UNIVERSITY OF GHANA

ERROR ASSESSMENT IN THE APPLICATION OF FOREIGN LIFE TABLES IN GHANA AND COMPETING RISK ANALYSIS

BY

EMMANUEL KOJO AIDOO

(10336154)

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DECLARATION

Candidate's Declaration

I, Emmanuel Kojo Aidoo hereby declare that apart from references to other people's publications, which have been duly acknowledged, this thesis is a result of my independent ideas, thought, deliberations and has not been submitted for the award of any degree at this institution and other universities elsewhere.

SIGNATURE: …………………………………… DATE: ………………

EMMANUEL KOJO AIDOO

(10336154)

Supervisors' Declaration

We hereby certify that this thesis was prepared from the candidate's own work and supervised in accordance with guidelines on supervision of thesis laid down by the University of Ghana.

SIGNATURE: …………………………………… DATE: ………………

DR. ISAAC BAIDOO

(PRINCIPAL SUPERVISOR)

SIGNATURE: …………………………………… DATE: ………………

DR. KWABENA DOKU-AMPONSAH

(CO-SUPERVISOR)

ABSTRACT

The application of foreign life table in Sub-Sahara Africa had been a major concern all over the world. However, assessing the error for applying the foreign life tables as well as analysing the impact of the leading causes of death on Ghanaian longevity had not been studied. This study aimed at assessing the error of applying Foreign Life Tables in Ghana and analysing the impacts of the leading causes of death in Ghana. A cohort data of 3260 were collected from the University of Ghana Hospital and the causes of death and the gender of each respondent were recorded. The study revealed that Ghanaians life expectancy at birth is 51.25 (combined sex), 49.51 years for male and 53.38 for females. Using UK, USA and South African life tables, the study found out the error obtained from applying South African life table is small relative to other foreign life tables but were significantly different from the Ghana life table. The mortality of males was greater than the females in most ages. The study also found out that cardiovascular disease and HIV/AIDS were the leading causes of death in Ghana. It was revealed that the life expectancy of Ghanaians will increase by 16.021% and 17.587% for males and females respectively, if cardiovascular disease is eliminated in the population. The study recommended that there is a need to construct a life table for Ghana and the Government of Ghana and other agencies should create awareness on cardiovascular diseases and HIV/AIDS.

DEDICATION

This work is dedicated to my parents and all the lecturers in Department of Statistics, University of Ghana.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

A life table is a useful tool for studying the implications of observed mortality rates in a population (Coale, Demeny, & Vaughan, 2013). Life tables provide the most complete description of mortality and serves as a key indicator of the health and wellbeing of any population. It has many applications in various areas of research where birth, death and illness may take place. There are two forms of the life table in general, we have the cohort life table and the period or current life table. A cohort life table records the actual mortality or death till the last member of the group. A period life table on the other hand, is the most common form. It is based on the mortality rates for a particular year, or averages over a few consecutive years (Denton & Spencer, 2011). The period life table draws out the implications for survivorship and life expectancy of the observed age-specific mortality probabilities of a given period. This is done under the assumption that the probabilities remain constant. Cohort and period life tables may either be complete or abridged. In Complete life tables, the functions or columns of life table are calculated for each year of life. For abridged life table, the ages of the year interval are greater than one, , taking the initial year as 0 to 1 year (Livingstone et al., 2015).

Life tables are mostly used by life insurance companies in determining the accurate premium for their clients. The required data needed for construction of a life table are obtained from vital registration and population censuses. In Sub-Saharan Africa, these accurate basic data do not exist due to lack of functioning vital registration systems and incompleteness of coverage and errors in reporting (Mathers, Ma Fat, Inoue, Rao, & Lopez, 2005). As a result of that actuaries and various insurance companies in Sub-Saharan Africa had adopted foreign life tables in setting their policy rates. The actuaries applied the foreign life table to determine the amount of premium to be paid by a person falling in a specific age group. However, this application of the foreign life table on sub-Saharan Africa also have shortcomings.

According to Hunter (2001), a life table can also have a multiple mode of decrement (death) instead of only one mode as mention earlier. In the multiple decrements, the causes of the death of the population is not grouped into one but are grouped in many mutually exclusive causes. Every human is continuously exposed to many risks of death such as cancer, heart disease, accidents, stroke, diabetes. Hence there are various risks competing for the life of an individual and death is attributed to one cause. According to Lin, So, and Johnston (2012), competing risks arise in studies in which individuals are subjected to a number of potential failure events and the occurrence of one event might impede the occurrence of other events. Competing risk analyses enable one to determine the impact of a disease in a particular population through the calculation of life expectancy gain when that disease is eliminated.

In Ghana, few people had constructed life table. Kpedekpo (1969), constructed a working life for males in Ghana and estimated the average number of years of working life, remaining to those of a given age and also compared the working life tables for Ghana to other industrialized countries such as the United States, England and Wales are made. Katara, Mohammed, Osman, and Faisal (2014), constructed an abridged life table in Ghana and estimated the life expectancy at birth to be 50.32 years for both male and female. Moreover, the World Health Organization (WHO) had been computing a period life table in Ghana from 2000, using the country's vital statistics. However, there are lots of limitation of the nation is vital statistics since not all deaths and births are reported. Hence the actuaries, the insurance companies and policy makers in Sub-Saharan Africa adjusted the foreign life tables in determining their policy rates.

1.2 Statement of the Problem

The construction of a life table requires the gathering of good empirical demographic data, which are inaccuracies in Sub-Saharan African countries like Ghana. Therefore, Sub-Saharan African countries adjust the foreign countries' life tables to study the longevity of its citizens (Katara et al., 2014), Clearly, these tables would not reflect Sub-Saharan African mortality rates in general and Ghana in particular. Mortality experiences generally vary greatly from place to place due to differences in occupation, place of residence and causes of death. Moreover, accessibility to standard health care may be higher in the developed countries than developing countries like Ghana. This absence of standard health care in the developing countries affects mortality experiences in the country. Death trends, patterns and causes, in developed countries where these tables are developed are different from that of Ghana. For example, according to World Health Organization (2000), malaria is the third leading cause of death in Africa, whiles it is not among the 50 leading causes of death in the world. However, life tables are expected to take into account mortality experiences in the environment in which it is to be applied. Therefore, using foreign life tables to study the mortality rate in Ghana have its own errors. However, assessing the error of applying the foreign life table had not been taken into consideration. Moreover, the impact of the leading cause of death has not been evaluated in Ghana. The theory of competing risk provides convenient methods of analysis of such problems.

It is in this light that, this research will assess the errors of applying the various foreign life tables in Ghana and also to evaluate the impact of leading causes of death.

1.3 Research Questions

The study is guided by the following research questions;

- Are the foreign adjusted life tables significantly different from the computed life table?
- What is the expectation of life at birth in Ghana?
- What is the force of mortality function of Ghana?
- What are the mortality rates by Gender?
- What are the life expectancy gain when eliminating the leading cause of death?

1.4 Objectives of the Study

The main objective is to assess the error in the application of foreign life table in Ghana and perform competing risk analysis on the leading causes of death.

The specific objectives are;

- To determine the expectation of life at birth in Ghana.
- To assess the error generated from adjusted foreign life tables.
- To derive the survival function of Ghana.
- To compare the mortality experience by males and females.
- To determine the life expectancy gain when eliminating the leading cause of death.

1.5 Hypotheses

The study tested two hypotheses namely;

1. H_1 :The foreign life tables are not significantly different from the computed life table

   H_0: The foreign life tables are significantly different from the computed life table
2. H_0 : The mortality experiences by gender are the same in Ghana.

   H_1: The mortality experiences by gender are significantly different in Ghana.

1.6 Significance of the study

Life expectancy is a key characteristic of human longevity and aids in formulating important policies. However, due to inaccurate data, Ghanaians use foreign life tables to make their policies. The significances of this research are as follows:

- Through the assessment of error of applying foreign life table in Ghana, the actuaries and the insurance companies will know the deviations, in calculating premiums and pension liabilities.
- The life table that will be constructed will serve as an indicator of the health of the nation which will help the government to make good policies.
- This research will serve as literature in research in the areas of health, population, pension and insurance.

1.7 Scope of the study

This research constructed a life table from a cohort of 3,260 people from birth to death and highlights the cause of death of each person for the period 1927 to 2016. The life table was compared to other foreign life tables that were used in the country in order to assess the error of applying foreign life tables in Ghana.

1.8 Limitations of the Research

Despite the efforts to minimise all limitations, there were certain constraints within which the research was done. The main limitation was on the data integrity; that is the geographical concentration of the sample (Greater Accra Region) which was used to represent the mortality in Ghana.

1.9 Organization of the study

The first chapter is the introduction of the study which focuses on the background, problem statement, research questions, objectives and significance of the study. The second chapter provides a review of relevant literature on life table and competing risk. Chapter three discusses the research methods which include the research design, the setting, the target population, and data collections. Chapter four presents the results and chapter five presents the conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of related literature of the study. It also reviews previous studies on life table and competing risks.

2.1 Definition and Concept of life table

A life table is a rectangular matrix, showing changes in a standard set of life table functions across ages (Grigoriev et al., 2014). The life table tells us the probability of surviving any particular year of age and the remaining life expectancy for people at different ages.

According to Lambert, Dickman, Nelson, and Royston (2010) "The life table is a mathematical model that portrays mortality condition at a particular time among a population and provides a basis for measuring longevity". Life tables are usually constructed separately for men and for women because of their different in mortality rates (Lambert et al., 2010).

There are two types of life table namely; Cohort or Generation Life Table, and Period or Current Life Table. The Cohort or Generation Life Table: It presents the age specific mortality experience of a given birth of a group of persons all born at the same time over many years. Period Life Table presents the age specific mortality conditions pertaining to a given or other short time period (Oeppen & Vaupel, 2002). A life table can have many modes of decrement instead of only one mode of decrement. This is known as multiple modes of decrement.

2.2 Methods of Constructing Life Table

Cohort life tables are constructed on the basis of a single cross-sectional time data for a generation. There is also a longitudinal life table method which takes a real cohort of persons that starts life at a specific age interval and follow it throughout life until they all die.

Moreover, there are two ways of constructing life table, namely; complete and abridge. A complete life table is constructed on the basis of single years of ages and abridged life table is constructed wherein ages are grouped in 5 or 10 years of interval, taking the initial year as 0 to 1.

2.3 Importance of Life Table

1. Life table is used to project future population on the basis of the present death rate.
2. It helps in determining the average expectation of life based on age specific death rates.
3. The method of constructing a life table can be followed to estimate the cause of specific death rates, male and female death rates, etc.
4. The survival rates in a life table can be used to calculate the net migration rate on the basis of age distribution at 5 or 10 years interval.
5. Life tables can be used to compare population trends at national and international levels.
6. Life tables are applied in the insurance field to calculate the amount of premium that is to be paid by a person falling in a specific age group.

2.4 Definitions and Concepts of Competing risk

Gichangi and Vach (2005), defined competing risk as a situation in which an individual is subjected to many distinct groups which are mutually exclusive. Putter, Fiocco, and Geskus (2007) also defined competing risks as a situation in which an individual is exposed to a risk of death from more than one mutually exclusive causes such that the occurrence of one of these will prevent any other event from ever happening.

These mutually exclusive causes of failure are considered as competing events and the problems resulting from such data are commonly referred to as competing risk problems. In analysing competing risk, the following probabilities must be clearly defined; Crude probability, Net probability and Partial probability.

2.4.1 Crude probability

Ratib, Fleming, Crooks, Walker, and West (2015), defined crude probability as the probability of dying from a specific cause in the present of all other causes acting in the population. This implies that with regards to crude probability, an individual will get to the likelihood of dying from that particular risk even though the person is exposed to many risks of death in the population.

2.4.2 Net probability

Pietersen et al. (2014), defined net probability in two ways; The first definition is net probability is the probability that an individual will die if there is only one particular risk acting in the population. Therefore, in this definition, there is an assumption that there is only one cause or risk of death acting in the population.

The second definition is that, net probability is the probability that a person will die if a specific risk of death is eliminated in the population. For instance, net probability will enable one to know the probability that an individual at age x will die if there is no HIV/AIDS in the population.

2.4.3 Partial crude probability

Partial crude probability as the probability that a person will die from a specific cause when another risk(s) is eliminated from the population (Gerds, Scheike, & Andersen, 2012).

Therefore, partial crude probability is the combination of both net probability and crude probability. For example, partial probability answers the probability of dying from HIV/AIDS when tuberculosis is eliminated in the population.

2.5 Previous Studies on Life Table

This chapter reviews some articles of life tables constructed in Ghana and other countries. Katara et al. (2014), constructed an abridge life table in the Tamale metropolis. Information regarding to death experiences and number of inhabitants in a house was gathered from 100 selected houses distributed in 10 selected suburbs in the Tamale metropolis. The hypothesis of the study was tested using chi-square test and Wilcoxon signed ranked test. It was found that mortality among males was higher than their female counterparts in most age groups. The study also found out that the expectation of life at birth for Ghana was 50.32 (combined sex).

Kpedekpo (1969), constructed a working life for males in Ghana and provides information on the expected average number of years of working life, remaining to those of a given age and many other aspects of working life. People of the working age were categorised into two broad groups, namely economically active and those who were economically inactive during a period of one month preceding the Census midnight. Kpedekpo also compared the working life tables of Ghana to other industrialized countries such as the United States of America (USA), United Kingdom (UK) and Wales. He found out that the working life table for Ghana was significantly different from that of United States, England and Wales.

Arias (2014), constructed a complete life table in 2009 for the United States by gender and race in 2009. The causes of deaths as well as the population per gender were obtained. She found out that changes in mortality levels by age and cause of death have a major effect on changes in life expectancy. She found out that the life expectancy at birth increase in 2009 was higher than 2008 and the reason was attributed to decreases in mortality from heart disease, cancer, unintentional injuries, stroke, and lower respiratory infections (LRI). She also found out that the life expectancy for females were higher than that of males and also the life expectancy for the white population were higher than that of the black population.

Scherbov and Ediev (2011), performed a research on "Significance of life table estimates for small populations". For one particular life table, they simulated various population size ranges from one thousand, five thousand, ten thousand, twenty-five thousand and one million people. From their analysis they found out that, for all small population less than ten thousand there was an upwards bias in life expectancy estimated. They concluded that higher population leads to lower life expectancies. They observed that to estimate a life expectancy at 60 years with a standard error of about 0.25 years, the population size should be above 100,000. They also revealed that abridged life table calculations can lead to strong biases when the population size are not evenly spread.

Denton and Spencer (2011), performed a dynamic extension of the period life table. They addressed the problem of period life table that their life expectancy typically ignores the fact that the expectancies make no allowance for future declines in mortality rates. They found out that the dynamic extension provides an informative supplement to standard life table calculations. Therefore, they concluded that the use of period life expectancies as if they represented the future usage is not appropriate and hence recommended that the use of dynamic life expectancies over period life expectancies.

Zeng, Morgan, Wang, Gu, and Yang (2012), discussed the method for calculating healthy life expectancy by considering the dynamic changes of mortality and health of people in United States. The data were obtained from the National Health Interview Survey in the United States. They constructed a cohort life table to estimate and forecast healthy life expectancy. They modelled the dynamic changes of both the mortality and health processes by using the Lee Carter model and constructs their stochastic projections.

2.6 Previous Studies that used multiple Decrement life table and Competing risk

This section, reviewed articles that used multiple decrement life table and competing risk in its analyses.

According to Haile (2008), the study of competing risks can be traced to a paper in 1958 where Mendenhall and Hader (1958) presented a model for the analysis of failure-time distributions when there are two, or more, types of failure. They illustrate their theory by analysing some data on the failure times of radio transmitter receivers. The failures were classed into two types, those confirmed on arrival at the maintenance centre and those unconfirmed. Due to restrictions on time available for testing, the sample were done through censoring in which the experimenter frequently desires to conclude the life test after a predetermined length of time has elapsed or after a predetermined number of units have failed.

Cox (1959), also illustrated and distinguished between a number of models that can be used for competing risk data. Using data that had previously been presented by Mendenhall and Hader (1958), Cox presented and discussed a number of models that could be used to analyse data where the failures were classified into two types. Cox suggested that, in modelling the parametric forms of competing risk data, Gompertz, exponential and Weibull parametric models should be used.

Chiang (1970), later studied competing risk in heath prospective by evaluating the impact of Cardiovascular-renal diseases on human longevity in USA. He obtained the data through, US Census of Population 1960. He calculated the net probability for eliminating cardiovascular diseases from the population and also calculated the probability that an individual alive will die without specifying any cause of death. The expectancies were derived from these probabilities and the difference between the two life expectancies as well as the probabilities were computed. Chiang found out that the difference in net probabilities of cardiovascular diseases was lower for females than that of the males and the life expectancy gain for the females were also higher than that of the males.

Luptáková and Bilíková (2014), performed a research on actuarial modelling of life insurance using many modes of decrement. The decrement models were death, voluntary withdrawal from the course and expulsion from the course due to poor results. The value of life insurance was computed by following a group of students on a two year post high school course. They first dealt with mortality table as a single-decrement model, where the students only leave the course because of death. They later extend the single decrement model to multiple decrements where students leave the course for reasons other than death such as voluntary withdrawal from the course and expulsion from the course due to poor results. With the assumptions that decrement intensities in both the multiple decrement model and single-decrement models are independent of time and hence are not influenced by the operation of the other decrements. .

Lai and Hardy (1999), measured the impact of premature deaths on US population of the working age (15-64 years). They compared two indicators and found out the appropriate one for measuring the impact. The indicators were the life expectancy by elimination of deaths from HIV/AIDS, diseases of the heart and malignant neoplasms and the years of potential life lost due to these causes. They used a monthly vital statistics report and data from National Centre for health Statistics. Multiple decrement life table technique was used to compute the life expectancy due to elimination of death from diseases such as heart diseases, malignant neoplasms and HIV/AIDS. They found out that the life expectancy gains for eliminating cardiovascular diseases were higher in ages above 60 years. They revealed that out that the life expectancy gains for eliminating HIV/AIDS from US population was higher for females than the males.

Schwartländer et al. (2011), assessed the human cost of mortality due to intentional violence in over 90 countries. Mortality data collected from international organizations and country statistical offices for the year 2004 were used. All homicides reported to the WHO were included. They employed multiple decrement life table analysis to estimate the potential gains in life expectancy that could be achieved by reducing the risk of intentional injury to deaths to a proposed "regular" level of 1.27 deaths per 100,000 persons. They found out that, Regional potential gains in life expectancy ranges from 0.44 years for men in the Americas to 0.02 years for women in the Western Pacific. They also noticed that violence prevention programs are likely to have the highest overall impact in countries such as Jamaica, Colombia, and Brazil characterized as they had high life expectancies and high levels of homicides.

Katzmarzyk, Church, Craig, and Bouchard (2009), obtained a measured that can be used to explain the mortality trends of a population. The two measures they used for analysing the effect of premature deaths were years of potential life lost and potential gains in life expectancy. Since the effect of premature deaths cannot be quantified using general mortality rates they are dominated by chronic diseases among the elderly. They used these measures enable to examine the premature mortality patterns of a population in terms of causes of death. The effects of premature deaths cannot be quantified by using general mortality rates since they are dominated by chronic diseases among the elderly. They obtained their data from Demographic and Health Survey 1998, 2003 and 2008 and the province and district death statistics derived by Turkish Statistical Institute (TURKSTAT) for the years 2000 and 2008. The data were analysed using cause specific mortality analyses, single and multiple decrement life tables. The results of the potential gains in life expectancy analyses were represented by complete and partial elimination of causes of death. Years of potential life lost results were estimated as lifetime years of potential life lost. From their findings, they suggested that the overall effect of premature mortality shows a decreasing trend during the period 2000 to 2008 in Turkey. Cardiovascular diseases and cancers are the leading causes of death affecting premature mortality. They observed that the impact of cancers and injuries on premature mortality are greater for the younger age groups in Turkey.

Rosamond et al. (2008) in his articles “Bounds in Competing Risks Models and the War on Cancer” derived a framework to estimate competing risk models with interval outcome data and discrete explanatory variables. They released that competing risks models used mortality from multiple causes and it was difficult to get a clear picture of the trends in cancer. They estimated changes in cancer and cardiovascular mortality from 1970 to 2000. They found out that find that males die from cardiovascular disease than the females.

Wolbers et al. (2014) studied the objectives and approaches of competing risks analyses. They gave a non-technical overview of competing risks concepts for descriptive and regression analyses. For descriptive statistics, they concluded that the cumulative incidence function (CIF) was the most important tool. For regression analyses, they suggested regression models for the cumulative incidence function and the cause-specific hazard function as the appropriate models. They stressed the importance of choosing the various statistical methods that were appropriate, if competing risks were present. The data used for their study were obtained from the implantable cardioverter-defibrillator registry of the Department of Cardiology, University Hospital Basel, Switzerland. The study included 442 subjects with dilated cardiomyopathy with an implantable cardioverter-defibrillator implanted for primary or secondary prevention, a median age of 63.4 years, and a median follow-up duration of 3.3 years. The study quantified the benefit of implantable cardioverter-defibrillator implantation in an unselected routine-care population by analysing the time from implantable cardioverter-defibrillator implantation to the first appropriate implantable cardioverter-defibrillator therapy or death without prior appropriate implantable cardioverter-defibrillator therapy. Implantable cardioverter-defibrillator therapy that failed to save the patient’s life at the time of the arrhythmia was classified as death, not as appropriate implantable cardioverter-defibrillator therapy.

They found out that for the composite endpoint, the standard survival analysis without competing risks was appropriate, and the effect estimates of covariates on the hazard function and the CIF are identical. They also found that both advanced age and an implantable cardioverter-defibrillator implantation for secondary prevention show a highly significant association with an increased rate (and risk) of the combined outcome of prior implantable cardioverter-defibrillator therapy or death.

Albertsen, Hanley, Gleason, and Barry (1998) performed a follow up study with consideration of competing risks. The data was collected by the Tumor Registry of the California State Department of Public Health which consists of 5982 patients admitted to certain California hospitals and clinics between January 1, 1982, and December 31, 1994, with a diagnosis of cancer of the cervix uteri. The date of entrance to follow-up for each patient is the date of hospital admission. The survival experience of the patients grouped according to their withdrawal status was constructed as well as the survival experience of non-withdrawals. The deaths were further divided by cause where 1105 deaths were due to cancer of the cervix uteri and 182 deaths were from all other causes. The survival status of the 1954 admissions was determined at the close of the study, as it is for patients’ due for withdrawal in any interval. In this study, 576 patients withdrew alive in the first interval, and 89 patients died before the closing date. The crude and net probabilities of cancer of the cervix uteri and other causes were estimated. They found out that since only two risks were studied, the probability of dying from cancer of the cervix uteri was equal to the net probability of death when cancer of the cervix uteri is eliminated as a risk of death from the population. For each age interval the estimated net probability was always greater than the corresponding crude probability.

Grude (2011), studied risk factors for breast, uterine and ovarian cancer. Theory of competing risks was used to identify possible risk factors for breast, uterine and ovarian cancer. This was done by performing regression on the cause specific hazard functions, the sub distribution hazard functions and two approximate methods. Cox regression was used for a complete analysis of the medical data. By following 61457 women over approximately 50 years, he noticed 3407 cases of breast cancer, 934 of uterine cancer and 843 of ovarian cancer. The data used in the analysis was selected from a screening program organized by the Norwegian Cancer Society for early diagnosis of breast cancer. His study found out that each additional birth decreases the risk of getting breast, uterine or ovarian cancer by 10 %, 10 % and 16%, respectively. He also found out that age at first birth, the risk of getting breast or uterine cancer whiles age at last birth affect the risk of uterine and breast cancer because early last birth is protective against breast cancer compared to late last birth. Age at menarche affects the risk of getting uterine and breast cancer as each year increase, in age at menarche decreases the risk of uterine and breast cancer with approximately 12% and 5%, respectively. But ovarian cancer risk was not affected by age at menarche. It was seen that obesity affects the risk of getting breast, uterine and ovarian cancer for postmenopausal women.

Oeppen and Vaupel (2002), did a research on competing risks analysis of end stage renal disease and mortality among adults with diabetes in Canada. The objective was to determine whether there are significant disparities in the risk of end stage renal disease and mortality without end stage renal disease between diabetic First Nations and other Saskatchewan people in Canada. The data was drawn from the Saskatchewan Ministry of Health administrative databases from 1980 to 2000. The competing risks survival analysis that was used were a Cox cause-specific model, Weibull proportional hazards (PH) model and piece-wise exponential PH hazards model. System Dynamics modelling (SDM) and agent-based modelling (ABM) methods were also used to build dynamic models of diabetic patients' progression to end stage renal disease. There was a total of 90,429 diabetic people in the study cohort, from 1980 to 2005. Among them, 8,254 (9%) of them were First Nations people. After adjusting for diabetes diagnosis age, sex, interaction between age and sex and interaction between age and ethnicity, Oeppen and Vaupel (2002) found out that First Nations had higher risk of death than other Saskatchewan given the same sex and diabetes diagnosis age (younger than 81 years old). Using the same hazard rate estimations from competing risks survival analysis, the agent-based modelling model demonstrated a better match between historical data and model predicted data compared to the System Dynamics model. They concluded that a much younger age of diabetes diagnosis among First Nations compared to other Saskatchewan likely contributes to higher rates of end stage renal disease because of a differential mortality effect First Nations with diabetes are more likely to live long enough to develop end stage renal disease.

Lin et al. (2012), performed a quantitative evaluation of competing risks in occupational studies. They noticed that adjustment for competing risks allowed more meaningful comparisons of cause-specific mortality of two populations, especially if dying from all other causes is significantly different between the two populations. In their study, they identified a method for adjusting competing causes of death in the calculation of relative risk. This method identifies three factors, namely; magnitude of the overall mortality risk of the study population, differential risk or adjustment factor for all other causes between two populations and age interval used in mortality calculation. Hence, the impact of competing risks is increased if the mortality risk of the study population is high. They used a refinery cohort data for which there was a certain age groups unadjusted for competing risks. They found out that the relative risk for groups unadjusted for competing risks was overestimated by 9%. They concluded that the impact of competing risks in their study was relatively small.

Higgins, Hoffman, and Dworkin (2010), did competing risks analysis in epidemiology by reviewing the concepts of rate and risk. They also introduced the analogous concepts of rate and risk in the context of competing risks. They used data from the European Group for Blood and Marrow Transplantation (EBMT). The data consist of all chronic myeloid leukemia (CML) patients, having received an allogeneic stem cell transplantation from an Human Leukocyte Antigen (HLA) during the years 2000–2008. They did a follow up of 8.5 years of 3,982 patients who were Philadelphia chromosome positive, transplanted with bone marrow or peripheral blood, and were above 18 years of age.

All-cause mortality analyses were performed and they noticed they are equivalent due to their one-to-one correspondence. They realized that in the presence of competing risk, when rates are now cause-specific hazards and risks are cumulative incidences a one-to-one correspondence between a single rate and the corresponding risk no longer exists. Therefore, any given cumulative incidence depends on all cause-specific hazards and vice versa. Also, covariates may affect the cause i specific hazard and the cause i cumulative incidence differently. They found out that the Kaplan–Meier estimator provides a biased estimate of the cumulative incidence in the presence of competing risks. In fitting a regression model, they found out that, Cox regression models for cause-specific hazards are easy to fit and it provides parameter estimates which possess simple rate ratio interpretations.

2.7 Summary of Literature Reviewed

From the literature reviewed, there are limited research on the impact of cardiovascular disease and other killer disease such as HIV/AIDS, Malaria on human longevity in Ghana. Moreover, there are few literatures on life table in Ghana. The literatures above give in-depth knowledge on how, the researcher could construct a life in Ghana and also analyses the impact of the major causes of death in the country.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter sets out the methodology that was used to achieve the study. The succeeding section presents the research approach and highlights on the setting, population of the study, sample techniques and size, data collection instrument, as well as methods of data analysis.

3.1 Setting

The study was done at University of Ghana Hospital. The hospital is located at Legon in La-Nkwantanang district in Greater Accra Region. The hospital is often attended by students, staff of the university and people living around the institution. The hospital was established in 1957 and is owned by the University of Ghana. It was under the charge of Dr. A.B. Boyd (a Scottish Doctor) and was assisted by one nursing staff. The hospital started as a clinic, sharing all facilities in common with the Achimota Hospital. In 1959, five (5) heath personnel consisting of a doctor and four nurses moved from Achimota to start work at the then University College Hospital. The facilities of the hospital grew over time to include Maternity Ward and Staff Quarters. The hospital is a quasi-government hospital with a bed capacity of 130 comprising of General Wards, Maternity Wing, Casualty and Emergency Ward, Pediatric Unit, Dental Unit and Operating Theatre. The mission of the hospital is to enhance the health status of all employees and students of the University of Ghana by providing them with world class Medical Services of the highest quality. Their mission also includes enhancing the health status of the communities in University of Ghana's immediate environs by providing affordable client focused quality health services. The hospital has established a Primary Health Care outreach programme aimed at teaching and advising students, pregnant women, nursing mothers and the general public about personal hygiene, good diet, child care, including immunization against childhood communicable diseases, family planning and school health services. The main referral point for the hospital is the Korle-Bu Teaching Hospital and 37 Military Hospital. The hospital has recently introduced specialist consultancy services.

3.2 Study population

According to Rothman, Greenland, and Lash (2008) ,a population is defined as a group of individuals, persons, objects, or items from which samples are obtained for measurement. Study population is a population from which the sample actually was drawn and about which a conclusion can be made (Degu & Yigzaw, 2006). The study is targeting the population of Ghana and hence conclusion made from this research will be generalized to the entire population of Ghana.

3.3 The Data

Secondary data were used for the study. The data were extracted from the administrative records unit of the hospital. The data include the causes of death by gender and age from the year the hospital started to 2015. The data were then converted into a cohort of 3250 people from birth to death where the researcher assumed that the individuals selected were born in the same year. The causes of death were grouped into five, namely; death due to cardiovascular diseases, HIV/AIDs, lower respiratory infections, malaria and other causes of death.’

3.4 Data Analysis

To ensure accuracy in the data processing, data editing and clearing of the data were done before analysing the data. The data were coded in order to make possible inputting into the data processor. The codes were transformed into units to facilitate their description and analyses. Diagrammatic presentation by means of tables and graphs were done. Although there will be several electronic means of analysing data, STATA and R were used for the analysis.

3.5 Construction of Life Table

In a cohort life table, given the number of people from the cohort l_o , l_j , is the number of people at the beginning of exact age j and d_j, the number of death at each age. The following represent the columns that can be found in life tables:

i. $\hat{q}_j$, Proportion dying $(j, j+1)$: The probability that an individual alive at age will die during the age interval $(j, j+1)$ is calculated directly as

$$\hat{q}_j = \frac{d_j}{l_j} \qquad \ldots\ldots\ldots(3.1)$$

ii. $\hat{p}_j$, Proportion dying $(j, j+1)$: The probability that an individual alive at age will survive during the age interval $(j, j+1)$ is calculated directly as

$$\hat{p}_j = \frac{l_{j+1}}{l_j} \qquad \ldots\ldots\ldots(3.2)$$

iii. a_x, Average fraction of the last year of life for age x . Each of the people who die during the interval $(x, x+1)$ has lived x complete years plus some fraction of the year $(x, x+1)$. Usually at the beginning of the year it is 0.10 and after 5 years it is taken as 0.5.

iv. L_x The number of years lived in the interval $(x, x+1)$. Each member of the cohort who survives the year $(x, x+1)$ contributes one year to L_x, while each member who dies during the year $(x, x+1)$ contributes to an average fraction a_x. Hence the formula is

$$L_x = l_x - (1 - a_x)d_x \qquad \ldots\ldots\ldots(3.3)$$

v. T_x The total number of people lived beyond age x. This is equal to the sum of the number of years lived in each interval. This implies

$$T_x = L_x + L_{x+1} + \cdots + L_n \qquad \dots\dots(3.4)$$

vi. $\hat{e}_x$ Observed expectation of life at age x. This is the average number of years yet to be lived by an individual at exact age x.

$$\hat{e}_x = \frac{T_x}{l_x} \qquad \dots\dots..(3.5)$$

3.6 Error Assessment

3.6.1 Absolute Error Analyses

Absolute error measures how a measurement deviate from the true value. It is also an indication of the uncertainty in a measurement.

Let e_{ab} be absolute error

$$e_{ab} = |True\ value - Approximate\ value| \qquad \dots\dots.(3.6)$$

$$= |X - X'| \qquad \dots\dots.(3.7)$$

3.6.2 Univariate Analysis of Variance (ANOVA)

The univariate Analysis of Variance (ANOVA) was done test whether the absolute error obtained from the three foreign life tables differ.

Suppose the absolute error of observations are as follows;

Absolute error from UK life table: $X_{11,}X_{12}, \dots, X_{1n}$

Absolute error from USA life table:$X_{21,}X_{22}, \dots, X_{2n}$

Absolute error from South Africa (SA) life table:$X_{21,}X_{22}, \dots, X_{2n}$

$$\mu_1 = \text{Absolute error from UK life table}$$

$$\mu_2 = \text{Absolute error from USA life table}$$

$$\mu_3 = \text{Absolute error from SA life table}$$

HYPOTHESES

$H0: \mu_1 = \mu_2 = \mu_3$

$H1: \mu_1 \neq \mu_2 \neq \mu_3$

Table 3.1: ANOVA Table

SOV	Df	SS	MS	F
Regression	$p-1$	SSR	$MSR = \frac{SSR}{P-1}$	
Error	$n-p$	SSE	$MSE = \frac{SSE}{P-1}$	$\frac{MSR}{MSE}$
Total	$n-1$	SST		

$n = 101$

$p = 3$

$SOV = Source\ of\ Variation$

$df = degrees\ of\ freedom$

$SS = Sum\ of\ Squares$

$MS = Mean\ Sum\ of\ Squares$

3.6.3 Paired t-test

Pared t-test was constructed to determine whether the minimum error obtained from the three foreign life tables significantly different from zero. This will tell us whether there is a significant need to construct a life table for Ghana or we can rely on of the foreign life table that exhibit the minimum error.

Specifying the model and simple testing for μ_D

Suppose the life expectancy observations are as follows;

The life expectancy of the study life table: $X_{11,}X_{12}, \ldots, X_{1n}$

The foreign life table with the minimum error:$X_{21,}X_{22}, \ldots, X_{2n}$

Since the data is paired, we can study the differences $D_i = X_{1i} - X_{2i}, i = 1, 2, \ldots \ldots .., n$

Assume that D is normally distributed, $t = \frac{\bar{D}-\mu_D}{s_D/\sqrt{n}} \sim t_{n-1}$ ……… (3.8)

Where $\mu_D = \mu_1 - \mu_2$

$\mu_1 =$ The life expectancy of the study life table

$\mu_2 =$ The foreign life table with the minimum error

Sample mean = $\bar{D} = \frac{\sum D_i}{n}$ where D is the difference between the study life table and the foreign life table with the minimum error

$N = \textit{the number of observartion (in this case the number of respondent was } 101)$

Sample standard deviation

$$s_D = \sqrt{\frac{\sum(D-\bar{D})^2}{n-1}} = \sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{n}}{n-1}} \qquad \ldots \ldots .. (3.9)$$

HYPOTHESES

$H0: \mu_D = 0, \ \mu_D = \mu_1 - \mu_2 = 0$

$H_1: \mu_D \neq 0 (Two - tailed)$

$H_1: \mu_D < 0 \ (left - tailed),$

$H_1: \mu_D > 0 \; (right - tailed)$

TEST STATISTIC

$$T = \frac{\bar{D}}{s_D/\sqrt{n}} \sim T_{n-1} \qquad \dots \dots .. (3.10)$$

CRITICAL REGION

The critical value is obtained from t-distribution table with n-1 degrees of freedom.

Table 3.2: Critical Region of Paired T-test

	LEFT-TAILED	***RIGHT-TAILED***	***TWO-TAILED***
Critical Value(s)	$-t_{\alpha,n-1}$	$t_{\alpha,n-1}$	$-t_{\frac{\alpha}{2},n-1}$ and $t_{\frac{\alpha}{2},n-1}$
Critical Region(s)	$T \leq -t_{\alpha,n-1}$	$T \geq t_{\alpha,n-1}$	$T \leq -t_{\alpha,n-1}$ or $T \geq t_{\alpha,n-1}$

3.7 Force of Mortality Model

According to Lee and Wang (2003), force of mortality measures the instantaneous rate of mortality of at a specific age.

Supposed l_x is the number of people living at aged x. Then the force of mortality which is the instantaneous rate of mortality at age x is given as

$$\mu_x = -\frac{1}{l_x}\frac{d}{d_x}l_x \qquad \dots \dots \dots (3.11)$$

$$\mu_x = -\frac{d}{d_x}logl_x \qquad \dots \dots \dots \dots (3.12)$$

There are many force of mortality models, this study used 4 survival models and the one with the least R-square was taken. The survival models considered were; Weibull model, Gompertz model and logistic and log-logistic.

Table 3.3: Distribution and its Force of Mortality Function

Distribution	Force of Mortality Function μ_x
Gompertz	$\beta e^{\theta t}$
Weibull	$\frac{\beta}{\theta}\left(\frac{x}{\theta}\right)^{\beta-1}$
Logistic	$\frac{\beta e^{\theta t}}{\left[1+\frac{\gamma\beta}{\theta}\left(e^{\theta t-1}\right)\right]}$
Log-logistic	$\frac{\beta\theta x^{\beta-1}}{(1+\theta x^{\beta})}$

3.8 Computation of competing risks

Suppose that five risks of death are acting mutually exclusively on the population of patient in University of Ghana Hospital. Let the risk of cardiovascular diseases, HIV/AIDs, lower respiratory infections, malaria and other risk of death be denoted as R_1, R_2, R_3, R_4 *and* R_5 respectively.

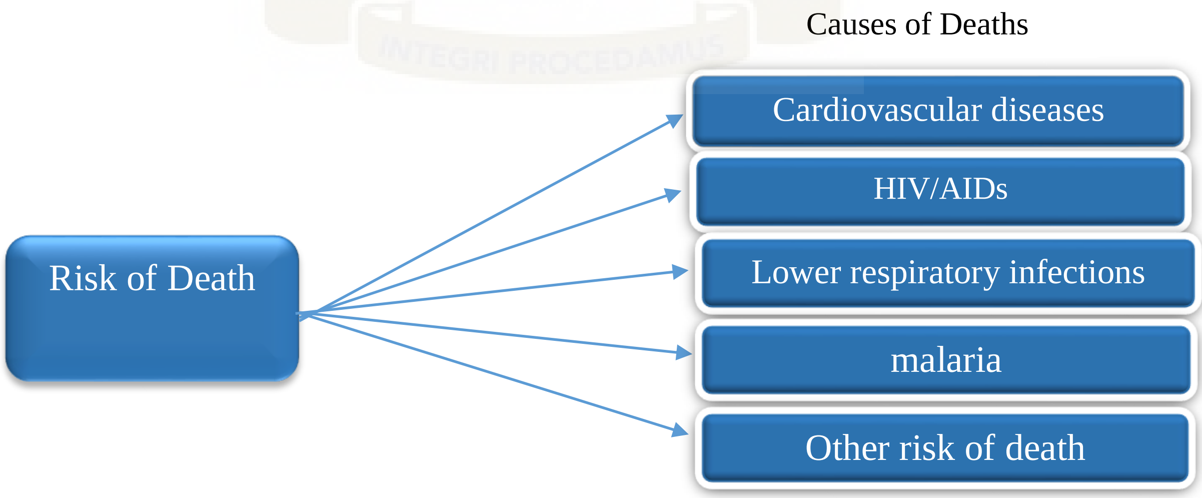

Figure 3.1 Competing risk Model: Death Attributed to 5 Mutually Exclusive Causes

For each risk, R_γ there is a corresponding force of mortality, which is presented by $\mu(\tau;\gamma)$. Therefore

$$\mu(\tau;\gamma)\Delta + 0(\Delta) = P\{an\,individual\,alive\,at\,t\,will\,die\,in\,the\,interval\,(t, t+\Delta)\ from\,cause\,R_\gamma\} \quad .....(3.13)$$

$where\ \gamma = 1,2,3,\dots,5$

Let the sum for each force of mortality of a risk be denoted by $\mu(\tau)$.

$$\sum_{\gamma=1}^{6} \mu(\tau;\gamma) = \mu(t) \qquad \dots\dots\dots (3.14)$$

and each risk R_γ the ratio $\mu(\tau;\gamma)/\mu(t)$ depends only on (x_j, x_{j+1}) and not on t.

The probability that an individual alive at x_j will live in the interval (x_j, x_{j+1}) without specify the cause of death is given as

$$p_j = exp\left\{-\int_{x_j}^{x_{j+1}} \mu(t)dt\right\}, \qquad \dots\dots\dots (3.15)$$

and the probability of dying within the interval (x_j, x_{j+1}) is given as

$$q_j = 1 - exp\left\{-\int_{x_j}^{x_{j+1}} \mu(t)dt\right\} \quad \dots\dots\dots (3.16)$$

3.8.1 Crude Probability

Crude Probability is the probability of dying from a specific risk (R_γ) in the present of all other risks acting in the population. Let $Q_{j\gamma}$ *represent crude probability*, to derive the crude probability let us consider the point t within the interval (x_j, x_{j+1}) . That is $x_j < t \le x_{j+1}$

$$Q_{j\gamma} = \int_{x_j}^{x_{j+1}} exp\left\{-\int_{x_j}^{t} \mu(\tau)d\tau\right\}\mu(t;\gamma)dt \quad \text{... ... ... (3.17)}$$

$$Q_{j\gamma} = \frac{d_{j\gamma}}{l_j} \quad \text{... ... ... (3.18)}$$

Variance of Crude Probability

The variance of the crude probability can be calculated as

$$Var(Q_{j\gamma}) = \frac{Q_{j\gamma}(1 - Q_{j\gamma})}{l_0 p_{0j}} \quad \text{... ... ... (3.19)}$$

l_0 $is\ the\ initial\ population\ size\ (number\ of\ people\ in\ the\ cohort)$

$p_{0j} = p_0 p_1 \dots p_{j-1}$

$Q_{j\gamma} = crude\ probablity\ \ and\ \gamma = 1,2,3,4,5$

3.8.2 Net probability

The net probability of death in the interval (x_j, x_{j+1}) when R_γ is the only risk acting in the population is denoted as $q_{j\gamma}$ and defined as

$$q_{j\gamma} = 1 - exp\left\{-\int_{x_j}^{x_{j+1}} \mu(t;\gamma)dt\right\} \quad \text{... ... ... (3.20)}$$

$$q_{j\gamma} = 1 - p_j^{\left(Q_{j\gamma}/q_j\right)} \quad \text{... ... ... (3.21)}$$

The net probability of death when a specific risk R_γ is eliminated is denoted by $q_{j.\gamma}$ and the formula is calculated as

$$q_{j.\gamma} = 1 - exp\left\{-\int_{x_j}^{x_{j+1}} \mu(t) - \mu(t;\gamma)dt\right\} \quad \text{... ... ... (3.22)}$$

$$q_{j.\gamma} = 1 - p_j^{\frac{\mu(t)-\mu(t;\gamma)}{\mu(t)}} \quad \ldots\ldots\ldots(3.23)$$

$$q_{j.\gamma} = 1 - p_j^{(q_j - Q_{j\gamma})/q_j} \quad \ldots\ldots\ldots(3.24)$$

Variance of Net Probability

The variance of the net probability of death when R_γ is the only risk acting in the population is given as

$$var(q_{j\gamma}) = \frac{(1-q_{j\gamma})^2}{l_0 p_{0j} p_j q_j}\{p_j log(1-q_{j\gamma})\, log(1-q_{j.\gamma}) + Q_{j\gamma}^2\} \quad \ldots\ldots\ldots(3.25)$$

The variance of the net probability of death if R_γ is eliminated from the population is given as

$$var(q_{j.\gamma}) = \frac{(1-q_{j.\gamma})^2}{l_0 p_{0j} p_j q_j}\Big\{p_j log(1-q_{j\gamma})\, log(1-q_{j.\gamma}) + (q_j - Q_{j\gamma})^2\Big\} \quad \ldots\ldots\ldots(3.26)$$

3.8.3 Partial Crude Probability

Let an assumed specific risk R_1 is eliminated from the population, in the presence of all other risks. Now the probability of death from a specific cause when a risk R_1 is eliminated from the population within the interval (x_j, x_{j+1}) is denoted by $Q_{j\gamma.1}$.

$$Q_{j\gamma.1} = \int_{x_j}^{x_{j+1}} exp\left\{-\int_{x_j}^{t}\big(\mu(\tau) - \mu(\tau;1)\big)d\tau\right\}\mu(t;\gamma)dt \quad \ldots\ldots\ldots(3.27)$$

$$Q_{j\gamma.1} = \frac{\mu(t;\gamma)}{\mu(\tau) - \mu(\tau;1)}\int_{x_j}^{x_{j+1}} exp\left\{-\int_{x_j}^{t}\big(\mu(\tau) - \mu(\tau;1)\big)d\tau\right\}[\mu(t) - \mu(t;1)]dt \quad \ldots\ldots(3.28)$$

$$Q_{j\gamma.1} = \frac{Q_{j\gamma}}{q_j - Q_{j1}} = \left(1 - exp\left\{-\int_{x_j}^{x_{j+1}} [\mu(t) - \mu(t;1)]dt\right\}\right) \quad \dots\dots\dots (3.29)$$

$$Q_{j\gamma.1} = \frac{Q_{j\gamma}}{q_j - Q_{j1}} q_{j.1} \quad \dots\dots\dots (3.30)$$

$$Q_{j\gamma.1} = \frac{Q_{j\gamma}}{q_j - Q_{j1}}\left(1 - p_j^{(q_j - Q_{j1})/q_j}\right) \qquad \gamma = 2,3,\dots,5 \quad \dots\dots\dots (3.31)$$

Now if R_1 *and* R_2 are eliminated, the partial probability of death from a specific cause when risks R_1 *and* R_2 are eliminated from the population within the interval (x_j, x_{j+1}) is denoted by $Q_{j\gamma.12}$.

$$Q_{j\gamma.1} = \int_{x_j}^{x_{j+1}} exp\left\{-\int_{x_j}^{t} (\mu(\tau) - \mu(\tau;1) - \mu(\tau;2))d\tau\right\}\mu(t;\gamma)dt \quad \dots\dots\dots (3.32)$$

$$Q_{j\gamma.12} = \frac{\mu(t;\gamma)}{\mu(\tau) - \mu(\tau;1) - \mu(\tau;2)}\int_{x_j}^{x_{j+1}} exp\left\{-\int_{x_j}^{t} (\mu(\tau) - \mu(\tau;1) - \mu(\tau;2))d\tau\right\}[\mu(t) - \mu(t;1)]dt \quad \dots\dots\dots (3.33)$$

$$Q_{j\gamma.12} = \frac{Q_{j\gamma}}{q_j - Q_{j1} - Q_{j2}} = \left(1 - exp\left\{-\int_{x_j}^{x_{j+1}} [\mu(t) - \mu(t;1) - \mu(\tau;2)]dt\right\}\right) \dots\dots (3.34)$$

$$Q_{j\gamma.12} = \frac{Q_{j\gamma}}{q_j - Q_{j1} - Q_{j2}}\left(1 - p_j^{(q_j - Q_{j1} - Q_{j2})/q_j}\right) \quad \dots\dots\dots (3.35)$$

Variance of Partial Probability

The variance of the partial probability of death from a specific cause when a risk R_1 is eliminated from the population within the interval (x_j, x_{j+1}) is given by

$$Var(Q_{j\gamma.1}) = \frac{q_j - Q_{j1} - Q_{j\gamma}}{l_0 p_{0j}(q_j - Q_{j1})Q_{j\gamma}} Q_{j\gamma.1}^2 + \frac{\left(Q_{j\gamma.1}(q_j - Q_{j1}) - Q_{j\gamma}\right)^2}{l_0 p_{0j}(q_j - Q_{j1})} \left[(q_j - Q_{j1}) + Q_{j1} p_j \left(\frac{logp_j}{q_j}\right)^2\right] \quad \dots (3.36)$$

The variance of the partial probability of death from a specific cause when the risks R_1 *and* R_2 are eliminated from the population within the interval (x_j, x_{j+1}) is given by

$$Var(Q_{j\gamma.12}) = \frac{q_j - Q_{j1} - Q_{j2} - Q_{j\gamma}}{l_0 p_{0j}(q_j - Q_{j1} - Q_{j2})Q_{j\gamma}} Q_{j\gamma.12}^2 + \frac{\left(Q_{j\gamma.12}(q_j - Q_{j1} - Q_{j2}) - Q_{j\gamma}\right)^2}{l_0 p_{0j}(q_j - Q_{j1} - Q_{j2})} \left[(q_j - Q_{j1} - Q_{j2}) + Q_{j12} p_j \left(\frac{logp_j}{q_j}\right)^2\right] \quad \dots\dots\dots (3.37)$$

3.8.4 Assumptions of Competing Risks

1. We assume that the set of $risks\ \gamma$ are mutually exclusive and exhaustive.

2. At any particular death the cause of death is only associated with a single cause

3.9 The Log Rank Test

Let e_{1j} be the expected cell counts for male and e_{1j} be the expected cell counts for female

$$e_{1j} = \left(\frac{n_j}{n_{1j} + n_{2j}}\right) \times \left(m_{1j} + m_{2j}\right) \qquad \text{........(3.38)}$$

Where $\left(\frac{n_j}{n_{1j} + n_{2j}}\right)$ represent the proportional in the risk set and

$\left(m_{1j} + m_{2j}\right)$ represent the death for both gender, If

$O_i - E_i = \sum_{j=1} \left(m_{ij} - e_{ij}\right)$ then the Log-Rank can be computed as

$$\frac{\left(O_2 - E_2\right)^2}{\operatorname{var}(O_2 - E_2)} \qquad \text{.........(3.39)}$$

3.10 Summary of Methodology

The researcher used absolute error analyses, univariate analysis of variance and paired t-test to assess the error of applying the foreign life table in Ghana. In order to derive the force of mortality function, a complete single decrement life table was constructed. The mortality rate was used to fit existing survival models such as Gomertz model, Weibull model, logistic and log-logistic and the most appropriate model that fit with the highest R-square was taken. Moreover, crude and net probabilities of the leading cause of death was computed and with the help of multiple decrement life table, the various life expectancy gains from the elimination of the leading cause of death was estimated.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.0 Introduction

This chapter presents the analysis and discussion pertaining to error assessment in the applications of Foreign Life Tables in Ghana and competing risk analysis. The analysis includes construction of Abridge Life Table, Force of mortality function and competing risks analysis.

A CONSTRUCTION OF LIFE TABLES

The construction of life table was done in complete and abridge method. The complete life table can be seen in Appendix I and the abridge life table are presented in Table 4.1 to 4.4.

4.1 Abridge Life Table

An abridge life table was constructed for male and female. This was done in order to determine the probability of dying and the expected life for each age interval and gender. The results were presented in Table 4.1 to 4.3.

4.1.1 Abridged Life Table for Males

Table 4.1 represent the abridge life able for males, the life expectancy (e_j) was computed with reference to equation (3.5). For example, in calculating for the life expectancy for ages between 0 and 1, $T_j/l_j = 9360.54/1890 = 49.53$. It was revealed that the life expectancy at birth was 49.53. The highest life expectancy record was 51.7417 and it was in the age group of 5 to 10 years. Then the life expectancy begins to decrease as the age group increase. According to Oeppen and Vaupel (2002) life expectancy had a positive relation with age. They explained the immune system of humans becomes weak as ones' years increases hence are not able to fight diseases. From Katara et al. (2014) , also constructed a local life able in Tamale and had the life expectancy at birth to be for male was 45 years. With regards to probability of dying (q_j), at the initial stage or at birth q_j was 0.0312 signifying that the probability that a male child at birth will not survive his/her next birthday was 0.0312. The probability of dying at the age of 100 and over interval is 1. This means that eventually every human being will die (a sure event).

Table 4.1A: Abridged Life Table for Males

$[x_j - x_{j+1})$	$q_j = \frac{d_j}{l_j}$	l_j	d_j	L_j	T_j	$e_j = \frac{T_j}{l_j}$
[0-1)	0.0312	1890	59	1836.9	93605.39	49.5267
[1-5)	0.1038	1831	190	6860.4	91768.49	50.1193
[5-10)	0.036	1641	59	8057.5	84908.09	51.7417
[10-15)	0.0076	1582	12	7880	76850.59	48.5781
[15-20)	0.0248	1570	39	7752.5	68970.59	43.9303
[20-25)	0.0222	1531	34	7570	61218.09	39.9857
[25-30)	0.0301	1497	45	7372.5	53648.09	35.8371
[30-35)	0.0482	1452	70	7085	46275.59	31.8702
[35-40)	0.0658	1382	91	6682.5	39190.59	28.3579
[40-45)	0.0837	1291	108	6185	32508.09	25.1805
[45-50)	0.1014	1183	120	5615	26323.09	22.2511
[50-55)	0.1232	1063	131	4987.5	20708.09	19.4808

Table 4.1B: Abridged Life Table for Males

$[x_j - x_{j+1})$	$q_j = \frac{d_j}{l_j}$	l_j	d_j	L_j	T_j	$e_j = \frac{T_j}{l_j}$
[60-65)	0.1944	792	154	3575	11410.59	14.4073
[65-70)	0.2586	638	165	2777.5	7835.59	12.2815
[70-75)	0.3044	473	144	2005	5058.09	10.6936
[75-80)	0.3252	329	107	1377.5	3053.09	9.2799
[80-85)	0.3964	222	88	890	1675.59	7.5477
[85-90)	0.5448	134	73	487.5	785.59	5.8626
[90-95)	0.5902	61	36	215	298.09	4.8867
[95-100)	0.76	25	19	77.5	83.09	3.3236
100+	1	6	6	5.59	5.59	0.9317

4.1.2 Abridged Life Table for Female

An abridge life tables for female population was constructed and the results is seen in Table 4.2. It can be seen that the life expected at birth was 53.6256 years and in the age group of 5 to 10 years, the life expectancy increases to 56.2354 years. However, from 10 years onwards the life expectancy started decreasing. With regards to the probability of dying (q_j), from the Table 4.2, the probability that a female child at birth will not survive to the next year was 0.02920. Then in the year group of 1 to 5 years the probability of the child dying increases to 0.10150. However, in the age group of 5 to 10 years the probability of the female child dying decreases. This implies that at early stage of life the probability a child will die in the age of 1 to 5 years is very high but when she passed that stage the probability that he will survive increases. According to Marmot (2005) children under 5 years venerable to many death due to because their immune system are well adapted to the environment.

Observing the probability of the people of the old age, it was found that, the probability of dying of them increases rapidly and their life expectancy also decreases. For instance, at age group 90 to 95 years the number of years expected for a female to live is 5.25 years and the probability that she will survive from the age group is 0.573. The standard error and the main functions of the female life table can be seen in Appendix II.

Table 4.2A: Female Abridge Life Table

$[x_j - x_{j+1})$	q_j	l_j	d_j	L_j	T_j	e_j
[0-1)	0.029	1370	40	1334.00	73467.10	53.63
[1-5)	0.102	1330	135	4990.60	72133.10	54.24
[5-10)	0.022	1195	26	5910.00	67142.50	56.19
[10-15)	0.013	1169	15	5807.50	61232.50	52.38
[15-20)	0.022	1154	25	5707.50	55425.00	48.03
[20-25)	0.024	1129	27	5577.50	49717.50	44.04
[25-30)	0.049	1102	54	5375.00	44140.00	40.05
[30-35)	0.059	1048	62	5085.00	38765.00	36.99
[35-40)	0.056	986	55	4792.50	33680.00	34.16
[40-45)	0.061	931	57	4512.50	28887.50	31.03
[45-50)	0.065	874	57	4227.50	24375.00	27.89
[50-55)	0.060	817	49	3962.50	20147.50	24.66

Table 4.2B: Female Abridge Life Table Cont.

$[x_j - x_{j+1})$	q_j	l_j	d_j	L_j	T_j	e_j
[55-60)	0.090	768	69	3667.50	16185.00	21.07
[60-65)	0.122	699	85	3282.50	12517.50	17.91
[65-70)	0.168	614	103	2812.50	9235.00	15.04
[70-75)	0.235	511	120	2255.00	6422.50	12.57
[75-80)	0.263	391	103	1697.50	4167.50	10.66
[80-85)	0.337	288	97	1197.50	2470.00	8.58
[85-90)	0.461	191	88	735.00	1272.50	6.66
[90-95)	0.573	103	59	367.50	537.50	5.22
[95-100)	0.727	44	32	140.00	170.00	3.86
100+	1.000	12	12	30.00	30.00	2.50

4.1.3 Life Expectancy for Combined Sex

The complete and abridged life table for combined sex was computed and they can be seen in Appendix II. The life expectancy of the complete life table was plotted to study the trend of the life expectancy at each age.

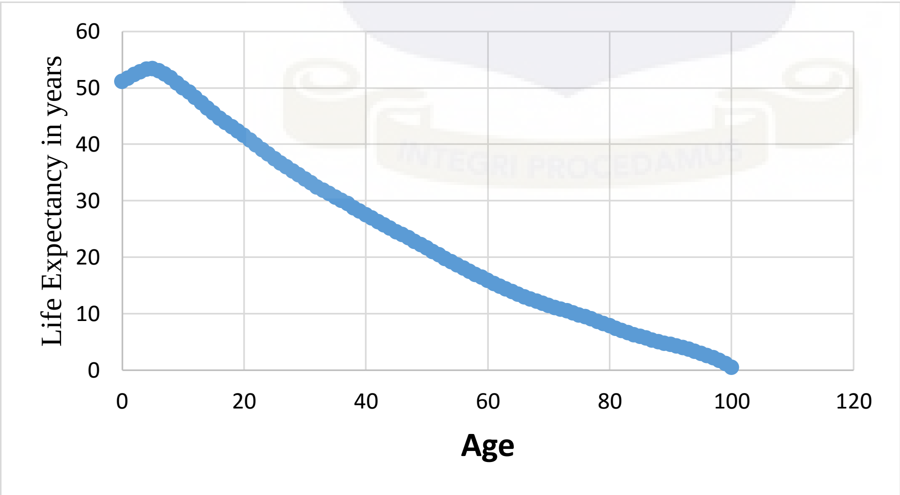

Figure 4.1: Life Expectancy plot for Combined sex

Combing the sex, it was revealed that the life expectancy at birth for Ghana was 51.1359. The life expectancy increases 53.342 at age 5 when it reaches its maximum and then slopes downwards from left to right. This is because children under five years' experience many risk of death. Hence their probability of dying becomes higher thereby reducing the life expectancy. However, at 5 years their probability of dying decreases drastically as a result of immunization and others health practices hence shoot their life expectancy high.

4.2 Comparing the Study Life Table with Other Foreign Life Tables

In order to assess the errors of applying the foreign life tables to Ghanaian mortalities, the life expectancy of complete life table constructed was used to compare three foreign life tables. The foreign life tables were USA Period Life Table, United Kingdom Life Table and South Africa Life Table. The life expectancies of the countries and that of this study were presented in Figure 4.2 and 4.3.

4.2.1 Life Expectancy for males in the various Countries

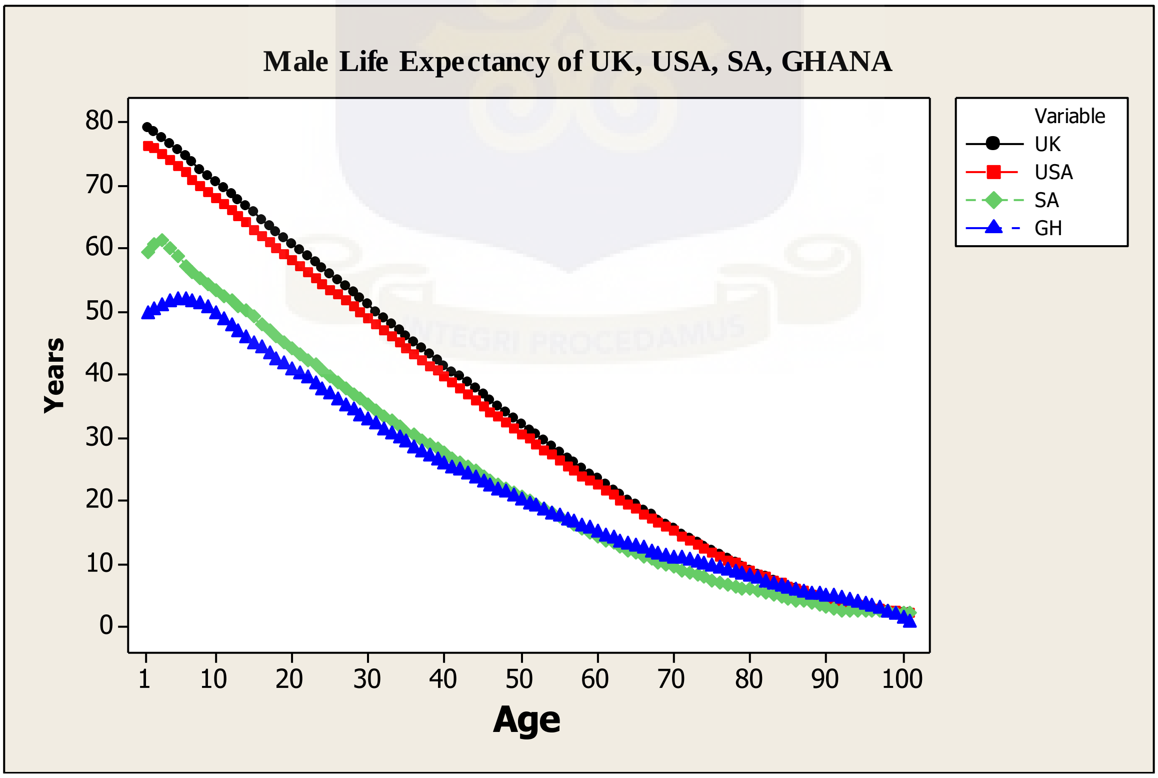

Figure 4.2: Life Expectancy for males in the various Countries

From Figure 4.2, comparing the life expectancy of the various countries, the life expectancy at birth for UK, USA, South Africa and Ghana (the study life table) was 79.09, 76.53, 59.30 and 49.51 respectively. The graph revealed that the life expectancy of USA and UK behave in almost the same manner and they far away from the Ghana life expectancy. The South Africa one is closed to the Ghana life expectancy.

4.2.2 Life Expectancy for females in the various Countries

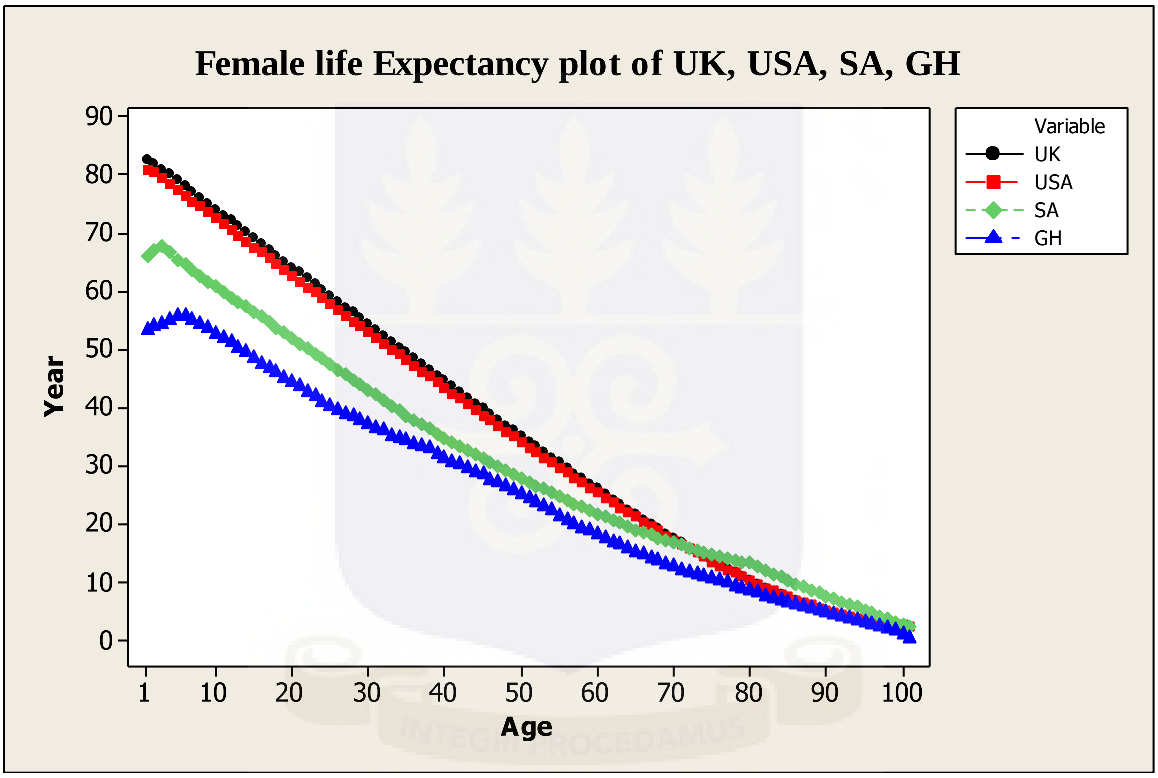

Figure 4.3: Life Expectancy for females in the various Countries

From Figure 4.3, it can be seen that the life expectancies for UK and that of US were far away from the life expectancy of Ghana. However, the South Africa one was closest to Ghana.

4.2.3 Testing for the Univariate Normality

A univariate normality test was done to test whether the errors obtained from the three foreign life tables are normally distributed. When the data is univariate normal then Univariate Analysis of Variance (ANOVA) can be carried out.

Table 4.3: Shapiro-Wilk normality test

W-Statistic	P-value
0.82725	0.1814

The null hypothesis of the Shapiro-Wilk's test states that the data is normal. From Table 4.3, the results revealed that the p-value of Shapiro-Wilk's statistic is greater than 0.05. This implies that we reject the null hypothesis and conclude that they are normal. Hence one-way univariate ANOVA was performed to compare for the differences between the errors obtained from the three foreign life tables and identify the one with the minimum average.

4.2.4 Univariate Analysis of Variance (ANOVA)

Table 4.4: One-way ANOVA

Gender	Country	Mean	Mean Square	F-value	P-value
Male	UK	11.3137	2477.977	56.793	0.0000
	USA	10.0085			
	SA	2.1560			
Female	UK	10.7598	1019.291	23.490	0.0000
	USA	9.9932			
	SA	4.914			

From Table 4.4, it can be seen that the error obtained from the males' life tables from the foreign life tables were significantly different with the South Africa exhibiting the minimum absolute error on the average. The United Kingdom error exhibit the highest error, followed by the USA foreign Life Table. This means that applying the UK and USA life tables on Ghana population is not appropriate. However, applying the South Africa Life table on Ghana population will yield a relative small error compare with the other two.

4.2.5 Testing for the difference between South Africa Life Table and the Study Life Table

From Table 4.4, it was established that the South Africa Life table had the minimum error, but is that error significantly different from zero? To answer this question paired t-test was performed to determine if the error is significantly different from zero. The results were presented in Table 4.5

Table 4.5: Independent Paired T-test

Gender	t-statistics	p-value
Male	4.0039	0.000
Female	19.2074	0.000

The null hypothesis of the paired t-test state that the paired difference (d) is equal to zero, whiles the alternative state that it is not different from zero. From Table 4.8, it can be seen that the p-value for paired difference of the south Africa and that of the Ghana are greater than 0.05 ($t = 4.0039, p = 0.000\ male\ ;\ t = 19.2074, p = 0.000\ female$). This implies that the life expectancies of the ages of South Africa life table and that of the study Life Table are significantly difference. This reject the study first hypothesis which state that foreign life tables are not significantly different from the study life table. Hence applying

South Africa life table and other foreign life table to Ghana population will also exhibit some significant errors and hence there is a need to construct our own life table.

4.3 Modelling he Force of Mortality

The second objective of the study was to derive the force of mortality function for Ghana. The studies used four parametric force of motility models namely Gompertz, Weibull, Logistic and Log-logistic. Choosing R-square as the test of goodness fit, the model that come out with the highest R-square was taken. The ages were group into two "5 years and below" and "above 5 years".

4.3.1 Force of Mortality Functions for Males

Table 4.6: Modelling the force of Mortality for Males

	$x \leq 5$	$x > 5$
Model	R-square	R-square
Gompertz	0.896	**0.904**
Weibull	**0.905**	0.881
Logistic	0.896	0.865
Log-logistic	0.854	0.865

Table 4.6 displayed the R-square of the various mortality models, Weibull model obtained the highest R-square for age 5 and below, whiles the Gompertz model obtained the highest R-Square for ages above 5 years.

This implies that for ages of 5 years and below the force of mortality follows a Weibull, whiles after 5 years the force of mortality follows a Gompertz model. The function of the force of mortality can be seen in equation 4.1.

$$\mu_x = \begin{cases} 0.006134 \times \left(\dfrac{x}{4.99715} \right)^{-0.96935} & x \le 5 \\ 0.0017 \times e^{0.0509x} & x > 5 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots. (4.1)$$

4.3.2 Force of Mortality Functions for Females

Table 4.7: Modelling the force of Mortality for Females

	$x \le 5$	$x > 5$
Model	R-square	R-square
Gompertz	0.895	**0.984**
Weibull	**0.909**	0.881
Logistic	0.726	0.855
Log-logistic	0.754	0.865

From Table 4.7, the model that obtained the highest R-square was Weibull and Gompertz for age 5 and below and above 5 years respectively. Hence Gompertz force of mortality model was appropriate for ages above 5 years and Weibull force of mortality model was appropriate for ages 5 and below. The force of mortality functions for the females can be seen in equation 4.2.

$$\mu_x = \begin{cases} 0.003666 \times \left(\dfrac{x}{8.10423} \right)^{-0.971168} & x \le 5 \\ 0.0016 \times e^{0.0485x} & x > 5 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (4.2)$$

4.3.3 Force of Mortality Functions for Combine Sex

Table 4.8: Modelling the force of Mortality for Combine Sex

	$x \leq 5$	$x > 5$
Model	R-square	R-square
Gompertz	0.796	**0.984**
Weibull	**0.899**	0.881
Logistic	0.792	0.825
Log-logistic	0.754	0.865

With regards to combining the sex, the Weibull force of mortality were appropriate for ages 5 years and below and Gompertz model was also appropriate for ages 5 years and above. The force of mortality functions can be seen in equation 4.3.

$$\mu_x = \begin{cases} 0.003666 \times \left(\dfrac{x}{8.10423} \right)^{-0.971168} & x \leq 5 \\ 0.0016 \times e^{0.0485x} & x > 5 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots..(4.3)$$

4.3.4 Graphical Representation

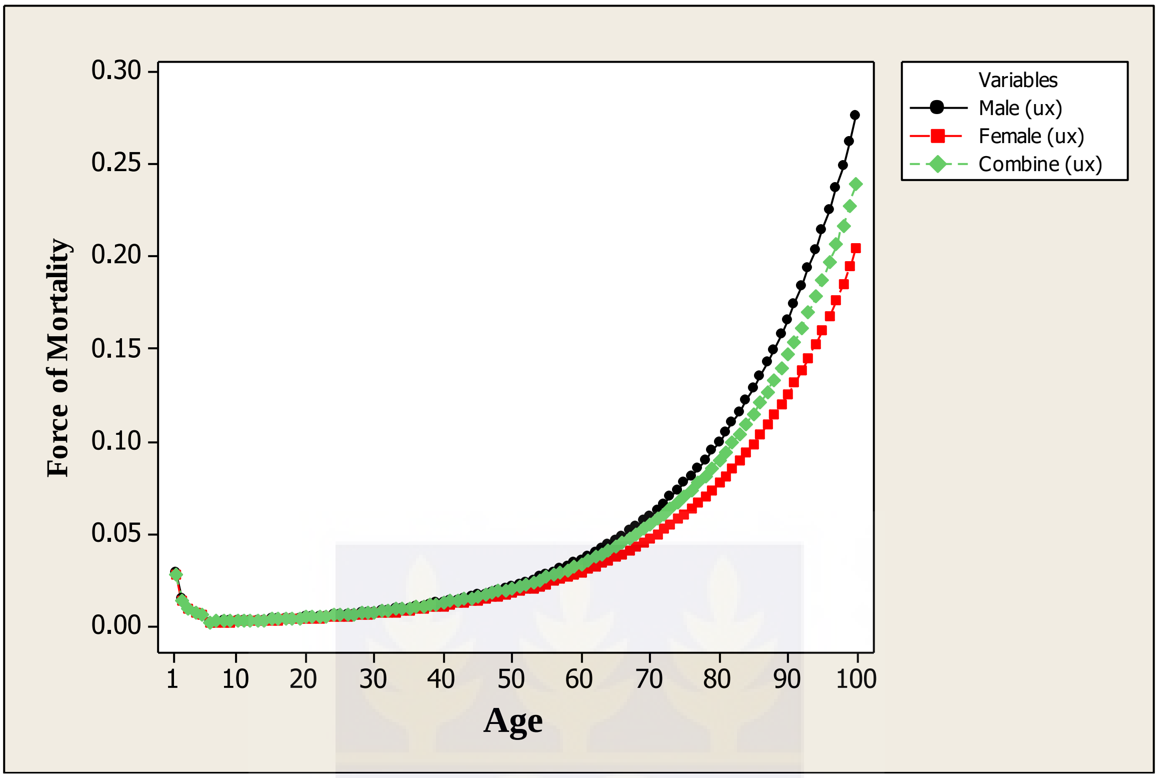

Figure 4.4: Force of Mortality Plot for Males, Female and Combines Sex.

The functions obtained in equation 4.1 to 4.3 were used to plot the force of mortality curve and graph were displayed in Figure 4.4. From Figure 4.4, it can be seen that the males exhibit the highest force of mortality in almost all the ages than the females. This implies that instantaneous rate of mortality of the males were higher than that of females.

4.4 Testing for the equality of survivor functions among Gender

From Figure 4.4, the force of mortality for males were higher than that on the females most of the ages. The study therefore employed the log rank equality of survivor to test if in deed the mortality or the survival for the gender significantly differ. This was done to meet the third objectives of the study.

Table 4.9: Log-rank test

Gender	Death observed	Death expected
Male	1890	1702.54
Female	1370	1557.46
Total	3260	3260.00
Chi-square (1)	= 46.22	
P-value	= 0.0000	

Ho: The survival curves for male and female are the same

Ha: The survival curves for male and female are significantly different

From Table 4.9, it can be seen that the survival curves for male and female are significantly different ($p = 0.00$). This implies that the mortality of the male is really greater than the females. According to Austad (2006), the males mortality are always higher than the females this is because the metabolism system of male developed faster than the females and hence males metabolism breaks down faster than the females causing the mortality in the males to be higher than the females. Kaplan-Meier survival curve was also done to analysis the survival trend per gender and it can be seen in appendix III.

B COMPETING RISK ANALYSIS

This section presents the competing risk analysis, in which the causes of death were grouped into 5 main causes, namely; Cardiovascular, HIV/AIDS, Lower respiratory infections, Malaria and Other causes.

4.5 Multiple Decrement Table

The multiple decrement table displayed the ages and causes of death for each age interval. The males multiple decrement table and females multiple decrement table can be seen in Appendix IV, whiles Table 4.10 displayed the multiple decrement table for combined sex.

From Table 4.10, it was revealed that among the four leading causes of death clearly specified, malaria recorded the highest death for children under one year (5 deaths were recorded), whiles for ages between 1 to 5 years' death due to Lower respiratory infections was the highest recording a death of 42. Many research such as had confirmed that malaria is one of leading causes of death for children in Africa. The age group that recorded the highest death of the cardiovascular diseases were 65 to 70 years. For ages, less than 15 years death due to cardiovascular diseases were few. According to Katzmarzyk et al. (2009) cardiovascular diseases are caused by poor blood circulatory due to lack of exercise, overweight, smoking, diabetes, stress and alcohol. Therefore, people in these age group lack exercise and bad blood circulation.

With regards to HIV/AIDs the age group of 45 to 50 years recorded the highest death whiles for ages of 80 years and above recorded few deaths. According to Schwartländer et al. (2011), the major causes of HIV/AIDS is by sexual intercourse and most people becomes sexual inactive at age 65 that time hence reduced the risk of being infected by the diseases, But for the youth they are sexually active and therefor stand at a higher risks of being infected by the HIV/AIDs. However, the virus stays longer a little before it kills the person this explained the reason why ages of 20 to 30 years did not record the highest death of HIV/AIDS but rather from 45 years to 50 years.

Table 4.10A: Multiple Decrement Table for Combined Sex

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
$[x_j - x_{j+1})$	αl_{x_j}	$(\alpha d)_{x_j}^{\beta_1}$	$(\alpha d)_{x_j}^{\beta_2}$	$(\alpha d)_{x_j}^{\beta_3}$	$(\alpha d)_{x_j}^{\beta_4}$	$(\alpha d)_{x_j}^{\beta_5}$	$(\alpha d)_{x_j}$
[0-1)	3260	0	2	7	13	77	99
[1-5)	3161	1	2	82	28	212	325
[5-10)	2836	0	1	17	11	56	85
[10-15)	2751	1	5	5	2	14	27
[15-20)	2724	2	2	6	2	52	64
[20-25)	2660	3	3	2	1	52	61
[25-30)	2599	5	28	3	4	59	99
[30-35)	2500	14	33	3	11	71	132
[35-40)	2368	17	34	4	9	82	146
[40-45)	2222	37	40	1	3	84	165
[45-50)	2057	55	31	0	7	84	177
[50-55)	1880	63	24	0	4	89	180

Table 4.10B: Multiple Decrement Table for (Combined Sex)

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
[55-60)	1700	78	15	0	5	111	209
[60-65)	1491	103	8	1	6	121	239
[65-70)	1252	156	4	5	9	94	268
[70-75)	984	113	1	1	13	136	264
[75-80)	720	102	1	1	11	95	210
[80-85)	510	85	0	1	19	80	185
[85-90)	325	67	2	4	17	71	161
[90-95)	164	36	0	0	2	57	95
[95-100)	69	17	0	4	12	18	51
100+	18	7	0	1	2	8	18

4.6 Crude Probabilities

The crude probability obtained present the probability of dying from a specific disease in the present of other disease. The crude probabilities of all the leading causes of diseases were computed with respect to age and gender and the results were presented in Table 4.11 to Table 4.15.

4.6.1 Crude Probabilities of Cardiovascular Diseases

The crude probabilities of dying from Cardiovascular Diseases and as well as its standard error with respect to age and gender were computed with referenced to equation (3.18) and (3.19) respectively and it can be seen in Table 4.11.

From Table 4.11, it was observed that the probability that a less than 5 years will die from cardiovascular diseases is negligible. Probability of 0 was recorded for males whiles 0.00075 was recorded for females. This means that children under 5 years are not at risk of being death from Cardiovascular Diseases. However, for both male and female the aged people (above 65 years) recorded high crude probabilities from dying from cardiovascular diseases and hence implies that death due to cardiovascular diseases are often experienced by this age groups. Comparing with gender, in all the ages except 100 years and above, the probability of a male dying from Cardiovascular Diseases were higher than that of the females one. According to Graham et al. (2007) males suffered from death of cardiovascular disease because of stress and activities such as smoking and alcoholism. Rosamond et al. (2008) in his research also confirmed that the males the probability that a male will die from cardiovascular diseases are higher than that of a female.

Table 4.11: Crude Probabilities of Cardiovascular Diseases

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{Q}_{jCD}$	$S_{\hat{Q}_{jCD}}$	$\hat{Q}_{jCD}$	$S_{\hat{Q}_{jCD}}$
[0-1)	0.00000	0.00000	0.00000	0.00000
[1-5)	0.00000	0.00000	0.00075	0.00064
[5-10)	0.00000	0.00000	0.00000	0.00000
[10-15)	0.00000	0.00000	0.00086	0.00073
[15-20)	0.00064	0.00064	0.00087	0.00074
[20-25)	0.00065	0.00065	0.00177	0.00107
[25-30)	0.00267	0.00133	0.00091	0.00077
[30-35)	0.00551	0.00194	0.00573	0.00198
[35-40)	0.00796	0.00239	0.00609	0.00211
[40-45)	0.01782	0.00368	0.01504	0.00340
[45-50)	0.03128	0.00506	0.02059	0.00409
[50-55)	0.04045	0.00604	0.02448	0.00460
[55-60)	0.04936	0.00710	0.04167	0.00614
[60-65)	0.08207	0.00975	0.05436	0.00730
[65-70)	0.13950	0.01372	0.10912	0.01071
[70-75)	0.11205	0.01450	0.11742	0.01212
[75-80)	0.14894	0.01963	0.13555	0.01474
[80-85)	0.15766	0.02446	0.17361	0.01900
[85-90)	0.18657	0.03365	0.21990	0.02552
[90-95)	0.13115	0.04322	0.27184	0.03732
[95-100)	0.28000	0.08980	0.22727	0.05379
100+	0.333333	0.19245	0.416667	0.121169

4.6.2 Crude Probabilities of HIV/AIDS

The probability of dying from HIV/AIDS (crude probability) and its standard error were computed and the results were displayed in Table 4.12.

Table 4.12: Crude Probabilities of HIV/AIDS

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{Q}_{jHIV}$	$S_{\hat{Q}_{jHIV}}$	$\hat{Q}_{jHIV}$	$S_{\hat{Q}_{jHIV}}$
[0-1)	0.00053	0.00053	0.00073	0.00062
[1-5)	0.00000	0.00000	0.00150	0.00090
[5-10)	0.00061	0.00058	0.00000	0.00000
[10-15)	0.00190	0.00109	0.00171	0.00103
[15-20)	0.00127	0.00090	0.00000	0.00000
[20-25)	0.00000	0.00000	0.00266	0.00130
[25-30)	0.00267	0.00133	0.02178	0.00374
[30-35)	0.00689	0.00217	0.02195	0.00385
[35-40)	0.01302	0.00305	0.01623	0.00343
[40-45)	0.01782	0.00368	0.01826	0.00374
[45-50)	0.01775	0.00384	0.01144	0.00306
[50-55)	0.01129	0.00324	0.01469	0.00358
[55-60)	0.00858	0.00302	0.00911	0.00292
[60-65)	0.00505	0.00252	0.00572	0.00243
[65-70)	0.00313	0.00221	0.00326	0.00196
[70-75)	0.00211	0.00211	0.00000	0.00000
[75-80)	0.00304	0.00303	0.00000	0.00000
[80-85)	0.00000	0.00000	0.00000	0.00000
[85-90)	0.00746	0.00743	0.00524	0.00445
[90-95)	0.00000	0.00000	0.00000	0.00000
[95-100)	0.00000	0.00000	0.00000	0.00000
100+	0.00000	0.00000	0.00000	0.00000

From the Table 4.13, it can be seen that the probability of dying from HIV/AIDS among people of ages below 20 years and above 90 years were negligible ($prop < 0.005$). This means that the probability that a person below 20 years and above 90 years dying from HIV/AIDS is very small. Hence people less than 20 years and above 90 years have a very low risk of dying from HIV/AIDS. For ages of 34 to 55 years in both male and female groups, the probability of a person dying from HIV.AIDS are more than 0.005. This implies that people in the age groups of 34 to 55 years have a higher chance of dying from HIV/AIDS. Leclerc-Madlala (1997) explained that youth are sexually active and a person can stay for a minimum of 10 years before dying from HIV/AIDS and thus answer why the probability of dying from HIV/AIDS are higher from 45 to 60 years.

4.6.3 Crude Probabilities of Lower Respiration Infections

The Lower Respiration Infections that were recorded in the study were bronchitis and pneumonia. The probability of dying from Lower Respiration Infections (LIR), in the present of all the other causes of death were computed as well as its standard error with respect to gender and age.

From Table 4.13, highest probability of dying from LIR were in the age group of 95 to 100 years and children from 1 to 5 years. According to Lodha, Kabra, and Pandey (2013), Pneumonia is the leading causes of for children under five years in developing countries such as Ghana. They explained that children under five years cannot withstand to excessive cold and are likely to have pneumonia diseases. Comparing with the gender, the probability that a female child will die from pneumonia is higher than the male. The probability of dying from LIR was also higher in 95 to 100 years. World Health Organization (2009) also explained that very old people cannot also stand cold weather and are at a higher risk of being infected with pneumonia.

Table 4.13: Crude Probabilities of Lower Respiration Infections

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{Q}_{jLR}$	$S_{\hat{Q}_{jLR}}$	$\hat{Q}_{jLR}$	$S_{\hat{Q}_{jLR}}$
[0-1)	0.00106	0.00075	0.00365	0.00139
[1-5)	0.02294	0.00350	0.03008	0.00399
[5-10)	0.00366	0.00141	0.00921	0.00223
[10-15)	0.00063	0.00063	0.00342	0.00145
[15-20)	0.00318	0.00142	0.00087	0.00074
[20-25)	0.00065	0.00065	0.00089	0.00075
[25-30)	0.00134	0.00094	0.00091	0.00077
[30-35)	0.00207	0.00119	0.00000	0.00000
[35-40)	0.00289	0.00145	0.00000	0.00000
[40-45)	0.00077	0.00077	0.00000	0.00000
[45-50)	0.00000	0.00000	0.00000	0.00000
[50-55)	0.00000	0.00000	0.00000	0.00000
[55-60)	0.00000	0.00000	0.00000	0.00000
[60-65)	0.00126	0.00126	0.00000	0.00000
[65-70)	0.00470	0.00271	0.00326	0.00196
[70-75)	0.00211	0.00211	0.00000	0.00000
[75-80)	0.00304	0.00303	0.00000	0.00000
[80-85)	0.00000	0.00000	0.00347	0.00295
[85-90)	0.00746	0.00743	0.01571	0.00766
[90-95)	0.00000	0.00000	0.00000	0.00000
[95-100)	0.04000	0.03919	0.06818	0.03235
100+	0.00000	0.00000	0.08333	0.06793

4.6.4 Crude Probabilities of Malaria

Table 4.14 displayed the crude probability and the standard error of dying from malaria.

Table 4.14: Crude Probabilities of Malaria

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{Q}_{jm}$	$S_{\hat{Q}_{jm}}$	$\hat{Q}_{jm}$	$S_{\hat{Q}_{jm}}$
[0-1)	0.00265	0.00118	0.00584	0.00175
[1-5)	0.00874	0.00218	0.00902	0.00221
[5-10)	0.00609	0.00182	0.00084	0.00068
[10-15)	0.00063	0.00063	0.00086	0.00073
[15-20)	0.00064	0.00064	0.00087	0.00074
[20-25)	0.00065	0.00065	0.00000	0.00000
[25-30)	0.00067	0.00067	0.00272	0.00134
[30-35)	0.00482	0.00182	0.00382	0.00162
[35-40)	0.00434	0.00177	0.00304	0.00149
[40-45)	0.00232	0.00134	0.00000	0.00000
[45-50)	0.00423	0.00189	0.00229	0.00138
[50-55)	0.00188	0.00133	0.00245	0.00147
[55-60)	0.00536	0.00239	0.00000	0.00000
[60-65)	0.00631	0.00281	0.00143	0.00122
[65-70)	0.01254	0.00441	0.00163	0.00139
[70-75)	0.01480	0.00555	0.01174	0.00406
[75-80)	0.01824	0.00738	0.01279	0.00484
[80-85)	0.05856	0.01576	0.02083	0.00717
[85-90)	0.05224	0.01922	0.05236	0.01372
[90-95)	0.01639	0.01626	0.00971	0.00823
[95-100)	0.16000	0.07332	0.18182	0.04950
100+	0.00000	0.00000	0.16667	0.09160

From Table 4.14, it revealed that children from 1 to 5 years as well as the aged people from 85 above are the age groups that recorded a significant crude probabilities. In African in every 30 seconds a child in Africa dies from malaria (Sachs & Malaney, 2002). According to Mermin et al. (2006) aged people are more likely to die from malaria than the adult people, this is because the elderly people have a weaker immune.

4.6.5 Graphical Presentation Crude Probabilities

The crude probabilities of all the leading causes of diseases were displayed in a graphical form in Figure 4.4.

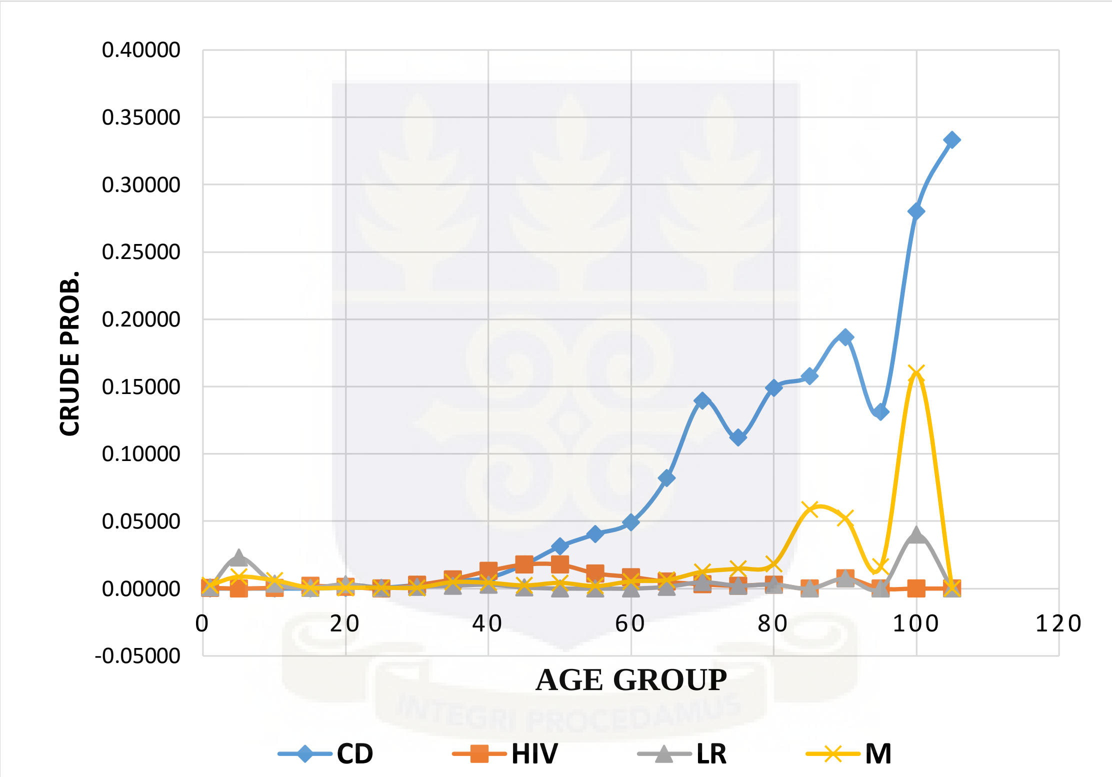

Figure 4.5: Crude Probabilities

From Figure 4.5, it can be seen that in the ages of 55 years and above the crude probability of cardiovascular diseases were higher than all the other diseases. This implies that that probability that a 55 year above person will die from cardiovascular diseases is high. From literature Katzmarzyk et al. (2009) found out that the leading causes of death for old people and the entire population was cardiovascular diseases. For children with 1 to 5 years, the probability that a person will die from Lower Respiratory Infections were higher, followed by malaria.

4.7 Net Probabilities

The net probability with respect to the probability of dying when only a particular risk is acting in the population for all the leading causes of death and their standard error for each age group and gender were computed with referenced to equation (3.24) and (2.26) respectively. The graphic presentation of these net probabilities per age gender were displayed in Figure 4.6 and 4.7.

4.7.1 Net Probabilities for Males

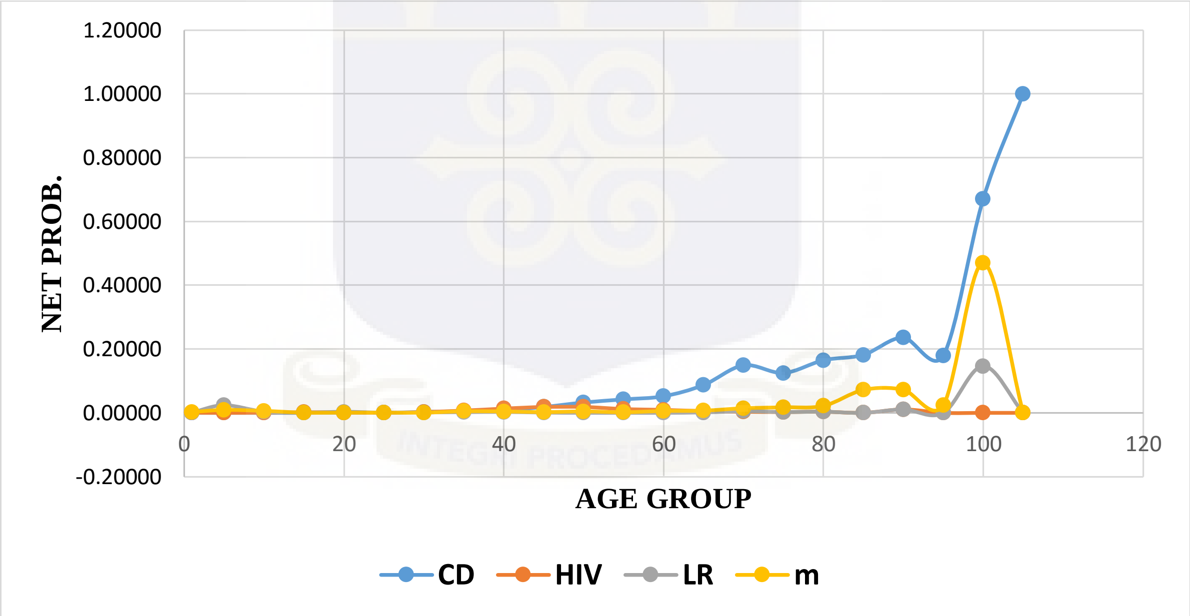

Figure 4.6: Net Probabilities for Males

4.7.2 Graphical Presentation the Female Net Probabilities

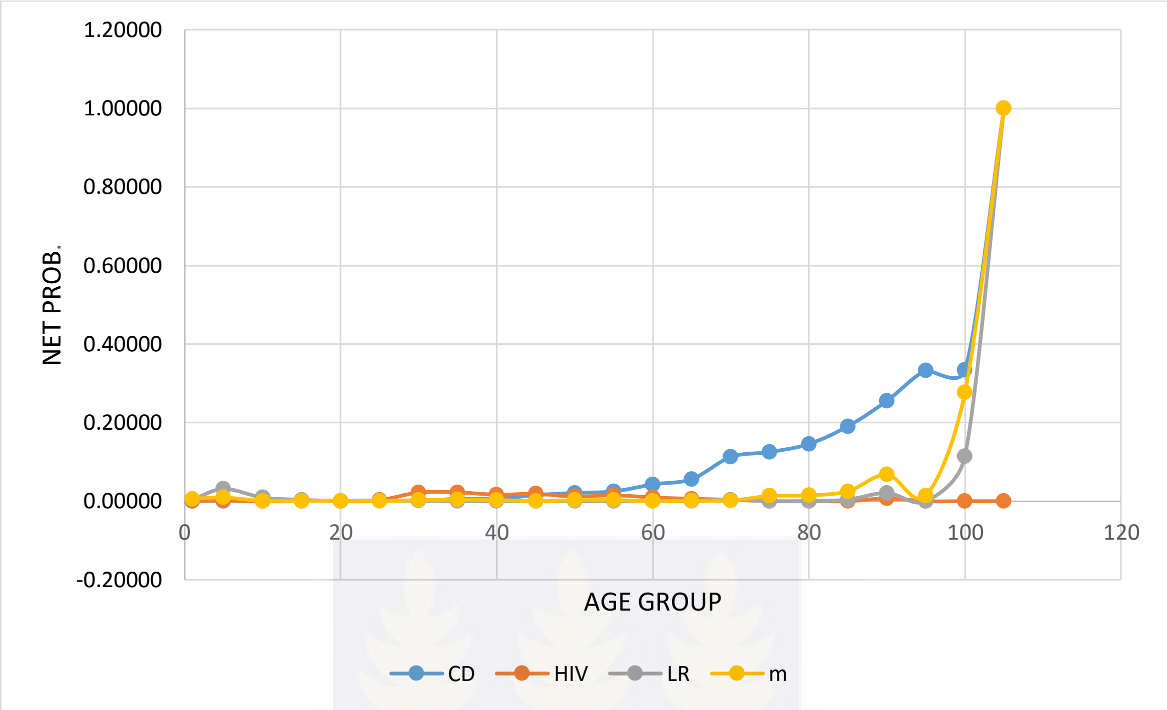

Figure 4.7: Net Probabilities for Females

From the Figure 4.6 and Figure 4.7, the net probability of all the leading causes of death for age 40 and below were less than 0.0005. This implies if the death is only caused cardiovascular, HIV/AIDS, almost everyone in the age of 40 years and below will not die but will experience mortality from ages above 40 years.

4.8 The Impact of Eliminating the Major Causes of Diseases

The objective of the study was to determine the impact of the leading causes of death. As a result of that the net probability of the various causes of death probability ($\hat{q}_{j.\gamma}$) were calculated and the results were used to compute for the life expectancy for eliminating the leading Causes of death for each age group and gender. The impacts were examined in two ways, they are by calculating the percentage decrease in probability of dying given that a particular risk of death is eliminated and the life expectancy gain when the cause of death is eliminated.

4.8.1 The Impact of Eliminating Cardiovascular Diseases

4.8.1.1 Percentage Decrease in Probability of Dying Given that Cardiovascular Diseases is eliminated

The probability of dying at a specific age is represented by $\hat{q}_j$, whiles $\hat{q}_{j.CD}$ represent the probability of dying given that the cardiovascular disease is eliminated. From Table 4.15, it was seen that the percentage decrease in probability of dying given that cardiovascular disease is eliminated are less than 1% for age 15 and below. This implies that at age 15 and below when the cardiovascular disease is eliminated the impact will not felt. On the contrary, in aged years especially 95 to 100 years for males and 65 to 70 years for the females the impact of eliminating the leading cause of death will felt massively since they recorded a percentage decreases above 15%. This massive reduction implies that when there are no cardiovascular diseases the probability that a male will die within 95 years 100 will decrease by 64% and 62% for female aged of 65 to 70 years.

Table 4.15: Percentage Decrease in Probability of Dying Given that Cardiovascular Diseases is eliminated

Age Group $[x_j - x_{j+1})$	Male			Female		
	Prob. of Dying	CD eliminated	Percentage Decrease	Prob. of Dying	CD eliminated	Percentage Decrease
	$\hat{q}_j$	$\hat{q}_{j.CD}$	$\frac{\hat{q}_j - \hat{q}_{j.CD}}{\hat{q}_j}$	$\hat{q}_j$	$\hat{q}_{j.CD}$	$\frac{\hat{q}_j - \hat{q}_{j.CD}}{\hat{q}_j}$
[0-1)	0.03122	0.03122	0.000%	0.02920	0.02920	0.000%
[1-5)	0.10377	0.10377	0.000%	0.10150	0.10079	0.702%
[5-10)	0.03595	0.03595	0.000%	0.02176	0.02176	0.000%
[10-15)	0.00759	0.00759	0.000%	0.01283	0.01198	6.627%
[15-20)	0.02484	0.02421	2.533%	0.02166	0.02081	3.958%
[20-25)	0.02221	0.02156	2.909%	0.02391	0.02216	7.325%
[25-30)	0.03006	0.02743	8.766%	0.04900	0.04812	1.807%
[30-35)	0.04821	0.04282	11.180%	0.05916	0.05359	9.413%
[35-40)	0.06585	0.05812	11.729%	0.05578	0.04985	10.632%
[40-45)	0.08366	0.06645	20.570%	0.06122	0.04654	23.979%
[45-50)	0.10144	0.07131	29.701%	0.06522	0.04510	30.853%
[50-55)	0.12324	0.08456	31.386%	0.05998	0.03594	40.071%
[55-60)	0.15021	0.10353	31.079%	0.08984	0.04923	45.208%
[60-65)	0.19444	0.11747	39.588%	0.12160	0.06918	43.108%
[65-70)	0.25862	0.12876	50.214%	0.16775	0.06216	62.943%
[70-75)	0.30444	0.20501	32.662%	0.23483	0.12526	46.659%
[75-80)	0.32523	0.19203	40.954%	0.26343	0.13793	47.639%
[80-85)	0.39640	0.26218	33.860%	0.33681	0.18044	46.425%
[85-90)	0.54478	0.40397	25.847%	0.46073	0.27589	40.120%
[90-95)	0.59016	0.50031	15.224%	0.57282	0.36039	37.085%
[95-100)	0.76000	0.27177	64.241%	0.72727	0.59068	18.782%
100+	1.00000	1.00000	0.000%	1.00000	1.00000	0.000%

4.8.1.2 Life Expectancy Gain from Eliminating Cardiovascular Diseases

Table 4.16 represent the life expectancy gain from Eliminating Cardiovascular Diseases. From the Table, it was recorded that when Cardiovascular Diseases.is eliminated Ghanaians life expectancy at birth will increase by 16.021% when the person is a male and 17.587% when the person is a female. Comparing the gender, the impact it felt more in females than the males. Lai and Hardy (1999) in their study also found out that in US, the life expectancy gain for eliminating cardiovascular diseases were higher in ages above 60 years.

Table 4.16: Life Expectancy Gain from Eliminating Cardiovascular Diseases

Age Group	Life Expectancy	CD eliminated	Expectancy Gain	Life Expectancy	CD eliminated	Expectancy Gain
$[x_j - x_{j+1})$	$\hat{e}_{j.CD}$	$\hat{e}_j$	$\frac{\hat{e}_{j.CD} - \hat{e}_j}{\hat{e}_j}$	$\hat{e}_{j.CD}$	$\hat{e}_j$	$\frac{\hat{e}_{j.CD} - \hat{e}_j}{\hat{e}_j}$
[0-1)	58.97507	49.52666	16.021%	65.06901	53.62562	17.587%
[1-5)	59.87875	50.11933	16.299%	66.02296	54.23541	17.854%
[5-10)	62.63107	51.74168	17.387%	69.24540	56.18619	18.859%
[10-15)	59.87363	48.57812	18.866%	65.72863	52.38024	20.308%
[15-20)	55.31216	43.93031	20.577%	61.49438	48.02860	21.898%
[20-25)	51.62212	39.98569	22.542%	57.74514	44.03676	23.739%
[25-30)	47.70353	35.83707	24.875%	53.99277	40.05445	25.815%
[30-35)	43.97468	31.87024	27.526%	51.58207	36.98950	28.290%
[35-40)	40.81668	28.35788	30.524%	49.33617	34.15822	30.764%
[40-45)	38.14597	25.18055	33.989%	46.75448	31.02846	33.635%
[45-50)	35.60730	22.25113	37.510%	43.85486	27.88902	36.406%
[50-55)	33.00095	19.48080	40.969%	40.71511	24.66034	39.432%
[55-60)	30.53310	16.86759	44.756%	37.03759	21.07422	43.100%
[60-65)	28.26096	14.40731	49.020%	33.63296	17.90773	46.755%
[65-70)	25.87525	12.28149	52.536%	30.57361	15.04072	50.805%
[70-75)	23.09312	10.69364	53.693%	26.98120	12.56849	53.418%
[75-80)	20.73252	9.27991	55.240%	24.21353	10.65857	55.981%
[80-85)	17.35443	7.54770	56.509%	20.99918	8.57639	59.158%
[85-90)	13.66876	5.86261	57.109%	17.54902	6.66230	62.036%
[90-95)	9.64172	4.88672	49.317%	13.89320	5.21845	62.439%
[95-100)	5.02407	3.32360	33.846%	9.62293	3.86364	59.850%
100+	1.03376	0.93167	9.876%	4.96212	2.50000	49.618%

4.8.2 The Impact of Eliminating HIV/AIDS

4.8.2.1 Percentage Decrease in Probability of Dying Given that HIV/AIDS is eliminated

Table 4.17: Percentage Decrease in Probability of Dying Given that HIV/AIDS is eliminated

Age Group $[x_j - x_{j+1})$	Male: Prob. of Dying $\hat{q}_j$	Male: HIV/AIDS eliminated $\hat{q}_{j.HIV}$	Male: Percentage Decrease $\frac{\hat{q}_j - \hat{q}_{j.HIV}}{\hat{q}_j}$	Female: Prob. of Dying $\hat{q}_j$	Female: HIV/AIDS eliminated $\hat{q}_{j.HIV}$	Female: Percentage Decrease $\frac{\hat{q}_j - \hat{q}_{j.HIV}}{\hat{q}_j}$
[0-1)	0.03122	0.03070	1.669%	0.02920	0.02848	2.464%
[1-5)	0.10377	0.10377	0.000%	0.10150	0.10008	1.405%
[5-10)	0.03595	0.03536	1.665%	0.02176	0.02176	0.000%
[10-15)	0.00759	0.00569	24.929%	0.01283	0.01113	13.259%
[15-20)	0.02484	0.02358	5.067%	0.02166	0.02166	0.000%
[20-25)	0.02221	0.02221	0.000%	0.02391	0.02129	10.992%
[25-30)	0.03006	0.02743	8.766%	0.04900	0.02753	43.825%
[30-35)	0.04821	0.04147	13.985%	0.05916	0.03763	36.387%
[35-40)	0.06585	0.05318	19.244%	0.05578	0.03988	28.501%
[40-45)	0.08366	0.06645	20.570%	0.06122	0.04337	29.166%
[45-50)	0.10144	0.08446	16.737%	0.06522	0.05409	17.060%
[50-55)	0.12324	0.11261	8.623%	0.05998	0.04563	23.921%
[55-60)	0.15021	0.14227	5.286%	0.08984	0.08111	9.721%
[60-65)	0.19444	0.18991	2.333%	0.12160	0.11623	4.421%
[65-70)	0.25862	0.25593	1.042%	0.16775	0.16478	1.772%
[70-75)	0.30444	0.30268	0.577%	0.23483	0.23483	0.000%
[75-80)	0.32523	0.32274	0.764%	0.26343	0.26343	0.000%
[80-85)	0.39640	0.39640	0.000%	0.33681	0.33681	0.000%
[85-90)	0.54478	0.53984	0.906%	0.46073	0.45694	0.824%
[90-95)	0.59016	0.59016	0.000%	0.57282	0.57282	0.000%
[95-100)	0.76000	0.76000	0.000%	0.72727	0.72727	0.000%
100+	1.00000	1.00000	0.000%	1.00000	1.00000	0.000%

From Table 4.17, the percentage decrease in probability of dying given HIV/AIDS is eliminated in the population are higher in most of the ages in female that that of the males. This implies that when there are no HIV/AIDs in the population the females will survive longer than the males. According to Higgins et al. (2010), the probability a male will contract the virus from females is less than a female contracting the virus from the male. His explained that the females the probability a female will contract AIDS are higher than that of the males.

4.8.2.2 Life Expectancy Gain from Eliminating HIV/AIDS

Table 4.18: Percentage Decrease in Probability of Dying Given that HIV/AIDS is eliminated

Age Group	Male			Female		
	Life Expectancy	HIV/AIDS eliminated	Expectancy Gain	Life Expectancy	HIV/AIDS eliminated	Expectancy Gain
$[x_j - x_{j+1})$	$\hat{e}_{j.HIV}$	$\hat{e}_j$	$\frac{\hat{e}_{j.HIV} - \hat{e}_j}{\hat{e}_j}$	$\hat{e}_{j.HIV}$	$\hat{e}_j$	$\frac{\hat{e}_{j.HIV} - \hat{e}_j}{\hat{e}_j}$
[0-1)	52.88507	49.52666	6.350%	59.61999	53.62562	10.054%
[1-5)	53.55622	50.11933	6.417%	60.36400	54.23541	10.153%
[5-10)	55.57283	51.74168	6.894%	62.89232	56.18619	10.663%
[10-15)	52.51616	48.57812	7.499%	59.23208	52.38024	11.568%
[15-20)	47.80196	43.93031	8.099%	54.86842	48.02860	12.466%
[20-25)	43.89180	39.98569	8.899%	51.02293	44.03676	13.692%
[25-30)	39.82752	35.83707	10.019%	47.07207	40.05445	14.908%
[30-35)	35.87361	31.87024	11.160%	43.31019	36.98950	14.594%
[35-40)	32.30085	28.35788	12.207%	39.83910	34.15822	14.260%
[40-45)	28.93653	25.18055	12.980%	36.29242	31.02846	14.504%
[45-50)	25.74144	22.25113	13.559%	32.69751	27.88902	14.706%
[50-55)	22.74921	19.48080	14.367%	29.24863	24.66034	15.687%
[55-60)	20.09551	16.86759	16.063%	25.37585	21.07422	16.952%
[60-65)	17.69060	14.40731	18.560%	22.11397	17.90773	19.021%
[65-70)	15.74911	12.28149	22.018%	19.27551	15.04072	21.970%
[70-75)	14.45978	10.69364	26.046%	16.94795	12.56849	25.841%
[75-80)	13.35556	9.27991	30.517%	15.32101	10.65857	30.432%
[80-85)	11.81108	7.54770	36.096%	13.53406	8.57639	36.631%
[85-90)	10.15547	5.86261	42.271%	11.94268	6.66230	44.214%
[90-95)	8.34156	4.88672	41.417%	10.56167	5.21845	50.591%
[95-100)	4.87657	3.32360	31.846%	8.39286	3.86364	53.965%
100+	1.04367	0.93167	10.732%	4.77941	2.50000	47.692%

From Table 4.18 the life expectancy gain from Eliminating AIDS at birth for the females was 10.054% and that of the males were 6.350. This implies that comparing by gender, the impact it eliminating AIDS will be higher in females' mortality that the males' mortality. This confirm to, Lai and Hardy (1999) who found out that the life expectancy for eliminating HIV/AIDS from US population was higher for females than the males.

4.8.3 The Effect of Eliminating Lower Respiration

4.8.3.1 Percentage Decrease in Probability of Dying Given that Lower Respiration (LIR) is eliminated

From Table 4.19, it can be seen that at age 10 and below there are a huge decrease in the probability of dying when in LIR is eliminated in the population. For instance, assuming that there is no LIR, the probability that a child at aged 5 to 10 years given she is a female will decrease by 42.039%. With respect to the male the probability that a child will die when LIR is eliminated will decrease by 21.172%. This implies that when LIR is eliminated in the population, the children mortality rate will reduce.

Table 4.19: Percentage Decrease in Probability of Dying Given that Lower Respiration is eliminated

Age Group $[x_j - x_{j+1})$	Male			Female		
	Prob. of Dying	LR eliminated	Percentage Decrease	Prob. of Dying	LR eliminated	Percentage Decrease
	$\hat{q}_j$	$\hat{q}_{j.LR}$	$\frac{\hat{q}_j - \hat{q}_{j.LR}}{\hat{q}_j}$	$\hat{q}_j$	$\hat{q}_{j.LR}$	$\frac{\hat{q}_j - \hat{q}_{j.LR}}{\hat{q}_j}$
[0-1)	0.03122	0.03017	3.338%	0.02920	0.02559	12.339%
[1-5)	0.10377	0.08180	21.172%	0.10150	0.07255	28.522%
[5-10)	0.03595	0.03236	10.003%	0.02176	0.01261	42.039%
[10-15)	0.00759	0.00696	8.304%	0.01283	0.00943	26.541%
[15-20)	0.02484	0.02169	12.680%	0.02166	0.02081	3.958%
[20-25)	0.02221	0.02156	2.909%	0.02391	0.02304	3.661%
[25-30)	0.03006	0.02874	4.380%	0.04900	0.04812	1.807%
[30-35)	0.04821	0.04619	4.185%	0.05916	0.05916	0.000%
[35-40)	0.06585	0.06305	4.254%	0.05578	0.05578	0.000%
[40-45)	0.08366	0.08291	0.886%	0.06122	0.06122	0.000%
[45-50)	0.10144	0.10144	0.000%	0.06522	0.06522	0.000%
[50-55)	0.12324	0.12324	0.000%	0.05998	0.05998	0.000%
[55-60)	0.15021	0.15021	0.000%	0.08984	0.08984	0.000%
[60-65)	0.19444	0.19331	0.582%	0.12160	0.12160	0.000%
[65-70)	0.25862	0.25458	1.564%	0.16775	0.16478	1.772%
[70-75)	0.30444	0.30268	0.577%	0.23483	0.23483	0.000%
[75-80)	0.32523	0.32274	0.764%	0.26343	0.26343	0.000%
[80-85)	0.39640	0.39640	0.000%	0.33681	0.33399	0.835%
[85-90)	0.54478	0.53984	0.906%	0.46073	0.44926	2.490%
[90-95)	0.59016	0.59016	0.000%	0.57282	0.57282	0.000%
[95-100)	0.76000	0.71876	5.426%	0.72727	0.69194	4.858%
100+	1.00000	1.00000	0.000%	1.00000	1.00000	0.000%

4.8.3.2 Life Expectancy Gain from Eliminating Lower Respiration

From Table 4.20, it can be seen that the life expectancy for females increased by 8.114% when LIR is eliminated from the population, whiles for males the life expectancy increases by 6.310%. This implies on the average eliminating LIR in the population will have a significant increase in our life expectancy and females impact will be higher than that of the males.

Table 4.20 Life Expectancy Gain from Eliminating Lower Respiration

Age Group	Male			Female		
	Life Expectancy	LR eliminated	Expectancy Gain	Life Expectancy	LR eliminated	Expectancy Gain
$[x_j - x_{j+1})$	$\hat{e}_{j.LR}$	$\hat{e}_j$	$\frac{\hat{e}_{j.LR}-\hat{e}_j}{\hat{e}_j}$	$\hat{e}_{j.LR}$	$\hat{e}_j$	$\frac{\hat{e}_{j.LR}-\hat{e}_j}{\hat{e}_j}$
[0-1)	52.86252	49.52666	6.310%	58.36073	53.62562	8.114%
[1-5)	53.50326	50.11933	6.325%	58.88816	54.23541	7.901%
[5-10)	54.06563	51.74168	4.298%	59.28024	56.18619	5.219%
[10-15)	50.74025	48.57812	4.261%	54.97551	52.38024	4.721%
[15-20)	46.06761	43.93031	4.639%	50.45099	48.02860	4.801%
[20-25)	42.00100	39.98569	4.798%	46.41807	44.03676	5.130%
[25-30)	37.83983	35.83707	5.293%	42.39905	40.05445	5.530%
[30-35)	33.84553	31.87024	5.836%	39.30243	36.98950	5.885%
[35-40)	30.29992	28.35788	6.409%	36.47760	34.15822	6.358%
[40-45)	27.08223	25.18055	7.022%	33.35765	31.02846	6.982%
[45-50)	24.18647	22.25113	8.002%	30.23479	27.88902	7.759%
[50-55)	21.48946	19.48080	9.347%	27.03125	24.66034	8.771%
[55-60)	18.97957	16.86759	11.128%	23.47774	21.07422	10.237%
[60-65)	16.66541	14.40731	13.550%	20.37730	17.90773	12.119%
[65-70)	14.73525	12.28149	16.652%	17.62186	15.04072	14.647%
[70-75)	13.37884	10.69364	20.071%	15.27344	12.56849	17.710%
[75-80)	12.25833	9.27991	24.297%	13.63487	10.65857	21.829%
[80-85)	10.76471	7.54770	29.885%	11.88385	8.57639	27.832%
[85-90)	9.27821	5.86261	36.813%	10.38911	6.66230	35.872%
[90-95)	7.89326	4.88672	38.090%	9.28779	5.21845	43.814%
[95-100)	4.85444	3.32360	31.535%	7.83186	3.86364	50.668%
100+	1.06143	0.93167	12.225%	4.67262	2.50000	46.497%

4.8.4 The Effect of Eliminating Malaria

4.8.4.1 Percentage Decrease in Probability of Dying Given that Eliminating Malaria Diseases

The probability of dying given that malaria is eliminated from the population presented as $\hat{q}_{j.CD}$ From Table 4.21, it was seen that the percentage decrease in probability of dying when malaria is eliminated are high in almost all the age group in the population. This implies in Ghana everyone is at risk of dying from malaria. Hence when the disease is eliminated the mortality rate experience in the country will reduced a crossed the age groups.

Table 4.21: Percentage Decrease in Probability of Dying Given that Eliminating Malaria Diseases

Age Group $[x_j - x_{j+1})$	Male			Female		
	Prob. of Dying	LR eliminated	Percentage Decrease	Prob. of Dying	LR eliminated	Percentage Decrease
	$\hat{q}_j$	$\hat{q}_{j.m}$	$\frac{\hat{q}_j - \hat{q}_{j.MR}}{\hat{q}_j}$	$\hat{q}_j$	$\hat{q}_{j.m}$	$\frac{\hat{q}_j - \hat{q}_{j.MR}}{\hat{q}_j}$
[0-1)	0.03122	0.02861	8.352%	0.029197	0.023427	19.764%
[1-5)	0.10377	0.09546	8.005%	0.101504	0.092915	8.462%
[5-10)	0.03595	0.02995	16.692%	0.021757	0.020929	3.806%
[10-15)	0.00759	0.00696	8.304%	0.012831	0.011981	6.627%
[15-20)	0.02484	0.02421	2.533%	0.021664	0.020806	3.958%
[20-25)	0.02221	0.02156	2.909%	0.023915	0.023915	0.000%
[25-30)	0.03006	0.02940	2.189%	0.049002	0.046344	5.425%
[30-35)	0.04821	0.04349	9.779%	0.05916	0.055451	6.269%
[35-40)	0.06585	0.06164	6.386%	0.055781	0.05282	5.308%
[40-45)	0.08366	0.08143	2.661%	0.061224	0.061224	0.000%
[45-50)	0.10144	0.09742	3.957%	0.065217	0.063003	3.396%
[50-55)	0.12324	0.12147	1.430%	0.059976	0.057599	3.962%

Table 4.21: Percentage Decrease in Probability of Dying Given that Eliminating Malaria Diseases Cont.

	Male			Female		
Age Group	Prob. of Dying	LR eliminated	Percentage Decrease	Prob. of Dying	LR eliminated	Percentage Decrease
$[x_j - x_{j+1})$	$\hat{q}_j$	$\hat{q}_{j.m}$	$\frac{\hat{q}_j - \hat{q}_{j.MR}}{\hat{q}_j}$	$\hat{q}_j$	$\hat{q}_{j.m}$	$\frac{\hat{q}_j - \hat{q}_{j.MR}}{\hat{q}_j}$
[55-60)	0.15021	0.14526	3.298%	0.089844	0.089844	0.000%
[60-65)	0.19444	0.18877	2.919%	0.121602	0.120261	1.103%
[65-70)	0.25862	0.24779	4.189%	0.167752	0.166267	0.885%
[70-75)	0.30444	0.29206	4.068%	0.234834	0.224525	4.390%
[75-80)	0.32523	0.31018	4.628%	0.263427	0.252413	4.181%
[80-85)	0.39640	0.34966	11.790%	0.336806	0.319742	5.066%
[85-90)	0.54478	0.50909	6.550%	0.460733	0.42153	8.509%
[90-95)	0.59016	0.57988	1.742%	0.572816	0.566613	1.083%
[95-100)	0.76000	0.54744	27.968%	0.727273	0.622605	14.392%
100+	1.00000	1.00000	0.000%	1	1	0.000%

4.8.4.2 Life Expectancy Gain from Eliminating Malaria

Table 4.22 represent the life expectancy gain from malaria. it be seen that when malaria is eliminated in Ghana, the life expectancy at birth will increase by 6.048% for males and 5.275% for females. This means that when the country succeeds in preventing death caused by malaria, the life expectancy of the citizens will increase and hence will have an impact in the life of the people.

Table 4.22: Life Expectancy Gain from Eliminating Malaria

Age Group	Male			Female		
	Life Expectancy	malaria eliminated	Expectancy Gain	Life Expectancy	malaria eliminated	Expectancy Gain
$[x_j - x_{j+1})$	$\hat{e}_{j.m}$	$\hat{e}_j$	$\frac{\hat{e}_{j.MR}-\hat{e}_j}{\hat{e}_j}$	$\hat{e}_{j.m}$	$\hat{e}_j$	$\frac{\hat{e}_{j.MR}-\hat{e}_j}{\hat{e}_j}$
[0-1)	52.71504	49.52666	6.048%	56.61174	53.62562	5.275%
[1-5)	53.26254	50.11933	5.901%	56.96329	54.23541	4.789%
[5-10)	54.67545	51.74168	5.366%	58.57202	56.18619	4.073%
[10-15)	51.26044	48.57812	5.233%	54.75000	52.38024	4.328%
[15-20)	46.59525	43.93031	5.719%	50.37202	48.02860	4.652%
[20-25)	42.66662	39.98569	6.283%	46.36936	44.03676	5.030%
[25-30)	38.53239	35.83707	6.995%	42.42222	40.05445	5.581%
[30-35)	34.59858	31.87024	7.886%	39.31797	36.98950	5.922%
[35-40)	31.01867	28.35788	8.578%	36.41978	34.15822	6.210%
[40-45)	27.82904	25.18055	9.517%	33.24948	31.02846	6.680%
[45-50)	24.98427	22.25113	10.939%	30.18192	27.88902	7.597%
[50-55)	22.29499	19.48080	12.623%	26.96890	24.66034	8.560%
[55-60)	19.87433	16.86759	15.129%	23.39752	21.07422	9.930%
[60-65)	17.61765	14.40731	18.222%	20.35666	17.90773	12.030%

Table 4.22 Life Expectancy Gain from Eliminating Malaria Cont.

	Male			Female		
Age Group	Life Expectancy	malaria eliminated	Expectancy Gain	Life Expectancy	malaria eliminated	Expectancy Gain
$[x_j - x_{j+1})$	$\hat{e}_{j.m}$	$\hat{e}_j$	$\frac{\hat{e}_{j.MR}-\hat{e}_j}{\hat{e}_j}$	$\hat{e}_{j.m}$	$\hat{e}_j$	$\frac{\hat{e}_{j.MR}-\hat{e}_j}{\hat{e}_j}$
[65-70)	15.80820	12.28149	22.309%	17.65721	15.04072	14.818%
[70-75)	14.61401	10.69364	26.826%	15.46818	12.56849	18.746%
[75-80)	13.64221	9.27991	31.976%	13.85894	10.65857	23.093%
[80-85)	12.26074	7.54770	38.440%	12.15237	8.57639	29.426%
[85-90)	10.36267	5.86261	43.426%	10.70850	6.66230	37.785%
[90-95)	8.41524	4.88672	41.930%	9.49704	5.21845	45.052%
[95-100)	4.94881	3.32360	32.840%	8.15315	3.86364	52.612%
100+	1.04300	0.93167	10.674%	4.71264	2.50000	46.951%

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the summary, conclusions and recommendations of errors assessment of applying the foreign life tables in Ghana and competing risk analysis.

5.2 Summary

The application of foreign life table in Sub-Sahara Africa had been a major concern all over the world. However, assessing the error for applying the foreign life tables as well as analysing the impact of the leading causes of death on Ghanaian longevity had not been studied. This study aimed at assessing the error of applying Foreign Life Table in Ghana and analysing the impacts of the leading causes of death on he lives of Ghanaians. The specific objectives were to construct a life table for Ghana and to determine the expectation of life at birth in Ghana. The other specific objectives were to assess the error generated from applying foreign life table, to derive the survival function of Ghana, to compare the mortality experience by male and female and to determine the life expectancy, gain when eliminating the leading cause of death.

A cohort data was extracted from the administrative records unit of University of Ghana Hospital. The gender, age and the age which each cohort member die was recorded. The causes of death were grouped into five main causes namely; death due to cardiovascular diseases, HIV/AIDs, lower respiratory infections, malaria and other causes of death.

5.3 Summary of findings

The study revealed that the highest life expectancy record was at age 5. Then the life expectancy begins to decrease as the ages increases, leading to a negative relationship between age and life expectancy. It can be seen that the life expected at birth was for females was 53.6256 years, that of males was 49.5267 and 51.1359 was record for combine sex. The complete life table was compare with some selected foreign life tables to assess the error of applying these foreign life tables in Ghana. Plotting a graph in Figure 4.2, it was revealed that graph life expectancy of USA and UK behave in almost the same manner and they were far away from the study life expectancy. The South Africa table was the closest to the study life table. The United Kingdom error exhibit the highest error, followed by the USA foreign Life Table whiles South Africa Life table yielded the lowest error. The force of mortality of males and females were compared and it was found that the instantaneous rate of mortality of the males were higher than that of females. The log-rank test performed also confirms that the survival curves for male and female were significantly different.

In calculating the crude probabilities for each cause of death it was realised that for children under 5 years, the probability of them dying from Lower Respiratory Infections and malaria were very high, whiles for the aged people 60 years and above, their chances of dying from cardiovascular diseases were very high. Examine the impact of the leading causes it was revealed that the life expectancy at birth for males in Ghana will increase by 16.021% and that of the female by 17.587% when death caused by Cardiovascular Diseases are eliminated. It was also found out that Ghana life expectancy will increase by 10.054% and 6.350% for male and female respectively, if the death of no HIV/AIDs diseases in the population the life expectancy at birth will increase by 6.048% for males and 5.275% for females. For malaria, it was released that if the country eliminates the death of malaria Ghanaians life expectancies will across all the ages.

5.3 Conclusions

The following conclusions were drawn from the study:

The life expectation at birth for Ghana is about 51.1359 (combined sex), 53.63 years for females and 49.5267 years for males. Mortality among males is higher than their females' counterparts in most age groups. The leading causes of death in Ghana is Cardiovascular disease followed by HIV/AIDS. The life expectancy of males will increase by 16.021% and 6.35% if cardiovascular diseases and HIV/AIDS is eliminated respectively in Ghana. Also, life expectancy of females will increase by 17.587% and 10.054% if cardiovascular diseases and HIV/AIDS is eliminated in Ghana.

5.4 Recommendations

Base on the findings and conclusion the following recommendation was made;

- There is a need for Ghana to have its own life table since the foreign life tables differ from Ghanaian mortality.
- The foreign life table that is similar to Ghana mortality is the South Africa Life table and therefore institutions and agencies such as SSNIT and insurance companies continue applying South African life table than other foreign life table.
- The government and other agencies should create awareness on cardiovascular diseases since it is the leading causes of death in the country.
- The Ghana AIDS commission should continue to create public awareness since the cause of death due to HIV/AIDS is still prevalence

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APPENDICES

Appendix I: Complete Life Table

Combined Sex

Age Group	l_i	q_j	d_j	a_j	L_j	T_j	e_j
0	0.0304	3260	99	0.1	3170.90	166703.19	51.1359
1	0.0310	3161	98	0.43	3105.14	163532.29	51.7344
2	0.0284	3063	87	0.45	3015.15	160427.15	52.3758
3	0.0269	2976	80	0.47	2933.60	157412.00	52.8938
4	0.0207	2896	60	0.49	2865.40	154478.40	53.3420
5	0.0109	2836	31	0.5	2820.50	151613.00	53.4602
6	0.0089	2805	25	0.5	2792.50	148792.50	53.0455
7	0.0050	2780	14	0.5	2773.00	146000.00	52.5180
8	0.0011	2766	3	0.5	2764.50	143227.00	51.7813
9	0.0043	2763	12	0.5	2757.00	140462.50	50.8370
10	0.0036	2751	10	0.5	2746.00	137705.50	50.0565
11	0.0011	2741	3	0.5	2739.50	134959.50	49.2373
12	0.0018	2738	5	0.5	2735.50	132220.00	48.2907
13	0.0015	2733	4	0.5	2731.00	129484.50	47.3782
14	0.0018	2729	5	0.5	2726.50	126753.50	46.4469
15	0.0026	2724	7	0.5	2720.50	124027.00	45.5312
16	0.0055	2717	15	0.5	2709.50	121306.50	44.6472
17	0.0048	2702	13	0.5	2695.50	118597.00	43.8923
18	0.0052	2689	14	0.5	2682.00	115901.50	43.1021
19	0.0056	2675	15	0.5	2667.50	113219.50	42.3250
20	0.0041	2660	11	0.5	2654.50	110552.00	41.5609

Complete Life Table Combined Sex Cont.

Age Group	l_i	q_j	d_j	a_j	L_j	T_j	e_j
21	0.0042	2649	11	0.5	2643.50	107897.50	40.7314
22	0.0049	2638	13	0.5	2631.50	105254.00	39.8992
23	0.0050	2625	13	0.5	2618.50	102622.50	39.0943
24	0.0050	2612	13	0.5	2605.50	100004.00	38.2864
25	0.0065	2599	17	0.5	2590.50	97398.50	37.4754
26	0.0074	2582	19	0.5	2572.50	94808.00	36.7188
27	0.0074	2563	19	0.5	2553.50	92235.50	35.9873
28	0.0102	2544	26	0.5	2531.00	89682.00	35.2524
29	0.0075	2518	19	0.5	2508.50	87151.00	34.6112
30	0.0108	2499	27	0.5	2485.50	84642.50	33.8705
31	0.0065	2472	16	0.5	2464.00	82157.00	33.2350
32	0.0134	2456	33	0.5	2439.50	79693.00	32.4483
33	0.0132	2423	32	0.5	2407.00	77253.50	31.8834
34	0.0105	2391	25	0.5	2378.50	74846.50	31.3034
35	0.0152	2366	36	0.5	2348.00	72468.00	30.6289
36	0.0129	2330	30	0.5	2315.00	70120.00	30.0944
37	0.0091	2300	21	0.5	2289.50	67805.00	29.4804
38	0.0145	2279	33	0.5	2262.50	65515.50	28.7475
39	0.0120	2246	27	0.5	2232.50	63253.00	28.1625
40	0.0149	2219	33	0.5	2202.50	61020.50	27.4991

Complete Life Table Combined Sex Cont.

Age Group	l_i	q_j	d_j	a_j	L_j	T_j	e_j
41	0.0151	2186	33	0.5	2169.50	58818.00	26.9067
42	0.0172	2153	37	0.5	2134.50	56648.50	26.3114
43	0.0165	2116	35	0.5	2098.50	54514.00	25.7628
44	0.0135	2081	28	0.5	2067.00	52415.50	25.1877
45	0.0205	2053	42	0.5	2032.00	50348.50	24.5244
46	0.0164	2011	33	0.5	1994.50	48316.50	24.0261
47	0.0172	1978	34	0.5	1961.00	46322.00	23.4186
48	0.0175	1944	34	0.5	1927.00	44361.00	22.8194
49	0.0183	1910	35	0.5	1892.50	42434.00	22.2168
50	0.0181	1875	34	0.5	1858.00	40541.50	21.6221
51	0.0190	1841	35	0.5	1823.50	38683.50	21.0122
52	0.0194	1806	35	0.5	1788.50	36860.00	20.4097
53	0.0209	1771	37	0.5	1752.50	35071.50	19.8032
54	0.0219	1734	38	0.5	1715.00	33319.00	19.2151
55	0.0236	1696	40	0.5	1676.00	31604.00	18.6344
56	0.0242	1656	40	0.5	1636.00	29928.00	18.0725
57	0.0260	1616	42	0.5	1595.00	28292.00	17.5074
58	0.0273	1574	43	0.5	1552.50	26697.00	16.9612
59	0.0287	1531	44	0.5	1509.00	25144.50	16.4236

Complete Life Table Combined Sex Cont.

Age Group	l_i	q_j	d_j	a_j	L_j	T_j	e_j
60	0.0296	1487	44	0.5	1465.00	23635.50	15.8948
61	0.0319	1443	46	0.5	1420.00	22170.50	15.3642
62	0.0344	1397	48	0.5	1373.00	20750.50	14.8536
63	0.0371	1349	50	0.5	1324.00	19377.50	14.3643
64	0.0393	1299	51	0.5	1273.50	18053.50	13.8980
65	0.0409	1248	51	0.5	1222.50	16780.00	13.4455
66	0.0434	1197	52	0.5	1171.00	15557.50	12.9971
67	0.0472	1145	54	0.5	1118.00	14386.50	12.5646
68	0.0504	1091	55	0.5	1063.50	13268.50	12.1618
69	0.0550	1036	57	0.5	1007.50	12205.00	11.7809
70	0.0582	979	57	0.5	950.50	11197.50	11.4377
71	0.0597	922	55	0.5	894.50	10247.00	11.1139
72	0.0611	867	53	0.5	840.50	9352.50	10.7872
73	0.0627	814	51	0.5	788.50	8512.00	10.4570
74	0.0642	763	49	0.5	738.50	7723.50	10.1225
75	0.0644	714	46	0.5	691.00	6985.00	9.7829
76	0.0659	668	44	0.5	646.00	6294.00	9.4222
77	0.0657	624	41	0.5	603.50	5648.00	9.0513
78	0.0669	583	39	0.5	563.50	5044.50	8.6527
79	0.0717	544	39	0.5	524.50	4481.00	8.2371

Complete Life Table Combined Sex Cont.

Age Group	l_i	q_j	d_j	a_j	L_j	T_j	e_j
80	0.0733	505	37	0.5	486.50	3956.50	7.8347
81	0.0791	468	37	0.5	449.50	3470.00	7.4145
82	0.0882	431	38	0.5	412.00	3020.50	7.0081
83	0.0941	393	37	0.5	374.50	2608.50	6.6374
84	0.1011	356	36	0.5	338.00	2234.00	6.2753
85	0.1156	320	37	0.5	301.50	1896.00	5.9250
86	0.1201	283	34	0.5	266.00	1594.50	5.6343
87	0.1285	249	32	0.5	233.00	1328.50	5.3353
88	0.1382	217	30	0.5	202.00	1095.50	5.0484
89	0.1497	187	28	0.5	173.00	893.50	4.7781
90	0.1572	159	25	0.5	146.50	720.50	4.5314
91	0.1567	134	21	0.5	123.50	574.00	4.2836
92	0.1681	113	19	0.5	103.50	450.50	3.9867
93	0.1702	94	16	0.5	86.00	347.00	3.6915
94	0.1795	78	14	0.5	71.00	261.00	3.3462
95	0.2031	64	13	0.5	57.50	190.00	2.9688
96	0.2157	51	11	0.5	45.50	132.50	2.5980
97	0.2500	40	10	0.5	35.00	87.00	2.1750
98	0.2667	30	8	0.5	26.00	52.00	1.7333
99	0.3182	22	7	0.5	18.50	26.00	1.1818
100+	1.0000	15	15	0.5	7.50	7.50	0.5000

Appendix II Abridge Life Table

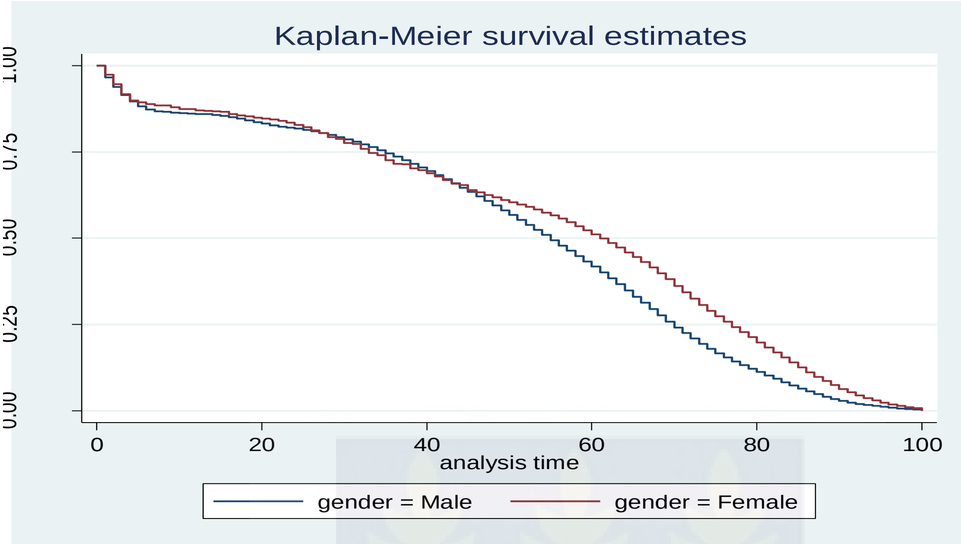
Abridge Life Table for Combined Sex

Age Group	l_i	q_j	d_j	a_j	n_j	L_j	T_j	e_j
[0-1)	0.030	3260	99	0.1	1	3170.9	167081.9	51.252
[1-5)	0.103	3161	325	0.39	4	11851	163911	51.854
[5-10)	0.030	2836	85	0.5	5	13967.5	152060	53.618
[10-15)	0.010	2751	27	0.5	5	13687.5	138092.5	50.197
[15-20)	0.023	2724	64	0.5	5	13460	124405	45.670
[20-25)	0.023	2660	61	0.5	5	13147.5	110945	41.709
[25-30)	0.038	2599	99	0.5	5	12747.5	97797.5	37.629
[30-35)	0.053	2500	132	0.5	5	12170	85050	34.020
[35-40)	0.062	2368	146	0.5	5	11475	72880	30.777
[40-45)	0.074	2222	165	0.5	5	10697.5	61405	27.635
[45-50)	0.086	2057	177	0.5	5	9842.5	50707.5	24.651
[50-55)	0.096	1880	180	0.5	5	8950	40865	21.737

Abridge Life Table for Combined Sex Cont.

[55-60)	0.123	1700	209	0.5	5	7977.5	31915	18.774
[60-65)	0.160	1491	239	0.5	5	6857.5	23937.5	16.055
[65-70)	0.214	1252	268	0.5	5	5590	17080	13.642
[70-75)	0.268	984	264	0.5	5	4260	11490	11.677
[75-80)	0.292	720	210	0.5	5	3075	7230	10.042
[80-85)	0.363	510	185	0.5	5	2087.5	4155	8.147
[85-90)	0.495	325	161	0.5	5	1222.5	2067.5	6.362
[90-95)	0.579	164	95	0.5	5	582.5	845	5.152
[95-100)	0.739	69	51	0.5	5	217.5	262.5	3.804
100+	1.000	18	18	0.5	5	45	45	2.500

Appendix III Kaplan-Meier Survival Curve



Appendix IV Multiple Decrement Table for Mortality

Multiple Decrement Table for Male Mortality

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
$[x_j - x_{j+1})$	αl_{x_j}	$(\alpha d)_{x_j}^{\beta_1}$	$(\alpha d)_{x_j}^{\beta_2}$	$(\alpha d)_{x_j}^{\beta_3}$	$(\alpha d)_{x_j}^{\beta_4}$	$(\alpha d)_{x_j}^{\beta_5}$	$(\alpha d)_{x_j}$
[0-1)	1890	0	1	2	5	51	59
[1-5)	1831	0	0	42	16	132	190
[5-10)	1641	0	1	6	10	42	59
[10-15)	1582	0	3	1	1	7	12
[15-20)	1570	1	2	5	1	30	39
[20-25)	1531	1	0	1	1	31	34
[25-30)	1497	4	4	2	1	34	45
[30-35)	1452	8	10	3	7	42	70
[35-40)	1382	11	18	4	6	52	91
[40-45)	1291	23	23	1	3	58	108
[45-50)	1183	37	21	0	5	57	120
[50-55)	1063	43	12	0	2	74	131

Multiple Decrement Table for Male Mortality Cont.

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
$[x_j - x_{j+1})$	αl_{x_j}	$(\alpha d)_{x_j}^{\beta_1}$	$(\alpha d)_{x_j}^{\beta_2}$	$(\alpha d)_{x_j}^{\beta_3}$	$(\alpha d)_{x_j}^{\beta_4}$	$(\alpha d)_{x_j}^{\beta_5}$	$(\alpha d)_{x_j}$
[50-55)	1063	43	12	0	2	74	131
[55-60)	932	46	8	0	5	81	140
[60-65)	792	65	4	1	5	79	154
[65-70)	638	89	2	3	8	63	165
[70-75)	473	53	1	1	7	82	144
[75-80)	329	49	1	1	6	50	107
[80-85)	222	35	0	0	13	40	88
[85-90)	134	25	1	1	7	39	73
[90-95)	61	8	0	0	1	27	36
[95-100)	25	7	0	1	4	7	19
100+	6	2	0	0	0	4	6

Multiple Decrement Table for Female Mortality

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
$[x_j - x_{j+1})$	αl_{x_j}	$(\alpha d)_{x_j}^{\beta_1}$	$(\alpha d)_{x_j}^{\beta_2}$	$(\alpha d)_{x_j}^{\beta_3}$	$(\alpha d)_{x_j}^{\beta_4}$	$(\alpha d)_{x_j}^{\beta_5}$	$(\alpha d)_{x_j}$
[0-1)	1370	0	1	5	8	26	40
[1-5)	1330	1	2	40	12	80	135
[5-10)	1195	0	0	11	1	14	26
[10-15)	1169	1	2	4	1	7	15
[15-20)	1154	1	0	1	1	22	25
[20-25)	1129	2	3	1	0	21	27
[25-30)	1102	1	24	1	3	25	54
[30-35)	1048	6	23	0	4	29	62
[35-40)	986	6	16	0	3	30	55
[40-45)	931	14	17	0	0	26	57
[45-50)	874	18	10	0	2	27	57
[50-55)	817	20	12	0	2	15	49

Multiple Decrement Table for Female Mortality Cont.

Age Group	No. of people living	Deaths by Cardio vascular	Deaths by HIV/AIDs	Deaths by lower respiratory	Deaths by Malaria	Deaths by other causes	Total death
$[x_j - x_{j+1})$	αl_{x_j}	$(\alpha d)_{x_j}^{\beta_1}$	$(\alpha d)_{x_j}^{\beta_2}$	$(\alpha d)_{x_j}^{\beta_3}$	$(\alpha d)_{x_j}^{\beta_4}$	$(\alpha d)_{x_j}^{\beta_5}$	$(\alpha d)_{x_j}$
[55-60)	768	32	7	0	0	30	69
[60-65)	699	38	4	0	1	42	85
[65-70)	614	67	2	2	1	31	103
[70-75)	511	60	0	0	6	54	120
[75-80)	391	53	0	0	5	45	103
[80-85)	288	50	0	1	6	40	97
[85-90)	191	42	1	3	10	32	88
[90-95)	103	28	0	0	1	30	59
[95-100)	44	10	0	3	8	11	32
100+	12	5	0	1	2	4	12

Appendix V: Net Probabilities (When there is Only that Risk)

Net Probabilities for Cardiovascular Diseases

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jCD}$	$S_{\hat{q}_{jCD}}$	$\hat{q}_{jCD}$	$S_{\hat{q}_{jCD}}$
[0-1)	0.00000	0.00000	0.00000	0.00000
[1-5)	0.00000	0.00000	0.00079	0.00030
[5-10)	0.00000	0.00000	0.00000	0.00000
[10-15)	0.00000	0.00000	0.00086	0.00036
[15-20)	0.00064	0.00029	0.00088	0.00035
[20-25)	0.00066	0.00030	0.00179	0.00054
[25-30)	0.00271	0.00069	0.00093	0.00036
[30-35)	0.00563	0.00105	0.00588	0.00105
[35-40)	0.00820	0.00132	0.00624	0.00113
[40-45)	0.01843	0.00229	0.01540	0.00216
[45-50)	0.03244	0.00348	0.02107	0.00282
[50-55)	0.04225	0.00426	0.02493	0.00348

Net Probabilities for Cardiovascular Diseases Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jCD}$	$S_{\hat{q}_{jCD}}$	$\hat{q}_{jCD}$	$S_{\hat{q}_{jCD}}$
[55-60)	0.05208	0.00505	0.04272	0.00504
[60-65)	0.08722	0.00754	0.05632	0.00619
[65-70)	0.14906	0.01156	0.11259	0.01077
[70-75)	0.12508	0.01126	0.12526	0.01214
[75-80)	0.16485	0.01617	0.14557	0.01572
[80-85)	0.18191	0.02002	0.19079	0.02162
[85-90)	0.23625	0.02866	0.25527	0.03109
[90-95)	0.17981	0.03562	0.33212	0.05141
[95-100)	0.67043	0.04740	0.33371	0.07934
100+	1.00000		1.00000	

Net Probabilities for HIV/AIDS

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jHIV}$	$S_{\hat{q}_{jHIV}}$	$\hat{q}_{jHIV}$	$S_{\hat{q}_{jHIV}}$
[0-1)	0.00054	0.00024	0.00074	0.00029
[1-5)	0.00000	0.00000	0.00158	0.00043
[5-10)	0.00062	0.00026	0.00000	0.00000
[10-15)	0.00190	0.00069	0.00172	0.00057
[15-20)	0.00129	0.00044	0.00000	0.00000
[20-25)	0.00000	0.00000	0.00269	0.00070
[25-30)	0.00271	0.00069	0.02208	0.00283
[30-35)	0.00703	0.00122	0.02237	0.00274
[35-40)	0.01338	0.00185	0.01656	0.00226
[40-45)	0.01843	0.00229	0.01867	0.00250
[45-50)	0.01854	0.00231	0.01176	0.00183
[50-55)	0.01198	0.00176	0.01503	0.00235

Net Probabilities for HIV/AIDS Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jHIV}$	$S_{\hat{q}_{jHIV}}$	$\hat{q}_{jHIV}$	$S_{\hat{q}_{jHIV}}$
[55-60)	0.00926	0.00158	0.00950	0.00169
[60-65)	0.00560	0.00128	0.00608	0.00136
[65-70)	0.00362	0.00114	0.00356	0.00111
[70-75)	0.00252	0.00111	0.00000	0.00000
[75-80)	0.00367	0.00162	0.00000	0.00000
[80-85)	0.00000	0.00000	0.00000	0.00000
[85-90)	0.01072	0.00477	0.00699	0.00370
[90-95)	0.00000	0.00000	0.00000	0.00000
[95-100)	0.00000	0.00000	0.00000	0.00000
100+	1.00000		1.00000	

Net Probabilities for Lower Respiratory Disease

Age Group $[x_j - x_{j+1})$	Male		Female	
	$\hat{q}_{jLR}$	$S_{\hat{q}_{jLR}}$	$\hat{q}_{jLR}$	$S_{\hat{q}_{jLR}}$
[0-1)	0.00107	0.00035	0.00370	0.00076
[1-5)	0.02393	0.00221	0.03122	0.00271
[5-10)	0.00372	0.00075	0.00926	0.00164
[10-15)	0.00063	0.00032	0.00344	0.00094
[15-20)	0.00322	0.00078	0.00088	0.00035
[20-25)	0.00066	0.00030	0.00090	0.00036
[25-30)	0.00136	0.00045	0.00093	0.00036
[30-35)	0.00212	0.00058	0.00000	0.00000
[35-40)	0.00299	0.00071	0.00000	0.00000
[40-45)	0.00081	0.00036	0.00000	0.00000
[45-50)	0.00000	0.00000	0.00000	0.00000
[50-55)	0.00000	0.00000	0.00000	0.00000

Net Probabilities for Lower Respiratory Disease Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jLR}$	$S_{\hat{q}_{jLR}}$	$\hat{q}_{jLR}$	$S_{\hat{q}_{jLR}}$
[55-60)	0.00000	0.00000	0.00000	0.00000
[60-65)	0.00140	0.00062	0.00000	0.00000
[65-70)	0.00543	0.00141	0.00356	0.00111
[70-75)	0.00252	0.00111	0.00000	0.00000
[75-80)	0.00367	0.00162	0.00000	0.00000
[80-85)	0.00000	0.00000	0.00422	0.00213
[85-90)	0.01072	0.00477	0.02083	0.00662
[90-95)	0.00000	0.00000	0.00000	0.00000
[95-100)	0.14664	0.04135	0.11468	0.04360
100+	1.00000	0.00000	1.00000	0.00000

Net Probabilities for Malaria

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jMR}$	$S_{\hat{q}_{jMR}}$	$\hat{q}_{jMR}$	$S_{\hat{q}_{jMR}}$
[0-1)	0.00268	0.00061	0.00591	0.00105
[1-5)	0.00918	0.00116	0.00947	0.00118
[5-10)	0.00619	0.00105	0.00085	0.00032
[10-15)	0.00063	0.00032	0.00086	0.00036
[15-20)	0.00064	0.00029	0.00088	0.00035
[20-25)	0.00066	0.00030	0.00000	0.00000
[25-30)	0.00068	0.00031	0.00279	0.00067
[30-35)	0.00493	0.00097	0.00393	0.00082
[35-40)	0.00448	0.00090	0.00313	0.00073
[40-45)	0.00242	0.00064	0.00000	0.00000
[45-50)	0.00445	0.00094	0.00236	0.00067

Net Probabilities for Malaria Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{jMR}$	$S_{\hat{q}_{jMR}}$	$\hat{q}_{jMR}$	$S_{\hat{q}_{jMR}}$
[50-55)	0.00201	0.00064	0.00252	0.00074
[55-60)	0.00580	0.00121	0.00000	0.00000
[60-65)	0.00700	0.00145	0.00152	0.00064
[65-70)	0.01440	0.00242	0.00178	0.00077
[70-75)	0.01749	0.00313	0.01329	0.00268
[75-80)	0.02182	0.00427	0.01473	0.00341
[80-85)	0.07187	0.01072	0.02508	0.00564
[85-90)	0.07269	0.01378	0.06777	0.01317
[90-95)	0.02447	0.01116	0.01431	0.00833
[95-100)	0.46968	0.05462	0.27734	0.07209
100+	1.00000		1.00000	

Appendix VI: Net Probabilities (When The Risk Is Eliminated)

Net Probabilities of Cardiovascular Disease

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{j.CD}$	$S_{\hat{q}_{j.CD}}$	$\hat{q}_{j.CD}$	$S_{\hat{q}_{j.CD}}$
[0-1)	0.03122	0.00000	0.02920	0.00000
[1-5)	0.10377	0.00000	0.10079	0.00029
[5-10)	0.03595	0.00000	0.02176	0.00000
[10-15)	0.00759	0.00000	0.01198	0.00031
[15-20)	0.02421	0.00028	0.02081	0.00032
[20-25)	0.02156	0.00028	0.02216	0.00045
[25-30)	0.02743	0.00056	0.04812	0.00034
[30-35)	0.04282	0.00081	0.05359	0.00084
[35-40)	0.05812	0.00100	0.04985	0.00088
[40-45)	0.06645	0.00147	0.04654	0.00131
[45-50)	0.07131	0.00190	0.04510	0.00152
[50-55)	0.08456	0.00225	0.03594	0.00161

Net Probabilities of Cardiovascular Disease Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{j.CD}$	$S_{\hat{q}_{j.CD}}$	$\hat{q}_{j.CD}$	$S_{\hat{q}_{j.CD}}$
[55-60)	0.10353	0.00267	0.04923	0.00214
[60-65)	0.11747	0.00344	0.06918	0.00270
[65-70)	0.12876	0.00435	0.06216	0.00328
[70-75)	0.20501	0.00566	0.12526	0.00488
[75-80)	0.19203	0.00705	0.13793	0.00618
[80-85)	0.26218	0.00975	0.18044	0.00857
[85-90)	0.40397	0.01592	0.27589	0.01349
[90-95)	0.50031	0.02434	0.36039	0.02330
[95-100)	0.27177	0.06333	0.59068	0.05181
100+	1.00000		1.00000	

Net Probabilities of HIV/AIDS

Age Group $[x_j - x_{j+1})$	**Male** $\hat{q}_{j.HIV}$	$S_{\hat{q}_{j.HIV}}$	**Female** $\hat{q}_{j.HIV}$	$S_{\hat{q}_{j.HIV}}$
[0-1)	0.03070	0.00023	0.02848	0.00027
[1-5)	0.10377	0.00000	0.10008	0.00041
[5-10)	0.03536	0.00025	0.02176	0.00000
[10-15)	0.00569	0.00041	0.01113	0.00042
[15-20)	0.02358	0.00039	0.02166	0.00000
[20-25)	0.02221	0.00000	0.02129	0.00054
[25-30)	0.02743	0.00056	0.02753	0.00124
[30-35)	0.04147	0.00089	0.03763	0.00135
[35-40)	0.05318	0.00122	0.03988	0.00127
[40-45)	0.06645	0.00147	0.04337	0.00139
[45-50)	0.08446	0.00158	0.05409	0.00125
[50-55)	0.11261	0.00142	0.04563	0.00143

Net Probabilities of HIV/AIDS cont'd

Age Group	**Male**		**Female**	
$[x_j - x_{j+1})$	$\hat{q}_{j.HIV}$	$S_{\hat{q}_{j.HIV}}$	$\hat{q}_{j.HIV}$	$S_{\hat{q}_{j.HIV}}$
[55-60)	0.14227	0.00138	0.08111	0.00134
[60-65)	0.18991	0.00120	0.11623	0.00121
[65-70)	0.25593	0.00110	0.16478	0.00106
[70-75)	0.30268	0.00109	0.23483	0.00000
[75-80)	0.32274	0.00159	0.26343	0.00000
[80-85)	0.39640	0.00000	0.33681	0.00000
[85-90)	0.53984	0.00463	0.45694	0.00361
[90-95)	0.59016	0.00000	0.57282	0.00000
[95-100)	0.76000	0.00000	0.72727	0.00000
100+	1.00000		1.00000	

Net Probabilities of Lower Respiration

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{j.LR}$	$S_{\hat{q}_{j.LR}}$	$\hat{q}_{j.LR}$	$S_{\hat{q}_{j.LR}}$
[0-1)	0.03017	0.00032	0.02559	0.00057
[1-5)	0.08180	0.00140	0.07255	0.00151
[5-10)	0.03236	0.00059	0.01261	0.00074
[10-15)	0.00696	0.00026	0.00943	0.00055
[15-20)	0.02169	0.00058	0.02081	0.00032
[20-25)	0.02156	0.00028	0.02304	0.00033
[25-30)	0.02874	0.00041	0.04812	0.00034
[30-35)	0.04619	0.00052	0.05916	0.00000
[35-40)	0.06305	0.00063	0.05578	0.00000
[40-45)	0.08291	0.00035	0.06122	0.00000
[45-50)	0.10144	0.00000	0.06522	0.00000
[50-55)	0.12324	0.00000	0.05998	0.00000

Net Probabilities of Lower Respiration Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{j.LR}$	$S_{\hat{q}_{j.LR}}$	$\hat{q}_{j.LR}$	$S_{\hat{q}_{j.LR}}$
[55-60)	0.15021	0.00000	0.08984	0.00000
[60-65)	0.19331	0.00061	0.12160	0.00000
[65-70)	0.25458	0.00135	0.16478	0.00106
[70-75)	0.30268	0.00109	0.23483	0.00000
[75-80)	0.32274	0.00159	0.26343	0.00000
[80-85)	0.39640	0.00000	0.33399	0.00208
[85-90)	0.53984	0.00463	0.44926	0.00613
[90-95)	0.59016	0.00000	0.57282	0.00000
[95-100)	0.71876	0.05718	0.69194	0.03883
100+	1.00000		1.00000	

Net Probabilities of Malaria

Age Group $[x_j - x_{j+1})$	Male		Female	
	$\hat{q}_{j.m}$	$S_{\hat{q}_{j.m}}$	$\hat{q}_{j.m}$	$S_{\hat{q}_{j.m}}$
[0-1)	0.02861	0.00050	0.02343	0.00069
[1-5)	0.09546	0.00095	0.09291	0.00096
[5-10)	0.02995	0.00073	0.02093	0.00029
[10-15)	0.00696	0.00026	0.01198	0.00031
[15-20)	0.02421	0.00028	0.02081	0.00032
[20-25)	0.02156	0.00028	0.02391	0.00000
[25-30)	0.02940	0.00029	0.04634	0.00058
[30-35)	0.04349	0.00077	0.05545	0.00070
[35-40)	0.06164	0.00077	0.05282	0.00064
[40-45)	0.08143	0.00060	0.06122	0.00000
[45-50)	0.09742	0.00084	0.06300	0.00061
[50-55)	0.12147	0.00061	0.05760	0.00066

Net Probabilities of Malaria Cont.

Age Group	Male		Female	
$[x_j - x_{j+1})$	$\hat{q}_{j.m}$	$S_{\hat{q}_{j.m}}$	$\hat{q}_{j.m}$	$S_{\hat{q}_{j.m}}$
[55-60)	0.14526	0.00110	0.08984	0.00000
[60-65)	0.18877	0.00133	0.12026	0.00062
[65-70)	0.24779	0.00215	0.16627	0.00075
[70-75)	0.29206	0.00279	0.22452	0.00238
[75-80)	0.31018	0.00374	0.25241	0.00303
[80-85)	0.34966	0.00788	0.31974	0.00488
[85-90)	0.50909	0.01141	0.42153	0.01040
[90-95)	0.57988	0.01055	0.56661	0.00804
[95-100)	0.54744	0.08555	0.62260	0.05173
100+	1.00000		1.00000	