to be the second highest broad causes of death among WRA in the Kintampo HDSS area between 2005 and 2014. The current study found that NCD causes of death were responsible for 29.9 percent of all the causes of death among WRA. CVDs were the top NCD cause of death in the current study. CVDs accounted for 7.2 percent of all causes of death and close to one-quarter of all NCD causes of death in the current study. Globally, CVDs cause more death than any other disease (WHO, n.d.-a). CVDs are also the world's number one cause of death of women (American Cancer Society, 2011). In Ghana, there is evidence of CVDs increasing and contributing more to the causes of death. Based on limited institutional data (excluding teaching hospitals), it is reported that CVD contributed 8.9 percent of health facility deaths in 2003 whilst malaria contributed 17.1 percent of the deaths. However, five years later, CVDs became the top cause of institutional deaths in 2008. It accounted for 14.5 percent of institutional deaths whilst malaria contributed 13.4 percent of the deaths (Saleh, 2012).

Compared to infectious and non-communicable causes of death, maternal causes were the least broad cause of death among the study population. Several studies have reported that maternal causes of death represent a small proportion of death among WRA (Melaku et al., 2014; Scrafford & Tielsch, 2016). Other studies have reported that there is some form of protection during the maternal risk period because of the selection bias for healthy women for childbirth (Garenne, 2011; Garenne et al., 2013).

According to the present study, maternal causes of death were responsible for 8.8 percent of all the causes of death among WRA in the Kintampo North Municipal and Kintampo South District during the study period. This is within the percentage of deaths

among WRA attributable to maternal causes ranging from 5.7 to 41.7 percent as found by Scrafford & Tielsch (2016). Therefore, the results of the present study are consistent with the findings of aggregated analysis of 38 DHS surveys from countries in three different regions, namely Latin American and Caribbean Countries, Asia and sub-Saharan Africa. However, Melaku et al. (2014) found that maternal causes of death were less than one percent (0.8 %) for the proportion for the Kilite-Awlealo HDSS data in Ethiopia.

The pattern of maternal causes of death found in this present study is comparable to the pattern that has been established in the literature on maternal causes of death. In this present study, the pattern of maternal causes of death peaked at 25-29 and started declining from 30-34 with sharp decline after 40 years. This finding is quite similar to that by Scrafford and Tielsch (2016) who used the sisterhood method with the DHS data to estimate maternal and non-maternal deaths for 38 countries in three different regions of the world among women 15–49 years of age. Their results indicated that the highest percentage of maternal deaths occurred from 25 to 29 and there is an increasing trend up to 30-35 years old followed by a decline, with a sharp decline after 40 years (Scrafford & Tielsch, 2016).

From the results of this present study, there is a trend of reduction of maternal causes of death in the study area over the study period. Although the level is still unacceptably high. This is in conformity with the global and regional as well as the trend in Ghana (Alkema et al., 2016; Say et al., 2014; WHO, UNICEF, The World Bank, UNFPA, 2015). However, the trends for both infectious and non-communicable causes of death for WRA within the Kintampo HDSS area are not reducing. This trend of the double burden of infectious and NCD causes of death has been identified in Ghana's epidemiological transition and described as 'protracted polarised model'(Agyei-Mensah & de-Graft Aikins, 2010 citing Frenk et al., 1989). This is because there has been a co-existence of infectious and NCD causes of death over a long period as observed in the current study. Together these findings suggest that it is

essential for at least equitable attention for other causes of death among WRA other than maternal causes.

This chapter has shown generally that maternal causes of death constitute a relatively small percentage of the total causes of death among the WRA in the Kintampo districts during the study period. The next chapter investigates this observation further by examining the relative risk of dying from maternal, infectious and non-communicable causes.

CHAPTER FIVE

RELATIVE RISK OF DYING FROM MATERNAL, INFECTIOUS AND NON-COMMUNICABLE CAUSES

5.1 Introduction

This chapter examines the relative risk of dying from infectious and non-communicable causes relative to maternal causes of death and vice versa. This is important because the maternal cause of death has been the focus of research and funding, especially over the past three decades. Currently, there is a debate on the need for equal attention on other causes of death among WRA, especially as the maternal causes of death are declining and NCD causes are rising whilst infectious causes of death are persistently high. As explained elsewhere (Section 3.5) in the study, a relative risk greater than 1.0 for infectious or non-communicable versus maternal causes of death (maternal cause of death as the denominator) shows that there is an increased risk of infectious or non-communicable causes of death whereas a relative risk that is lower than 1.0 demonstrates that there is a lesser risk of infectious or non-communicable causes of death. Conversely, where either infectious or non-communicable cause of death is the denominator (maternal versus infectious or non-communicable), a relative risk of less than 1.0 indicates that there is an increased risk of infectious or non-communicable causes of death whereas a relative risk that is more than 1.0 illustrates that there is a decreased risk of infectious or non-communicable causes of death.

5.2 Relative risk of infectious and maternal causes of death

Figure 5.1 depicts the relative risk of death for the causes of death under consideration from 2005 to 2014 (infectious or non-communicable versus maternal causes of death). A relative risk greater than 1.0 for infectious versus maternal causes of death persists

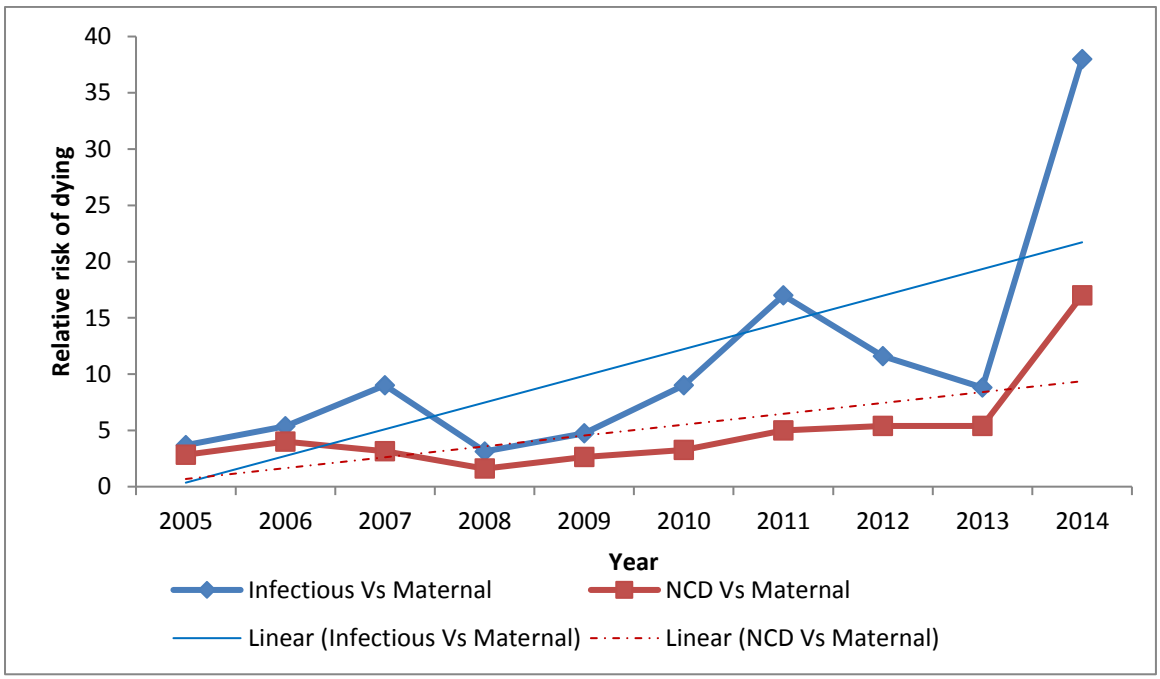
throughout the study period. This trend shows that there is an increased risk of infectious causes of death among WRA from 2005 to 2014 relative to maternal causes of death. The relative risk for infectious versus maternal causes of death increased from 2005 and peaked in 2007. It dropped to its lowest level in 2008, started another upward trend in 2009, and peaked again in 2011. It started dropping again in 2012 and then to another low in 2013 and began an upward trend in 2014 when the highest level was recorded. Although the relative risk for infectious versus maternal for both 2008 and 2013 levels were low, the 2013 low level was about three times higher than the level in 2008. Furthermore, while there were both peaks and troughs in certain years, the trend gives an indication of increased risk of infectious causes relative to maternal causes of death throughout the period under consideration. Moreover, the trend illustrates a worsening situation of the risk of dying from infectious relative to maternal causes of death year by year. Finally, the relative risk for infectious causes versus maternal causes of death was at a higher level throughout the period compared to the relative risk for NCD versus maternal causes of death.

5.3 Relative risk of NCD and maternal causes of death

In addition, from Figure 5.1, a relative risk of greater than 1.0 for NCD compared to maternal causes of death persists throughout the study period similar to the trend observed in the case of infectious versus maternal causes of death. This trend also demonstrates that there is an increased risk of NCD causes of death among WRA from 2005 to 2014 relative to maternal causes of death. The relative risk for NCD versus maternal causes of death increased from 2005 to 2006 and started falling in 2007 to its lowest in 2008 as observed in the case of infectious causes. It started rising in 2009 and continued to rise for the rest of the period. It recorded the highest level in 2014 also, as observed in the case of infectious causes. Once more, although there were peaks and troughs in certain years, there was an increased risk of

NCD relative to maternal causes of death throughout the period similar to the trend for the relative risk of dying from infectious causes. This observation confirms the second hypothesis of the study that WRA are more likely to die from NCD than maternal causes of death. In addition, the trend depicts a worsening situation of dying from NCD relative to maternal causes year by year similar to that of infectious causes.

Figure 5.1: Relative risk of dying among WRA from 2005 to 2014, Kintampo HDSS (infectious or non-communicable versus maternal causes)

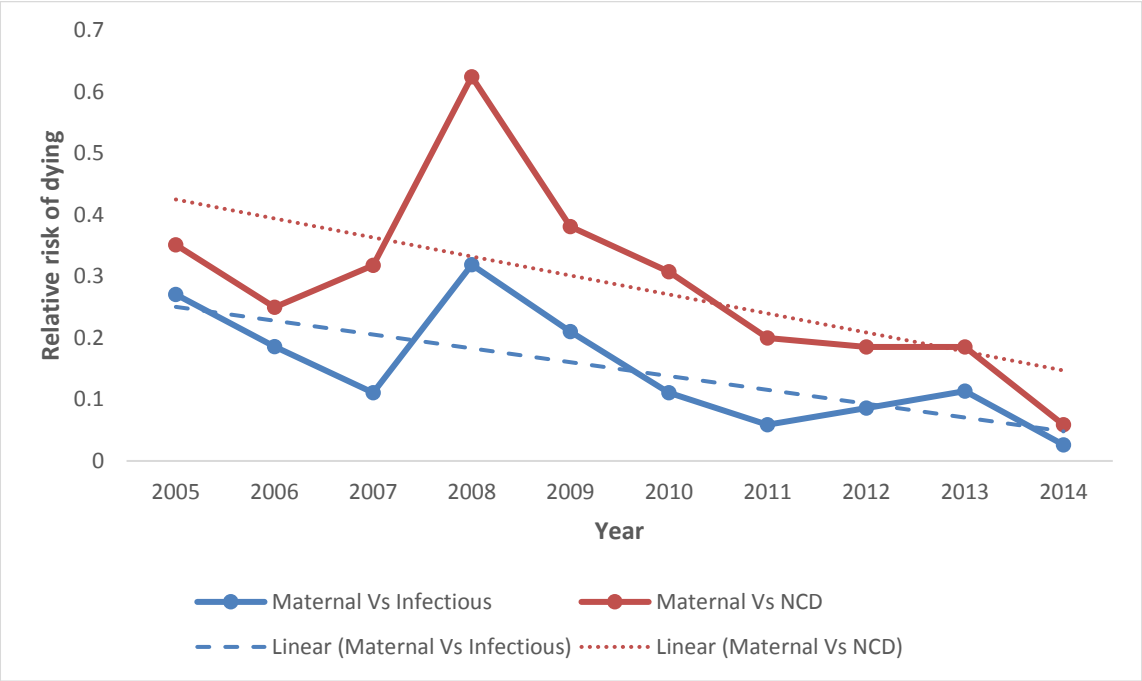


Source: Kintampo HDSS (2005-2014)

5.4 Relative risk of maternal versus infectious or non-communicable causes of death

Figure 5.2 illustrates the relative risk of death for maternal versus infectious or non-communicable causes of death. A relative risk lesser than 1.0 for maternal versus infectious or non-communicable causes of death persists all over the study period. This trend shows that there is an increased risk of infectious or non-communicable causes of death among WRA from 2005 to 2014 relative to maternal causes of death.

Figure 5.2: Relative risk of dying among WRA from 2005 to 2014, Kintampo HDSS (maternal causes versus infectious or non-communicable)



Source: Kintampo HDSS (2005-2014)

5.5 Discussion

This chapter sought to examine the relative risk of dying from infectious and non-communicable causes relative to maternal causes of death among women of reproductive age in the Kintampo HDSS area from 2005 to 2014. The study found that there was an increased risk of both infectious and NCD causes of death throughout the study period although the risk of infectious causes of death is much higher. In addition, the trend for both causes of death depicts a worsening situation year by year. This observation from the present study re-enforces the justification for the choice of the theoretical framework that suggest that Africa and LMICs in general, have not experienced any sustained shift from one epidemiological regime to another.

The higher increased risk of infectious causes of death observed in the current study confirms the first hypothesis that WRA are more likely to die from infectious than maternal

causes of death. Several studies using HDSS data have reported that infectious diseases are the leading causes of death among WRA. Kone et al. (2015) used the InterVA-4 model to examine Taabo HDSS data in Cote d'Ivoire and reported that about three in five of the deaths subjected to InterVA-4 were due to infectious diseases. In addition, Melaku et al. (2014) in Ethiopia analysed the Kilite-Awlealo HDSS data for all female population and observed that maternal causes of death constituted less than one percent, however, infectious diseases were the main causes of death and contributed 37.2 percent of the total deaths (Melaku et al., 2014). Again, Lulu and Berhane (2005) used the Butajira HDSS data for the adult population 15-49 and reported that infectious causes of death contributed greater than three in five causes of death.

Furthermore, the trend of an increased risk of both infectious and NCD causes of death observed throughout the study period in the current study demonstrates the triple burden of maternal, infectious and non-communicable causes in the study area since the level of maternal mortality is still high in the study area. The existence of double burden, which focuses on the general population has been reported mostly in urban Ghana by others (Agyei-Mensah & de-Graft Aikins, 2010; de Graft Aikins et al., 2012; The World Bank, 2006). The finding in the present study highlights the occurrence of triple burden in rural Ghana and among WRA. Therefore, this finding suggests the need for increased government and non-governmental attention and funding to control the triple burden of maternal, infectious and NCD causes of death. This is because of the substantial changes in the amount and nature of demand for health services that is likely to accompany this phenomenon, especially in the immediate future. However, health systems in LMICs are generally not prepared to confront the problems of quality and affordability in health services, particularly for NCDs (Allotey et al., 2014).

Moreover, double burden of disease has been shown to correlate with poverty (Agyei-Mensah & de-Graft Aikins, 2010). Yet, a sizeable proportion of the populations in LMICs live in abject poverty and their basic needs such as access to potable water and standard sanitation systems are either inadequate or non-existent (WHO, 2009a). Beside these challenges, it is reported that women, whether in urban or rural settings in Ghana, are relatively more disadvantaged and occupy the lowest position on the socio-economic ladder compared to men (GSS, GHS & ICF International, 2015). These observations make this finding even more relevant.

Again, this current study observed that the trend of both infectious and non-communicable causes of death depicted a worsening situation relative to maternal causes of death year by year. The level of maternal mortality is reported to be unacceptably high, especially in SSA, including Ghana (Kassebaum et al., 2014; Wilmoth et al., 2012). The level of infectious diseases has also been found to be persistently high and they have been the traditional causes of death in LMICs (WHO, 2009a). Again, it is reported that the level of NCD causes of death from CVDs, cancers and metabolic diseases is rising globally and it has been described as rising epidemic in LMICs especially, in SSA (Ezzati et al., 2005; Parkin et al., 2008; Peer, 2015). It is suggested that since women are likely to die more from NCDs, there is the need to prioritise women in the fight against NCDs and to shift from over concentration on maternal causes to all major causes of death among WRA including maternal mortality (NCD Alliance, 2011; Scrafford & Tielsch, 2016).

This chapter has provided evidence on the comparative influence of maternal, infectious and non-communicable causes of death among WRA in the Kintampo HDSS area for the period 2005 to 2014. The next chapter investigates the determinants of these causes of death to be able to come out with appropriate intervention to contain the problem.

CHAPTER SIX

DETERMINANTS OF MATERNAL, INFECTIOUS AND NON-COMMUNICABLE CAUSES OF DEATH

6.1 Introduction

In this chapter, the determinants of maternal, infectious and non-communicable causes of death among the women of reproductive age during the study period (2005-2014) within the Kintampo North Municipality and Kintampo South District are examined using multinomial logistic regression models based on hierarchical analyses as shown in Tables 6.1, 6.2 and 6.3. The results show all explanatory variables at the adjusted and unadjusted levels. The likelihood ratio chi-square test was used to test the statistical significance of the association between maternal, infectious and non-communicable causes of death and the explanatory variables.

6.2 Factors influencing causes of death in the study area (Model 1)

Table 6.1 shows the relationship between socio-demographic, environmental factors (distal factors) and maternal, infectious and non-communicable causes of deaths from 2005 to 2014 in the study area. Model 1 explains about 11 percent of the variations with 846 observations and log likelihood of -657.10051. In this model, it is assumed that only distal factors, namely age at death, children ever born, marital status, highest educational level attained, place of residence, district of residence, religion, employment status, migration status, land ownership, place of death, season of death, year of death, distance from household to health facility affect maternal, infectious and non-communicable causes of death. The Wald $\chi 2$ (prob>chi2) of the model is significant at 99% confidence interval indicating that the model is a good fit.

Table 6.1: Multinomial logistic regression for the relationship between socio-demographic, environmental factors and causes of maternal, infectious and non-communicable deaths from 2005 to 2014 in the study area (Model 1)

Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Age at death		
15-19 (ref)	1.00	1.00
20-24	1.74 (1.04)	1.81 (1.13)
25-29	2.29 (1.37)	1.68 (1.05)
30-34	5.33* (3.50)	4.49* (3.09)
35-39	7.61** (5.34)	7.39** (5.38)
40-44	13.58** (10.89)	11.27** (9.35)
45-49	20.60** (19.58)	19.95** (19.48)
Parity		
0 (ref)	1.00	1.00
1-3	2.46* (0.96)	1.52 (0.63)
4+	1.98 (0.93)	2.08 (1.02)
Marital status		
Never-married (ref)	1.00	1.00
Ever-married	0.12*** (0.07)	0.12*** (0.07)
Highest educational level attained		
No Education (ref)	1.00	1.00
Primary	1.04 (0.48)	1.43 (0.68)
Middle/JHS+	0.77 (0.32)	0.85 (0.38)
Migration status		
Non-migrant (ref)	1.00	1.00
Migrant	0.43* (0.16)	0.48 (0.19)
Religion		
Christianity (ref)	1.00	1.00
Muslim	0.71 (0.26)	0.65 (0.26)
Other	0.63 (0.26)	0.62 (0.27)

Model 1 CONTINUATION		
Determinants of causes of death	**Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)**	**NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)**
Employment status		
Unemployed (ref)	1.00	1.00
Employed	0.86 (0.29)	0.66 (0.23)
Land ownership		
No (ref)	1.00	1.00
Yes	0.80 (0.32)	0.72 (0.30)
Place of residence		
Rural	1.00	1.00
Urban	0.70 (0.28)	0.90 (0.38)
District of residence		
North (ref)	1.00	1.00
South	0.30** (0.10)	0.47* (0.17)
Season of death		
Wet (ref)	1.00	1.00
Dry	2.04* (0.59)	1.76 (0.54)
Year		
2005 (ref)	1.00	1.00
2006	1.30 (0.73)	1.14 (0.66)
2007	1.84 (1.11)	0.72 (0.46)
2008	0.50 (0.28)	0.28* (0.17)
2009	1.53 (0.93)	0.88 (0.56)
2010	1.94 (1.12)	0.74 (0.45)
2011	3.61 (2.46)	1.10 (0.78)
2012	3.68 (2.52)	1.85 (1.31)
2013	3.62 (2.47)	2.70 (1.89)
2014	7.54 (8.48)	3.39 (3.89)
Distance to facility		
<5km	1.00	1.00
5km+	0.61 (0.20)	0.61 (0.20)
Place of death		
Other (ref)	1.00	1.00
Health facility	0.24*** (0.08)	0.25*** (0.08)
Log likelihood = -657.10051 Pseudo R2 = 0.1112 Prob > chi2 <0.001 Number of observations = 846		

***** p<0.001; ** p<0.01; *p<0.05** **Source: Kintampo HDSS (2005-2014)**

The results show that the relative risk ratio (RRR) for infectious and maternal causes of death indicated that WRA who were between the age groups from 30 to 49 years were significantly more likely to die from infectious than maternal causes compared to their counterparts who were aged 15-19. Women of reproductive age who were 30-34 years had increased relative risk of dying from infectious than maternal causes by more than five times (RRR=5.33; $p<0.05$) compared to WRA who were 15-19 years. Similarly, the WRA who were 35-39 years had increased relative risk of dying from infectious than maternal causes by more than seven times (RRR=7.61; $p<0.01$) compared to those who were 15-19 years. In addition, WRA who were 40-44 years had increased relative risk of dying from infectious than maternal causes by about thirteen times (RRR=13.58; $p<0.01$) relative to those who were 15-19 years. Yet still, WRA who were 45-49 years had increased relative risk of dying from infectious than maternal causes by more than twenty times (RRR=20.60; $p<0.01$) compared to WRA who were 15-19 years. It is observed that the RRR increases in magnitude with increasing age.

A similar pattern is observed when WRA who died from non-communicable causes is compared to those who died from maternal causes. The results of the RRR for non-communicable and maternal causes of death indicated that WRA aged 30 to 49 years were significantly more likely to die from non-communicable causes than maternal causes compared to those aged 15-19 years. Compared to WRA who were 15-19 years, those who were 30-34 years had increased relative risk of dying from non-communicable than maternal causes by more than four times (RRR=4.49; $p<0.05$). In addition, relative to WRA who were 15-19 years, those who were 35-39 years had increased relative risk of dying from non-communicable than maternal causes by more than seven times (RRR=7.39; $p<0.01$). Furthermore, compared to WRA who were 15-19 years, those who were 40-44 years had increased relative risk of dying from non-communicable than maternal causes by more than

eleven times (RRR=11.27; p<0.01). Moreover, relative to deceased WRA who were 15-19 years, those who were 45-49 years had increased relative risk of dying from non-communicable than maternal causes by over nineteen times (RRR=19.95; p<0.01). It is observed that the RRR increases in magnitude with increasing age as noticed with infectious versus maternal causes of death. However, the magnitude of the RRR is generally lower compared to that of the infectious versus maternal causes of death. This means that compared with dying from maternal causes, the relative risks of dying from infectious causes are higher than dying from NCD causes.

Another distal factor, parity of WRA at the time of death was observed to significantly influence the causes of death. Compared to WRA who had no child, those who had between 1 to 3 children at the time of death were more than twice (RRR=2.46; p<0.05) likely to die from infectious than maternal causes of death. However, for those who have had more than four children, there was no such relationship. Furthermore, parity had no significant effect when non-communicable causes were compared to maternal causes of death.

Marital status was also found to be a significant predictor of cause of death among the women of reproductive age. Compared to deceased WRA who were single, those who had ever been married (RRR=0.12; p<0.001) had 88 percent reduced risk of dying from infectious than maternal causes of death. This means that WRA who were ever married were significantly less likely to die from infectious than maternal causes compared to those who were never married. Similarly, WRA who were married (RRR=0.12; p<0.001) showed 88 percent reduced risk of dying from non-communicable than maternal causes. This also means that WRA who were ever married were significantly less likely to have died from non-communicable than maternal causes relative to those who were single. This finding is expected since more pregnancies occur within marriages and the never-married are expected

to die less from maternal compared to other causes of death. Coincidently, the RRR, p-value and standard error for infectious versus maternal and that for non-communicable and maternal were the same. This means that the influence of marital status on the causes of death is the same.

Furthermore, migration status was observed to significantly influence the causes of death. WRA who were migrants had reduced relative risk of dying from infectious than maternal causes by 57 percent (RRR=0.43; $p<0.05$) compared to non-migrants. However, migration status did not have significant effect when non-communicable causes were compared to maternal causes of death.

Moreover, district of residence emerged as a significant determinant of causes of death. Compared to living in Kintampo North Municipal, living in Kintampo South District reduced the relative risk of dying from infectious than maternal causes by 70 percent (RRR=0.30; $p<0.01$). However, district of residence had no significant effect when non-communicable causes were compared to maternal causes of death.

The season of death also appeared as a significant determinant of causes of death. Compared to WRA who died in the rainy season, those who died in the dry season had increased risk of dying from infectious than maternal causes by about two times (RRR=2.04; $p<0.05$). Thus, WRA who died in the dry season were significantly more likely to die from infectious than maternal causes. In contrast, season had no significant effect when non-communicable causes were compared to maternal causes of death.

In addition, the year of death was found to be a significant predictor of cause of death among the women of reproductive age. WRA who died in 2008 had reduced risk of dying from NCD than maternal causes by 72 percent (RRR=0.28; $p<0.05$) compared to those who died in 2005. However, the year of death had no significant effect when infectious causes were compared to maternal causes of death.

Finally, the results from Model 1 showed that place of death significantly affected the causes of death. The results indicated that dying in a health facility reduced the risk of dying from infectious than maternal causes by 76 percent (RRR=0.24; p<0.001) compared to those who died at other places. Similarly, WRA who died in health facilities had relatively lower risks of dying from NCD than maternal causes by 75 percent (RRR=0.25; p<0.001) compared to those who died in other places. This means that relative to WRA who died in other places, those who died in health facilities were significantly less likely to die from infectious or NCD than maternal causes. This observation may be as a result of the introduction of the free maternal care intervention as explained in Section 4.3.

6.3 Factors influencing causes of death in the study area (Model 2)

Table 6.2 presents the results of Model 2. It shows the relationship between socio-demographic, environmental, behavioural factors (distal and intermediate factors) and maternal, infectious and non-communicable causes of death from 2005 to 2014 in the study area. Model 2 explains about 12 percent of the variations with 846 observations and log likelihood of -647.5523. The change of the R^2 from about 11 percent to about 12 percent means that addition of the intermediate factors only accounted for about one percent of the variance in the causes of death. With respect to Model 2, it is assumed that only distal and intermediate factors, namely age at death, parity, marital status, highest educational level attained, place of residence, district of residence, religion, employment status, migration status, land ownership, place of death, season of death, year of death, distance from household to health facility, household socio-economic status, source of drinking water, toilet facility type, alcohol and tobacco use affect maternal, infectious and non-communicable causes of death. The Wald $\chi 2$ (prob>chi2) of the model is significant at 99% confidence interval, indicating that the model is a good fit.

Table 6.2: Multinomial logistic regression for the relationship between socio-demographic, environmental, behavioural factors and causes of maternal, infectious and non-communicable deaths from 2005 to 2014 in the study area (Model 2)

Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Age at death		
15-19 (ref)	1.00	1.00
20-24	1.76 (1.05)	1.88 (1.17)
25-29	2.27 (1.37)	1.73 (1.10)
30-34	5.02* (3.32)	4.51* (3.12)
35-39	7.02** (4.98)	6.95** (5.11)
40-44	11.96** (9.61)	10.46** (8.71)
45-49	16.30** (15.56)	17.72** (17.76)
Parity		
0 (ref)	1.00	1.00
1-3	2.35* (0.94)	1.51 (0.63)
4+	1.91 (0.92)	2.13 (1.07)
Marital status		
Never-married (ref)	1.00	1.00
Ever-married	0.12*** (0.07)	0.12*** (0.07)
Highest educational level attained		
No Education (ref)	1.00	1.00
Primary	1.02 (0.47)	1.40 (0.67)
Middle/JHS+	0.70 (0.30)	0.79 (0.35)
Migration status		
Non-migrant (ref)	1.00	1.00
Migrant	0.45* (0.18)	0.49 (0.20)
Religion		
Christianity (ref)	1.00	1.00
Muslim	0.79 (0.31)	0.66 (0.27)
Other	0.68 (0.29)	0.63 (0.28)

Model 2 CONTINUATION Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Employment status		
Unemployed (ref)	1.00	1.00
Employed	0.86 (0.29)	0.66 (0.23)
Land ownership		
No (ref)	1.00	1.00
Yes	0.89 (0.37)	0.78 (0.33)
Place of residence		
Rural	1.00	1.00
Urban	0.63 (0.28)	0.98 (0.45)
District of residence		
North (ref)	1.00	1.00
South	0.32** (0.11)	0.47* (0.17)
Season of death		
Wet (ref)	1.00	1.00
Dry	2.02* (0.59)	1.78 (0.55)
Year		
2005 (ref)	1.00	1.00
2006	1.32 (0.75)	1.26 (0.74)
2007	1.98 (1.21)	0.77 (0.50)
2008	0.56 (0.32)	0.31 (0.19)
2009	1.52 (0.95)	0.97 (0.63)
2010	2.01 (1.19)	0.82 (0.51)
2011	3.53 (2,44)	1.08 (0.79)
2012	3.76 (2.60)	1.88 (1.35)
2013	3.49 (2.41)	2.66 (1.89)
2014	6.32 (7.17)	3.15 (3.64)
Distance to facility		
<5km	1.00	1.00
5km+	0.69 (0.23)	0.64 (0.22)
Place of death		
Other (ref)	1.00	1.00
Health facility	0.24*** (0.08)	0.25*** (0.08)

Model 2 CONTINUATION Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Household socio-economic status		
Most Poor	1.00	1.00
Poor	0.84 (0.31)	1.40 (0.55)
Least Poor	0.86 (0.35)	1.25 (0.54)
Source of drinking water		
Improved	1.00	1.00
Unimproved	0.58 (0.18)	0.74 (0.24)
Type of toilet facility		
Improved	1.00	1.00
Unimproved	0.83 (0.33)	1.22 (0.51)
Substance use		
Yes	1.00	1.00
No	3.71 (2.89)	2.41 (1.93)
Log likelihood = -647.5523 Pseudo R2 = 0.1241 Prob > chi2 <0.001		**Number of observations = 846**

***** p<0.001; ** p<0.01; *p<0.05** **Source: Kintampo HDSS (2005-2014)**

Similar to the observation in Model 1, the results from Model 2 also showed that the age at death of WRA significantly correlated with the causes of death (maternal, infectious and non-communicable). Again, similar to the results of Model 1, the relative risk ratio (RRR) for infectious and maternal causes of death showed that WRA who were within the age group 30-49 years were significantly more likely to die from infectious causes than maternal causes of death relative to those who were aged 15-19-years. Although, the p-values remained unchanged, the magnitude of the RRR reduced. This means that although age continued to maintain its significant influence on the causes of death, addition of the intermediate variables slightly diminished its effects on the causes of death.

Women of reproductive age who were 30-34 years had increased relative risk of dying from infectious than maternal causes by more than five times (RRR=5.02; p<0.05) compared to WRA who were 15-19 years. Similarly, WRA who were 35-39 years had increased relative risk of dying from infectious than maternal causes by more than seven times (RRR=7.02; p<0.01) compared to those who were 15-19 years. Also, WRA who were 40-44 years had increased relative risk of dying from infectious than maternal causes by more than eleven times (RRR=11.96; p<0.01) relative to WRA who were 15-19 years. Furthermore, WRA who were 45-49 years had increased relative risk of dying from infectious than maternal causes by more than sixteen times (RRR=16.30; p<0.01) compared to WRA who were 15-19 years. It is observed again that the RRR increases with increasing age although the level of the magnitude of the RRR is lower across the age groups compared to the Model 1.

A similar pattern is observed when WRA who died from non-communicable causes were compared to those who died from maternal causes. The results of the RRR for non-communicable and maternal causes of death indicated that WRA 30-49 were significantly more likely to die from non-communicable causes than maternal causes of death compared to those aged 15-19. WRA who were 30-34 years (RRR=4.51; p<0.05) were more than four times as likely as those who were 15-19 years to die from non-communicable than maternal causes. Also, those who were 35-39 years (RRR=6.95; p<0.01) were more than six times as likely as their counterparts who were 15-19 to die from non-communicable than maternal causes. Also, those who were 40-44 years (RRR=10.46; p<0.01) were more than ten times as likely as WRA (15-19) to die from non-communicable than maternal causes. Moreover, those who were 45-49 years (RRR=17.72; p<0.01) were more than seventeen times as likely as WRA (15-19) to die from non-communicable than maternal causes. As observed in Model 1, it is noticed that the RRR increases in magnitude with increasing age as noticed with

infectious versus maternal causes of death. However, the RRR, apart from that for age group 45-49, is lower compared to that of the infectious versus maternal causes of death.

Parity of the deceased WRA at the time of death also continued to have significant influence on the causes of death after introducing the intermediate variables. Nevertheless, the p-values and the magnitude of the RRR reduced in Model 2 as in the case of the age at death variable. This also means that although parity continued to maintain its significant effect on the causes of death, adding the intermediate variables diminished its effects on the causes of death. WRA who had between one to three children at the time of death were more than twice (RRR=2.35; $p<0.05$) as likely as those who had no child to die from infectious than maternal causes of death. However, for those who had more than four children, there was no such relationship. Again, parity had no significant effect when non-communicable causes were compared to maternal causes of death. It is observed that the p-values remained at the same level but the magnitude of the RRR decreased slightly. This means that the variable, parity maintained its significance on the causes of death after adding the intermediate variables but its effects on the causes of death slightly depreciated.

Marital status continued to be a significant predictor of causes of death among the women of reproductive age after introducing the intermediate variables. Unlike age at death and parity, the p-values and the magnitude of the RRR for marital status remained the same in Model 2 as in Model 1. This means that marital status continued to maintain the same importance as a significant determinant of the causes of death after introducing the intermediate variables. Compared to WRA who were single, those who had ever been married (RRR=0.12; $p<0.001$) had 88 percent reduced risk of dying from infectious than maternal causes of death. Similarly, WRA who were married (RRR=0.12; $p<0.001$) showed 88 percent reduced risk of dying from non-communicable than maternal causes. This means

that WRA who were ever married were significantly less likely to die from infectious or non-communicable than maternal causes relative to those who were single.

Furthermore, migration status maintained the level of significance in Model 2 as it was in Model 1. But the magnitude of the RRR slightly increased. This means that migration status maintained its significant influence on the causes of death but its effect on the causes of death slightly reduced. WRA who were migrants had reduced relative risk of dying from infectious than maternal causes by 55 percent (RRR=0.45; $p<0.05$) but migration status did not have significant effect when non-communicable causes were compared to maternal causes of death.

Moreover, similar to the behaviour of the migration status variable in Model 2, where the p-value remained unchanged but the magnitude of the RRR increased, district of residence maintained its significant influence on the causes of death in the second model as it was in the first one but its effect on the causes of death slightly increased. WRA who lived in Kintampo South District were 0.32 times (RRR=0.32; $p<0.01$) as likely as those in the Kintampo North to die from infectious than maternal causes. Similarly, WRA who lived in Kintampo South District were 0.47 times (RRR=0.47; $p<0.05$) as likely as those in the Kintampo North to die from NCD than maternal causes.

In the case of season of death, although the p-value was the same in Model 2 as it was in Model1, the magnitude of the RRR slightly reduced, which is different from what was observed for either marital status (unchanged) or district of residence (increased). This means that although, season of death maintained its significant influence on the causes of death in the second model, its effect on the causes of death slightly reduced. WRA who died in the rainy season were more than twice (RRR=2.02; $p<0.05$) as likely as those who died in the dry season to die from infectious than maternal causes. This means that WRA who died in the dry season were significantly more likely to die from infectious than maternal causes.

Alternatively, this means that WRA who died in the rainy season were significantly more likely to die from maternal than infectious causes. On the other hand, season had no significant effect when non-communicable causes were compared to maternal causes of death.

In addition, the results from Model 2 showed that place of death continued to be a significant determinant of the causes of death. The p-values and the magnitude of the RRR for place of death remained the same in Model 2 as was observed in the case of the marital status. The results showed that dying in a health facility reduced the risk of dying from infectious than maternal causes by 76 percent (RRR=0.24; $p<0.001$). This means that WRA who died in health facilities were significantly less likely to die from infectious than maternal causes. Similarly, WRA who died in health facilities had reduced risk of dying from NCD than maternal causes by 75 percent (RRR=0.25; $p<0.001$) compared to those who died in other places, which is the same as observed in Model 1. The reason for this result may be the free maternal care intervention as discussed in Section 4.3.

Finally, none of the intermediate variables showed any significant difference in the Model 2 when they were introduced. This observation probably suggests that the effect of the distal factors on the causes of death do not operate through the intermediate variables. Therefore, there is the need for future studies to expand the scope of the intermediate variables.

6.4 Factors influencing causes of death in the study area (Model 3)

Table 6.3 presents the results of Model 3. It shows the relationship between socio-demographic, environmental, behavioural, health-related factors (distal, intermediate and proximate factors) and maternal, infectious and non-communicable causes of death from 2005 to 2014 in the study area. Model 3 explains about 15 percent of the variations with 846

observations and log likelihood of -626.28364. The change of the R^2 from about 12 percent to about 15 percent means that addition of the proximate factors accounts for about three percent of the variance in the causes of death. Model 3 is the adjusted model where all the factors are controlled for. Therefore, it is assumed that distal, intermediate and proximate factors, namely age at death, parity, marital status, highest educational level attained, place of residence, district of residence, religion, employment status, migration status, land ownership, place of death, season of death, year of death, distance from household to health facility, household socio-economic status, source of drinking water, toilet facility type, alcohol-tobacco use, admission in the last 12 months before death, surgical operation in the last 24 months, whether death was sudden or not affect maternal, infectious and non-communicable causes of death. The Wald $\chi 2$ (prob>chi2) of the model is significant at 99% confidence interval indicating that the model is a good fit.

Table 6.3: Multinomial logistic regression for the relationship between socio-demographic, environmental, behavioural, health-related factors and causes of maternal, infectious and non-communicable deaths from 2005 to 2014 in the study area (Model 3)

Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Age at death		
15-19 (ref)	1.00	1.00
20-24	1.78 (1.12)	1.78 (1.15)
25-29	2.02 (1.30)	1.49 (1.00)
30-34	3.77 (2.64)	3.43 (2.49)
35-39	6.77* (5.12)	6.80* (5.29)
40-44	10.05** (8.60)	9.05* (7.96)
45-49	9.80* (9.75)	11.12* (11.32)
Parity		
0 (ref)	1.00	1.00
1-3	2.36 (1.04)	1.59 (0.73)
4+	1.78 (0.93)	2.04 (1.10)
Marital status		
Never-married (ref)	1.00	1.00
Ever-married	0.12*** (0.07)	0.12*** (0.07)
Highest educational level attained		
No Education (ref)	1.00	1.00
Primary	1.21 (0.59)	1.74 (0.87)
Middle/JHS+	0.78 (0.35)	0.88 (0.41)
Migration status		
Non-migrant (ref)	1.00	1.00
Migrant	0.45 (0.19)	0.48 (0.20)
Religion		
Christianity (ref)	1.00	1.00
Muslim	0.70 (0.29)	0.59 (0.26)
Other	0.61 (0.28)	0.55 (0.26)

Model 3 CONTINUATION Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Employment status		
Unemployed (ref)	1.00	1.00
Employed	0.80 (0.29)	0.61 (0.23)
Land ownership		
No (ref)	1.00	1.00
Yes	3.50* (2.11)	2.45 (1.51)
Place of residence		
Rural	1.00	1.00
Urban	0.69 (0.33)	1.05 (0.51)
District of residence		
North (ref)	1.00	1.00
South	0.35** (0.13)	0.51 (0.20)
Season of death		
Wet (ref)	1.00	1.00
Dry	2.26** (0.71)	2.02* (0.65)
Year		
2005 (ref)	1.00	1.00
2006	1.52 (0.89)	1.40 (0.84)
2007	1.72 (1.17)	0.83 (0.59)
2008	0.35* (0.22)	0.24* (0.16)
2009	1.06 (0.71)	0.80 (0.56)
2010	1.55 (1.01)	0.74 (0.51)
2011	2.77 (2.06)	0.96 (0.74)
2012	3.17 (2.38)	1.74 (1.34)
2013	2.71 (2.01)	2.23 (1.69)
2014	3.39 (3.94)	1.87 (2.21)
Distance to facility		
<5km	1.00	1.00
5km+	0.74 (0.26)	0.68 (0.25)
Place of death		
Other (ref)	1.00	1.00
Health facility	0.32** (0.11)	0.31** (0.11)

Model 3 CONTINUATION Determinants of causes of death	Infectious causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)	NCD causes of death Vs. Maternal causes of death Relative Risk Ratio (RRR) (Standard Error)
Household socio-economic status		
Most Poor	1.00	1.00
Poor	0.91 (0.35)	1.52 (0.62)
Least Poor	0.89 (0.37)	1.34 (0.59)
Source of drinking water		
Improved	1.00	1.00
Unimproved	0.57 (0.18)	0.74 (0.25)
Type of toilet facility		
Improved	1.00	1.00
Unimproved	0.90 (0.39)	1.32 (0.59)
Admission in last 12 months before death		
No (ref)	1.00	1.00
Yes	3.97** (1.85)	4.48 (2.12)
Surgical operation in last 24 months before death		
No (ref)	1.00	1.00
Yes	0.14*** (0.07)	0.28 (0.14)
Sudden death		
No (ref)	1.00	1.00
Yes	0.32** (0.14)	0.42 (0.19)
Log likelihood = -626.28364 Pseudo R2 = 0.1529 Prob > chi2 <0.001 Number of observations = 846		

***** p<0.001; ** p<0.01; *p<0.05** **Source: Kintampo HDSS (2005-2014)**

From Model 3, it is observed that the age at death of WRA continued to have significant influence on the causes of death (maternal, infectious and non-communicable). However, the age category, 30-34 that was significant in both Models 1 and 2 was no longer significant in Model 3. This means that once the proximate factors are introduced, the risk of dying from infectious relative to maternal causes for women aged 30-34 is not significantly different from those aged 15-19. In addition, the significance levels for age groups 35-39 and 45-49 dropped from p-value < 0.01 to < 0.05 for infectious versus maternal causes of death,

and for age groups 35-39, 40-44 and 45-49 for NCD versus maternal causes of death. This means that the effect of age is diminished once proximate factors are introduced.

Furthermore, the magnitude of the relative risk ratio increased with age across the age categories as was observed in Models 1 and 2, but in Model 3, the magnitude of the RRR for age group 45-49 was lower than the preceding age group 40-44 in the case of infectious versus maternal causes of death. This means that though age is still significant, its effect as observed initially is diminished once proximate factors are accounted for. Therefore, part of the initial strength of age was due to proximate factors. Thus, provision of health services such as admission and surgical operation facilities as proximate factors diminishes the age difference in cause of death.

The results showed that women of reproductive age who were 35-39 years had increased relative risk of dying from infectious than maternal causes by more than six times (RRR=6.77; $p<0.05$) compared to those who were 15-19 years. Similarly, WRA who were 40-44 years had increased relative risk of dying from infectious than maternal causes more than ten times (RRR=10.05; $p<0.01$) compared to those who were 15-19 years. Also, WRA who were 45-49 years had increased relative risk of dying from infectious than maternal causes by about nine times (RRR=9.980; $p<0.05$) relative to those who were 15-19 years.

Similarly, for NCD versus maternal causes, the results showed that WRA who were 35-39 years (RRR=6.80; $p<0.05$) were more than six times as likely as those who were 15-19 to die from non-communicable than maternal causes. Furthermore, those who were 40-44 years (RRR=9.05; $p<0.05$) were more than nine times as likely as those 15-19 to die from non-communicable than maternal causes. Moreover, those who were 45-49 years (RRR=11.12; $p<0.05$) were more than eleven times as likely as WRA (15-19) to die from non-communicable than maternal causes.

After the introduction of the proximate factors, parity and migration status that had been significant in Models 1 and 2 ceased to be significant in Model 3. However, land ownership that was not significant in neither of the first two models appeared significant in Model 3. This means that parity and migration status lost their significant effect on the causes of death after adding the proximate factors whilst land ownership gained significance on the causes of death after introducing the proximate factors. From Table 6.3, WRA who owned land at the time of death were three and a half times (RRR=3.50; $p<0.05$) as likely as those who did not own any land to die from infectious than maternal causes of death. Land in the study area is mainly used for agricultural purposes. Therefore, women who own land are probably engaged in agricultural activities which are seasonal and financially unstable. This means lower income for WRA who own land while some of those who do not own land are probably engaged in other occupations that are more stable and generate better incomes. However, land ownership had no significant effect when non-communicable causes were compared to maternal causes of death.

Marital status still continued to be a significant predictor of cause of death among the women of reproductive age after introducing the proximate factors. Unlike other variables, the p-values and the magnitude of the RRR for marital status remained the same in all three models. This means that marital status maintained the same importance as significant determinant of the causes of death after introducing the proximate factors. From the results of Table 6.3, it is again observed that compared to WRA who were never-married, those who were ever-married (RRR=0.12; $p<0.001$) still had 88 percent reduced risk of dying from infectious than maternal causes of death. This means that WRA who were ever-married were significantly less likely to die from infectious than maternal causes compared to those who were never-married. Similarly, WRA who were married (RRR=0.12; $p<0.001$) still showed 88 percent reduced risk of dying from non-communicable than maternal causes. This also

means that WRA who were ever-married were significantly less likely to die from non-communicable than maternal causes relative to those who were never married at the time of death.

Furthermore, district of residence maintained its significant influence on the causes of death in the final model as it was in the first two models but its effect on the causes of death slightly increased further in Model 3. This suggests that the effect of district of residence is fairly stable even after accounting for the proximate factors. From Table 6.3, WRA who lived in Kintampo South District were 0.35 times (RRR=0.35; $p<0.01$) as likely as those who lived in the Kintampo North to die from infectious than maternal causes. However, unlike in Models 1 and 2 where district of residence had significant effect when non-communicable causes were compared to maternal causes of death, in Model 3, district of residence had no significant effect when non-communicable causes were compared to maternal causes of death. This means that it did not matter in which district WRA lived in the study area when proximate factors are accounted for in the model.

With respect to the season of death variable, the significance level improved from p-value of < 0.05 to < 0.01 for infectious versus maternal causes of death. Furthermore, the magnitude of the RRR also increased. In addition, although season was not significant for the NCD versus maternal causes of death in both Models 1 and 2, it became significant after the introduction of the proximate variables in Model 3. This means that season of death increased its significant influence on the causes of death in the final model when the proximate factors were added. From the final or adjusted model, WRA who died in the dry season were more than twice (RRR=2.26; $p<0.01$) as likely as those who died in the rainy season to die from infectious than maternal causes. This is unexpected as explained elsewhere in the present study, (Section 4.3). However, the result also means that WRA who died in the rainy season were significantly more likely to die from maternal than infectious. Therefore, challenges

with access to maternal services during the rainy season may partly explain this result. In addition, it could partly be because infections in the rainy season linger on in the dry season.

Similarly, WRA who died in the dry season (RRR=2.02; p<0.05) were more than twice likely to die from non-communicable than maternal causes compared to those who died in the rainy season. This means that WRA who died in the dry season were significantly more likely to die from NCD than maternal causes. This means that WRA who died in the dry season were significantly more likely to die from infectious or NCD than maternal causes. Alternatively, this means that WRA who died in the rainy season were significantly more likely to die from maternal than infectious or NCD causes. This finding may be because of challenges with access to maternal services as explained above.

Year of death significantly predicted the causes of death in Model 1 but not Model 2. However, in Model 3, it appeared again as a significant predictor of the causes of death. The introduction of the proximate factors made it to recover its significance. From the results, WRA who died in 2008 had reduced risk of dying from infectious than maternal causes by 65 percent (RRR=0.35; p<0.05) compared to those who died in 2005. Similarly, for NCD versus maternal, the results showed that WRA who died in 2008 (RRR=0.24; p<0.05) showed 76 percent reduced risk of dying from non-communicable than maternal causes. In Model 1, it was only NCD versus maternal that showed significant effect. This means that the year of death also matters for the infections versus maternal deaths once the proximate factors are accounted for.

The results from Model 3 showed that place of death continued to significantly influence the causes of death. With respect to the place of death, it was observed that the significance level reduced from P-value < 0.001 in Models 1 and 2 to < 0.01 in Model 3. The results indicated that dying in a health facility reduced the risk of dying from infectious than maternal causes by 68 percent (RRR=0.32; p<0.01). Similarly, WRA who died in health

facilities had reduced risk of dying from NCD than maternal causes by 69 percent (RRR=0.31; p<0.01) compared to those who died in other places. This means that compared to WRA who died in other places, those who died in health facilities were significantly less likely to have died from infectious or NCD than maternal causes. As explained elsewhere (Section 4.3), this finding may probably be the effect of the free maternal care intervention introduced in Ghana in 2005, and as a result, more WRA are relatively using health services for maternal care compared to other conditions.

All three variables measured under the proximate factors significantly correlated with the causes of death only for infectious versus maternal causes of death but not for NCD versus maternal causes of death. One of such variables is whether the WRA was admitted in the last 12 months before dying. From the results, WRA who were admitted in the last 12 months before dying (RRR=3.97; p<0.01) were more than three times likely to die from infectious than maternal causes compared to those who were not admitted. However, hospital admission in the last 12 months before death had no significant effect when NCD were compared to maternal causes of death. This is expected given that, for example, infectious causes increase the risk of hospital admission relative to maternal compared to NCDs relative to maternal.

Another significant proximate determinant of causes of death was whether the deceased WRA had surgical operation or not. From the results, WRA who had surgical operation 24 months before dying (RRR=0.14; p<0.001) had 86 percent reduced relative risks of dying from infectious than maternal causes compared to those who did not have surgical operation 24 months before dying. This means that women who had surgical operations 24 months prior to death were more likely to die from maternal causes than infectious causes. This is expected, given that surgical operations usually characterise delivery and abortions.

However, surgical operation 24 months before dying did not have a significant effect on NCD and maternal causes of death.

Finally, the other significant health-related factor on causes of death was whether the deceased WRA died suddenly or not. From the results, WRA who died suddenly had reduced relative risks of dying from infectious than maternal causes by about 68 percent (RRR=0.32; $p<0.01$). This means that compared to WRA who did not die suddenly, those who died suddenly were significantly less likely to have died from infectious than maternal causes of death. This is expected because maternal deaths are more sudden given that the women do not die from a prolonged illness. It is usually during delivery or surgical operations that they die which is unexpected, untimely and sudden. However, sudden death did not have a significant effect on NCD and maternal causes of death.

6.5 Discussion

The findings of the multinomial logistic regression analyses showed the determinants of maternal, infectious and non-communicable causes of death among women of reproductive age in the Kintampo HDSS area from 2005 to 2014. All the significant bivariate variables, apart from source of drinking water and alcohol use, were also significant at the multivariate level. Therefore, Infectious causes of deaths differed from the maternal causes of deaths by both distal and proximate factors whilst non-communicable causes of death differed from maternal causes by only distal factors as per the theoretical framework of the present study.

The results of all the three models indicated that age is an important determinant of cause of death. Although the literature for both Global North and South is replete with the observation that mortality, generally, positively correlates with age for various causes of death, this present study specifically found that older women are more likely to die of infectious or NCD causes than maternal causes when compared with younger women. A

recent study in Ghana that reviewed a five-year autopsy cases by examining age and sex patterns of CVD mortality at Korle-Bu Teaching Hospital (KBTH) in Accra, observed that the proportionate mortality ratio of CVD increased with age (Sanuade et al., 2014). This finding corroborates the result of the present study.

Furthermore, several studies conducted in Africa and Asia including Ethiopia, Tanzania, Bangladesh and Nepal identified that maternal cause of death is significantly more dangerous in older women compared to their younger counterparts (Evjen-Olsen et al., 2008; Gidey et al., 2013; Jahromi & Husseini, 2008; Kang et al., 2010; A. R. Khan et al., 1986). Studies in the Global North, including the UK and USA, have shown that older women were at higher risk of maternal causes of death compared to their younger counterparts (Al-Zirqi et al., 2008; de Vienne et al., 2009).

The present study found that marital status maintained its importance as a predictor of causes of death among the WRA consistently in all the three models at 99.9 percent confidence level. It was observed in the present study that ever been in union women were significantly less likely to have died from infectious and non-communicable than maternal causes relative to those who were never-married. This means that ever been in union women were at a higher risk of dying from maternal mortality. This finding is consistent with that of Asamoah et al. (2011). The authors reported that married women died mostly (93.7%) from maternal causes of death. This observation may be because, in the Ghanaian and other sub-Saharan African setting, often, a greater proportion of married women are likely to get pregnant or experience childbirth.

Conversely, Illah et al. (2013) used HDSS data from Rufiji, a rural setting in Tanzania and reported that WRA who were ever-married were 62 percent less likely to die from maternal mortality compared to WRA who were never married (HR=0.38, 95% CI=0.176-0.839). The authors further observed that the relationship continued to be significant even

after adjusting for maternal age (Illah et al., 2013). In addition, a case-controlled study using health facility data from a hospital in Dakar, Senegal, reported that women who were never-married were one and half times more likely to die from maternal causes relative to women who had ever been married (Garenne et al., 1997). This reported protection for married persons may be partly due to the social, psychological and other support systems that those in union may benefit from. It may also be probably because those in union are less exposed to unwanted pregnancies that are likely to end in abortion. Less abortion will mean less maternal mortality since abortion is one of the leading causes of maternal deaths in Ghana (Adjei et al., 2015).

The results of the present study showed that season of death was a significant predictor in all three models and even improved from 95 to 99 percent significant level at the adjusted level. WRA who died in the dry season were significantly more likely to have died from infectious causes than maternal causes of death. This probably suggests that the rainy season increases the risk of dying from maternal causes due possibly to the limited access to maternal health services in such a season. This finding from the present study is consistent with the observation by Etard, Kodio, and Ronsmans (2003) in Burkina Faso. They also found greater number of deaths from obstetric causes in the rainy season (Etard et al., 2003). Perhaps, it is difficult to reach the health facility or for the health officers to reach the community during the rainy season. On the contrary, Hounton et al. (2008) reported greater maternal deaths in the dry season in Senegal. However, a study in the current study area by Dery et al. (2010) observed that malaria transmission, which was the highest cause of death in the present study, occurred all year round even though there are differences in inoculation rates during the rainy and dry seasons.

The findings of this study indicated that the district of residence is an important predictor of cause of death. It was found that WRA who resided in Kintampo South District

were significantly less likely to die from infectious than maternal causes compared to those who lived in the Kintampo North Municipal. This means that women who lived in the Kintampo South were at a greater risk of dying from maternal mortality. Several factors may explain this observation. One hypothesis is that Kintampo South is a relatively new district and thus relies on Kintampo North Municipal for social infrastructure including health. Another related hypothesis is the availability of both health equipment and personnel at the Kintampo North Municipal, which continues to serve as referral for the Kintampo South during emergencies including emergency obstetric care.

As earlier noted, all the three proximate factors related to health status namely hospital admission in the last 12 months before death, surgical operation in the last 24 months, and the nature of death, whether sudden or not, significantly predicted the causes of death under study only for infectious versus maternal causes of death. This means that the effect of the proximate factors is more pronounced for infectious causes relative to maternal than NCD relative to maternal. For example, the present study observed that WRA who were admitted in the last 12 months before dying were significantly more likely to have died from infectious than maternal causes of death. However, admission did not have a significant effect on NCD and maternal causes of death. This observation holds true for the remaining two proximate variables used in this present study.

At the adjusted level, infectious causes of death differed from the maternal causes of deaths in terms of age at death, marital status, land ownership, district of residence, year, season, place of death, admission in the last 12 months, surgical operation in the last 24 months and sudden death. On the other hand, non-communicable causes of death differed from maternal causes in terms of age at death, marital status, year, season, and place of death. Therefore, the determinants of maternal, infectious and non-communicable causes of death

are distal and proximate factors but not intermediate factors as used in this present study. However, there is the need to expand the scope of the intermediate variables in future studies.

This chapter examined the determinants of maternal, infectious and non-communicable causes of death in the Kintampo districts during the study period. The next chapter estimates the effects on life expectancy assuming these causes of death among the WRA were hypothetically eliminated separately.

CHAPTER SEVEN

EFFECTS OF SEPARATELY ELIMINATING MATERNAL, INFECTIOUS OR NON-COMMUNICABLE CAUSES OF DEATH ON LIFE EXPECTANCY

7.1 Introduction

This chapter presents multiple and associated single decrement life tables for maternal, infectious and non-communicable causes of death. The multiple and single decrement life tables are presented for all females in the Kintampo HDSS area from 2005 to 2014 for both infectious and non-communicable causes of death. Although the scope of this study is for WRA (15-49), this approach was adopted because infectious and non-communicable causes of death affect the general population. In contrast, for maternal causes of death, both multiple and associated single decrement life tables are restricted to WRA 15-49 years. In addition, the chapter shows separate graphs of the age pattern of the specific broad causes of death and the overall mortality as well as separate graphs comparing the estimated gain in life expectancy by age with and without the respective specific broad causes of death.

7.2 Effects of eliminating maternal causes of deaths

Table 7.1, shows multiple decrement life table for only the WRA population in the Kintampo districts from 2005 to 2014. As earlier mentioned, with respect to maternal mortality, reproductive-aged life expectancy (RALE) that estimates female life expectancy computed from age 15 to 49 years is used. According to the results, if no death happens from ages 15 to 49 years, then the average number of years lived between these ages is 28.7 for the female population in the Kintampo HDSS area from 2005 to 2014. According to the results, with a cohort of 100,000 WRA (15-49), it is estimated that 703 of them may eventually die of

maternal-related mortality by age 49, supposing that the mortality conditions of 2005-2014 between the ages 15-49 persist. This means that about 0.7 percent of WRA (15-49) may ultimately die of maternal-related causes by age 49.

Table 7.1: A multiple-decrement life table for WRA, Kintampo HDSS (2005 to 2014)

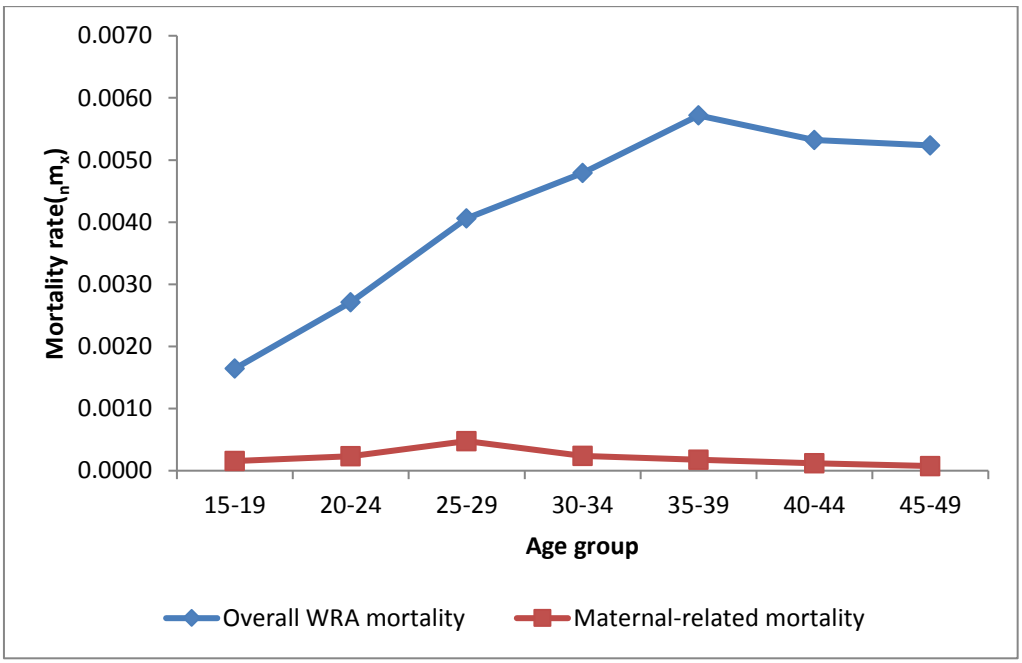
Age x	PYO	D^{All}	D^{MM}	${}_na_x$	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x	${}_nq_x^{MM}$	${}_nd_x^{MM}$	l_x^{MM}	${}_nm_x^{MM}$
15-19	70605	116	11	2.478	0.0016	0.0082	0.9918	100000	818	497937	2865517	28.7	0.0008	78	703	0.0002
20-24	60178	163	14	2.711	0.0027	0.0135	0.9865	99182	1335	492853	2367580	23.9	0.0012	115	626	0.0002
25-29	52484	213	25	2.605	0.0041	0.0201	0.9799	97847	1966	484525	1874727	19.2	0.0024	231	511	0.0005
30-34	46333	222	11	2.565	0.0048	0.0237	0.9763	95881	2271	473874	1390202	14.5	0.0012	113	280	0.0002
35-39	39707	227	7	2.534	0.0057	0.0282	0.9718	93610	2639	461544	916327	9.8	0.0009	81	168	0.0002
40-44	33456	178	4	2.470	0.0053	0.0262	0.9738	90971	2388	448816	454784	5.0	0.0006	54	86	0.0001
45-49	26742	140	2	2.606	0.0052	0.0259	0.9741	88584	2290	5968	5968	0.1	0.0004	33	33	0.0001
Total	329505	1259	74	-	-	-	-	-	-	-	-	-	-	703	-	-

Source: Kintampo HDSS (2005-2014)

Notes
PYO = Person years of observation.
MM_ = Maternal causes of death.
${}_na_x$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_nm_x$ = Mortality rate for people in age group x to x + n.
${}_nq_x$ = Probability of dying between ages x and x + n.
${}_np_x$ = Probability of surviving between ages x and x + n.
l_x = Number surviving at each age.
${}_nd_x$ = Number of deaths between ages x and x + n.
${}_nL_x$ = Person-years lived between ages x and x + n.
T_x = Person-years lived beyond age x.
e_x = Life expectancy at age x.

Figure 7.1 shows the age pattern of causes of death for overall WRA mortality and maternal-related mortality. The results depict that the age pattern of maternal-related mortality is not similar to that of all-cause mortality for WRA. The maternal-related mortality peaked at 25-29 and declined steadily after that while the overall mortality for WRA peaked at 35-39 and began a downward trend but remained stable from age 40 to 49. This suggests that other causes than maternal-related mortality are the major causes of death among the WRA in the study area and during the study period.

Figure 7.1: Age pattern of maternal causes for overall mortality and maternal causes-specific mortality



Source: Kintampo HDSS (2005-2014)

Table 7.2 shows the expected gains in reproductive-aged life expectancy if maternal-related mortality were hypothetically eliminated. The results indicate that the average number of years lived at age 15 increased from 28.7 to 33.1 years in the absence of maternal mortality, a probable gain of about 4.4 years.

Table 7.2: Associated single-decrement life table for causes of death other than maternal causes for Kintampo HDSS from 2005 to 2014

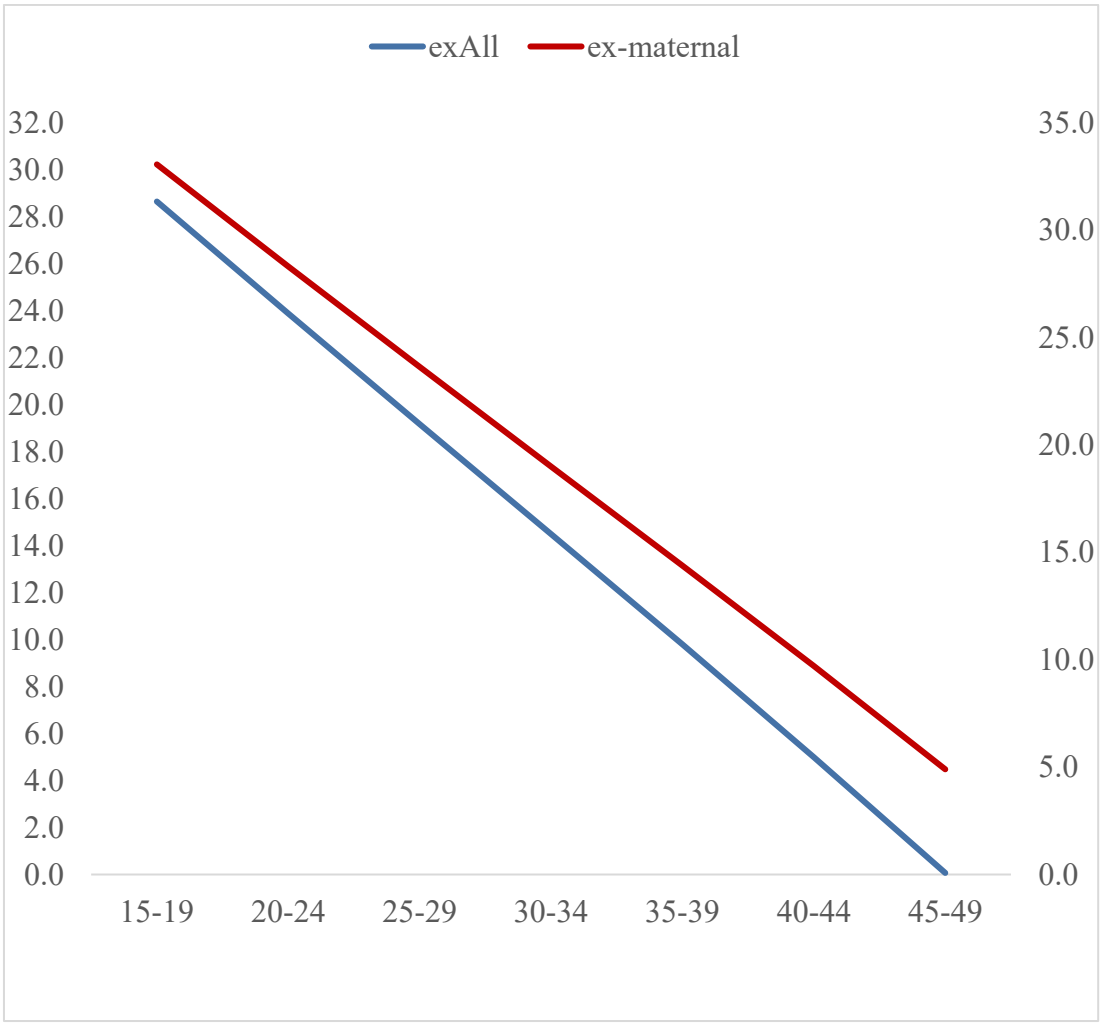
Age x	l_x	${}_np_x$	R^{-MM}	P^{-MM}	l_x^{-MM}	${}_nq_x^{-MM}$	${}_nd_x^{-MM}$	${}_nq_x/{}_nq_x^{-MM}$	${}_na_x^{-MM}$	${}_nm_x^{-MM}$	${}_nL_x^{-MM}$	T_x^{-MM}	e_x^{-MM}
15-19	100000	0.9918	0.9052	0.9926	100000	0.0074	741	1.1043	2.4969	0.0015	498146	3306877	33.1
20-24	99182	0.9865	0.9141	0.9877	99259	0.0123	1222	1.0933	2.6705	0.0025	493450	2808731	28.3
25-29	97847	0.9799	0.8826	0.9822	98037	0.0178	1741	1.1316	2.6133	0.0036	486031	2315282	23.6
30-34	95881	0.9763	0.9505	0.9775	96296	0.0225	2169	1.0515	2.5799	0.0046	476233	1829251	19.0
35-39	93610	0.9718	0.9692	0.9727	94128	0.0273	2573	1.0314	2.5147	0.0055	464244	1353018	14.4
40-44	90971	0.9738	0.9775	0.9743	91555	0.0257	2350	1.0227	2.4892	0.0052	451875	888774	9.7
45-49	88584	0.9741	0.9857	0.9745	89205	0.0255	2274	1.0143	0.9857	0.0052	436899	436899	4.9

Source: Kintampo HDSS (2005-2014)

Note:
MM = Maternal causes of death.
R^{-MM} = the proportion of deaths due to all causes other than maternal causes.
${}_na_x$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_nm_x$ = Mortality rate for people in age group x to x + n.
${}_nq_x$ = Probability of dying between ages x and x + n.
${}_np_x$ = Probability of surviving between ages x and x + n.
l_x = Number surviving at each age.
${}_nd_x$ = Number of deaths between ages x and x + n.
${}_nL_x$ = Person-years lived between ages x and x + n.
T_x = Person-years lived beyond age x.
e_x = Life expectancy at age x.

Figure 7.2 shows RALE at every age when all causes of death among WRA are put together and the corresponding RALE if maternal mortality were removed. The results represented in the figure indicate that at every age, RALE increased if maternal mortality were averted. As expected, the rise in life expectancy is relatively more evident at the older ages of life, where the force of mortality is higher than at other ages.

Figure 7.2: Comparison of estimated life expectancy for WRA with all cause of death and without maternal causes, Kintampo HDSS (2005-2014)



Source: Kintampo HDSS (2005-2014)

7.3 Effects of eliminating infectious causes of deaths

Table 7.3 shows a multiple decrement life table for the whole female population in the Kintampo HDSS area from 2005 to 2014. The infant mortality (${}_1m_0$) and child mortality rates (${}_4m_1$) are estimated at 0.044 and 0.006 respectively. The corresponding probabilities of dying before age 1 (${}_1q_0$) is 0.043 and from ages 1– 4 for newborn females who survive to age 1 (${}_4q_1$) is 0.025. These estimates result in a life expectancy at birth for the female population at 70.9 years under existing conditions in the Kintampo HDSS area from 2005 to 2014. However, with the general population for the same period, a life expectancy at birth of 66.8 years is recorded (Appendix I).

The age-specific mortality rate (ASMR) for 15-19 (${}_5m_{15}$) is estimated at 0.002 and the corresponding probability of dying between ages 15–19 for those who survive to age 15 (${}_5q_{15}$) is 0.008, resulting in a life expectancy at age 15 of 62 years for the female population in the Kintampo HDSS area from 2005 to 2014. Similarly, the ASMR for 45-49 (${}_5m_{45}$) is estimated at 0.005 and the corresponding probability of dying between ages 45-49 for those who survive to age 45 (${}_5q_{45}$) is 0.026, resulting in a life expectancy at age 45 of 37.7 years for the female population in the Kintampo districts between 2005 to 2014.

In order to estimate the effect of infectious-related mortality on total mortality, deaths due to infectious causes were isolated. This was achieved by using a multiple decrement life table to answer the question, "How many female newborns may eventually die from infectious-related mortality if the age-specific mortality conditions of 2005-2014 prevail?" With a cohort of 100,000 female newborns, it is expected that 36,107 of them may ultimately die of infectious-related mortality by age 85, supposing that the mortality conditions of 2005-2014 persist during their life span. This suggests that over 36 percent of all female newborns may ultimately die of infectious diseases by age 85.

In the case of WRA, starting at age 15 with a cohort of 91,841 WRA (15-49), it is estimated that 5,254 of them may eventually die of infectious-related mortality by the time they are 49 years old, if the age-specific mortality conditions of 2005-2014 persisted for the ages 15-49. This means that about 5.7 percent of WRA (15-49) may ultimately die of infectious diseases by the time they are 49 years old.

Table 7.3: A general and multiple-decrement life table for Kintampo HDSS female population (2005 to 2014)

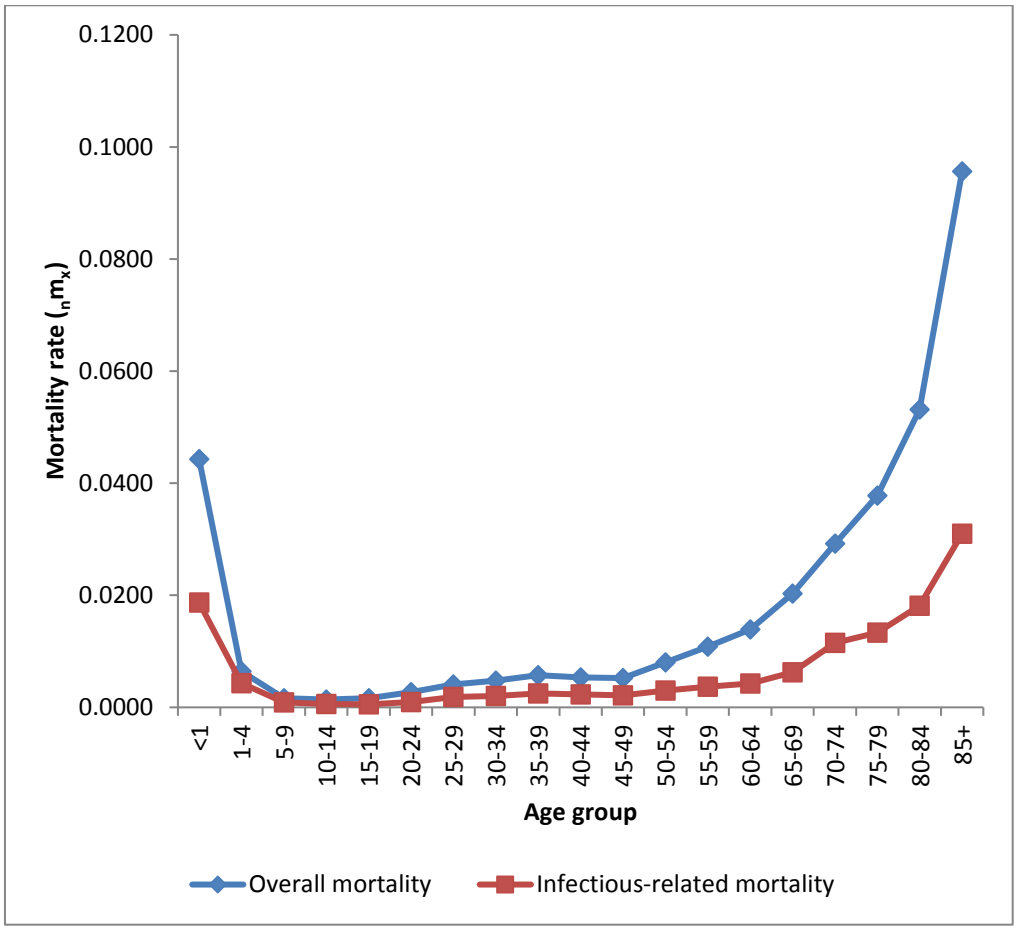
Age x	PYO	D^{All}	D^{CD}	${}_na_x$	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x	${}_nq_x^{CD}$	${}_nd_x^{CD}$	l_x^{CD}	${}_nm_x^{CD}$
<1	20618	913	386	0.498	0.0443	0.0433	0.9567	100000	4332	97826	7094403	70.9	0.0183	1831	36107	0.0187
1-4	79690	512	343	1.746	0.0064	0.0253	0.9747	95668	2424	377211	6996577	73.1	0.0170	1624	34276	0.0043
5-9	97717	159	87	2.497	0.0016	0.0081	0.9919	93245	756	464054	6619366	71.0	0.0044	413	32652	0.0009
10-14	88188	124	53	2.483	0.0014	0.0070	0.9930	92489	648	461067	6155312	66.6	0.0030	277	32239	0.0006
15-19	70605	116	38	2.478	0.0016	0.0082	0.9918	91841	751	458772	5694245	62.0	0.0027	246	31962	0.0005
20-24	60178	163	56	2.711	0.0027	0.0135	0.9865	91090	1226	454023	5235473	57.5	0.0046	421	31716	0.0009
25-29	52484	213	96	2.605	0.0041	0.0201	0.9799	89864	1806	445638	4781450	53.2	0.0091	814	31295	0.0018
30-34	46333	222	95	2.565	0.0048	0.0237	0.9763	88058	2085	436003	4335812	49.2	0.0101	892	30481	0.0021
35-39	39707	227	99	2.534	0.0057	0.0282	0.9718	85973	2423	423163	3899809	45.4	0.0123	1057	29588	0.0025
40-44	33456	178	77	2.470	0.0053	0.0262	0.9738	83549	2193	412261	3476646	41.6	0.0114	949	28532	0.0023
45-49	26742	140	58	2.606	0.0052	0.0259	0.9741	81356	2103	404639	3064385	37.7	0.0107	871	27583	0.0022
50-54	21160	170	63	2.680	0.0080	0.0394	0.9606	79253	3125	391180	2659746	33.6	0.0146	1158	26712	0.0030
55-59	15957	173	59	2.621	0.0108	0.0528	0.9472	76128	4023	373278	2268566	29.8	0.0180	1372	25553	0.0037
60-64	11914	166	51	2.623	0.0139	0.0674	0.9326	72105	4862	353445	1895288	26.3	0.0207	1494	24181	0.0043
65-69	8959	182	56	2.644	0.0203	0.0969	0.9031	67242	6518	325287	1541843	22.9	0.0298	2006	22688	0.0063
70-74	7053	206	81	2.613	0.0292	0.1365	0.8635	60725	8290	285929	1216556	20.0	0.0537	3260	20682	0.0115
75-79	4949	187	66	2.615	0.0378	0.1733	0.8267	52434	9086	241230	930627	17.7	0.0612	3207	17422	0.0133
80-84	3311	176	60	2.418	0.0532	0.2337	0.7663	43348	10130	342145	689397	15.9	0.0797	3453	14215	0.0181
85+	4098	392	127	5.300	0.0957	1.0000	0.0000	33218	33218	347253	347253	10.5	0.3240	10762	10762	0.0310
Total	693,119	4,619	1,951	-	-	-	-	-	-	-	-	-	-	36,107	-	-

Source: Kintampo HDSS (2005-2014)

Notes
PYO = Person years of observation.
CD = Communicable disease.
${}_nA_x$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_nm_x$ = Mortality rate for people in age group x to x + n.
${}_nq_x$ = Probability of dying between ages x and x + n.
${}_np_x$ = Probability of surviving between ages x and x + n.
l_x = Number surviving at each age.
${}_nd_x$ = Number of deaths between ages x and x + n.
${}_nL_x$ = Person-years lived between ages x and x + n.
T_x = Person-years lived beyond age x.
e_x = Life expectancy at age x.

Figure 7.3 shows the age pattern of infectious causes of death for overall mortality and infectious-related mortality. The results demonstrate that the age pattern of mortality for infectious-related mortality is similar to that for overall mortality except for the ages at which the rates increase for adult females. Mortality levels at both the younger and older ages are higher compared to the middle ages. Relatively, mortality rates are high before age 5 and after age 49 years for the overall mortality and after 69 years for the infectious-related mortality. However, generally, mortality rates are much higher after age 60 for both overall and infectious-related mortality. This suggests that the level of susceptibility to the causes of death, and to infectious-related mortality in particular, are increased considerably at both before age 5 and after age 69 years.

Figure 7.3: Age pattern of infectious diseases for overall mortality and infectious causes-specific mortality



Source: Kintampo HDSS (2005-2014)

Table 7.4 shows the expected gains in life expectancy if infectious-related mortality were eliminated as a cause of death within the female population of the Kintampo districts. The results show that life expectancy at birth increased from 70.9 to 81.5 years in the absence of infectious diseases, a probable gain of about 10.6 years. With respect to WRA, life expectancy at age 15 for those who attain this age increased from 62 to 68.8 years in the absence of infectious diseases, a probable gain of about 6.8 years.

Table 7.4: Associated single-decrement life table for causes of death other than infectious diseases for Kintampo HDSS from 2005 to 2014

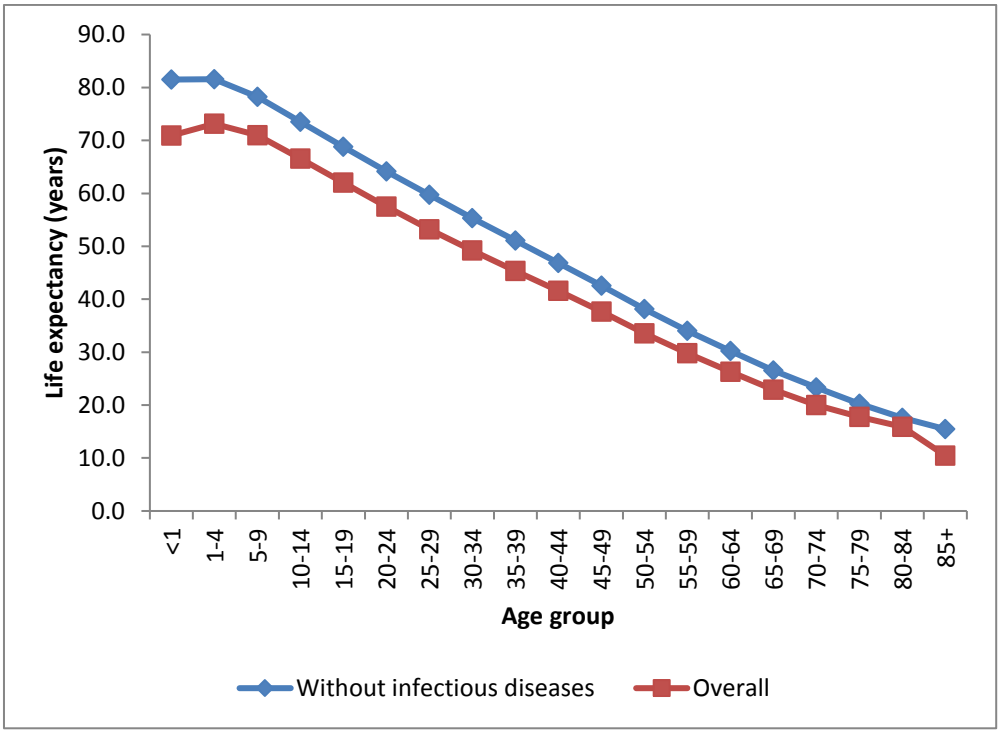
Age x	l_x	${}_np_x$	R^{-CD}	P^{-CD}	l_x^{-CD}	${}_nq_x^{-CD}$	${}_nd_x^{-CD}$	${}_nq_x/{}_nq_x^{-CD}$	${}_na_x^{-CD}$	${}_nm_x^{-CD}$	${}_nL_x^{-CD}$	T_x^{-CD}	e_x^{-CD}
<1	100000	0.9567	0.5772	0.9748	100000	0.0252	2524	1.7164	0.4979	0.0256	98733	8146843	81.5
1-4	95668	0.9747	0.3301	0.9916	98673	0.0084	832	3.0037	2.0666	0.0021	393085	8048110	81.6
5-9	93245	0.9919	0.4528	0.9963	97841	0.0037	360	2.2034	2.4985	0.0007	488306	7655025	78.2
10-14	92489	0.9930	0.5726	0.9960	97481	0.0040	392	1.7439	2.5931	0.0008	486465	7166719	73.5
15-19	91841	0.9918	0.6724	0.9945	97090	0.0055	535	1.4852	2.6806	0.0011	484209	6680254	68.8
20-24	91090	0.9865	0.6564	0.9911	96555	0.0089	855	1.5198	2.6198	0.0018	480740	6196045	64.2
25-29	89864	0.9806	0.5493	0.9893	95700	0.0107	1027	1.8735	2.5869	0.0022	476023	5715305	59.7
30-34	88117	0.9764	0.5721	0.9864	94673	0.0136	1283	1.7469	2.5779	0.0027	470259	5239282	55.3
35-39	86039	0.9716	0.5639	0.9839	93390	0.0161	1507	1.7472	2.5107	0.0032	463200	4769023	51.1
40-44	83593	0.9740	0.5674	0.9852	91883	0.0148	1361	1.7721	2.4788	0.0030	455986	4305823	46.9
45-49	81423	0.9743	0.5857	0.9849	90522	0.0151	1368	1.7102	2.6322	0.0031	449372	3849838	42.5
50-54	79333	0.9606	0.6294	0.9750	89154	0.0250	2229	1.5770	2.6576	0.0051	440548	3400466	38.1
55-59	76204	0.9472	0.6590	0.9649	86925	0.0351	3055	1.5037	2.6180	0.0071	427347	2959917	34.1
60-64	72177	0.9326	0.6928	0.9528	83870	0.0472	3960	1.4282	2.6258	0.0097	409948	2532571	30.2
65-69	67310	0.9031	0.6923	0.9318	79910	0.0682	5446	1.4223	2.5913	0.0141	386432	2122623	26.6
70-74	60786	0.8635	0.6068	0.9148	74464	0.0852	6346	1.6020	2.5803	0.0177	356965	1736190	23.3
75-79	52487	0.8267	0.6471	0.8841	68118	0.1159	7892	1.4957	2.5883	0.0244	321558	1379225	20.2
80-84	43392	0.7663	0.6591	0.8391	60226	0.1609	9691	1.4524	2.4271	0.0350	276198	1057667	17.6
85+	33251	0.0000	0.6760	0.0000	50536	1.0000	50536	1.0000	15.4637	0.0647	781469	781469	15.5

Source: Kintampo HDSS (2005-2014)

Note:
CD = Communicable disease.
R^{-CD} = the proportion of deaths due to all causes other than infectious diseases.
${}_na_x$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_nm_x$ = Mortality rate for people in age group x to x + n.
${}_nq_x$ = Probability of dying between ages x and x + n.
${}_np_x$ = Probability of surviving between ages x and x + n.
l_x = Number surviving at each age.
${}_nd_x$ = Number of deaths between ages x and x + n.
${}_nL_x$ = Person-years lived between ages x and x + n.
T_x = Person-years lived beyond age x.
e_x = Life expectancy at age x.

Figure 7.4 presents life expectancy at every age when all causes of death were pooled together and the corresponding life expectancies when infectious causes were removed. The results showed in Figure 7.4 demonstrate that life expectancy improved at each age if infectious causes of death were averted. As expected, the rise in life expectancy is more noticeable at the earlier ages of life compared to other ages.

Figure 7.4: Comparison of estimated life expectancy for each age group with all cause of death and without infectious diseases, Kintampo HDSS (2005-2014)



Source: Kintampo HDSS (2005-2014)

7.4 Effects of eliminating NCD causes of deaths

Table 7.5 shows another multiple decrement life table for all the female population in the Kintampo HDSS area from 2005 to 2014. Apart from a section of the results on the evaluation of the impact of non-communicable causes on overall mortality, Table 7.5 as expected, shows the same results as found in Table 7.3. The life expectancy, ASMR and other results are the same since

the whole female population in the Kintampo HDSS area for the same study period (2005-2014) was used as in the case of the infectious causes of death.

With the aim of evaluating the impact of NCD-related mortality on overall mortality, deaths due to NCDs were removed. This was done by estimating a multiple-decrement life table to answer the question, "How many female newborns may eventually die from NCD-related mortality if the age-specific mortality conditions of 2005-2014 prevail?" From the results shown in Table 7.5, it was assumed that if a hypothetical cohort of 100,000 female new births were born, 32,031 of them may eventually die of NCD-related mortality by age 85, supposing that the mortality conditions of 2005-2014 continued through their life span. This indicates that over 32 percent of all female newborns may ultimately die of NCDs by age 85.

In the case of WRA, starting at age 15 with a cohort of 91,841 WRA (15-49), it is estimated that 2,545 of them may eventually die of NCD-related mortality by the time they are 49 years old, if the age-specific mortality conditions of 2005-2014 persisted for the ages 15-49 years. This means that about 2.8 percent of WRA (15-49) may ultimately die of NCDs by the time they are 49 years old.

Table 7.5: A general and a multiple-decrement life table for Kintampo HDSS female population (2005-2014)

Age x	PYO	D^{All}	D^{NCD}	${}_na_x$	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x	${}_nq_x^{NCD}$	${}_nd_x^{NCD}$	l_x^{NCD}	${}_nm_x^{NCD}$
<1	20618	913	91	0.498	0.0443	0.0433	0.9567	100000	4332	97826	7094403	70.9	0.0043	432	32031	0.0044
1-4	79690	512	51	1.746	0.0064	0.0253	0.9747	95668	2424	377211	6996577	73.1	0.0025	241	31599	0.0006
5-9	97717	159	22	2.497	0.0016	0.0081	0.9919	93245	756	464054	6619366	71.0	0.0011	105	31358	0.0002
10-14	88188	124	40	2.483	0.0014	0.0070	0.9930	92489	648	461067	6155312	66.6	0.0023	209	31253	0.0005
15-19	70605	116	27	2.478	0.0016	0.0082	0.9918	91841	751	458772	5694245	62.0	0.0019	175	31044	0.0004
20-24	60178	163	32	2.711	0.0027	0.0135	0.9865	91090	1226	454023	5235473	57.5	0.0026	241	30869	0.0005
25-29	52484	213	36	2.605	0.0041	0.0201	0.9799	89864	1806	445638	4781450	53.2	0.0034	305	30629	0.0007
30-34	46333	222	42	2.565	0.0048	0.0237	0.9763	88058	2085	436003	4335812	49.2	0.0045	395	30324	0.0009
35-39	39707	227	50	2.534	0.0057	0.0282	0.9718	85973	2423	423163	3899809	45.4	0.0062	534	29929	0.0013
40-44	33456	178	36	2.470	0.0053	0.0262	0.9738	83549	2193	412261	3476646	41.6	0.0053	444	29395	0.0011
45-49	26742	140	30	2.606	0.0052	0.0259	0.9741	81356	2103	404639	3064385	37.7	0.0055	451	28952	0.0011
50-54	21160	170	56	2.680	0.0080	0.0394	0.9606	79253	3125	391180	2659746	33.6	0.0130	1030	28501	0.0026
55-59	15957	173	76	2.621	0.0108	0.0528	0.9472	76128	4023	373278	2268566	29.8	0.0232	1767	27472	0.0048
60-64	11914	166	74	2.623	0.0139	0.0674	0.9326	72105	4862	353445	1895288	26.3	0.0301	2167	25704	0.0062

Table 7.5 CONTINUATION

Age x	PYO	D^{All}	D^{NCD}	${}_na_x$	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x	${}_nq_x^{NCD}$	${}_nd_x^{NCD}$	l_x^{NCD}	${}_nm_x^{NCD}$
65-69	8959	182	78	2.644	0.0203	0.0969	0.9031	67242	6518	325287	1541843	22.9	0.0415	2793	23537	0.0087
70-74	7053	206	67	2.613	0.0292	0.1365	0.8635	60725	8290	285929	1216556	20.0	0.0444	2696	20743	0.0095
75-79	4949	187	73	2.615	0.0378	0.1733	0.8267	52434	9086	241230	930627	17.7	0.0676	3547	18047	0.0147
80-84	3311	176	62	2.418	0.0532	0.2337	0.7663	43348	10130	342145	689397	15.9	0.0823	3569	14500	0.0187
85+	4098	392	129	5.300	0.0957	1.0000	0.0000	33218	33218	347253	347253	10.5	0.3291	10931	10931	0.0315
Total	693,119	4,619	1,072	-	-	-	-	-	-	-	-	-	-	32,031	-	-

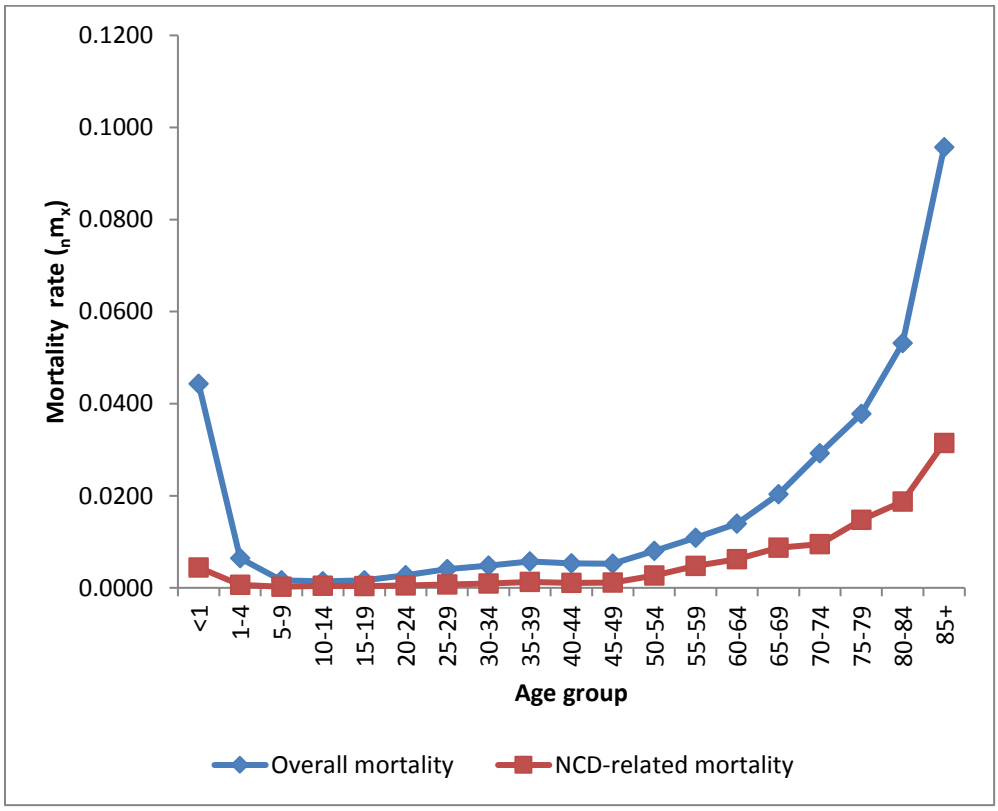
Source: Kintampo HDSS (2005-2014)

Notes

PYO = Person years of observation
NCD = Non-communicable disease
${}_na_x$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_nm_x$ = Mortality rate for people in age group x to x + n.
${}_nq_x$ = Probability of dying between ages x and x + n.
${}_np_x$ = Probability of surviving between ages x and x + n.
l_x = Number surviving at each age.
${}_nd_x$ = Number of deaths between ages x and x + n.
${}_nL_x$ = Person-years lived between ages x and x + n.
T_x = Person-years lived beyond age x.
e_x = Life expectancy at age x.

Figure 7.5 presents the age pattern of causes of death for overall mortality and NCD-related mortality. The results demonstrate that the age pattern of mortality for NCD-related mortality is different from that for overall mortality. The level of mortality, unlike what was observed with the infectious-related mortality, is high at the older ages but not at the younger ages. Relatively, mortality rates are high after ages 49 years for the overall mortality and after 69 years for the NCD-related mortality but very low before age 5. However, just as in Figure 7.3, mortality rates are generally much higher after age 60. This suggests that the level of susceptibility to the causes of death, and to NCD-related mortality in particular, are increased considerably after age 69 years.

Figure 7.5: Age pattern of infectious diseases for overall mortality and infectious causes-specific mortality



Source: Kintampo HDSS (2005-2014)

Table 7.6 shows the expected gains in life expectancy if NCD-related mortality were averted. The results show that life expectancy at birth increased from 70.9 to 77.1 years in the absence of NCDs, a probable gain of about 6.2 years. With respect to WRA, life expectancy at age 15 for those who attained this age increased from 62 to 67.9 years in the absence of NCDs, a probable gain of about 5.9 years.

Table 7.6: Associated single-decrement life table for causes of death other than non-communicable diseases for Kintampo HDSS from 2005 to 2014

Age x	l_x	$_np_x$	R^{-NCD}	P^{-NCD}	l_x^{-NCD}	$_nq_x^{-NCD}$	$_nd_x^{-NCD}$	$_nq_x/\ _nq_x^{-NCD}$	$_na_x^{-NCD}$	$_nm_x^{-NCD}$	$_nL_x^{-NCD}$	T_x^{-NCD}	e_x^{-NCD}
<1	100000	0.9567	0.9003	0.9609	100000	0.0391	3909	1.1083	0.4967	0.0399	98033	7711207	77.1
1-4	95668	0.9747	0.9004	0.9772	96091	0.0228	2195	1.1092	2.2530	0.0058	380531	7613174	79.2
5-9	93245	0.9919	0.8616	0.9930	93897	0.0070	656	1.1599	2.4971	0.0014	467842	7232643	77.0
10-14	92489	0.9930	0.6774	0.9952	93241	0.0048	443	1.4745	2.4657	0.0010	465081	6764801	72.6
15-19	91841	0.9918	0.7672	0.9937	92798	0.0063	583	1.3021	2.6986	0.0013	462647	6299720	67.9
20-24	91090	0.9865	0.8037	0.9892	92215	0.0108	999	1.2426	2.6863	0.0022	458763	5837072	63.3
25-29	89864	0.9806	0.8310	0.9838	91216	0.0162	1476	1.2418	2.6017	0.0034	452540	5378309	59.0
30-34	88117	0.9764	0.8108	0.9808	89740	0.0192	1719	1.2361	2.5583	0.0039	444501	4925769	54.9
35-39	86039	0.9716	0.7797	0.9778	88021	0.0222	1958	1.2674	2.5072	0.0045	435223	4481268	50.9
40-44	83593	0.9740	0.7978	0.9792	86063	0.0208	1787	1.2642	2.4705	0.0042	425795	4046045	47.0
45-49	81423	0.9743	0.7857	0.9798	84276	0.0202	1705	1.2782	2.5502	0.0041	417205	3620250	43.0
50-54	79333	0.9606	0.6706	0.9734	82572	0.0266	2198	1.4814	2.5668	0.0054	407510	3203045	38.8
55-59	76204	0.9472	0.5607	0.9700	80374	0.0300	2410	1.7625	2.5658	0.0061	396002	2795535	34.8
60-64	72177	0.9326	0.5542	0.9620	77964	0.0380	2959	1.7767	2.6292	0.0077	382804	2399532	30.8
65-69	67310	0.9031	0.5714	0.9434	75005	0.0566	4245	1.7127	2.6823	0.0116	365186	2016728	26.9
70-74	60786	0.8635	0.6748	0.9057	70760	0.0943	6673	1.4478	2.5866	0.0197	337696	1651543	23.3
75-79	52487	0.8267	0.6096	0.8905	64087	0.1095	7020	1.5820	2.5702	0.0230	303379	1313847	20.5
80-84	43392	0.7663	0.6477	0.8416	57067	0.1584	9037	1.4757	2.4283	0.0344	262096	1010467	17.7
85+	33251	0.0000	0.6709	0.0000	48030	1.0000	48030	1.0000	15.5813	0.0642	748372	748372	15.6

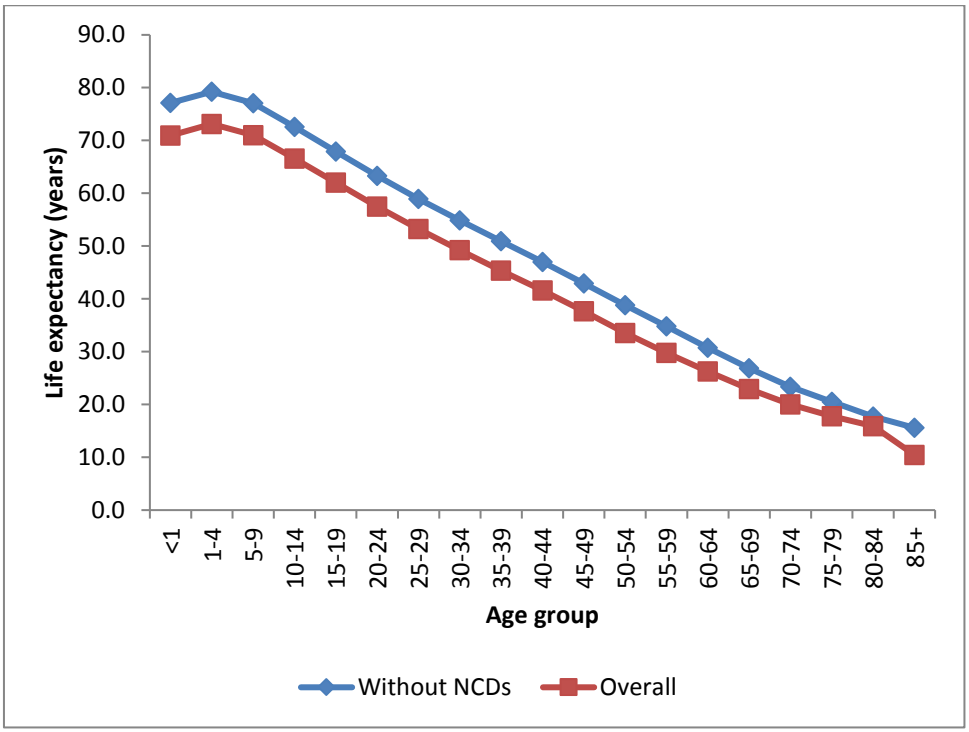
Source: Kintampo HDSS (2005-2014)

Note:

NCD = Non-communicable disease.
R^{-NCD} = the proportion of deaths due to all causes other than non-communicable disease.
${}_{n}a_{x}$ = Average number of person-years lived in the interval by those who have died in the interval.
${}_{n}m_{x}$ = Mortality rate for people in age group x to x + n.
${}_{n}q_{x}$ = Probability of dying between ages x and x + n.
${}_{n}p_{x}$ = Probability of surviving between ages x and x + n.
l_{x} = Number surviving at each age.
${}_{n}d_{x}$ = Number of deaths between ages x and x + n.
${}_{n}L_{x}$ = Person-years lived between ages x and x + n.
T_{x} = Person-years lived beyond age x.
e_{x} = Life expectancy at age x.

Figure 7.6 shows life expectancy at every age when all causes of death were pooled together and the corresponding life expectancies when NCDs were averted. The results depicted in the figure show that life expectancy increased at every age in the absence of NCD deaths. As expected, the increase in life expectancy is less pronounced at the early ages of life compared to the pattern in Figure 7.4. This observation is because NCDs disproportionately affect the older population.

Figure 7.6: Comparison of estimated life expectancy for each age group without non-communicable diseases, Kintampo HDSS (2005-2014)



Source: Kintampo HDSS (2005-2014)

7.5 Discussion

The analyses in this chapter demonstrate the potential contributions of eliminating the different causes of death to the improvement of life expectancy. It was observed that averting any of the causes of death considered leads to improved life expectancy. However, some of the causes of death contributed more compared to others. The gains in life expectancy after any cause of death elimination were different for the various age groups. Similar to the observations in the current study, Arriaga (1984) and De Castro (2001) reported that when comparing abridged life tables with different mortality levels, it is observed in most cases that mortality differs in all age groups by different magnitude.

The findings of the current study suggest that eliminating infectious causes of death lead to the highest number of years gained in life expectancy. The elimination of infectious-

related deaths increased life expectancy at age 15 by 6.8 years, which has a much greater impact compared to NCD (5.9 years) and maternal mortality (4.4 years). This is a confirmation of the third and fourth hypotheses that elimination of maternal death will lead to a lower improvement in life expectancy among WRA than elimination of infectious causes of death; and elimination of maternal death will lead to a lower improvement in life expectancy for WRA than that of NCD causes of death.

This finding also suggests that mortality in the study area is at the first stage of the epidemiological transition where infectious diseases are the main cause of mortality (Omran, 1971). According to the ETT, deaths from cardiovascular, neoplasm and other NCDs conditions increasingly become the main causes when deaths from infectious causes are reduced to very low levels (Omran, 1971).

However, the situation in the study area could best be described as following a 'protracted polarised model' (Agyei-Mensah & de-Graft Aikins, 2010) since it has been shown elsewhere (Section 5.3) in the present study that there is increased risk of both the infectious and non-communicable relative to maternal causes of death. This observation from the present study, again, give credence to the choice of the theoretical framework since, at least, both infectious and non-communicable causes of death, predominantly co-exist among WRA in the two Kintampo districts.

Furthermore, the findings from the present study are consistent with the nature of causes of death found in limited income settings. Preston et al. (1972) observed that the greatest gain in life expectancy across high-income countries occurred from the eradication of causes of death due to non-communicable conditions whereas most of the large gains in life expectancy in LMICs happened from the elimination of causes of death due to infectious diseases (Preston et al., 1972). Following from this argument, a study in Pakistan that examined the gains in life expectancy after elimination of specific causes of death reported

that the elimination of causes of death due to circulatory system diseases resulted in a lower gain in life expectancy of 1.29 years compared to 3.9 years gained if malaria were eliminated (Ali et al., 1988). This finding from the Pakistani study is similar to that of the present study where removal of infectious causes of death resulted in the highest gain in life expectancy. Yet, in a more recent study in another Asian country with a relatively higher income, CVDs contributed the highest number of years gained in life expectancy. Mohammadpour et al. (2014) observed that elimination of CVDs led to most years gain in life expectancy. The foregoing discussions suggest that causes of death are context and time specific.

Moreover, Canudas-Romo et al. (2014) used the DHS and other data sources to estimate the improvement in reproductive-aged life expectancy in developed and African countries by eliminating maternal mortality. Their study involved 28 countries and they observed that the RALE values range from 27.9 to 33.4 years across countries in SSA. The results of the present study indicated RALE of 28.9 years, which is within the range estimated by Canudas-Romo et al. (2014) for sub-Saharan Africa countries.

In addition, elsewhere (Section 5.2) in this current study, it was observed that the burden of infectious causes of death was heaviest among WRA relative to non-communicable and maternal causes of death. This observation is further corroborated by the fact that from age 15, about 5.7 percent of WRA (15-49) may ultimately die of infectious diseases by age 49. In contrast, about half of this proportion may finally die of NCDs by age 49 and approximately one-eighth of the proportion for infectious causes of death may in the end die of maternal causes of death by age 49.

This chapter estimated the potential gains in life expectancy assuming that maternal, infectious or non-communicable causes was averted. The next chapter examines which age group will contribute most to the overall change in life expectancy among the WRA in the

Kintampo North Municipality and Kintampo South District following elimination of any of the causes.

CHAPTER EIGHT

DECOMPOSITION OF THE TOTAL CHANGE IN LIFE EXPECTANCY BY AGE SEPARATELY FOR MATERNAL, INFECTIOUS OR NON-COMMUNICABLE CAUSES OF DEATH

8.1 Introduction

This chapter presents a decomposition of the total difference in life expectancy (after hypothetically separately eliminating maternal, infectious and non-communicable causes of death) into specific age groups to establish the ages that a decrease in mortality from the respective causes of death would make the greatest impact on survival. This is essential because changes in life expectancy as observed in the preceding chapter do not mean that mortality rates or the directions are the same across all age groups. Generally, most age groups will record a decline in mortality and therefore, contribute to increase in life expectancy. However, mortality may increase for some age groups that would offset the improvement in life expectancy. Hence, decomposition is used to account for the contribution of the various age groups to the total difference in life expectancy. This approach makes it possible for policy intervention to target the age group that will yield the highest returns in the mix of scarce resources.

8.2 Decomposition of total change in reproductive-aged life expectancy

Table 8.1 presents a decomposition of the gains in reproductive-aged life expectancy for the women of reproductive age population of the Kintampo HDSS area from 2005 to 2014. The results show that the total change in reproductive-aged life expectancy is 4.4 years. The gains in reproductive-aged life expectancy clearly increase with age though there is little variation across the age groups as depicted in Figure 8.1. The youngest group account for the

least (13.8%) gains in reproductive-aged life expectancy whilst the oldest group contributed the highest (15.1%) if mortality from maternal causes of death were removed from the population.

Table 8.1: Decomposition of estimated changes in reproductive-aged life expectancy if maternal mortality were eliminated by age group, Kintampo HDSS (2005 to 2014)

Age x	lx	nLx	Tx	lx^{-MM}	nLx^{-MM}	Tx^{-MM}	Change	Percent
15-19	100000	497937	2865517	100000	498146	3306877	0.610	13.8
20-24	99182	492853	2367580	99182	493450	2808731	0.610	13.8
25-29	97847	484525	1874727	97847	486031	2315282	0.614	13.9
30-34	95881	473874	1390202	95881	476233	1829251	0.621	14.1
35-39	93610	461544	916327	93610	464244	1353018	0.633	14.4
40-44	90971	448816	454784	90971	451875	888774	0.650	14.8
45-49	88584	5968	5968	88584	436899	436899	0.667	15.1
Total	-	-	-	-	-	-	4.406	100.0

Source: Kintampo HDSS (2005-2014)

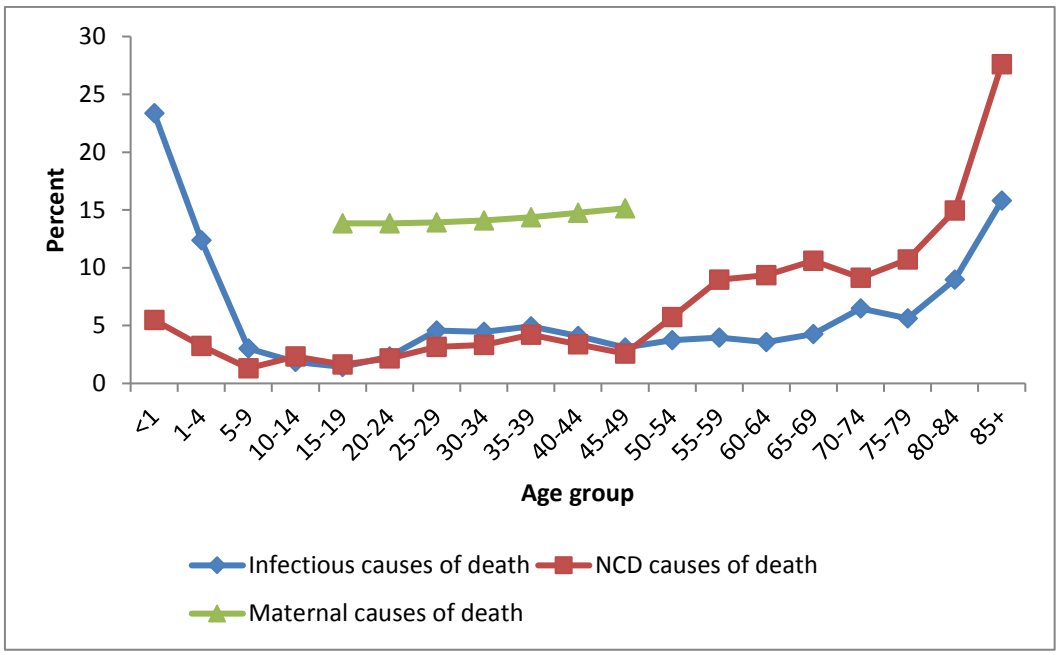
Notes
MM = Maternal-related causes of death
lx = Number surviving at each age.
nlx = Person-years lived between ages x and x + n.
Tx = Person-years lived beyond age x

8.3 Age decomposition of total change in life expectancy for infectious causes of deaths

Table 8.2, unlike Table 8.1, presents a decomposition of the total gain in life expectancy at birth for the female population of the Kintampo HDSS area from 2005 to 2014. The results show that the total change in life expectancy at birth is 10.5 years. Female children less than one-year old accounted for the highest gain in life expectancy at birth (19.8%). Together female children less than five years old contributed about a third of the gains in life expectancy at birth (30.3%) whilst WRA (15-49) accounted for about a fifth

(21.1%) of the gains in life expectancy if mortality from infectious causes of death were removed from the population. The aged (65 years and above) also contributed more than a third (34.9%) of the gains in life expectancy if mortality from infectious causes of death were averted among the female population in the Kintampo districts. Generally, the results show a wide variation across the various age groups as depicted in Figure 8.1.

Figure 8.1: Comparison of total change in life expectancy by age and by causes of deaths in Kintampo HDSS (2005-2014)



Source: Kintampo HDSS (2005-2014)

Table 8.2: Decomposition of estimated changes in life expectancy at birth if infectious diseases were eliminated as a cause of death, by age group, Kintampo HDSS, 2005 to 2014

Age x	l_x	$_nL_x$	T_x	l_x^{-CD}	$_nL_x^{-CD}$	T_x^{-CD}	Change	Percent
<1	100000	97826	7094403	100000	98733	8146843	2.460	19.8
1-4	95668	377211	6996577	98673	393085	8048110	1.304	10.5
5-9	93245	464054	6619366	97841	488306	7655025	0.316	2.6
10-14	92489	461067	6155312	97481	486465	7166719	0.195	1.6
15-19	91841	458772	5694245	97090	484209	6680254	0.150	1.2
20-24	91090	454023	5235473	96555	480740	6196045	0.245	2.0
25-29	89864	445638	4781450	95700	476023	5715305	0.480	3.9
30-34	88058	436003	4335812	94673	470259	5239282	0.469	3.8
35-39	85973	423163	3899809	93390	463200	4769023	0.518	4.2
40-44	83549	412261	3476646	91883	455986	4305823	0.430	3.5
45-49	81356	404639	3064385	90522	449372	3849838	0.325	2.6
50-54	79253	391180	2659746	89154	440548	3400466	0.394	3.2
55-59	76128	373278	2268566	86925	427347	2959917	0.417	3.4
60-64	72105	353445	1895288	83870	409948	2532571	0.377	3.0
65-69	67242	325287	1541843	79910	386432	2122623	0.450	3.6
70-74	60725	285929	1216556	74464	356965	1736190	0.683	5.5
75-79	52434	241230	930627	68118	321558	1379225	0.592	4.8
80-84	43348	342145	689397	60226	276198	1057667	0.946	7.6
85+	33218	347253	347253	50536	781469	781469	1.664	13.4
Total	-	-	-	-	-	-	10.524	100.0

Source: Kintampo HDSS (2005-2014)

Notes
CD = Communicable disease
lx = Number surviving at each age.
nlx = Person-years lived between ages x and x + n.
Tx = Person-years lived beyond age x.

8.4 Age decomposition of total change in life expectancy for NCD causes of deaths

Table 8.3 also presents a decomposition of the total gain in life expectancy at birth for the female population of the Kintampo HDSS area from 2005 to 2014. The results show that the total change in life expectancy at birth is 6.2 years. Adult females aged 85 years and above accounted for the greatest gains in life expectancy (21.3%). Together, adult females 60 years and above contributed more than three out of five (63.4%) of the gains in life expectancy whilst WRA (15-49) accounted for less than one out of five (15.7%) of the total gain in life expectancy if mortality from non-communicable causes of death were eliminated from the population. This result is expected because adults aged 60 years and over disproportionately die of non-communicable causes. The results also show a wide variation similar to the infectious causes of death across the various age groups as depicted in Figure 8.1.

Table 8.3: Decomposition of estimated changes in life expectancy at birth if NCDs were eliminated as a cause of death, by age group, Kintampo HDSS, 2005 to 2014

Age x	lx	nLx	Tx	lx^{-NCD}	nLx^{-NCD}	Tx^{-NCD}	Change	Percent
<1	100000	97826	7094403	100000	98033	7711207	0.337	4.2
1-4	95668	377211	6996577	96091	380531	7613174	0.200	2.5
5-9	93245	464054	6619366	93897	467842	7232643	0.081	1.0
10-14	92489	461067	6155312	93241	465081	6764801	0.144	1.8
15-19	91841	458772	5694245	92798	462647	6299720	0.101	1.3
20-24	91090	454023	5235473	92215	458763	5837072	0.133	1.7
25-29	89864	445638	4781450	91216	452540	5378309	0.195	2.4
30-34	88058	436003	4335812	89740	444501	4925769	0.204	2.6
35-39	85973	423163	3899809	88021	435223	4481268	0.260	3.2
40-44	83549	412261	3476646	86063	425795	4046045	0.208	2.6
45-49	81356	404639	3064385	84276	417205	3620250	0.159	2.0
50-54	79253	391180	2659746	82572	407510	3203045	0.353	4.4
55-59	76128	373278	2268566	80374	396002	2795535	0.554	6.9
60-64	72105	353445	1895288	77964	382804	2399532	0.577	7.2
65-69	67242	325287	1541843	75005	365186	2016728	0.654	8.2
70-74	60725	285929	1216556	70760	337696	1651543	0.564	7.0
75-79	52434	241230	930627	64087	303379	1313847	0.662	8.3
80-84	43348	342145	689397	57067	262096	1010467	0.922	11.5
85+	33218	347253	347253	48030	748372	748372	1.703	21.3
Total	-	-	-	-	-	-	6.168	100.0

Source: Kintampo HDSS (2005-2014)

Notes
NCD = Non-communicable disease
lx = Number surviving at each age.
nlx = Person-years lived between ages x and x + n.
Tx = Person-years lived beyond age x

8.5 Discussion

This chapter answered the question regarding the age group that will contribute most to increased life expectancy at birth if infectious or non-communicable causes of death were eliminated as well as which age group will account for the most increase in reproductive-age life expectancy when maternal mortality were averted.

The results indicate that children less than five years old experienced the highest gain in life expectancy of 30.3 percent if infectious causes of death were eliminated compared to WRA who gained 21.1 percent. This finding is consistent with what has been observed with the decomposition method where the age group with the highest level of mortality for a given cause of death tends to gain most from the removal of that specific cause of death (Arriaga, 1984; Bawah & Binka, 2007). Bawah and Binka (2007) in their study on number of years that could be saved if malaria were eliminated found that children under five years had the greatest gain in life expectancy of about 45 percent after elimination of malaria. According to the authors, the greatest gain in life expectancy was expected for children less than five years old since most of the deaths (36%) occurred among these children.

Furthermore, the results suggested that the gains in life expectancy resulting from elimination of infectious causes of death diminish with increasing age. This trend is also consistent with Bawah and Binka's (2007) study which used data from Navrongo HDSS to demonstrate that malaria affects all ages but noted that the effects of malaria mortality reduce with increase in age because increase in immunity occurs with increase in age. The results from the current study are similar to the observations in Navrongo since the current study also found infectious causes of death with malaria as the leading specific cause of death

affecting all age groups and mostly female children aged less than five years in the Kintampo HDSS study area.

According to the results of the present study, adults aged 60 years and over disproportionately die of non-communicable causes. It is observed from the findings that adult female, 60 years and above accounted for more than 60 percent of the gains in life expectancy whilst WRA (15-49) accounted for about 16 percent of the gains in life expectancy if mortality from non-communicable causes of death were removed from the population. This finding from the current study is supported by a publication in 2011 on the global economic burden of NCDs in 2010 and projection through 2030 by the World Economic Forum and the Harvard School of Public Health. According to the report, the proportion of the population aged 60 years and over is rising and the percentage, in the coming years, is expected to rise very rapidly. The report further observed that since NCDs disproportionately affect the age group 60 years and over, the incidence of NCDs can be expected to accelerate among this group as globalisation and urbanisation take greater hold in the LMICs (Bloom et al., 2011). In view of this, the 60 years and above sub-population are likely to benefit most from the elimination of NCDs.

In addition, the present study suggests that the youngest age group of WRA accounted for the least gains in reproductive-age life expectancy whilst the oldest group contributed the greatest if mortality from maternal causes of death were removed from the population. This observation is supported by the fact that several studies conducted in Africa and Asia including Ethiopia, Tanzania, Bangladesh and Nepal found that pregnancies are significantly relatively more dangerous among older WRA than younger ones (Evjen-Olsen et al., 2008; Gidey et al., 2013; Jahromi & Husseini, 2008; Kang et al., 2010; A. R. Khan et al., 1986).

CHAPTER NINE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

9.1 Summary

This study examined the relative risk of dying from maternal, infectious and non-communicable causes among women of reproductive age. The study was conducted in the two districts of Kintampo that constitute the coverage area of the Kintampo Health and Demographic Surveillance System. Quantitative data collection and analytical techniques were used to achieve the objectives of the study. Univariate analyses were conducted to assess the levels of causes of death and the relative risk of death. Multinomial logistic models were employed to determine the factors of the various causes of death. Multiple decrement and associated single decrement life tables methods were also used to estimate the effect of separately eliminating maternal, infectious, and non-communicable causes of death on life expectancy and to decompose the total change in life expectancy by age separately for the respective causes of death among WRA within the study area and period.

There is evidence to the effect that maternal, infectious and non-communicable causes of death combine to be simultaneously a major health problem for WRA in LMICs especially in SSA countries. However, few researches in the past three decades have examined the relative risk of each of them when taken together and none has examined the impact of separately eliminating maternal, infectious and non-communicable causes of death on life expectancy though such analyses are very useful for targeting programmes and policies where life expectancy returns are highest. In addition, reliable data, especially, for maternal mortality, was a major challenge in tracking the MDG 5A and reliable data are still crucial for achieving the targets of the health indicators of the SDGs. Yet, data on causes of death are not readily available in most low-income countries. Fortunately, the verbal autopsy method

used by the health and demographic surveillance systems provides valuable information on patterns of causes of death. But more importantly, the value of HDSS data is derived from its longitudinal structure that permits the accurate tracking of changes over time. In view of this attribute of the HDSS, deaths are reported more completely. Therefore, the present study used HDSS data, to provide empirical evidence to fill the gap created due to the paucity of data and lack of understanding of maternal, infectious and non-communicable causes of death among WRA in the Kintampo districts of Ghana. It employed competing risks analysis to measure the demographic impact of three broad causes of death namely: maternal, infectious and non-communicable causes among WRA.

The WHO has described infectious diseases as traditional causes of death in LMICs because infectious diseases have been the major causes of death in these limited income settings. The results of this study were similar to other SSA countries as they indicated that infectious causes of death were the main broad cause of death among WRA within the study area and period. NCD causes of death were the second highest broad causes of death, and compared to infectious and non-communicable causes of death, maternal causes were the least broad cause of death among the study population.

The public health importance of infectious causes of death within the study area is further corroborated by the top five specific causes of death. Infectious causes of death contributed four out of the five top causes of death and the first three were from infectious causes. Malaria was found to be the main specific cause of death though it showed a downward trend after peaking in 2011. HIV/AIDS was the second highest specific cause of death but the level has remained low since it peaked in 2007 and recorded one case in 2011. Unlike malaria and HIV/AIDS, septicaemia, which was the third specific cause of death showed an increasing trend. There was no maternal mortality in the top five causes of death but CVDs were the fourth cause of death and as in the case of the general trend shown by

NCD causes of death, it showed a stable trend. Intestinal infection was the fifth cause of death and the remaining specific causes of death contributed less than five percent each of the total causes of death.

The findings in the present study also highlighted the occurrence of the double burden in rural Ghana and among WRA. The study found that there was an increased risk of dying from both infectious and NCD causes relative to maternal cause of death throughout the study period although the risk of infectious causes of death is much higher. In addition, the trend for both causes of death depicts a worsening situation year by year. This trend of the double burden of infectious and non-communicable disease causes of death has been identified in Ghana's epidemiological transition and described as 'protracted polarised model' in an urban setting (Agyei-Mensah & de-Graft Aikins, 2010). However, the results of the current study suggest a co-existence of infectious and non-communicable causes of death over a long period in a predominantly rural area in Ghana and among WRA. In addition, the unacceptably high level of the maternal causes of death in this setting, suggests a situation of a triple burden of causes of death among WRA in the study area.

Causes of maternal, infectious and non-communicable deaths among WRA in the Kintampo districts during the study period were determined by distal and proximate but not intermediate factors. Distal factors consisting age, marital status, district of residence, season and place of death significantly correlated with the causes of death. Deceased WRA who were within the age group 20-49 years were significantly more likely to die from infectious and non-communicable causes than maternal causes of death compared to their younger counterparts aged 15-19-years. This is because it is well established that generally, death occurs in older persons. In addition, deceased WRA who were ever married were significantly less likely to die from infectious and non-communicable causes than maternal causes of death relative to those who were never married. This suggests that marriage

protects WRA from dying early. This reported protection for married persons may be partly due to the social, psychological and other support that those in a union may benefit from.

Another distal determinant was the season. Deceased women were at a greater risk of dying from maternal causes in the wet or rainy season. This is similar to the observation by Etard, Kodio, and Ronsmans (2003) in Burkina Faso who also found greater mortality due to obstetric causes in the wet season. It is important to note that Dery et al. (2010) observed that malaria transmission, which was found to be the highest cause of death in the present study, was all year round even though there were variations in rates of inoculation during the rainy and dry seasons. There may be the need for further research in this area since WRA were observed to have increased risk of dying from infectious causes in the dry season relative to maternal causes.

In addition, women who lived in the Kintampo South were at a greater risk of dying from maternal mortality. It is hypothesised that two related factors may explain this observation. The first hypothesis is that Kintampo South is relatively new and relied on Kintampo North Municipal for social infrastructure including health. The second hypothesis is the availability of both health equipment and personnel at the Kintampo North Municipal, which continues to serve as a referral for the Kintampo South during emergencies including emergency obstetric care. This assertion is supported by the finding in the current study that WRA who died in hospitals were significantly less likely to die from maternal causes relative to infectious causes of death.

Moreover, proximate factors related to health status namely hospital admission in the last 12 months before death and the nature of death, whether sudden or not, significantly correlated with the causes of death under study. Findings from a combined systematic review and meta-analysis in SSA reveal that the density of health staff, availability of equipment and type of health facility influenced the MMR between studies. The present study also found

that WRA who were admitted in the last 12 months before dying were less likely to have died from maternal causes than infectious or NCD causes of death. This is so because activities of the Kintampo Health Research Centre in terms of supporting the health facilities with clinicians, donation of health equipment, ambulance services and ensuring maximum health care for study participants who are invariably WRA, may have partly contributed to this finding.

Another proximate factor, the nature of death, whether sudden or not, significantly correlated with the causes of death under study. CVDs are the main causes of death globally and fast becoming the leading cause of death in LMICs (WHO, 2010c). Consistent with global and regional epidemiological trend, the current study observed that WRA who died suddenly were significantly more likely to have died from NCDs and most probably from CVDs, which topped the NCD causes of death. This observation highlights the growing importance of NCD causes of death in the study area.

Generally, the present study has shown that averting any of the causes of death considered leads to improved life expectancy among WRA in the study area. However, eliminating infectious causes of death leads to most years gain in life expectancy. This is consistent with the finding elsewhere (Section 5.2) in the present study that suggests that infectious causes of death have the heaviest burden compared to the other causes of death. Furthermore, this observation is consistent with the nature of causes of death found in limited income settings where the elimination of causes of death from infectious diseases leads to most of the large gains in life expectancy (Preston et al., 1972).

It is important to know the causes of death that are affecting a given population but perhaps, it is more important to know which age group has the greatest potential for improving life expectancy to appropriately target interventions to achieve the desired results. In line with what has been observed with the decomposition method, where the age group

with the highest level of mortality for a given cause of death tends to gain most from the elimination of that specific cause of death, under-five-year female children had the highest gain in life expectancy when infectious causes of death are assumed to have been eliminated. Furthermore, the results suggested that infectious causes of death affect all ages but the gains in life expectancy because of elimination of infectious causes of death diminish with increasing age. This is probably because mortality impact of malaria, which was found to have the heaviest burden in the present study, reduces with age since immunity increases with time (Bawah & Binka, 2007).

Similarly, the results indicated that NCD causes of death affect all ages but the gains in life expectancy because of elimination of NCD causes of death, generally, increase with increasing age. Adults over 60 years disproportionately die of non-communicable causes. It is observed from the findings that adult femalse 60 years and above accounted for more than 60 percent of the total gain in life expectancy compared to WRA (15-49) who accounted for about 16 percent of the total gain in life expectancy if mortality from non-communicable causes of death were eliminated from the population. This is because adults 60 years and above have the highest level of mortality with regards to NCD causes of death. Additionally, the present study suggests that the youngest group of WRA accounted for the least gains in reproductive-aged life expectancy compared to older age groups if maternal causes of death were eliminated from the population. Again, this is because older WRA have the highest level of mortality with respect to maternal causes of death.

9.2 Conclusions

General mortality and epidemiological theory indicates higher mortality among WRAs are due to maternal deaths but the present study finds that in the Kintampo districts, the greatest contributor to causes of death among WRAs is infectious causes and NCDs with

maternal mortality contributing the least. This is because the study revealed that infectious causes of death were the main broad cause of death among WRA within the study area and period. This confirms the findings of other studies in SSA countries that have shown that infectious causes were the major cause of death within populations in the sub-region. In addition, the study showed that NCD causes of death have the second highest burden whilst relatively, maternal causes have the least burden among the study population. It is therefore, necessary to attach importance to tackling all the major causes of death since eliminating maternal mortality leads to the least gain in life expectancy.

No woman should lose her life while giving life. Although this study has shown that maternal mortality has a lesser burden among WRA compared to mortalities from infectious and NCD conditions, it is still imperative to keep the momentum or improve upon the strategies that has resulted in consistent reduction in maternal deaths especially since the introduction of the MDGs in 2000. However, the present study has highlighted the need to give equitable attention to infectious and NCD causes of death that have been shown in this study to significantly affect WRA. Relatively higher burden of infectious and NCD causes of death as found in this study was partly as a result of the reduction in maternal deaths which is the outcome of deliberate global, regional and local efforts. Equitable attention to infectious and NCD causes of death by LMICs will go a long way to reduce the major health challenges not only in Kintampo or Ghana but throughout similar settings in LMICs.

9.3 Recommendations

9.3.1 Policy recommendations

From the results of the study, it is evident that WRA face a triple burden of maternal, infectious and non-communicable causes of death. However, health among WRA has been synonymous with maternal health in the past three decades at the global, regional and local

levels. There is, therefore, the need for a paradigm shift to consider health needs among WRA as women's health, where all the health challenges facing WRA, as found by this study, are given equal attention.

Resources have been the main challenge for implementing research findings. In view of this, a very cost-effective approach is proposed where existing structures being used for maternal, neonatal and child health (MNCH) are utilised for other health needs of WRA in the two districts of Kintampo in particular and similar settings in Ghana as a whole. Anecdotal evidence suggests that the general Ghanaian population only visit the health facility when sick. The findings from this study suggest that there is the need to change this attitude so that WRA visit the MNCH routinely whether sick or not. Perhaps, a change of name from MNCH to WNCH (Women, Neonatal and Child Health) unit would help to re-enforce this standard. This is because the change of name is expected to re-brand MNCH and re-focus it on all women health issues so that WRA irrespective of their pregnancy status could assess services of the unit.

At the WNCH, WRA should be screened and treated for the top 10 causes of death that constitute about 75 percent of all the causes of death of the present study or a minimum of the top 5 causes of death that account for more than 50 percent of all the causes of death. This proposal means that WRA should at least be screened and treated for malaria, HIV/AIDS, septicaemia, CVDs and intestinal infections at the ante-natal, delivery and post-natal clinics. In addition, surveillance on these major causes of death among WRA should be prioritised to monitor and control them. It is further recommended that existing interventions such as intermittent preventive treatment in pregnancy (IPTp) should be expanded to cover all WRA since this intervention seeks to prevent malaria, which was found to be the leading cause of death in the present study. With regards to this suggestion, all WRA, including their

non-pregnant counterpart could be administered with antimalarials just as is being done for those pregnant.

The results from the study showed that WRA in the Kintampo North Municipal, which is relatively more developed in terms of health infrastructure die less from maternal mortality compared to those living in the Kintampo South District. This observation highlights the importance of skilled birth attendant and other health services at the health facility. This assertion is further supported by the fact that WRA who were admitted in the last 12 months before dying were less likely to die from maternal causes. It is, therefore, recommended that government and non-government organisations in the health sector should put strategies in place to ensure equal access to health facilities and motivate women to utilise them. Again, from the results of the present study, older WRA have a higher likelihood of dying from the various causes. Hence, there is the need to evolve some strategies including health education to minimise this effect. At the proposed WNCH unit, all WRA could be provided with health education on all the three broad causes of death that affect their health as well as education on the need to give birth early as found by the present study.

9.3.2 Further research needs

This study used the Physician Coded Verbal Autopsy, which is the commonest method of determining the probable cause of death but the PCVA is associated with some challenges including the fact that it is expensive and it takes a lot of time to organize and successfully diagnose a cause of death. However, in the last ten years, computerised models have been created for diagnosing causes of death to minimise the challenges with the PCVA method. Therefore, one of the next steps of this research will be to use the interVA4, which is a version of the computerised model for determining causes of death to compare with the PCVA method.

This study considered only females of reproductive age. However, infectious and non-communicable causes of death affect the general population. There is the need to also consider all females, adult females 15 years and above and both male and female populations. This is because the results of the study showed that the under-five-year-old children had the highest burden of infectious causes of death and adult females 60 years and above also had the highest burden of non-communicable causes of death.

The findings of the present study also suggested that women were at a greater risk of dying from maternal causes in the rainy season. Yet, a study found that malaria transmission, which was found to be the highest cause of death in this current study, took place all year round though there are variations in the rates of inoculation in the rainy and dry seasons. Therefore, another step for this research will be to investigate further why there is increased risk of maternal mortality during the rainy season in the study area since WRA were observed to have increased risk of dying from infectious causes in the dry season relative to maternal causes.

In addition, the study found that deceased WRA who were ever married were significantly less likely to die from infectious and non-communicable causes than maternal causes of death relative to those who were never married. Other studies have reported protection for married persons due to the social, psychological and other support that those in a union may benefit from. One other step in this research will be to examine the nuances of the protection that those in a union enjoy using both quantitative and qualitative methods in the face of globalisation and its threats to the stability and quality of marriage.

Finally, the eco-epidemiological model adopted for this study is at its earliest stages of development. This study is one of the first to apply it in the SSA context. Some of the components of the original model were excluded because they fell outside the scope of this study or no data were available to cover them. There is, therefore, the need for further studies

using additional data that will allow these other dimensions to be examined. Fortunately, the HDSS setup in future will be able to produce data to examine some other aspects of the framework, including the pre-conceptional, conceptional, and multigenerational macro-contextual variables.

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APPENDICES

Appendix I

A general life table for Kintampo HDSS (2005 to 2014)

Age x	PYO	D^{All}	${}_na_x$	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
<1	41,880	2065	0.4981	0.0493	0.0481	0.9519	100,000	4,812	97,585	6,675,182	66.8
1-4	161,275	1065	1.7463	0.0066	0.0260	0.9740	95,188	2,477	375,170	6,577,597	69.1
5-9	194,939	353	2.4972	0.0018	0.0090	0.9910	92,711	836	461,083	6,202,427	66.9
10-14	181,753	273	2.4830	0.0015	0.0075	0.9925	91,875	687	458,067	5,741,344	62.5
15-19	150,089	284	2.4777	0.0019	0.0094	0.9906	91,188	859	455,216	5,283,277	57.9
20-24	116,138	341	2.7105	0.0029	0.0146	0.9854	90,329	1,317	449,909	4,828,061	53.4
25-29	93,259	394	2.6049	0.0042	0.0209	0.9791	89,012	1,861	441,413	4,378,152	49.2
30-34	82,110	421	2.5651	0.0051	0.0253	0.9747	87,151	2,207	432,140	3,936,739	45.2
35-39	72,854	511	2.5340	0.0070	0.0345	0.9655	84,944	2,928	417,597	3,504,599	41.3
40-44	62,648	474	2.4701	0.0076	0.0371	0.9629	82,015	3,044	402,951	3,087,002	37.6
45-49	50,880	408	2.6058	0.0080	0.0393	0.9607	78,971	3,107	390,129	2,684,051	34.0
50-54	42,104	459	2.6797	0.0109	0.0532	0.9468	75,864	4,033	373,066	2,293,922	30.2
55-59	33,033	506	2.6205	0.0153	0.0739	0.9261	71,831	5,308	348,269	1,920,855	26.7

(Continued) A general life table for Kintampo HDSS (2005 to 2014)

60-64	25,028	469	2.6233	0.0187	0.0897	0.9103	66,523	5,967	322,950	1,572,586	23.6
65-69	18,293	490	2.6438	0.0268	0.1260	0.8740	60,556	7,629	286,664	1,249,637	20.6
70-74	13,981	482	2.6132	0.0345	0.1593	0.8407	52,927	8,430	246,092	962,973	18.2
75-79	9,548	429	2.6146	0.0449	0.2029	0.7971	44,497	9,029	201,093	716,881	16.1
80-84	6,327	409	2.4176	0.0646	0.2770	0.7230	35,468	9,824	264,130	515,788	14.5
85+	7,399	754	5.3000	0.1019	1.0000	0.0000	25,644	25,644	251,657	251,657	9.8
Total	1,363,537	10587									

Appendix II

Estimation Procedure for Multiple Decrement and Associated Single Decrement Life Tables

In the analysis of causes of death, the force of the mortality function from different causes is additive because disentangling precisely the effects of other causes of death is difficult, especially in settings where precise measurement is not possible. Thus, the sum of the different causes is equal to all causes combined as represented in equation (1) thus:

$$\mu(x) = \sum_{i=1}^{I} \mu_i(x), \tag{1}$$

where $\mu(x)$ is the force of mortality from all causes combined and parameters $\mu_i(x)$ refer to the death rate for the ith cause of death. This implies that the rates of decrements are also additive:

$${}_nm_x = \sum_{i=1}^{i} {}_nm_{xi}, \tag{2}$$

where ${}_nm_x$ is the rate of decrement from all causes and ${}_nm_{xi}$ in this case is the rate of decrement from maternal or infectious or non-communicable causes of death.

Considering the basic relationship between mortality rates (${}_nm_x$) and the probability of dying (${}_nq_x$) as shown in the conventional life table, the transformation of the rates to probabilities of dying is shown in the following equation as:

$${}_nq_x = \frac{n\,{}_nm_x}{1 + (n - {}_na_x)\,{}_nm_x}, \tag{3}$$

where ${}_na_x$ is defined as the average number of person-years lived in the interval x to $x + n$ by those who died in the interval. This relationship extends to multiple-decrement processes as follows:

$$ {}_nq_{xi} = \frac{n\,{}_nm_{xi}}{1 + (n - {}_na_x)({}_nm_{xi} + {}_nm_{x,-1})}, \quad (4) $$

where ${}_nm_{xi}$ and ${}_nm_{x,-i}$ represent decrement rates from maternal or infectious or non-communicable and all other causes other than maternal or infectious or non-communicable combined, respectively. Data concerning the causes of death by age and the corresponding number of person-years by the same sub-categories define the probabilities of dying at each age (${}_nq_x$), by cause of death. However, obtaining the ${}_na_x$ values is often difficult. Therefore, different techniques are employed to estimate the ${}_na_x$ values. First, it is assumed that those who died in the interval on average lived halfway through the interval. Based on this assumption, an initial value of 2.5 is adopted for all age groups with an interval of 5 years. For the younger than 1-year and 1–4-year age groups, a procedure suggested by Coale and Demeny is adopted (Bawah and Binka, 2007).

Using the ${}_na_x$ values of 2.5 in the ${}_nm_x \rightarrow {}_nq_x$ conversion formula, ${}_nq_x$ values are estimated first and the values are used to obtain *ndx* (the number of deaths between age *x* and *x* + *n*) in a life table. These ${}_nd_x$ estimates are plugged into the iteration formula below to obtain new sets of ${}_na_x$ values. These values are subsequently re-introduced into the ${}_nm_x \rightarrow {}_nq_x$ conversion formula to re-estimate new ${}_nd_x$ values, which are re-introduced in the iteration formula to obtain a new set of ${}_na_x$ values. This process is repeated until stable estimates of ${}_na_x$ are achieved (Bawah and Binka, 2007). The iteration equation used is specified as follows:

$$ {}_na_x = \frac{-\frac{n}{24}{}_nd_{x-n} + \frac{n}{2}{}_nd_x + \frac{n}{24}{}_nd_{x+n}}{{}_nd_x}. \quad (5) $$

The stable ${}_na_x$ values then are used to generate a life table for females in the Kintampo HDSS area through the basic ${}_nm^x \rightarrow {}_nq_x$ conversion formula. With the overall life table generated, the probability of dying from maternal, infectious or non-communicable causes of death (${}_nq_{xi}$)

is estimated, by applying the proportion of deaths that are due to maternal, infectious or non-communicable causes of death to the overall probabilities of dying for each age, ${}_nq_x$, as follows:

$$ {}_nq_{xi} = {}_nq_x \cdot \frac{{}_nD_{xi}}{{}_nD_x}, \tag{6} $$

where ${}_nq_{xi}$ and ${}_nD_{xi}$ represent the probability of dying from maternal, infectious or non-communicable causes of death and the observed number of deaths from maternal, infectious or non-communicable causes of death, respectively. The above relationship assumes that the observed death rates for maternal, infectious or non-communicable causes of death (${}_nM_{xi}$) are equal to the life-table death rates for maternal, infectious or non-communicable causes of death (${}_nm_{xi}$), that is, ${}_nM_{xi} = {}_nm_{xi}$.

Estimating the contribution of mortality from maternal, infectious or non-communicable causes of death to overall mortality also allow to estimate the effect of eliminating maternal, infectious or non-communicable causes of death through "cause-deleted" lifetable analysis (Bawah and Binka, 2007). If maternal, infectious or non-communicable causes-related mortality were eliminated as a cause of death, survival at age interval x to $x + n$, will be represented as:

$$ {}_nP_{x,-i} = {}_np_x\left(\frac{{}_nD_{xi}}{{}_nD_x}\right). \tag{7} $$

The approach described above assumes that the force of mortality function from each cause is proportional to all causes combined in the interval x to $x + n$ and constant throughout the interval (Arriaga, 1984). The ${}_na_x$ values for the associated single decrement life table were obtained using the following formula for all age groups except the first two and the last:

$$ {}_na_{x,-i} = n + R^i \frac{{}_nq_x}{{}_nq_{x,-i}}({}_na_x - n), \tag{8} $$

where ${}_na_{x,\,-i}$ refers to the average number of person-years lived by those dying in the interval from all causes other than maternal, infectious or non-communicable-related death, and *Ri* represents the proportion of deaths due to maternal, infectious or non-communicable-related mortality. For the other age groups, the iteration procedure used for estimating the ${}_na_x$ values in the parent life table is used.

Appendix III

Estimation Procedure for Decomposition by Age

To ascertain the age groups likely to contribute most to the total difference in life expectancy because of the elimination of maternal or infectious or non-communicable causes of death, the total difference in life expectancy is decomposed into specific age groups, using the procedure proposed by Arriaga. This approach permits estimation of specific reductions in mortality due to the cause of death by age group and consequent increases in life expectancy in the population.

$$ {}_n\Delta_x = \frac{l_x^{all}}{l_0^{all}} \cdot \left(\frac{{}_nL_x^{-COD}}{l_x^{-COD}} - \frac{{}_nL_x^{all}}{l_x^{all}} \right) + \frac{T_{x+n}^{-COD}}{l_0^{all}} \cdot \left(\frac{l_x^{all}}{l_x^{-COD}} - \frac{l_{x+n}^{all}}{l_{x+n}^{-COD}} \right), $$

where the superscripts *all* and *–COD* (maternal or infectious or non-communicable) indicate, respectively, with and without maternal or infectious or non-communicable causes of death. The first term at the right side of the equation refers to the direct effect of a change in mortality rates between ages x and $x + n$, whereas the second term refers to the sum of both the indirect and interaction effects of contributions resulting from the number of person-years to be added because of additional survivors at age $x + n$ exposed to the new mortality conditions. The equation used for the open-ended interval is as follows:

$$ {}_\infty\Delta_x = \frac{l_x^{all}}{l_0^{all}} \cdot \left(\frac{T_x^{-COD}}{l_x^{-COD}} - \frac{T_x^{all}}{l_x^{all}} \right). $$

Thus, the change in life expectancy ($l_0{}^{o(-COD)} - l_0{}^{o(all)} \sum_x {}_n\Delta_x$) can be decomposed according to the contribution of the different age groups.

Appendix IV

Study Questionnaire

KINTAMPO HEALTH RESEARCH CENTER KINTAMPO HEALTH AND DEMOGRAPHIC SURVEILLANACE SYSTEM ADULT VPM FORM 060206 ENG	ADULT VPM Form No.

1. BACKGROUND and ID:

1.1 Cluster code:……..

1.2 Deceased woman's ID:…….

1.3 Deceased woman's name:……

1.4. Woman's KDSS ID [09090909090 = NA]

1.5 Deceased woman's age:……..

1.6 Age group:…….

1. 15 –19 yrs	2. 20 – 45 yrs	3. 45+ yrs

1.7 Date of death: ……..……..

1.8 Date of visit: ……..

1.9 Staff code: ……..…….……

1.10 Is a respondent available?..... 1. Yes 2. No

1.11 What is the respondent's name?.....

1.12 Respondent's age……..

1.11 What is your relation to the deceased? Are you her husband, mother etc…?

11. Husband	12. Mother	13. Sister	14. Mother-in-law
15. Sister-in-law	16. Friend	17. Daughter	18. Son
19. Brother	20. Brother-in-law	21. Father	22. Father-in-law
23. Uncle	24. Aunt	25. Other:	

2. CIRCUMSTANCES SURROUNDING HER DEATH:

2.1 Where did she die?

1. Clinic/hospital or maternity home	2. On way to hospital/clinic	3. At TBA/healer's home, or spiritualist
4. At home	5. Other (Specify):	

2.2 IF THE ANSWER TO 2.1 IS 1, STATE WHERE. [USE CODE FROM FACILITY KEY]…….

2.3 IF SHE DIED OUTSIDE THE HOME:
Was she conscious when she arrived at where she died?..... 1. Yes 2. No 8. NK 9. NA

2.4 Were you present at the time she died?..... 1. Yes 2. No

2.5 Were you present when her condition started to deteriorate?..... 1. Yes 2. No

2.6 Did you care for her in the final illness/period leading to her death?..... 1. Yes 2. No

2.7 TYPE OF DEATH

These questions are extremely important. We may not know from the monthly visits that the woman was pregnant, especially if she was early on in her pregnancy. Please ask these questions carefully and sensitively to make sure that we are certain of the pregnancy status of the woman when she died.

2.7.1	Was she pregnant when she died?.....	1. Yes	2. No	8. NK
2.7.1.1	If so, what month in pregnancy did she die? 99 = Not applicable; did not die in pregnancy……			
2.7.2	Did she die during labour or delivery?.....	1. Yes	2. No	8. NK
2.7.2.1	At what month did the pregnancy end? 99 = Not applicable; was still pregnant at the time she died……..			
2.7.3	Did she die soon after delivery, that is, within 24 hours?.....	1. Yes	2. No	8. NK
2.7.4	Did she die within the 42 days after delivery?.....	1. Yes	2. No	8. NK
2.7.4.1	How many days after delivery did she die? [99 = NA]……..……			
2.7.5	Was she nursing an infant at the time of her death, that is, did she have a baby who was less than 12 months of age?.....	1. Yes	2. No	8. NK
2.7.6	Did she have an abortion before her death?.....	1. Yes	2. No	8. NK
2.7.6.1	How many days before her death did she have an abortion? [99 = NA]……..…….			

2.8 Did she want this pregnancy?.....	1. Yes	2. No	8. NK	9. NA
2.9 Do you think she did anything to make the pregnancy end?.....	1. Yes	2. No	8. NK	9. NA

3. DETAILS OF EVENTS SURROUNDING HER DEATH (ADDITIONAL SPACE ON NEXT PAGE)

3.1 *Write the details surrounding the death event from the beginning. Probe for what problems developed, who did she see, where did she go, how was she treated. Also ask how much time it took from one intervention to the other.*

If she was pregnant ask about events related to care in pregnancy and delivery and ask what happened to the baby.

If the informant says that they think she tried to do something to end the pregnancy, please ask them to elaborate here.

You can carefully probe for this by asking "did she do anything to bring back her menses? For example, did she use enema, herbs, or drug store medicine?"

NOTE FOR SUPERVISOR: Please write in the space below if you suspect that this woman may have had an abortion and, if yes, the reason why you suspect this. You should also confer with the fieldworker from this area if necessary.

3.2 SUMMARY OF SIGNS AND SYMPTOMS REPORTED BY RESPONDENT

Symptoms	Day since start of illness	Duration (days)	Severity Mild/Moderate=1 Severe=2
3.2.1			
3.2.2			
3.2.3			
3.2.4			
3.2.5			
3.2.6			
3.2.7			
3.2.8			
3.2.9			
3.2.10			

3.3 LIST OF HOSPITAL ADMISSIONS IN THE PAST 2 YEARS (BEGIN WITH MOST RECENT)

Name of health facility	Date (day/month/year)	Reasons for hospitalisation
3.3.1	/ /	
3.3.2	/ /	
3.3.3	/ /	
3.3.4	/ /	
3.3.5	/ /	

3.4 INJURIES

3.4 Did she sustain any injury which led to her death?.....	1. Yes	2. No	8. NK

3.4.1 If yes, what kind of injury or accident? (*Allow respondent to answer spontaneously*)

1. Transport accident (pedestrian)	2. Transport accident (passenger/driver)	3. Fall	4. Drowning
5. Poisoning	6. Dog bite	7. Snake bite	8. Other animal bite or sting
9. Burn	10. Firearm	11. Sharp object (e.g. knife)	12. Circumcision
13. Other assault or abuse	14. Other injury	99. NA, no injury	

Please specify if other bite, other assault or other injury….. _____ OTHINJ

3.4.2 Was the injury accidental or intentional?.	1. Accidental	2. Intentional	8. NK

3.4.3 Did she die at the site where the accident or injury occurred?.....	1. Yes	2. No	8. NK

3.4.4 How long after the accident did she survive?.....	1<24 hours	2.>24 hours	8. NK

3.4.5 After the accident, did she receive medical care before she died?.....	1. Yes	2. No	8. NK

3.4.6 Do you think she may have done something to end her own life?.....	1. Yes	2. No	8. NK

3.4.6.1 If yes, how did she commit suicide?

1. Hanging	2. Poisoning	3. Burns	4. Gunshot	5. Other (specify below)	9. NA

3.4.6.2 If yes, why?.... _____

3.5 DURATION OF ILLNESS

3.5.1 For how long (in days) was she ill before she died? [88 = not known].....				
3.5.2 Was she ill in the last month before her death (including before an accident or injury)?.....	1. Yes	2. No	8. NK	
3.5.3 Was this a new illness, or something she had frequently suffered from in the past?.....	1. Yes, new illness	2. No, old illness	8. NK	9. NA
3.5.4 Did she die suddenly, or was it expected that she was going to die?.....	1. Yes, suddenly	2. No, knew she would die	8. NK	

4. DEATH DURING PREGNANCY, LABOUR AND DELIVERY, OR AFTER A RECENT DELIVERY

COMPLETE THIS SECTION IF THE WOMAN DIED DURING PREGNANCY, LABOUR OR DELIVERY, OR IF SHE HAD A DELIVERY OR ABORTION IN THE 6 WEEKS BEFORE SHE DIED

DEATH DURING PREGNANCY OR AFTER AN ABORTION: QUESTION 2.7.1 or 2.7.6 = Yes, COMPLETE ONLY SECTION 4.1
DEATH DURING LABOUR: QUESTION 2.7.2 = Yes, COMPLETE ONLY SECTIONS 4.1 AND 4.2
DEATH AFTER DELIVERY: QUESTION 2.7.3 = Yes, OR QUESTION 2.8.4 = Yes, COMPLETE THE WHOLE OF SECTION 4 (i.e. 4.1; 4.2 AND 4.3)
OTHERWISE DRAW A DOUBLE HORIZONTAL LINE THROUGH THIS SECTION AND PROCEED WITH SECTION 5.

4.1 NOW I'D LIKE TO ASK ABOUT PROBLEMS SHE MAY HAVE EXPERIENCED DURING THE PREGNANCY:

4.1.1 How would you describe her health in general before the pregnancy where she died?.....	1. Excellent	2. Good	3. Poor	8. NK

Can you let me know if she experienced any of the following?

4.1.2 Convulsions:……..		1. Yes	2. No	8. NK
4.1.2.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.2.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.3 Swelling of the face……..		1. Yes	2. No	8. NK
4.1.3.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.3.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.4 Swelling of the hands……..		1. Yes	2. No	8. NK
4.1.4.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.4.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.5 Blurring of vision……		1. Yes	2. No	8. NK
4.1.5.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.5.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.6 Severe headache, to the degree that she was not able to work……..		1. Yes	2. No	8. NK
4.1.6.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.6.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.7 Doctor or nurse said she had "eclampsia" or severe hypertension:…….		1. Yes	2. No	8. NK
4.1.7.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.7.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.8 Bleeding in pregnancy?.....		1. Yes	2. No	8. NK
4.1.8.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.8.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.9 Abdominal pain with bleeding?.....		1. Yes	2. No	8. NK
4.1.9.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]…….				
4.1.9.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA

4.1.10 Did she complain that she could not feel the baby move?.....		1. Yes	2. No	8. NK
4.1.10.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.10.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.11 Severe and continuous abdominal pain that was not labour pain?.....		1. Yes	2. No	8. NK
4.1.11.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.11.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.12 Foul smelling vaginal discharge in pregnancy?.....		1. Yes	2. No	8. NK
4.1.12.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.12.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.13 Very hot fever at any time during pregnancy?.....		1. Yes	2. No	8. NK
4.1.13.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.13.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.14 Eyes became yellow?.....		1. Yes	2. No	8. NK
4.1.14.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.14.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.15 Urine became dark like coca cola……..		1. Yes	2. No	8. NK
4.1.15.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.15.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.16 Did a doctor examine her blood and told her she was short of blood?.....		1. Yes	2. No	8. NK
4.1.16.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.16.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.17 Did she have palpitations and shortness of breath?.....		1. Yes	2. No	8. NK
4.1.17.1 At what month of pregnancy did this first occur? [88 = NK; 99 = NA]……...				
4.1.17.2 Did this also occur in the 7 days leading to her death?.....	1. Yes	2. No	8. NK	9. NA
4.1.18 Did she have any other serious problem during the pregnancy?.....		1. Yes	2. No	8. NK

4.1.19 What?

_____

4.2 DEATH DURING LABOUR, DELIVERY, OR UP TO 6 WEEKS AFTER DELIVERY

IF SHE DIED DURING PREGNANCY, THAT IS, BEFORE THE ONSET OF LABOUR, DRAW A DOUBLE LINE THROUGH SECTIONS 4.2 AND 4.3 AND CONTINUE WITH SECTION 5.1

4.2.1 Did the waters break before labour or during labour?.....

1. Before labour started	2. During labour	8. Don't know

4.2.2 How much time before she started labour did the waters break?

1.Less than 4 hours	2. 4 to 24 hours	3. More than 24 hours	8. Don't know	9. NA, broke during labour

4.2.3 How long was it from when she started labour pains till she delivered (or died)? [DAYS:HOURS]……..

4.2.4 How long was it from when she started strong and regular labour pains till she delivered or died? [DAYS:HOURS]……

	:			
	:			

4.2.5 Did anyone give her any herbs or drugs to encourage labour?.....

4.2.6 Did they put any IV drip before the delivery or before she died?.....

1. Yes	2. No	8. NK
1. Yes	2. No	8. NK

4.2.7 In the opinion of the most experienced person who was around:

4.2.7.1 Was the length of labour short, normal or long?.....

4.2.7.2 Was the labour difficult?.....

1. Short	2. Normal	3. Too long	8. NK	9. NA, died
	1. Yes	2. No	8. NK	9. NA, died

4.2.8 How many babies did she delivered?.....

4.2.9 What happened to the first baby?

1. "wawo" (term live birth)	2. "wawo atwene" (term stillbirth)	3. "wasane awoe" (live birth, but died)
4. "wapon ba" (premature, lost the baby)	5. ectopic	6. "apon"/"asei" (lost before 6mo)

4.2.10 What happened to the second baby?

1. "wawo" (term live birth)	2. "wawo atwene" (term stillbirth)	3. "wasane awoe" (live birth, but died)	
4. "wapon ba" (premature, lost the baby)	5. ectopic	6. "apon"/"asei" (lost before 6mo)	9. NA, one child

4.2.11 What happened to the third baby?

1. "wawo" (term live birth)	2. "wawo atwene" (term stillbirth)	3. "wasane awoe" (live birth, but died)	
4. "wapon ba" (premature, lost the baby)	5. ectopic	6. "apon"/"asei" (lost before 6mo)	9. NA, one child

4.2.12 Where did she give birth?

1. Clinic or hospital	2. Private maternity home	3. At home/TBA
4. Other: ……	5. On the way to hospital	8. NK

4.2.13 IF THE ANSWER IS 1 OR 2, STATE WHERE. [USE CODE FROM FACILITY KEY]……

4.2.14 Who delivered the baby?.....

1. Doctor	2. Midwife	3. TBA	4.Other person/relative	5. Delivered herself alone	8. NK

4.2.15 Did she have a delivery through the vagina?.....

1.Normally, through the vagina	2. Baby was pulled with an instrument	3. By CS	8. NK

4.2.16 Which part of the baby came out first?.....

1. Head	2. Feet/bottom	3. CS	8. NK

4.2.17 Did she know she was going to have a CS before she went into labour?.....

1. Yes	2. No	8. NK	9. NA; no CS

4.2.18 What made the doctor decide to do a CS?

1. Bleeding during pregnancy (APH)	2. Obstructed labour	3. Previous CS	4. Toxaemia
5. Malpresentation	6. Other:	8. NK	9. NA; no CS

4.2.19 Did the placenta come out on its own?.....	1. Yes	2. No	8. NK
4.2.20 How long after the baby came out did the placenta come out? (in hours)……..			
4.2.121 Did someone have to put his/her hand inside her womb to remove the placenta?.....	1. Yes	2. No	8. NK

4.2.22 Who did this?..	1. Doctor	2. Midwife	3. TBA	4.Other person/relative:	8. NK	9. NA

Now I'd like to ask about problems she may have experienced during labour.

Can you let me know if she experienced any of the following?

4.2.23 Excessive bleeding during labour……..	1. Yes	2. No	8. NK
4.2.24 Convulsions during labour …….	1. Yes	2. No	8. NK
4.2.25 Fever during labour…….	1. Yes	2. No	8. NK
4.2.26 Loss of consciousness during labour……..	1. Yes	2. No	8. NK
4.2.27 Burst or torn womb during delivery……	1. Yes	2. No	8. NK

4.3 DEATH DURING DELIVERY OR UP TO 6 WEEKS AFTER DELIVERY

IF SHE DIED DURING PREGNANCY OR LABOUR, DRAW DOUBLE HORIZONTAL LINE THROUGH THIS SECTION

Now I'd like to ask about problems she may have experienced after delivery.

Can you let me know if she experienced any of the following?

4.3.1 Tear in the vagina after delivery……..	1. Yes	2. No	8. NK

4.3.2 Heavy bleeding after delivery…….	1. Yes	2. No	8. NK	
4.3.2.1 How many days after delivery did this occur?.....				
4.3.2.2 How many days did it last for?.....				
4.3.3 Convulsions after delivery……	1. Yes	2. No	8. NK	
4.3.3.1 How many days after delivery did this occur?.....				
4.3.4 Fever after delivery…….	1. Yes	2. No	8. NK	
4.3.4.1 How many days after delivery did this occur?.....				
4.3.4.2 How many days did it last for?.....				

4.3.5 Loss of consciousness after delivery……..	1. Yes	2. No	8. NK	
4.3.5.1 How many days after delivery did this occur?.....				
4.3.5.2 How many days did it last for?.....				
4.3.6 Foul discharge from the vagina……..	1. Yes	2. No	8. NK	
4.3.6.1 How many days after delivery did this occur?.....				
4.3.6.2 How many days did it last for?.....				
4.3.7 Yellow eyes after delivery……..	1. Yes	2. No	8. NK	
4.3.7.1 How many days after delivery did this occur?.....				
4.3.7.2 How many days did it last for?.....				
4.3.8 Urine dark like coca cola after delivery……..	1. Yes	2. No	8. NK	
4.3.8.1 How many days after delivery did this occur?.....				
4.3.8.2 How many days did it last for?.....				
4.3.9 Chest pain……	1. Yes	2. No	8. NK	
4.3.9.1 How many days after delivery did this occur?.....				
4.3.9.2 How many days did it last for?.....				

4.3.10 Did she have any other problem during labour or delivery?.....	1. Yes (specify):		2. No	8. NK
4.3.10.1 When did this occur?.....	1. During labour	2. After delivery	8. NK	9. NA

4.3.11 Was any operation done for her after she delivered?.....	1. Yes	2. No	8. NK

4.3.11.1 What operation?.....	1. Sewing her "under"	2. Sewing her womb	3. Removing her womb	
	4. D and C or EOU	5.Other:	8. NK	9. NA

4.3.11.2 Who did this?..	1. Doctor	2. Midwife	4.Other:	8. NK	9. NA

4.3.11.3 Where was this done?
[USE FACILITY KEY CODE; 88 = NK; 99 = NA] _____

4.3.11.4 Was she put to sleep for this operation?.....	1. Yes	2. No	8. NK	9. NA

5. ADULT VERBAL AUTOPSY

THE QUESTIONS IN SECTIONS 5.1 AND 5.2 ASK ABOUT THE OCCURRENCE AND DURATION OF SPECIFIC SYMPTOMS DURING THE TERMINAL ILLNESS. ENTER 90 IF DURATION IS 3 MONTHS AND ABOVE.

Now I would like to check whether she had any of the following:

5.1 FEVER

5.1.1 Did she have fever?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.1.2 Was the fever……..……	1. Mild or moderate	2. Extremely high	8. NK	9. NA, no fever		
5.1.3 Was the fever continuous or on and off?.....	1. Yes, continuous	2. No, on and off	8. NK	9. NA, no fever		
5.1.4 Did she have chills and/or rigors?.....	1. Yes	2.No	8. NK			
5.1.5 Did she have night sweats?.....	1. Yes	2. No	8. NK			

5.2 HEART AND LUNG SYMPTOMS

5.2.1 Did she have chest pain?...	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.1.1 If yes, where was the pain?.....	1. Over the sternum	2. Over the heart/ in the arm	3. In the ribs	9. NA, no chest pain		
5.2.2 Did the pain start suddenly or gradually?.....	1. Yes, started suddenly	2. No, was gradual	8. NK	9. NA, no chest pain		
5.2.3 When resting, was the pain…..……?	1. Continuous	2. On and off	8. NK	9. NA, no chest pain		
5.2.4 During activity, was the pain……?	1. Continuous	2. On and off	8. NK	9. NA, no chest pain		

5.2.5 When she had an attack of the pain, how long did it last?.....	1. <30 min	2. >30 min, but <24 hrs	3. >=24 hrs	8. NK	9. NA, no chest pain

5.2.6 Was she breathless on light work?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.7 Was she breathless on lying flat?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.8 Did she have ankle swelling?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.9 Did she have palpitations?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.10 Did she look pale?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.11 Did she have puffiness of face?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.12 Did she have wheezing?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.13 Did she have noisy breathing?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.14 Did she have dry cough?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.15 Did she have productive cough?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.2.16 Was she coughing blood?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.2.17 If she had a cough, when was it worse?.....	1. Day	2. Night	3. Same	8. NK	9. NA

5.3 APPETITE, WEIGHT LOSS AND SWALLOWING

5.3.1 Did she have poor appetite?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.3.2 Did she have weight loss?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.3.2.1 If she had weight loss, how long did she have this before her death ?	1. Days	2. Months	3. Years	8.NK	9. NA

5.3.2.2 If she had weight loss, was it……	1. Mild/Moderate (a little)	2. Severe (a lot)	8. NK	9. NA

5.3.3 How did she look at the end of her life?.....	1. Normal	2. Extremely thin and wasted	8. NK	9. NA

5.3.4 Did she have mouth sores?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.3.5 Did she complain pain on swallowing?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.3.6 Did she have difficulty in swallowing?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.4 ABDOMINAL SYMPTOMS

5.4.1 Did she have abdominal pain?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.4.1.1 What type of pain was it?.....	1. Cramp	2. Dull ache	3. Burning pain	4. Other	8. NK	9. NA
5.4.1.2 Was the pain in upper, lower, or all over her abdomen?.....	1. Upper abdomen	2. Lower abdomen	3. All over abdomen	4. Middle abdomen	8. NK	9. NA
5.4.1.3 What was the severity of the pain?.....	1. Mild or moderate		2. Severe		8. NK	9. NA

5.4.2 Was she unable to pass stool before her death?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.4.3 Did she have a mass in the abdomen?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.4.4 Where exactly was the mass?.....	1. Right upper abdomen	2. Left upper abdomen	3. Lower abdomen	4. Other	8. NK	9. NA

5.4.5 Did she have abdominal distension?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.4.5.1 Did the distension start suddenly (days) or gradually (over weeks)?	1. Suddenly, in days	2. Gradually, over weeks	8. NK	9. NA, no Distension

5.4.6 Did her eye colour change to yellow (jaundice)?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.5 DIARRHOEA AND VOMITING

5.5.1 Did she vomit?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.5.1.1 When the vomiting was most severe, how many times did she vomit in a day? [88=NK; 99=NA]……....		

5.5.1.2 What did the vomit look like?.....	1. Watery fluid	2. Yellowish fluid	3. Coffee coloured fluid	4. Blood	
	5. Faecal matter	6. Other (specify) ……		8. NK	9. NA

5.5.2 Did she have diarrhoea?....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.5.2.1 Was the diarrhoea continuous?.....	1. Yes	2. No	8. NK	9. NA, no Diarrhoea
5.5.2.2 What was the consistency of stools?	1. Soft	2. Watery	8. NK	9. NA, no Diarrhoea
5.5.2.3 When the diarrhoea was most severe, how many times did she pass stool in a day? [88=NK; 99=NA]……..				

5.5.3 Did she have bloody diarrhoea?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.5.4 Did she have sunken eyes?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	

5.6 URINARY SYMPTOMS

5.6.1 Was there a change in the colour of the urine?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.6.2 What was the colour of her urine?.....	1. Dark yellow	2. Coffee-like	3. Blood stained	8. NK	9. NA
5.6.3 Did the amount of urine she passed daily change?...	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.6.4 How much urine did she pass in a day?.....	1. Too much	2. Too little	3. No urine at all	8. NK	9. NA
5.6.5 Did she have difficulty or pain in passing urine?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	

5.6.5.1 What type of difficulty did she have?.....	1. Unable to pass urine	2. Continuous dribbling	3. Burning sensation	4. Intense pain
	5. Other …….		8. NK	9. NA

5.7 NEUROLOGICAL SYMPTOMS

5.7.1 Did she have headache?....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.7.2 Did she become mentally confused?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.7.3 Did she have loss of consciousness?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	

5.7.4 Did she become confused or unconscious suddenly or gradually?...	1. Suddenly (within hours)	3. Within a day	8. NK
	4. Slowly over a few days	5. Other …….	9. NA

5.7.5 Was she paralysed on one side of the body?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.7.6 Did she have paralysis of both legs?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	

5.7.7 How long did the paralysis take to develop?..	1. Instantly	2. Hours	3. Days	4. Months
	5. Years	8. NK	9. NA	

5.7.8 Did she have neck pain?....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.7.9 Did she have a stiff neck?.	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	
5.7.10 Did she develop stiffness of the whole body?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]	

5.7.11 Did she have fits?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.7.11.1 Did she have stiffness of the whole body during fits?	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.7.11.2 When the fits were most frequent, how many did she have in a day? [88=NK; 99=NA]……..						
5.7.11.3 Between fits, was she……	1. Awake	2. Unconscious	8. NK	9. NA, no fits		
5.7.11.4 Did she have difficulty in opening her mouth during fits?.....	1. Able to open	2. Unable to open	8. NK	9. NA, no fits		
5.7.12 Did she have pins and needles in feet?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.8 RASHES, ULCERS AND SWELLINGS

5.8.1 Did she have any rash?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.8.1.1 If yes, where was the rash?...	Face	1. Yes	2. No	8. NK	9. NA
	Trunk	1. Yes	2. No	8. NK	9. NA
	Extremities	1. Yes	2. No	8. NK	9. NA
	All over the body	1. Yes	2. No	8. NK	9. NA
	Other: (specify)	1. Yes	2. No	8. NK	9. NA

5.8.1.2 If yes, what did the rash look like?

1. Measles	2. Rash with clear fluid	3. Rash with pus	4. Other (specify)	8. NK	9. NA

5.8.1.3 Did the skin crack/split or peel after the rash started?.....	1. Yes	2. No	8. NK	9. NA

5.8.2 Did she have red eyes?.....	1. Yes	2. No	8. NK
5.8.3 Did she have itching of skin?.....	1. Yes	2. No	8. NK

5.8.4 Did she have ulcer or swelling in breast?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.8.5 Did she have ulcer on any other part of the body?.....	1. Yes	2. No	8. NK	
5.8.5.1 If yes, please specify where the ulcer was...			9. NA	

5.8.6 Did she have swelling in the neck?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.8.7 Did she have swelling in the armpit?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.8.9 Did she have swelling in the groin?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.8.10 Did she have swelling of joints?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.9 ABNORMAL BLEEDING AND DISCHARGE

5.9.1 Did she have bleeding from the body openings (other than her normal menstruations)?.....	1. Yes	2. No	8. NK

5.9.2 Did she have abnormal vaginal bleeding?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		
5.9.3 Did she have abnormal vaginal discharge?.....	1. Yes	2. No	8. NK	For how long? (in days) [99=NA]		

5.10 MEDICAL CARE

5.10.1 Had she been admitted to hospital for more than 2 days in the past 12 months?

1. Yes, for illness/complication related to pregnancy or childbirth	2. Yes, for other illness	3. Yes, for accident/injury	4. No	8. NK

5.10.2 Where was she admitted?
[USE FACILITY KEY CODE; 88 = NK; 99 = NA] _____

5.10.3 Did she have any operation before death?.....	1. Yes	2. No	8. NK
5.10.4 How many days before death did s/he have the operation? [88=NK; 99=NA]…..…			

5.10.5 If yes, what was the site of the operation?.....	1. Abdomen	2. Heart	3. Head
	4. Other	8. NK	9. NA

Has a 'doctor' ever told her she had any of the following illnesses?

5.10.6	Heart disease?	1. Yes	2 No	8. NK
5.10.7	Hypertension?	1. Yes	2 No	8. NK
5.10.8	Varicose veins?	1. Yes	2 No	8. NK
5.10.9	Kidney disease?	1. Yes	2 No	8. NK
5.10.10	Asthma?	1. Yes	2 No	8. NK
5.10.11	TB?	1. Yes	2 No	8. NK
5.10.12	Epilepsy?	1. Yes	2 No	8. NK
5.10.13	Diabetes?	1. Yes	2 No	8. NK
5.10.14	Jaundice or hepatitis?	1. Yes	2 No	8. NK
5.10.15	Leprosy?	1. Yes	2 No	8. NK
5.10.16	Cancer?	1. Yes	2 No	8. NK
	5.10.16.1 If yes, please specify type:			
5.10.17	HIV/AIDS?	1. Yes	2 No	8. NK
5.10.18	Any other serious illness:	1. Yes	2 No	8. NK

5.10.18.1 If yes, please specify: …… _____

5.10.19 Did she REGULARLY take any medicines for an illness or health condition?.....	1. Yes	2. No	8. NK
5.10.20 Did she receive any drugs during her final illness?.....	1. Yes	2. No	8. NK
5.10.21 Did she receive any antibiotics during her final illness?.....	1. Yes	2. No	8. NK
5.10.22 Did she receive any anti-malarial drug during the illness?.....	1. Yes	2. No	8. NK

5.10.22.1 What kind of antimalarial did she receive?.....	1. Chloroquine	2. Fansidar	3. Quinine	
	4. Amodiaquine	5. Other	8. NK	9. NA

5.11 CAUSE OF DEATH

5.11.1 Do you know the cause(s) of her death?.....	1. Yes	2. No	8. NK

5.11.2 What do you personally think was the cause of her death?

_____

_____

5.11.3 Did anybody tell you the cause of her death? Who?

1. Yes, doctor	2. Yes, nurse	3. Yes, other health worker	4. Yes, other health provider	5. Other person	6. No

5.11.4 What did they say it was?

_____

_____

5.11.5 Is there anything more concerning her death, which I have not asked about, that you want to tell me?

_____

_____

6. SOCIO ECONOMIC CHARACTERISTICS

Now, I would like to ask some questions about her personal details and her household

6.1 Did she attend school? What is the highest educational level that she reached?

1. None [CODE 99 FOR 6.2]	2. Primary school	3. Middle/continuation school, JSS
4. Technical/commercial/SSS secondary school	5. Post-middle college – teacher training, secretarial	6. Post secondary – nursing, teacher, polytechnic, etc.
7. University	8. Not known	

6.2 Number of years successfully completed at the highest level reached [88 = NK]…….. | | |

6.3 Was she single, married, or living with a man, or widowed, divorced, or separated?.....

1. Married	2. Living together	3. Widowed	
4. Divorced	5. Separated	6. Single, unmarried	8. NK

6.4 What was her religion?

1.Catholic	2. Protestant	3. Pentecostal	4. Muslim	5. Traditional African Religion	6. Other:	8. NK

6.5 Which ethnic group did she belong to?.....

11. Akan: Bono, Ashanti, Fanti.	12. Bimoda, Chokosi,Kokosi	13. Dagarti, Frafra, Kusasi	14. Fulani
15. Ga, Adangbe, Ewe	16. Gonja, Dagomba, Mamprusi	17. Konkomba, Basare	18. Mo
19. Sisala, Wala	20. Zambraba	21. Banda/Pantra	22. Other:

6.6 Did she own any land?..... | 1. Yes | 2. No |

6.7 Did she have land to farm on?.....

1. Yes, her own	2. Yes, part of family land	3. Yes part of husband's	4. Yes, rented land	5. No	8. NK

6.8 What did she grow on her land?

1. Food items, mainly for home consumption	2. Food items, mainly for sale on the market	3. Cash crops: yam, tobacco, maize, tomatoes, etc.	8. NK	9. NA, no farm

6.9 Did she have a regular cash income/was she a salaried worker?

1. Yes, professional – teacher, nurse, accounts, administrative	2. Yes, clerical/secretarial	3. Yes, seamstress, hairdresser etc.		
4. Yes, trader/food seller	5. Yes, labourer/domestic worker	6. Other:	7. No	8. NK

SAY NOW YOU ARE GOING TO ASK ABOUT HER 'HOUSEHOLD' AT THE TIME OF HER DEATH AND EXPLAIN WHAT A HOUSEHOLD IS

6.10. Who was the household head?

1. Her	2. Her husband	3. Her father	4. Her mother	5. Other:	8. NK

6.11. In what year was the household head born? [88 = NK]…… | 1 | 9 | | |

6.12. How old is the household head now (in years)? [88 = NK]…… | | |

6.13. What was the household head's highest educational level reached?

1. None	2. Primary school	3.Middle,continua-tion school, JSS	4. Technical, commercial, SSS, Secondary school
5. Post-middle college, teacher training, secretarial	6. Post secondary, nursing, teacher, polytechnic	7. University	8. Not known

6.14. What was the number of years that the household head completed at the highest level reached? [88 = NK, 00 = no education]…… ……..…….……. | | |

6.15. Did the household head have a regular cash income or salaried job?

1. Professional – teacher, nurse, accounts, administrator etc.	2. Clerical / secretarial	3. Trader / businessman / driver with own car etc.	4. Employed tradesman, driver without own car, builder, etc.	
5. Farmer/labourer/domestic worker	6. Other:		7. No	8. NK

6.16. Did members of the household do any farming?.....	1. Yes	2. No
6.17. Did anyone in the household own any land?.....	1. Yes	2. No
6.18. Did anyone in the household own their own farm?.....	1. Yes	2. No

6.19. What did they grow?

1. Food items, mainly for home consumption	2. Food items, mainly for sale on the market	3. Cash crops – yam, tobacco, maize, tomatoes, etc.	9. NA, no farm

6.20. Did anyone in the household own:…..	Chickens or ducks?	1. Yes	2. No
	Sheep or goats?	1. Yes	2. No
	Other animals?	1. Yes	2. No
	Table?	1. Yes	2. No
	Sleeping mattress?	1. Yes	2. No
	Cupboard, wardrobe, room divider?	1. Yes	2. No
	Mosquito net?	1. Yes	2. No
	Sewing machine?	1. Yes	2. No
	Bicycle?	1. Yes	2. No
	Radio?	1. Yes	2. No
	TV?	1. Yes	2. No
	Gas or electric cooker?	1. Yes	2. No
	Fridge or freezer?	1. Yes	2. No
	Motorcycle?.....	1. Yes	2. No
	Car?.....	1. Yes	2. No

6.21. Did her household have electricity?.....	1. Yes	2. No

6.22. What was the main source of drinking water for members of the household?

11. Piped into dwelling/yard/plot	12. Public tap	13. Handpump / closed bore hole	14. Closed well	15. Open well
16. Stream / river	17. Lake / dam /pond	18. Water trucks	19.Rain water	20. Other

6.23. How long did it take for her to go there, get water and come back?

1. Less than 15 minutes	2. 15 minutes- less than 30 minutes	3. 30 minutes – less than 60 minutes
4. 60 minutes or more	9. NA / drinking water source is in compound	

6.24. What kind of toilet facility did the household have?

1. Flush latrine / WC	2. Ventilated improved pit /VIP /KVIP	3. Other pit latrine	4. Open fields
5. Defaecate in house, faeces transferred elsewhere / bucket latrine		6. Other:	

6.25. What were the total number of rooms in the household used for sleeping? 88 = NK..... | | |

6.26. What were the total number of people that slept in the household last night? 88 = NK..... | | |

6.27. Do she own or rent the house she lived in, or did she have another type of arrangement, such as "perching"?

1. Sole Ownership	2. Joint Ownership	3. Renting	4. Family/relation's house
5. House provided rent free	6. Perching	7. Other:	8. NK

WHAT MATERIALS WERE USED IN THE CONSTRUCTION OF HER HOUSE [OBSERVE IF POSSIBLE]?

6.28. Floor of sleeping room	1. Cement	2. Mud/clay	3. Other:	8. NK
6.29. Roofing	1. Metal/asbestos	2. Thatch/mud	3. Other:	
6.30. Wall	1. Cement	2. Mud	3. Other:	

6.31. Did her household have a separate room with a roof just for cooking?.....	1. Yes	2. No	8. NK
6.32. Did her household have a separate sleeping room for children?.....	1. Yes	2. No	8. NK
6.33. Did her household have a domestic worker not related to the household head?.....	1. Yes	2. No	8. NK

7. FERTILITY AND OBSTETRIC HISTORY

Now, I would like to ask you some questions about any pregnancies and children that she had.
[IF SHE DIED DURING PREGNANCY, LABOUR , DELIVERY OR 42 DAYS AFTER DELIVERY, EXCLUDE THAT PREGNANCY OR BIRTH]

7.1 How many male children of her own did she have that lived with her when she died?
[00 = NONE] EXCLUDE ANY BIRTH FROM THE PREGNANCY WHICH LED TO HER DEATH……..
7.2 How many male children of her own are living elsewhere? [00 = NONE]…… | | |

7.3 How many female children of her own did she have that lived with her when she died?
[00 = NONE] EXCLUDE ANY BIRTH FROM THE PREGNANCY WHICH LED TO HER DEATH……
7.4 How many female children of her own are living elsewhere? [00 = NONE]…… | | |

7.5 Did she have any children who were born alive but died later? How many?
[0 = NONE] EXCLUDE ANY BIRTH FROM THE PREGNANCY WHICH LED TO HER DEATH……
7.6 Did she ever lose a pregnancy? How many?
[0 = NONE] EXCLUDE THE PREGNANCY WHICH LED TO HER DEATH …….. | |

7.7 Did she ever have a stillbirth? How many?
EXCLUDE ANY BIRTH FROM THE PREGNANCY WHICH LED TO HER DEATH……
7.8 Did she ever have an ectopic? How many?
[0 = NONE]. EXCLUDE THE PREGNANCY WHICH LED TO HER DEATH…….. | |

CALCULATE THE TOTAL NUMBER OF PREGNANCIES SHE HAS HAD, THAT IS THE SUM FOR 7.1

TO 7.8 CHECK THIS NUMBER WITH HER IN 7.9 AS FOLLOWS:…… | |

7.9 I would like to check with you the total number of pregnancies she had.
From what you have told me, she had a total of [SUM] pregnancies, excluding the pregnancy which led to her death. Is this correct?..... | 1. Yes | 2. No

IF THE ANSWER IS NO, REPEAT QUESTIONS 7.1 TO 7.8 UNTIL YOU HAVE AGREEMENT

7.10 In the past, did she ever have a caesarean section (NB: before the pregnancy which led to her death?)…… | 1. Yes | 2. No

7.11 Before the pregnancy which led to her death, did she ever have a delivery where the baby had to be pulled out with an instrument?.....	1. Yes	2. No

7.12 DATE OF BIRTH OF LAST CHILD BEFORE THE PREGNANCY WHICH LED TO HER DEATH [090909 = No child]……						

7.13 Where did she deliver her last child, before the pregnancy which led to her death? [USE FACILITY KEY CODE; 98 = Home; 99 = NA, no child]……..		

8.0 LIFE STYLE

Now, I would like to end by asking a few questions about her personal habits.

8.1 ALCOHOL

8.1.1 Did the deceased ever drink alcohol?.....	1. Yes	2. No	8. NK

IF NO OR NOT KNOWN, DRAW A DOUBLE LINE THROUGH THE REMAINDER OF SECTION 8.1

8.1.2 How long had she been drinking alcohol?.....	1. Less than 1 year	2. 1-5 years	3. 6-10 years
	4. 11-15 years	5. >15 years	8. NK

8.1.3 How often did she drink alcohol?.....	1.Daily	2. Weekly	3.Fortnightly
	4. Once in a while	8. NK	

8.1.4 How often did she get drunk?..	1. Daily	2. Weekly	3. Fortnightly
	4. Once in a while	8. NK	

8.1.5 Which kind of alcohol did she consume?. (You may circle more than 1 option)	Beer	1. Yes	2 No	8. NK
	Spirits	1. Yes	2 No	8. NK
	Wines	1. Yes	2 No	8. NK
	Traditional brews	1. Yes	2 No	8. NK
	Traditional illicit brews	1. Yes	2 No	8. NK
	Other (SPECIFY) …….	1. Yes	2 No	8. NK

8.1.6 What was the source of the alcohol?..... (You may circle more than 1 option)	Bar	1. Yes	2 No	8. NK
	Brewed herself at home	1. Yes	2 No	8. NK
	Friends/relatives brew	1. Yes	2 No	8. NK
	Local traditional brewer	1. Yes	2 No	8. NK
	Other (SPECIFY) ……..	1. Yes	2 No	8. NK

8.1.7 Was she ever in trouble as a result of drinking alcohol?.....	1. Yes	2.No	8. NK

8.1.8 If yes, what sort of trouble?..... (You may circle more than 1 option)	Trouble with the law	1. Yes	2 No	8. NK
	Violence (domestic, rape…)	1. Yes	2 No	8. NK
	Got ill	1. Yes	2 No	8. NK
	Neglect of responsiblities (family break-up, job loss…)	1. Yes	2 No	8. NK
	Other (SPECIFY) …..	1. Yes	2 No	8. NK

8.2 TOBACCO SMOKING

8.2.1 Did the deceased ever smoke tobacco?.....	1. Yes	2. No	8. NK

IF NO OR NOT KNOWN, DRAW A DOUBLE LINE THROUGH THE REMAINDER OF SECTION 8.2

8.2.2 How long had she been smoking tobacco?.....	1. Less than 1 year	2. 1-5 years	3. 6-10 years
	4. 11-15 years	5. >15 years	8. NK

8.2.3 How often did she smoke?.....	1.Chain smoked	2. Hourly	3. Daily
	4. Weekly	5. Once in a while	8. NK

8.2.4 How much tobacco did she smoke per day?.....	1. Less than 5 sticks	2. < 1 packet	3. 2-5 packets
	4. > 5 packets	5. Other	8. NK

8.2.5 Which kind of tobacco did she consume?. (You may circle more than 1 option)	Filtered cigarette	1. Yes	2 No	8. NK
	Unfiltered cigarette	1. Yes	2 No	8. NK
	Pipe	1. Yes	2 No	8. NK
	Cigar	1. Yes	2 No	8. NK
	Other (SPECIFY) …….	1. Yes	2 No	8. NK

8.2.6 What was the source of the tobacco?..... (You may circle more than 1 option)	Bar	1. Yes	2 No	8. NK
	Local retailer	1. Yes	2 No	8. NK
	Home made pipe	1. Yes	2 No	8. NK
	Friends or relatives	1. Yes	2 No	8. NK
	Other (SPECIFY) ……..	1. Yes	2 No	8. NK

8.3 DRUG USE

8.3.1 Did the deceased ever take drugs to get high?.....	1. Yes	2. No	8. NK

IF NO OR NOT KNOWN, DRAW A DOUBLE LINE THROUGH THE REMAINDER OF SECTION 8.3

8.3.2 How long had she been using drugs to get high?.....	1. Less than 1 year	2. 1-5 years	3. 6-10 years
	4. 11-15 years	5. >15 years	8. NK

8.3.3 How often did she use drugs to get high?.....	1. Daily	2. Weekly	3. Fortnightly
	4. Monthly	5. Once in a while	8. NK

8.3.5 Which type of drugs did she consume?..... (You may circle more than 1 option)	Heroin	1. Yes	2 No	8. NK
	Cocaine	1. Yes	2 No	8. NK
	Ecstacy	1. Yes	2 No	8. NK
	Marijuana	1. Yes	2 No	8. NK
	LSD	1. Yes	2 No	8. NK
	Prescription drugs (specify)..	1. Yes	2 No	8. NK
	Anabolic steroids	1. Yes	2 No	8. NK
	Inhalants	1. Yes	2 No	8. NK
	Others (specify) …..	1. Yes	2 No	8. NK

8.3.6 Was she ever in trouble as a result of taking drugs?.....	1. Yes	2.No	8. NK

8.3.7 If yes, what sort of trouble?..... (You may circle more than 1 option)	Trouble with the law	1. Yes	2 No	8. NK
	Violence (domestic, rape…)	1. Yes	2 No	8. NK
	Got ill	1. Yes	2 No	8. NK
	Neglect of responsiblities (family break-up, job loss…)	1. Yes	2 No	8. NK
	Other (SPECIFY)…..	1. Yes	2 No	8. NK

END OF ADULT VPM FORM. CHECK YOUR FORM AND THANK THE RESPONDENT

Appendix V

Verbal Autopsy Coding Sheet