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RISK FACTORS AND CAUSES OF ADULT DEATHS IN THE IFAKARA HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM POPULATION, 2003 – 2007

BY

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(Wits Johannesburg, South Africa 2010)

DECLARATION

I, Solomon Ayertey Narh-Bana declare that this research report is my own work. It is being submitted for the degree of Master of Science in Medicine in the field of Population-Based Field Epidemiology in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature: 

25th Day of May, 2010.

DEDICATION

This work is dedicated to my wife Nana Esi, my son Joel, my siblings (Dave and Eben), my dad Nene Awate Bana Atropka I and mom Comfort Maku Tetteh. They, through thick and thin, provided all the support to make this level of my education come to pass.

EXECUTIVE SUMMARY

Introduction: The achievements of the United Nations' millennium development goals (MDGs) are not possible in isolation. Adult health and mortality with the exception of maternal health is one of the health issues that were openly missing among the list of MDGs. But eradicating extreme poverty and hunger would not be possible if the economically active population is not supported to be healthy and to live longer. Little has been done on adult health, especially to reduce mortality as compared to child health. Adult mortality is expected to equal or exceed child mortality in sub-Saharan Africa if nothing is done. There are varying factors associated with specific-causes of adult deaths within and among different settings. Obtaining more and better data on adult deaths and understanding issues relating to adult deaths in Africa are crucial for long life and development.

Objectives: The study seeks to (i) describe causes of adult mortality, (ii) estimate adult cause-specific mortality rates and trends and (iii) identify risk factors of cause-specific mortality in the Ifakara Health and Demographic Surveillance System (IHDSS) population from 2003 – 2007 among adults aged 15 – 59 years.

Methodology: The data for the study was extracted from the database of the Ifakara Health and Demographic Surveillance System (IHDSS) in Tanzania from 2003-2007. It was an open cohort study. The cohort was selected based on age (15-59years) and active residency from 1st January 2003 to 31st December 2007. Survival estimates were computed using Kaplan-Meier survival technique and adult mortality rates were estimated expressed per 1000 person years observed (PYO). Verbal autopsy method was used to ascertain causes of deaths. Cox proportional hazards method was used to identify socio-demographic factors associated with specific-causes of adult deaths.

Findings: A total 65,548 adults were identified and followed up, yielding a total of 184,000 person years. A total of 1,352 deaths occurred during the follow-up. The crude adult mortality rate (AMR) estimated over the period was 7.3/1000PYO. There was an insignificant steady increase in annual AMR over the period. The AMR in 2007 increased by 11% over year 2003. Most people died from HIV/AIDS (20.4%) followed by Malaria (13.2%). The AMR for the period was 2.49 per 1000PYO for communicable disease (CD) causes, 1.21 per 1000PYO for non communicable disease (NCD) causes and 0.53 per 1000PYO for causes related to accidents/injuries. Over the study period, deaths resulting from NCDs increased significantly by 50%. The proportion of deaths due to NCDs in 2003 was 16% increasing to 24% in year 2007. Adult deaths from Accidents/Injuries were significantly higher among men (hazard ratio (HR) = 2.2) after adjusting for socioeconomic status (SES), level of education and household size. For communicable and NCDs, most people died at home while for Accidents/Injuries most people died elsewhere (neither home nor health facility). The risk factors that were found to be associated with adult deaths due to NCDs were age and level of education. An improvement in level of education saw a reduction in the risk of dying from NCDs ((HR(Primary)=0.67, 95%CI:0.49, 0.92) and (HR(beyond Primary)=0.11, 95%CI:0.02, 0.40) after adjusting for age and sex. Age, SES and "entry type" were the factors found to be associated with dying from communicable diseases among the adults. In-migrants were 1.7 times more likely to die from communicable disease causes than residents having adjusted for age, household size, educational level, employment status of the head of household and SES.

Conclusion: HIV/AIDS is the leading cause of adult deaths in IHDSS area followed by malaria. Most adult deaths occurred outside health facility in rural areas. This could probably be explained by the health seeking behavior and or health care accessibility in

the rural area of sub-Saharan Africa. NCDs are increasing as a result of demographic and epidemiological transitions taking place in most African countries including Tanzania. Without preventions the rural community in Tanzania will soon face increased triple disease burden; (CD), NCD and Accident/Injuries. Policies on accident/injury preventions in developing countries will be effective if based on local evidence and research.

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DEFINITION OF TERMS

1. **Socioeconomic status (SES):** A classification of the social group of an individual based on his/her assets, type of residence and utilities.
2. **Adults:** Men and women aged 15-59 years.
3. **Adult death:** The death of a person aged between 15 years and 59 years.
4. **Risk factor:** An aspect of personal behavior or lifestyle, environmental exposure, or inborn or inherited characteristic, which, on the basis of epidemiologic evidence, is known to be associated with a health-related condition considered important to prevent (WHO definition). In this study, the risk factors considered are the socio-economic and demographic factors of adults.
5. **Health and Demographic Surveillance System (HDSS):** A combination of field and computer operations in which individuals and households demographic and health records (births, deaths, migrations, morbidity etc.) are captured and updated on a continuing basis within a geographically defined area.
6. **Demographic Surveillance Area (DSA):** The catchment area of a Health and Demographic Surveillance System
7. **Principal Component Analysis (PCA):** A multivariate statistical technique used in creating uncorrelated indices, where each index created is a linear weighted combination of the initial variables. This was used to generate SES in this study.
8. **Household:** A unit to which individual members belong, often defined as social subunits of the residential unit.
9. **Cohort:** A group of people sharing a common temporal demographic experience who are observed through time.

10. **In-migration:** This is where a person changes residence from outside the DSA to a residential unit in the DSA and registered into the DSS for the first time.

LIST OF ABREVIATIONS AND ACRONYMS

aHR	Adjusted Hazard Ratio
AIDS	Acquired Immune Deficiency Syndrome
AMMP	Adult Morbidity and Mortality Project
AMR	Adult Mortality Rate
CD	Communicable Disease
DSA	Demographic Surveillance Area
HDSS	Health and Demographic Surveillance System
HIV	Human Immunodeficiency Virus
ICD 10	International Classification of Diseases version 10
IHDSS	Ifakara Health and Demographic Surveillance System
IHI	Ifakara Health Institute
INDEPTH	International Network for Continuous Demographic Evaluation of Populations and Their impact on Health in Developing Countries
MDGs	Millennium Development Goals
NCD	Non Communicable Disease
PCA	Principal Component Analysis
PYO	Person's Year Observed
SES	Socioeconomic Status
uaHR	Unadjusted Hazard Ratio
VA	Verbal Autopsy
WHO	World Health Organization

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CHAPTER ONE: INTRODUCTION

1.1 Background

Until recently, adult health in developing countries had received little attention and also ranked low on public health experts' agenda at both national and international levels as compared to child health. The reason has been the over concentration of primary health care provision on child related issues (1). The current attention and rising importance in adult health has been because of the demographic, fertility and epidemiological transition in the world including Africa. These transitions resulted in the change from high fertility and child mortality rates to low fertility and child mortality rates. Although such is the case, adult mortality is currently on the increase and this is partly attributable to HIV/AIDS(2). This increase has been observed in Sub-Saharan African countries (3) including Tanzania (4).

Some risk factors for adult mortality have changed over time. For example, communicable diseases experienced now are not comparable to those experienced some decades ago. On the other hand, some other risk factors of health and mortality have remained unchanged over time. It has been shown that factors primarily associated with mortality include age, gender, health, genetic endowment, and the environment (5). These factors vary considerably from one setting to another and often operate together, influenced by a complex sets of social and historical factors (6). Other studies conducted in some developing countries showed that adult mortality is a result of detrimental behavioral pattern, including poor or inadequate health care services and information (5;7). This presupposes that there must be something important about the association between the risk factors and health related issues that causes it to persist in the face of changing conditions (8).

Births, deaths and migrations are the three main components responsible for changes in the total number of people in a defined area. Mortality as a public health issue is the only component of population change that permanently removes people from the population balancing equation (9) shown below.

P1 + (B – D) + (I – E) = P2
Where:
P2= the population at the later date;
P1 = the population at the earlier date;
B = births between the two dates;
D = deaths between the two dates;
I = immigration (or in-migration) between the two dates and
E = emigration (or out-migration) between the two dates.

Statistics on causes of death are required although data on adult mortality is scarce, especially in Sub-Saharan Africa (10). The need for consistent data on causes of adult mortality in Africa is crucial to enable formulation of national and international health policies (1) and for prevention and control of adult morbidity and mortality. The Health and Demographic Surveillance Systems (HDSS) generate good and reliable information on adult all cause mortality (6) and provides a unique opportunity for such analysis. There are several and emerging Health and Demographic Surveillance Sites (HDSS) in Africa now and in Tanzania to be specific. This study was conducted using a longitudinal data from the Ifakara rural HDSS in Tanzania.

1.2 Literature Review

Little is known with regards to information on adult mortalities even though adults die from a broader range of Non-communicable and Communicable Diseases (NCDs) (11-15) and now accidents/injuries (16;17). The Adult Morbidity and Mortality Project (AMMP) is among the few projects that concentrated on NCDs parallel to investigating the all-cause adult mortality in Tanzania (18). Causes of deaths among adults vary from country to country in Africa (19) but empirical evidences support the fact that HIV/AIDs is rapidly emerging as a leading cause of adult deaths in areas of Sub-Saharan Africa (2;3;7;20) given that adult mortality has increased steadily since HIV became prevalent (1).

The factors that are associated with adult morbidity and mortality vary considerably but operate together. Poverty does not only concern those with the lowest income (21) and is not the only cause of death in the developing countries but it compounds the impact of adult mortality and morbidity (22).

The consistent association of adult mortality with risk factors of health including socio-economic status had also led to universal fight against poverty and inequality by researchers. This fight will achieve MDG one which aims to reduce extreme poverty. Hence it will indirectly contribute towards mortality reduction in the adult population. Most studies have found social and economic indicators to be risk factors for adult mortality (23-26). For instance Bobak et al (2003) identified in their study that smoking, low education and alcohol consumption are risk factors for adult mortality. Other researchers also observed similar findings, specifically between education and adult mortality (27;28). Winkleby et al (2006) who conducted a study in different classes of neighborhoods observed among the high socio economic status neighborhood that

mortality rates were low. Mortality was high among moderate socio economic status class neighborhoods and highest in low socio economic status class neighborhoods (29). The main indicators of socioeconomic status used include household wealth which had to do mostly with income, occupation, education, type of residence, area of residence and lifestyle or behavior. However, the more standard indicators include social status measured by the level of education and network of social relations; household wealth measured by the assets, means of transport, energy, water and sanitation; and residence measured by the type of housing structure and location of the residence. Children from poor households or families or neighborhoods are more likely to have less resistance to communicable diseases because of undernourishment and some other risk factors. Such weakened immune systems may persist to adulthood and contribute significantly to adult mortality. Thus, it is believed that adult survival is based on surviving the early childhood diseases. But adults, by distinction, suffer from a wide variety of problems, many of which are not amenable to cost-effective interventions. This was shown in Tanzania, where survivors of childhood diseases continued to portray high mortality rates throughout adult life (30).

Verbal autopsy which has been used for over 20 years is a systematic process of soliciting information about cause of death from close family member or friend or caretaker who was present either during the illness that led to death or the circumstances that led to the death of a person (31). The method is very important in ascertaining and estimating the cause of death in areas where death registration is not done, especially Africa. Its interpretation relies on either expert independent physicians' assessment or the application of predetermined algorithms.

Chandramohan et al. (1994) argued that information available for verbal autopsy is inadequate to draw firm conclusions on the actual cause of death. In support of their

argument, they recommended that before the technique is used more widely for adult deaths, further research is required to compare alternative methods and to evaluate the validity of the tool in a range of settings (31). Since then verbal autopsy tools have been improved accordingly (26). Byass et al who described the development of a Bayesian probability model for verbal autopsy interpretation as a simple, reliable and consistent method of ascertaining cause of death also argue that the verbal autopsy technique alone is time consuming and cannot always be repeated (32), but they found out in their study that over 70% of the causes of deaths ascertained with verbal autopsy technique corresponded with their model's assertion (33). It can therefore be used to produce useful data that can effectively guide priority health interventions in rural areas where routine information system on death is either very weak or not available. Similarly, Kamali et al argued that the verbal autopsy technique is a good surveillance tool and good for ascertaining the cause of death in a rural population (34). Nevertheless, it is more accurate and effective when at least two independent physicians ascertain the cause of a particular death. Most of the studies that estimated cause-specific mortality rates in sub Saharan Africa were based on verbal autopsy technique within health and demographic surveillance sites. Among such are studies from Tanzania (4;30;35;36), South Africa (37-39), Burkina Faso (11;40-42) and Kenya (43).

Diseases and risk factors of health at global and regional levels have been assessed over time using global mortality estimates (44). These are being used by various agencies both at national and international levels for policy analysis, interventions and decision-making in different countries. The use of these estimates have limitations hence the call for strengthening the quality, availability, analysis, and use of local data and statistics to meet country as well as international needs (45).

Information on adult deaths is not readily available in most countries (26) although attempts have been made to provide such information. Such attempts include mortality calculated by counting the number of deaths with respect to the given mid-year population over specified a period of time in a well defined population. A further reason for the lack of information on causes and consequences of adult mortality is the need to have sufficiently large population denominators to obtain a sufficient number of deaths for analysis by age, sex, and cause. Also census and vital registration are sources of information for estimating such mortality. However, the disadvantages with these sources are the long time interval for conducting a census and the lack of vital registration in the sub-Saharan Africa (46). Due to these limitations, indirect estimation methods such as survival of parents, the sibling histories or the counting of deaths by way of national surveys has been used to measure adult deaths (47-50).

In the context of these limitations, Health and Demographic Surveillance System (HDSS) has been an essential source of data for national and international development information (51) as the systems update information collected routinely on larger scale and within shorter periods of time. Pooled data from HDSS are being used to develop life tables for developing countries (6) and form a good source for estimating adult deaths in Sub-Saharan Africa.

This study therefore analyzed data from Ifakara HDSS to add to existing knowledge on causes and risk factors of adult mortalities in rural Tanzania. The findings from this study will also add on to information needed for the improvement of adult health in Africa.

1.3 Statement of the Problem

Epidemiologists and demographers are yet to understand factors predisposing to living to old age, the natural hypothetic age limit of 120 years. They are pushing for improving and increasing life expectancy over and above what is currently being observed.

The attainment of one of the United Nations' millennium development goals (MDGs) can lead to achievement of at least one other goal. This means that the MDGs are intertwined and therefore lie very prominent on stakeholders' priorities within specific countries to assess which goal when achieved will best achieve most of the other goals. However, there are other issues that are not explicitly targeted by any goal although some goals have an indirect link to them. Apart from maternal mortality, adult health and mortality is one of the health issues that were openly missing among the list of the MDGs. However eradicating extreme poverty and hunger would not be possible if adults who are normally the working class (economically active population) are not explicitly supported to be healthy and to live longer in order to be able to produce and contribute to development.

It is estimated that the proportion of all adult deaths occurring between 15 and 59 years may equal or even exceed the proportion caused by childhood deaths (11;18). Since there is evidence that HIV is one of the commonest causes of death in Sub Saharan Africa (2), it is time for a systematic attempt to reconcile the demographic and epidemiological evidence concerning AIDS in Africa (52) by looking into the causes and risk factors of adult deaths. Adults do not only die from the same causes of child deaths hence the need to study into other causes of adult deaths.

Analysis of longitudinal datasets in Sub-Saharan Africa showed that patterns of adult deaths, trends of causes and risk factors of morbidity and mortality were different across

countries (19). The authors speculated that different interventions might be the cause of such varied patterns. Hence policies for reducing adult morbidity and mortality have to be country-specific. As the health of adults is essential for the wellbeing of the community, there is an urgent need to develop country specific policies that deal with the causes of adult mortality (30). Therefore finding lasting solutions to some possible preventable deaths among adults is absolutely necessary. In Sub-Saharan Africa, and in Tanzania to be specific, not much has been done in this area. Some studies that were carried out using the longitudinal data available in Tanzania were not exclusively done for only Tanzania. Such studies were based on demographic surveillance populations or DHS datasets from different countries. Some of these studies included those conducted by Adjuik (2006), Osman (2003), and Timaeus (2004).

For these reasons, this study has analyzed the IHDSS datasets specifically to look at the risk factors, trends and causes of adult mortalities and provided information that will contribute to improving the health of adults in rural Tanzania and potentially in other rural areas in Sub-Saharan Africa.

1.4 Justification of the Study

Data for producing levels and patterns of child mortality prevailing across the continent are readily available but this is not the case for adult mortality (53). The gap in information on levels, causes and risk factors of adult mortality in sub-Saharan Africa, including Tanzania justifies a study that contributes knowledge in that subject. The HDSS provide valuable information on mortality both on adulthood and childhood (6;53) which provided unique opportunity for this study.

Adult mortalities could be measured using census, vital event registration, or the indirect demographic methods. The assessment of the current status of global data on death registration at the end of 2003 showed that, out of 115 countries worldwide that provided data on death registration, only 64 countries have their data essentially complete. It was also found that 90% of African countries had no information on cause of death for any year after 1990 (10). However, due to the absence and enormous limitations of these techniques, the use of longitudinal data collected by HDSS and the strengths of using longitudinal data for estimating causes of death through verbal autopsies (53) justifies this study. Tanzania is one of the African countries which have several Health and Demographic Surveillance Sites (HDSS) covering large populations in rural areas.

Also, the fact that not much has been done on adult mortality in Africa and in Tanzania to be specific, this study will fill the gap and contribute knowledge to improving adult health.

1.5 Study Question

The research questions are; what are the causes, levels and trends of adult deaths and what are the risk factors for cause-specific adult mortality in the IHDSS population?

1.6 Main Objective

The main aim of this study is to describe causes, levels and trends of deaths and identify risk factors of cause-specific mortality among adults in the IHDSS from 2003 to 2007.

1.7 Specific Objectives

1. To describe causes of adult mortality in the IHDSS from 2003 – 2007 among adults aged 15 – 59 years.
2. To estimate cause-specific adult mortality rates and trends from 2003 – 2007 in the IHDSS population among adults aged 15 – 59 years.
3. To identify risk factors of cause-specific mortality in the IHDSS population from 2003 – 2007 among adults aged 15 – 59 years.

CHAPTER TWO: METHODOLOGY

2.1 Description of the study area

The Ifakara Health and Demographic Surveillance Site (IHDSS) includes the urban/peri urban and rural areas. This study was conducted among the population covered by the IHDSS in rural southern Tanzania.

The IHDSS is housed in southern Tanzania in parts of two districts, Kilombero and Ulanga both in Morogoro region as showed by Figure 2.1. It is located on latitude 8° 00'to 8° 35'S and longitudes 35°58'–36°48'E with altitude 270–1000 m above sea level. It is about 320 kilometers from Dar es Salaam, the major commercial city in the country. The area covers 80 kilometers by 18 kilometers in Kilombero District and 40 kilometers by 25 kilometers in Ulanga District, making a total of 2400 square kilometers of Guinea Savannah in the floodplain of the Kilombero River, which divides the two districts. The Udzungwa Mountains lie to the northwest. The area is mountainous.

Figure 2.1: Map showing location of the IHDSS within the Morogoro region, Tanzania

The area is predominately rural with scattered households. The main ethnic groups are Wapogoro, Wandamba, Wabena and Wambunga. The main rainy season is from

November to May. In the rainy season there are many villages that are inaccessible except with a four-wheel drive. Sometimes at the peak of the rains, even a 4WD has difficulty accessing some of these villages. At the same time the scattered nature of the population means that a lot of effort is needed to reach a few people and good road networks are vital (54).

2.1.1 Demography

The IHDSS had recorded a total population of 92, 375 by the year 2007 (the end year of this study) with 21,365 households. The mean household size is five people usually living in a compound with one or two houses. The ratio of males to females is 96:100. About half of the total population is made up of adult within the age of 15 to 59 years. The literacy rate in adults is quite high, 88% for men and 69% for women. The population is highly mobile, with most families moving to the *shamba* areas for few weeks at a time. The *shamba* areas are the farming areas. Their movement depended on the farming and rainfall season.

2.1.2 Economics and Health

The area covered by the HDSS is very poor and typical of poor disadvantaged rural districts across the country. About three-quarters of the inhabitants are subsistence farmers of maize and rice. Other occupations are petty trading. There are a handful of trained artisans and craftsmen and a few civil servants mainly migrant employees of government ministries, departments and agencies.

Within the Demographic Surveillance Area (DSA), there are 14 health facilities; 12 Dispensaries and 2 Health Centers. There is no hospital within the DSA. But there are 2 nearby hospitals that serve as referral points. Health services are delivered from the above-mentioned health facilities and health care accessibility by adults is purely cash and carry. Children under five years of age access free health care. Also antenatal care for pregnant women is free. Most people who really need the health services live far from the services. HIV/AIDS and malaria are the leading causes of morbidity and mortality in the area. According to the Tanzania HIV/AIDS and Malaria Indicator Survey of 2007-08, the national HIV/AIDS prevalence among adults was 6%. Ifakara area has prevalence 4.7% (55).

The widespread poverty in the district affects health. Poor health status and poverty are closely related. Factors associated with living in poverty such as unhealthy environment are the cause of much ill-health and are compounded by a lack of access to essential goods (e.g. nutrition), knowledge and services. The experience of ill health in turn exacerbates household poverty due to loss of income and the cost of health care.

2.1.3 The Rural IHDSS

The rural Ifakara HDSS started in 1996 where all resident persons within 25 rural communities from the Ulanga and the Kilombero districts were enumerated for the first time as baseline. The baseline enumeration took place in these selected communities from September to December 1996. For each individual a unique identification was assigned along with the name, date of birth, sex and relationship to the head of household. After the baseline, each registered household was visited by a trained interviewer once in every four months to update the household registers by recording births, deaths, in and out migrations as well as pregnancies. Visits are termed HDSS

rounds and as at December 2007, a total of 33 rounds had been done. All the information is captured within a computer database. The current database for capturing the HDSS information is called Household Registration System II built on the platform of FoxPro. A person is registered into the HDSS if such person resided within the DSA for at least 4 months prior to an update round. Such person is classified external in-migrants and he/she is coded as "Entry" in the database. Those who were present during the baseline were coded as "Enumerated". Currently, total midyear population of over 100, 000 people is being followed up within the DSA.

2.1.4 The IHDSS Verbal Autopsy System

Verbal autopsy is simply a technique for ascertaining causes of deaths by collecting relevant information on the deceased from a close relative or caretaker who was present during the ailment preceding the death. Information ranges from the circumstances leading to death and signs and symptoms seen before death. The assignment of cause from the information is normally done by physicians. The number of physicians who are mandated to assign a cause to a particular death vary from site to site (19). In the IHDSS, vital registration is in place but is patchy and most deaths also occur at home. The ascertainment of causes of deaths in this rural area is largely based on verbal autopsies (VAs). Deaths that occurred within the DSA are recorded during each HDSS update round. These deaths are compiled by a VA team for interviews to be conducted on them. Experienced and well trained field interviewers are sent to conduct interview after a minimum of 40 days of the occurrence of the death. The 40 days are considered to be the mourning period during which it is unacceptable to conduct such interview. These 40 days delay was set in agreement with the communities that habitat the IHDSS. The tools used for the interview are semi-structured questionnaires adopted from

INDEPTH-Network and modified to suit local customs and standards. Two physicians independently code each VA, and a third coder reconciles disagreements. The VA coders generally code only one cause for each death, usually the immediate cause using the ICD-10 (during the period of this study, 2003 to 2007). Where all three coders disagree, causes are said to be undetermined and are assigned "Undetermined". Despite limitations that are quite obvious, verbal autopsies are presently identified as the best possible method to ascertain reasonably precise information on cause-specific deaths in poor countries (32;35;41) where vital registration is not available as in the case of this study area. One of these limitations is huge proportion of deaths assigned undetermined, resulting either from completely missing information from the relatives, insufficient information or complex information that led to conflicting evaluations from the physicians (26).

2.2 Study Design

This study was a secondary data analysis of longitudinal dataset collected over a period of five years from 1st January 2003 to 31st December 2007. The study made use of the strengths of health and demographic surveillance's ability of routinely and continually collecting and recording of births, deaths, migration and other socio-demographic indicator data on households and individuals. This information was collected from within the catchment area of the IHDSS. Although a lot of information was collected but for the purposes of this study, only relevant variables were extracted and used for the analysis as described below.

2.3 Study Population

The IHDSS currently covers nearly 100,000 people (2009 mid-year population). The study population was all adults in the age group 15 to 59 years in the Ifakara Health and Demographic Surveillance area.

2.4 Study Sample

The individuals included in this study were all registered and active adults in the age group 15 to 59 years in the IHDSS recorded from the 1st January 2003 to 31st December 2007. Records of all these individuals were extracted for this study. More than 50% (n=65,548) of the total population were adults aged between 15 and 59 years. Over the 5 year period (2003 – 2007), a total of 1,352 deaths occurred among the adult (15-59 years) population.

2.5 Inclusion and Exclusion Criteria

Only resident adults aged from 15 to 59 years registered in the IHDSS from 1st January 2003 to 31st December 2007 including those who died during this period were included in this study. Persons resident in the IHDSS who did not fall between ages 15 to 59 years or were not active residents within the IHDDS from 1st January 2003 to 31st December 2007 were excluded from the study.

2.6 Variable Measurement and Data Sources

2.6.1 Exposure Variables

The exposure variables for this study were considered as potential risk factors for adults. The study used the risk factors for adults that were available in the dataset. During the period 2003 to 2007, factors such as Socio-Economic Status (SES), age, sex, education, household size, employment status and occupation of head of household, place of death and mode of entry into HDSS (entry type) were collected.

SES was measured using an index, based on social status, assets ownership and availability of utilities. The index measures were combined into a wealth index using weights derived through principal component analysis (56). The proxies from the principal component analysis were divided into five quintiles; poorest, very poor, poor, less poor and least poor. The SES was calculated at the household level and assigned to adults from same household as a proxy.

Age at recruitment was calculated as the difference between date of birth and date of recruitment into the study. Also age at death was also calculated for those who died during the analysis period as the difference between date of birth and date of death. A 15-year interval age grouping was done which is similar to what had been used in a global burden of diseases study by Murray and Lopez (57). The age groups were therefore 15-29, 30-44 and 45-59 years.

Education was measured by the level reached and classified into three categories; no education, primary level and beyond primary level of education. This education grouping has been used in many studies including that conducted by Eijk et al (2008) and Becher et al (2008).

The occupation and employment status of heads of households were extracted as one of the variables. It would have been appropriate to use the individual's employment status in the analysis but such data was not available for the period under study. It was only available for heads of households. The heads of households' employment status were categorized into 2 groups; the status "employed" for heads of households who get income from doing some work and "not employed" for heads of households who do not do any paid job/work.

Study like that conducted by Eijk et al (2008) categorized place of death into "health facility" and "elsewhere (outside health facility)". In this study, place of deaths was categorized into three groups; dying at "health facility", dying at "home" and dying "elsewhere". This grouping was necessary since most people died at home but deaths due to accidents and injuries occurred mostly elsewhere.

Mode of entry or entry type is how the individual got recruited by the IHDSS for the very first time. "In-migrants" were those who were not present during the baseline data collection whereas "enumeration" was for those who were present during the baseline data collection.

Sex was coded conventionally as male and female. Household size is the number of people living in a household. The individual's marital status and religious denomination were other variables of interest but data was not available for the period under study. These variables explained above were selected for this study based on published literature (1,4-5,11-12,15,24).

2.6.2 Outcome Variable

The main outcome variable for this study was Adult (aged 15-59) death. This was categorized and measured as either "Alive=0" or "Dead=1".

For the cause-specific analysis, causes of deaths were assigned to deaths for which VA was successfully conducted. The process is described under IHDSS VA system. The narrow causes were re-classified into broad causes as described by Chasin et al (1992) (58) and used by other studies (12-15;59). These broad classifications were Communicable diseases causes (CD), Non-communicable diseases causes (NCD), Accidents/Injuries causes and Undetermined.

2.7 Data Management

The IHDSS captures and processes their data using a database called HRS2 which had been built on the platform of FoxPro program. Variables needed to answer the research questions were extracted and transferred via Stat transfer software version 11 into STATA version 10 for analysis.

The variables were selected from four different files namely member file, mortality file, cause specific file and SES file. The total number of deaths was obtained from the mortality table of all adult residents in the demographic surveillance area. Age at recruitment was calculated and for those whose age was from 15 to 59 years were kept for the analysis. From this dataset, those whose exit dates were before the start date (1st January 2003) or those whose entry date was after end date of the study (31st December 2007) were dropped but those who left within the observation period were kept for the final analysis.

All these tables were linked together by household or person unique identifiers to form one flat file. The extracted data was thoroughly cleaned for missing values, anomalies and internal consistency of responses. Hard copies of the completed questionnaires were also used for references and validation during the data cleaning process.

2.8 Data Analysis

2.8.1 Descriptive Analysis

Objectives one and two of this study were addressed using descriptive analysis. To answer objective one, proportion of adult mortality by causes, frequencies, means and standard deviations of the risk factors were generated and presented in tables. The proportion of adult deaths by broad causes was estimated. The characteristics of the cohort and of those who died were presented in tables and figures.

Also, objective two was addressed by calculating adult AMR for each calendar year and cause-specific mortality rates for the five year period from 2003 to 2007. Adult mortality rates were directly estimated by dividing number of deaths by person years observed for a specific period of time and expressed per 1000 person years observed. Mortality calculations were limited to deaths of those 15-59 years of age, which is in line with other studies of adult mortality in Africa (2;30;52)

The numerator for the cause-specific rates were provided by the verbal autopsy system and the denominator was extracted from the IHDSS which is similar in principle to the way mortality rates were calculated (18). A trend test was used to examine linear relationship in the annual mortality rates over the five year period. This was stratified by sex and age (in 3 categories) using person years observed. Graphs and charts were used to give clearer description of significance and trend over the 5 years of observation.

Survival estimates were computed using Kaplan-Meier survival technique expressed per 1000 person years observed.

2.8.2 Inferential Analysis

To achieve objective three, broad specific causes (CD, NCD and Accident/Injure) were analyzed independently. Adults who died from one of these causes were said to have experienced the event of interest at a time. Cox proportion hazard regression model was used to determine factors including the SES, Sex, Age, Educational status, Head of household employment status, Household size and Entry type that were associated with each of the causes over the five year period. Hazard ratios and their respective 95% confidence intervals were calculated. Statistical significance was considered at 5% level. A Log-rank test for equality of survivor functions was used to assess significant difference in survivorship and also Kaplan-Meier survival technique was used to assess the proportionality assumption model in Cox regression.

2.9 Ethical Considerations

Authorization was sought from the Ifakara Health Institution before the data was used (appendix 1). Ethical clearance was given by the Human Research Ethics Committee (Medical), University of the Witwatersrand, Johannesburg before the commencement of the study. The ethical clearance number is M090949 (appendix 2). The title of the study was also approved by the Faculty of Health Sciences of the University (appendix 3).

The extracted data was used strictly for the purposes of this study. Confidentiality and anonymity were maintained by ensuring that unique identifiers are used instead of names of individuals in the report.

CHAPTER THREE: FINDINGS

This chapter reports results from the analysis of population-based longitudinal data covering a period of five years (2003-2007) with a focus on adults aged between 15 and 59 years. The results here are in four parts. The first part presents the socio demographic characteristics of the study participants. The second part describes the causes of adult mortality in the Ifakara DSA for the 5 year period. The third part shows the trends in overall adult mortality rates and Kaplan-Meier survival estimates, expressed per 1000 person years of observation (PYO), for that period. We have shown how these estimates vary by sex and age. It also presents the cause-specific mortality rates for the period of observation. The final part of this section involved identification of factors that were associated with adult cause-specific mortality. Cox proportional hazard model was used to identify the associations.

3.1 Socio Demographic Characteristics of the study cohort

Table 3.1 shows the socio-demographic characteristics of the study population. During the observation period of 1 January 2003 to 31 December 2007, a total number of 65,548 adults (participants) were followed. This was the cohort size for the 5 years of follow up, out of which 64% (41,729) were enumerated during the baseline while 36% (23,819) migrated into the area during the period. Of the total cohort, the sex distribution showed that the proportion of females were slightly higher than males, 51% (33,677) for females compared to 49% (31,871) for males. The age distribution of the cohort showed that proportion of adults 15-29 years was more than half the cohort size (57%) followed by the 30-44 years (30%) and those aged 45-59 years (13%). Socio economic status (SES) was generated at the household level and assigned to the

individuals belonging to the respective households in the cohort as a proxy of their SES. The study showed that the poorest and the poorer group of SES, with 21% each, are proportionally higher than other SES groups. Of the total participants, 51,034 (78%) had primary education while 15% had never attended school at all and 7% went beyond primary level of education. It was found that 94% (61,728) of the cohort had their heads of households employed. Of the employed (doing some economic activity) heads of households, 88% were farmers, 12% were petty traders while less than one percent were salary workers.

Table 3.1: Socio-Demographic Characteristics of the Adults in the IHDSS by Sex, 2003-2007

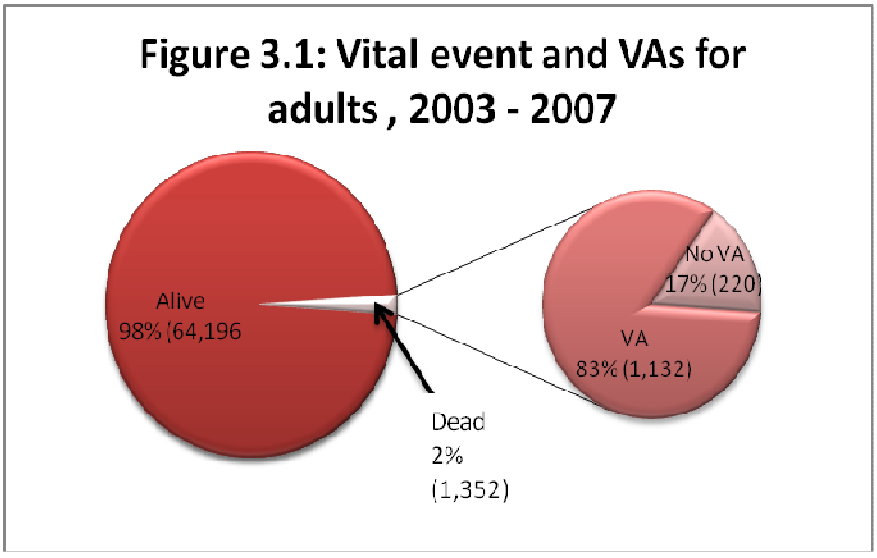
Variable	Male Number (%)	Female Number (%)	Total Number (%)
Cohort Size	31, 871 (48.6)	33, 677 (51.4)	65, 548
Age (in years)			
15-29	17, 542 (46.7)	20, 022 (53.3)	37,564 (57.3)
30-44	10, 152 (52.3)	9, 265 (47.7)	19,417 (29.6)
45-59	4, 177 (48.8)	4, 390 (51.2)	8,566 (13.1)
Socioeconomic Status			
Poorest	6, 572 (47.2)	7, 341 (52.8)	13,908 (21.2)
Poorer	6, 690 (49.3)	6, 869 (50.7)	13,559 (20.7)
Poor	5, 721 (48.5)	6, 081 (51.5)	11,797 (18.0)
Less poor	6, 408 (48.7)	6, 749 (51.3)	13,159 (20.1)
Least poor	6, 480 (49.4)	6, 637 (50.6)	13,125 (20.2)
Level of Education			
No Education	3, 183 (33.2)	6, 399 (66.8)	9,582 (14.6)
Primary Education	25, 745 (50.4)	25, 289 (49.5)	51,034 (77.7)
Beyond Primary	2, 943 (59.7)	1, 989 (40.3)	4,932 (7.5)
Head of household Employment status			
Employed	30, 032 (48.6)	31, 696 (51.4)	61,728 (94.2)
Not employed	1, 839 (48.1)	1, 981 (51.9)	3, 820 (5.8)
Entry type			
In-Migrant	11, 128 (34.9)	12, 691 (37.7)	23, 819 (36.3)
Enumerated	20, 743 (65.1)	20, 986 (62.3)	41, 729 (63.7)

The average household size was 5 (standard deviation= 2.31) with the minimum number of household size of one and the maximum number of household size of 49.

Nevertheless, only one household was found to have 49 members. Within each household, an average of 4 males existed compared to an average of 5 for females during the observation period.

3.2 Adult mortality in the IHDSS

A total number of 1,352 adult deaths were recorded over the five year period representing 2% of the total cohort. Of this, verbal autopsies were successfully conducted for 83% (1,132) over the period of follow up. The rest (17%) had their verbal autopsies not done. This result is also presented with the aid of a pie chart in Figure 3.1.



3.2.1 Characteristics of the Persons who Died

Table 3.2 presents the characteristics of the adults who died during the period of observation. It also presents results of statistical association between the characteristics by sex. Of the 1,352 persons who died, 49% (656) were males and 51% (696) were

females. The study revealed that, among those who died 72% had primary level of education, 25% had no education and 3% had gone beyond primary level of education. Among those who had no education, 41% were males and 59% were females. It was also revealed that 51% males compared to 49% females and 43% males compared to 57% females had primary level and beyond primary level of education respectively. The study found a statistical association (p=0.006, chi2=10.24, df=2) between level of education and sex of the deceased.

An important factor associated with death that we explored was place of death. The study found that 59% (334) and 51% (410) of the females and males respectively died at home. It was revealed that, of the 744 people who died at home, high proportion (43%) was among the adults between 30-44 years old at the age of death. The age at death was found to be statistically associated with sex of the deceased with p-value less than 0.001. The study revealed that, for the age group 15-29 years, higher proportion of deaths occurred among females (66%) while for the age groups 30-44 and 45-59, higher percentages (51% and 57% respectively) occurred among the males.

There was also significant association between sex and how the individuals were registered into the IHDSS (p = 0.001, chi2 = 11.67, df=1). Among those who died, 74% (974) were registered at baseline while 26% (358) were registered as in-migrants. Fifty-nine percent (212) of the in-migrants who died were females while 51% (54) of those registered at baseline that died were females. The study showed that, there was no significant association between those who died and their head of household's employment status (p=0.603).

Table 3.2: Characteristics of those who Died by Sex in IHDSS, 2003 – 2007

Factors	Total N=1352 (%)	Sex		X^2 test d.f. (p-value) α=0.05
		Male: n (%) *656 (48.5)*	Female: n (%) *696 (51.5)*	
Level of Educational				
No Education	343 (25.4)	142 (41.4)	201 (58.6)	10.242
Primary Education	972 (71.9)	498 (51.2)	474 (48.8)	2
Beyond Primary	37 (2.7)	16(43.2)	21 (56.8)	(0.006)
Age at death (in years)				
15-29	347 (25.7)	119 (34.3)	228 (65.7)	40.532
30-44	564 (41.7)	287 (50.9)	227 (49.1)	2
45-59	441 (32.6)	250 (56.5)	191 (43.3)	<0.001
Socioeconomic status				
Poorest	325 (24.0)	159 (48.9)	166 (51.0)	
Poorer	251 (18.6)	129 (51.4)	122 (48.6)	1.578
Poor	237 (17.5)	115 (48.5)	122 (51.5)	4
Less poor	278 (20.6)	133 (47.8)	145 (52.2)	(0.813)
Least poor	261 (19.3)	120 (46.0)	141 (54.0)	
Place of Death				
Home	744 (55.0)	334 (44.9)	410 (55.1)	9.411
Health facility	467 (34.5)	243 (52.0)	224 (48.0)	2
Elsewhere	141 (10.4)	79 (56.0)	62 (44.0)	(0.009)
Entry Type				11.674
In-migration	358 (26.5)	146 (40.8)	213 (59.2)	1
Enumeration	974 (73.5)	510 (51.3)	483 (48.7)	(0.001)
Employment status of the head of household				0.270
Employed	1246 (92.2)	602 (48.3)	644 (51.7)	1
Not employed	106 (7.8)	54 (50.9)	52 (49.1)	(0.603)

3.2.1 Causes of Deaths among Adults 15-59 years

3.2.1.1 Narrow Classification of Adults Causes of Deaths

Among the total number of 1132 (83% of the total deaths) deaths that VA was successfully conducted, 31% had their causes classified as undetermined. Undetermined cases came about as a result of either the information collected for coding was insufficient or was complex for ascertaining the right and specific cause of the death.

Table 3.3 gives an overview of the overall 5 most frequent causes of deaths among adults in the IHDSS from 2003 to 2007. Overall, 20% of the 1132 deaths were attributed to HIV/AIDS related causes and 13% to Malaria. Besides HIV/AIDS and Malaria, Unintentional Injuries (5%), Acute Abdominal conditions (4%) and Pneumonia (2%) were also frequent in that order and were among the overall top 5 causes of adult deaths within the IHDSS. When the narrow specific causes of deaths were looked at separately to find the top 5 causes of deaths by sex (Appendix 4a), HIV/AIDS and malaria were still the top two most frequent causes of deaths among the adults. Among the males, Unintentional Injuries, Acute Abdominal Conditions and Cerebrosvascular diseases in that order respectively constituted the bottom three most common causes of deaths. Acute Abdominal Conditions, Pneumonia and Unintentional Injuries in that order also constituted the bottom three most frequent cause of death among the females.

Table 3.3: Overall Top Five Narrow Specific-Causes of Deaths in IHDSS by Sex, 2003-2007

Rank	Overall		Sex	
			Male	Female
	Cause	n (%)	n (%)	n (%)
1	HIV/AIDs Related	231 (20.4)	107 (19.6)	124 (21.2)
2	Malaria	149 (13.2)	82 (15.0)	65 (11.1)
3	Unintentional Injuries	60 (5.3)	43 (7.9)	17 (2.9)
4	Acute Abdominal conditions	49 (4.3)	28 (5.0)	21 (3.6)
5	Pneumonia	28 (2.5)	10 (1.8)	18 (3.1)
	Others	264 (23.3)	112 (20.5)	154 (26.3)
	Undetermined	351 (31.0)	165 (30.2)	186 (31.8)
	Total	**1132 (100)**	**547 (48.3)**	**585 (51.7)**

Considering narrow specific causes of deaths by age and sex (Appendix 4b), younger adult males within the age 15-29 years died mostly from Unintentional Injuries (19%) followed by Malaria (15%) and HIV/AIDS (12%). In all the other age groups both

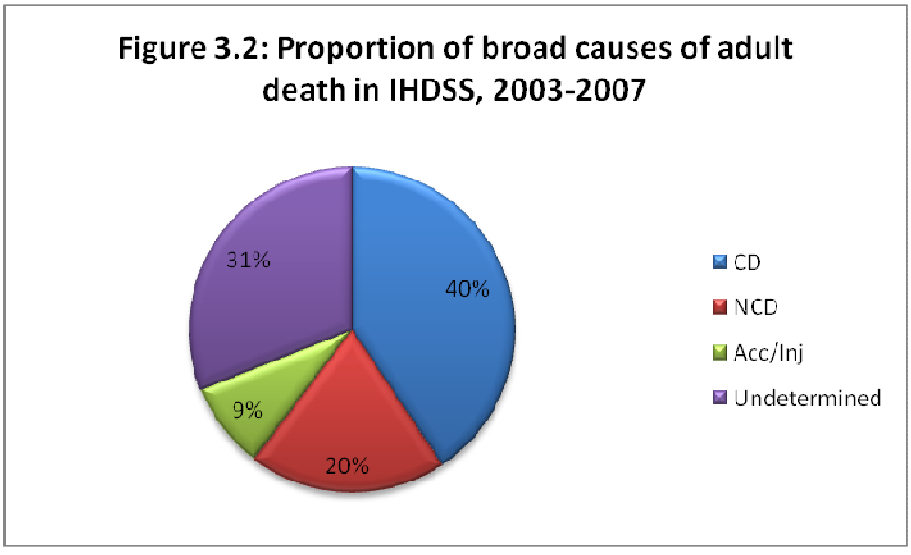
males and females died mostly from HIV/AIDS followed by Malaria. The third, fourth and fifth most frequent causes for these age groups that constitute the top 5 most common causes of deaths among the adults varied and are shown in Appendix 4b.

Causes of deaths that were classified as "Others" in Table 3.3 are specific causes that constituted smaller proportion of death within the respective narrow cause of death.

3.2.1.2 Broad Classification of Adults Causes of Deaths

In further analysis, causes of deaths have been broadly classified into Communicable disease, Non-communicable disease, Accidents/Injuries and Undetermined causes.

The study revealed that overall, about 40% of the 1132 deaths were attributed to communicable causes, 20% to Non-communicable causes and 9% to Accident and Injuries causes as shown also graphically in Figure 3.2.



The study also showed as presented in Table 3.4 that, among males, 40.8% died from CD compared to 40.5% among females. Also, among male, 13% died from

Accident/injury compared to 5% among females. On other hand, among female adults 23% died from NCD compared to 16% among males.

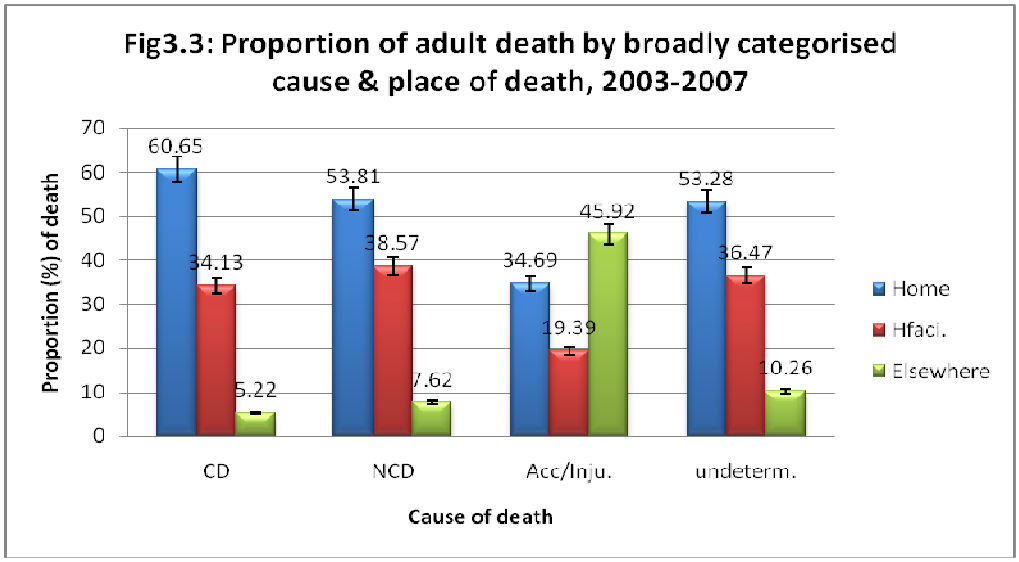
Table 3.4: Proportion of Broad Causes of Deaths by Sex in IHDSS, 2003 – 2007

Cause of Death	Sex		Total
	Male n (%)	Female n (%)	n (%)
Communicable Disease	223 (40.8)	237 (40.5)	460 (40.6)
Non-communicable	90 (16.4)	133 (22.7)	223 (19.7)
Accident/ Injuries	69 (12.6)	29 (5.0)	98 (8.7)
Undetermined	165 (30.2)	186 (31.8)	351 (31.0)
Total	**547 (100)**	**585 (100)**	**1132 (100)**

Among those who died from communicable diseases (460), half (50%) of the deaths were attributed to HIV/AIDS related causes, 32% were due to malaria and 6% were due to pneumonia. About 44% of the 460 communicable causes occurred among adults aged 30-44 years, followed by those aged 45-59 years (34%) and then 15-29 years (22%).

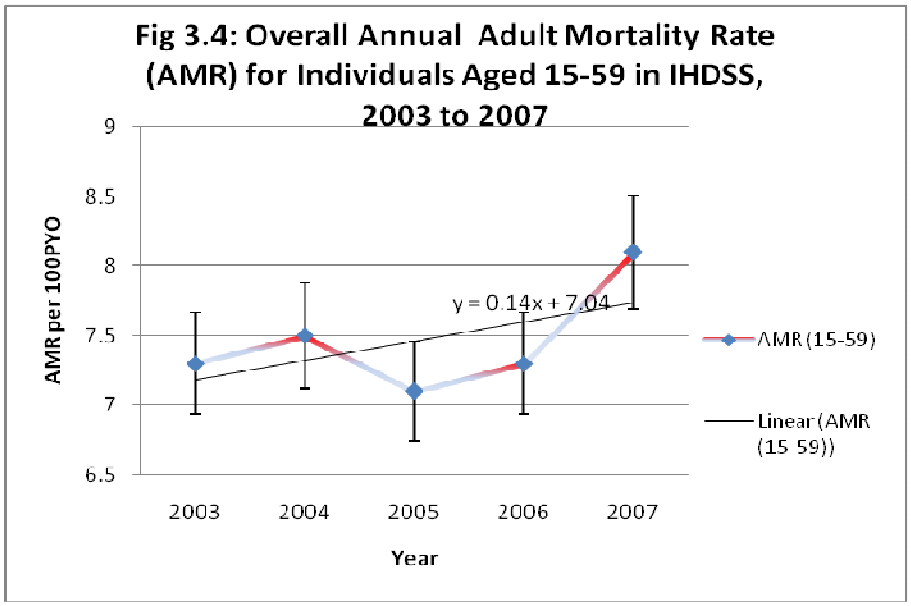
Among those who died from non-communicable causes, it was mostly due to Acute Abdominal Conditions (22%), followed by Cerebrovascular disease (9%) and then Epilepsy (8%). The rest of other non-communicable causes accounted for smaller fraction. Also, of the 98 deaths that were due to accidents/injuries, Unintentional injury was most (61%), followed by homicide injuries (12%) and road traffic accidents (11%). Higher proportions of these deaths were reported to have occurred at places other than home or health facility as shown graphically by Figure 3.3. The confidence intervals on the graph do not overlap within each cause group meaning there was significant association between place of death and cause of death. While deaths from communicable and non-communicable causes were found to be occurring mostly at home, deaths due to accidents/injuries happened mostly outside the home and health facility. However, the study could not explore further to ascertain where, specifically,

the accidents/injuries deaths occurred because such information was not available in our data.



3.3 Adult Mortality Rates

The total cohort of 65,548 adults aged 15 to 59 years that were recorded and followed up for the 5 years yielded 184,000 person years of observation (PYO). The overall adult deaths registered during the 5 years of follow up from 2003 to 2007 were 1,352 which were about 2% of the total cohort. The all-cause mortality rate for the adult deaths recorded for the period was 7.3 per 1000 PYO. The study showed that the annual adult mortality rates fluctuated between the calendar years 2003 and 2005, but showed an increasing trend from 2005 to 2007. In 2003, the rate was 7.3 per 1000 PYO but declined to a minimum rate of 7.1 per 1000 PYO in 2005. It steadily increased to 8.1 per 1000 PYO in 2007. This showed that the rate in 2007 had increased by 11% compared with that in 2003. This is shown graphically in Figure 3.4.



The trend line on Figure 3.4 showed that annual adult mortality rate over the 5 year period of analysis from 2003 to 2007 increased steadily but without statistical significance at 95% level. The mortality rates recorded for selected factors are presented in Table 3.5. The result showed that female adult mortality rate of 7.2 per 1000 PYO was 3% less than male adult mortality rate of 7.4 per 1000 PYO, but this was not statistically significant (p= 0.940). Those aged 45 to 59 years old had the highest mortality rate of 12.2 (95% CI: 11.0, 13.5) per 1000 PYO followed by adults aged 30 to 44 years old with mortality rate of 8.4 (95% CI: 8.4, 9.9) per 1000 PYO and then by younger adults aged 15 to 29 years old with mortality rate of 4.6 (95% CI: 3.3, 4.3) per 1000 PYO. As expected this revealed that adult mortality rate significantly increased with age ($p<0.001$). The results also showed that the poorest group of the socioeconomic status had the highest mortality rate of 8.1 (95% CI: 7.3, 9.1) per 1000 PYO. The poorest to least poor ratio was 1.12. The results, however, showed no statistically significant trend in the rates across socio-economic groups (p=0.534).

The study also revealed that there was a statistically significant decreasing trend in adult mortality rate over the level of education ($p<0.001$). The highest mortality rate was found among those who had never attended school (AMR= 12.4 (95% CI: 11.2, 13.8) per 1000 PYO), followed by those who had only primary education (AMR= 6.6 (95%CI: 6.2, 7.1) per 1000 PYO) and then those who had beyond primary level of education (AMR= 3.5 (95%CI: 2.5, 4.8) per 1000 PYO). A further analysis into adult mortality rate by employment status of the head of household indicated that, mortality rate of adults whose heads of households were employed was 7.1 per 1000 PYO, lower than for those whose heads of households were not employed (AMR=10.5 per 1000PYO). The result showed that adults whose heads of households were not employed were, on average, 1.5 times more likely to die than those whose heads of households were employed. These differences in adult mortality rate by employment status of head of household were found to be statistically significant ($p=0.001$).

This study also sought to estimate rates and trend by cause of death. Over the 5 year period of observation, mortality rate for all the causes have increased apart from undetermined.

The proportion of death from communicable cause was 40% in 2003 against 53% in 2007 and between the calendar years 2003 and 2007, communicable cause mortality rate was 2.49 per 1000 PYO. By sex, there was no statistical significant difference in communicable cause mortality with male to female mortality rate ratio of 1.04 ($p=0.738$).

Table 3.5: Adult Mortality Rates by Socio-demographic Factors in IHDSS, 2003-07

Factors	Person Years Observed	Deaths	AMR / 1000 PYO (95% CI)	Rate Ratio	*P-value (5%)*
Sex					
Male	88000	656	7.4 (6.9, 8.0)	1	
Female	96000	696	7.2 (6.7, 7.8)	0.97	0.940
Age (in years)					
15-29	94000	436	4.6 (4.2, 5.1)	1	
30-44	60000	551	9.1 (8.4, 9.9)	1.98	
45-59	30000	365	12.2 (11.0, 13.5)	2.65	**<0.001**
Socioeconomic stat.					
Poorest	39000	325	8.3 (7.4, 9.2)	1	
Poorer	38000	251	6.5 (5.8, 7.4)	0.78	
Poor	34000	237	6.9 (6.1, 7.9)	0.83	0.534
Less poor	37000	278	7.5 (6.6, 8.3)	0.90	
Least poor	36000	261	7.4 (6.6, 8.3)	0.89	
Level of Education					
No Education	27000	343	12.4 (11.2, 13.8)	1	
Primary Education	147000	972	6.6 (6.2, 7.1)	0.53	
Beyond Primary	10000	37	3.5 (2.5, 4.8)	0.28	**<0.001**
Employment of the head of household					
Employed	172000	1246	7.1 (6.8, 7.5)	1	**0.001**
Not employed	12000	106	10.5 (8.7, 12.7)	1.48	
Year					
2003	36000	263	7.3 (6.4, 8.2)	1	
2004	36000	269	7.5 (6.7, 8.5)	1.03	
2005	37000	250	7.1 (6.2, 8.0)	0.97	0.204
2006	37000	267	7.3 (6.4, 8.2)	1	
2007	38000	303	8.1 (7.2, 9.1)	1.11	

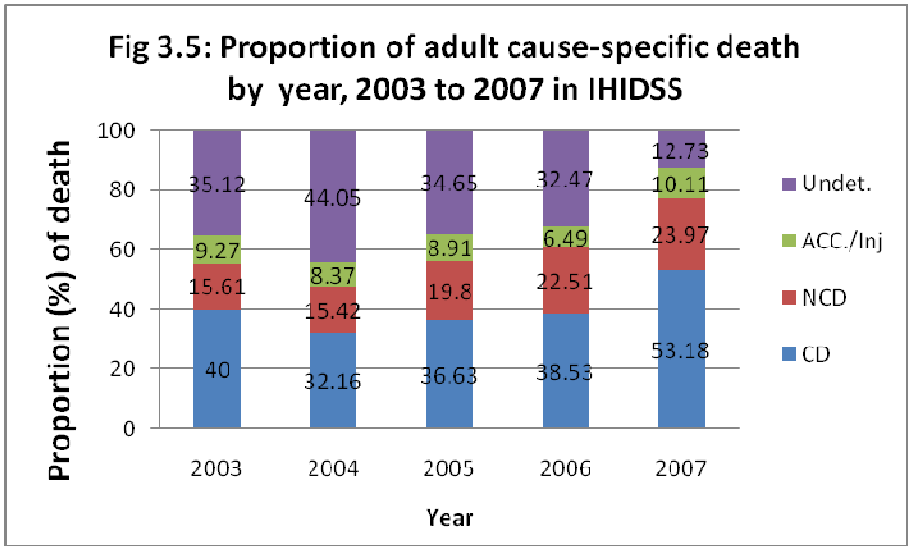
But the study found significant difference in communicable cause mortality by age group as age increases ($p<0.001$). Adults aged 15-29 years died from communicable cause at a rate of 1.3 per 1000 PYO, those aged 30-44 years died at 3.4 per 1000 PYO and those aged 45-59 years died at a rate of 4.2 per 1000PYO.

The proportion of death from non communicable cause was 16% in 2003 against 24% in 2007. The non communicable cause mortality rate was 1.21 per 1000 PYO in this study. The study found statistical significant differences in non communicable cause mortality rate by sex and age group. The non communicable cause death rate for males was 1 per 1000 PYO whereas that of females was 1.4 per 1000 PYO ($p=0.029$). Among

the age groups, adult aged 15-29 years had a non communicable death rate of 0.7 per 1000 PYO, those aged 30-44 years had a non communicable death rate of 1.5 per 1000 PYO and for those aged 45-59 years, the rate was 2.1 per 1000 PYO ($p<0.001$).

The proportion of death from accidents and injuries cause was 9% in 2003 against 10% in 2007. The study revealed an accident/injury cause mortality rate of 0.53 per 1000 PYO over the study period. There was no significant difference in accident/injury cause mortality rate by age group ($p=0.581$). But the study found a significant difference in accident/injury cause mortality rate by sex. The accident/injury cause mortality rate for males was 0.8 per 1000 PYO whereas that of females was 0.3 per 1000 PYO ($p<0.001$).

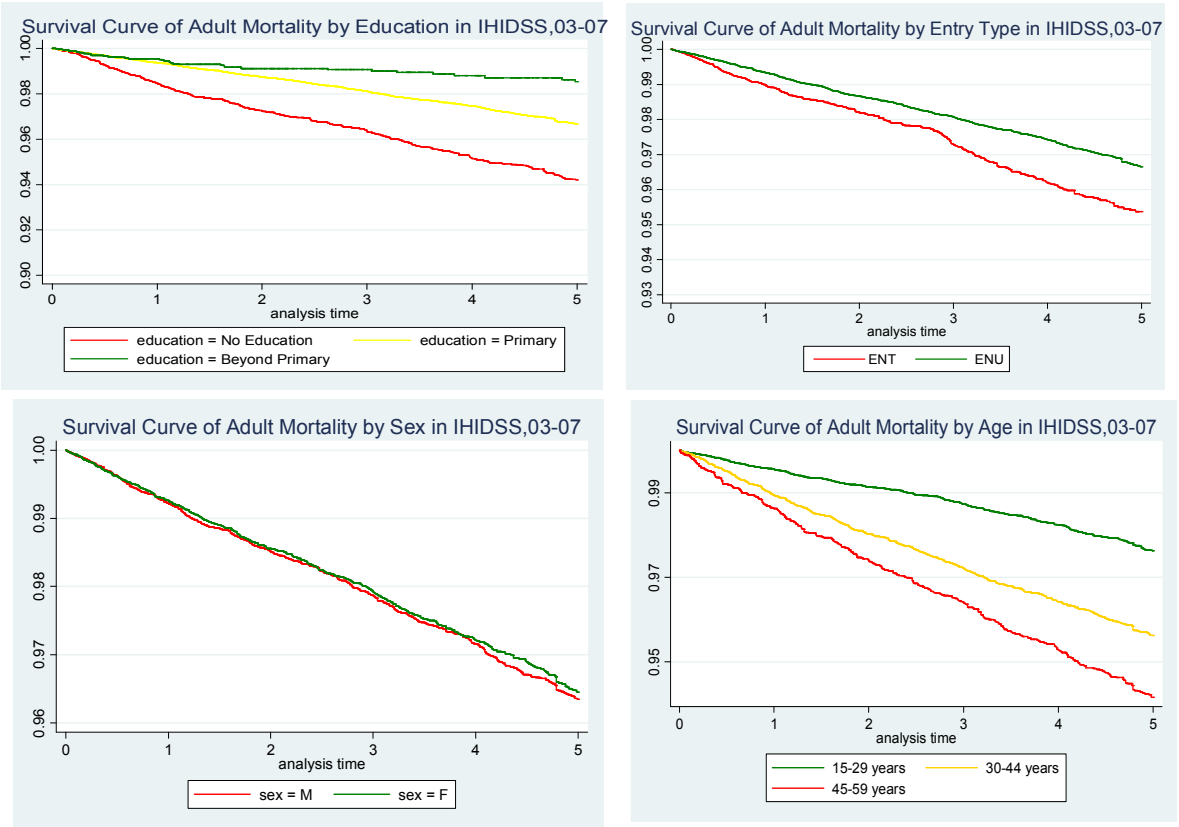
Contrary, the proportion of undetermined decreased by 63.7% between the two years as it was 35% in 2003 against 13% in 2007. Thus, the observed increase in the proportions in communicable, non-communicable and accident/injury causes of deaths as well decrease in undetermined could simply be due to improvement in coding. The proportion of cause-specific deaths per year for the five years is presented in Figure 3.5.



3.3.1 Survival Probabilities

The survival analysis showed that adult males and females in the cohort have survival rates with a steady and almost a constant decreasing rate over time. A Log-rank test for equality of survivor functions revealed that there was no significant difference in survivorship among adult men and women in the cohort (p-value of 0.568). The survival varied with an advance in age group. On the whole the young adults aged 15-29 years had the highest chances of survival followed by the adults aged 30-44 years. The older adults aged 45-59 years had the lowest chances of survival. The study also found that, the higher the level of education the adult attained, the higher the survival rate. Also it revealed that adults who were enrolled in the HDSS as in-migrants had a lower survival compared to those who were enrolled into the HDSS by enumeration. These differences were confirmed, using the log-rank test for equality of survivor functions to be statistically significant ($p<0.001$). Figure 3.6 showed the Kaplan-Meier survival curves for sex, age, level of education and entry type.

Figure 3.6: Kaplan-Meier survival curves for adults in the IHDSS, 2003 – 2007



3.4 Risk Factors of Cause-specific Deaths

An independent association between adult cause-specific mortality and socio demographic characteristics such as sex, age, SES, education, household size, entry type and employment status of the head of household was investigated using a Cox proportional hazard model. The independent models were fitted for each explanatory variable for the entire 5 year period of follow up to assess their significance as risk factors for adult cause-specific mortality. Tables 3.6, 3.7 and 3.8 present the univariate and multivariate analysis of adult communicable, non communicable and accident/injury causes of deaths respectively in the IHDSS from the 2003 to 2007.

3.4.1 Risk Factors of Communicable Cause of Deaths

Table 3.6 showed the risk factors in both the univariate and multivariate model for communicable diseases causes of deaths among adults residing in the IHDSS population from 2003 to 2007.

In the univariate analysis, age, sex, education, employment status of the head of household and entry type were found to be factors associated with communicable cause of deaths among the adults. The study revealed an increasing risk of deaths with increase in age. The hazards for death from a communicable disease for adults between the age group 30-44 years were 2.4 times more than young adults 15-29 years whereas adults aged 45-59 years were almost 3 times more likely to die from communicable disease than the young adults aged 15-29 years [(uaHR=2.40, p<0.001, 95% CI: 1.92, 2.99) and (uaHR=2.99, p<0.001, 95% CI: 2.33, 3.82) respectively]. The SES showed no particular trend although there was a 6% reduction in the hazards of death due to communicable cause when SES improved from poorest to least poor status.

Table 3.6: Univariate and Multivariate Analysis of Adult Communicable Cause Mortality in the IHDSS, 2003-2007

Factors	Univariate Analysis		Multivariate Analysis	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Sex				
Female	Reference			
Male	1.03 (0.86, 1.23)	0.739	-	-
Age				
15-29	Reference		Reference	
30-44	2.40 (1.92, 2.99)	**<0.001**	2.56 (2.05, 3.19)	**<0.001**
45-59	2.99 (2.33, 3.82)	**<0.001**	3.19 (2.49, 4.10)	**<0.001**
SES				
Poorest	Reference		Reference	
Poorer	0.72 (0.53, 0.92)	**0.012**	0.73 (0.55, 0.97)	**0.030**
Poor	0.68 (0.51, 0.92)	**0.011**	0.71 (0.53, 0.94)	**0.023**
Less poor	0.82 (0.62, 1.07)	0.144	0.85 (0.65, 1.11)	0.242
Least poor	0.90 (0.69, 1.18)	0.437	0.93 (0.71, 1.22)	0.617
Level of Education				
No Education	Reference		Reference	
Primary Education	0.48 (0.39, 0.59)	**<0.001**	0.39 (0.21, 1.20)	0.098
Beyond Primary	0.35 (0.21, 0.59)	**<0.001**	0.30 (0.18, 1.07)	0.071
Employment status (head of household)				
Employed	Reference		Reference	
Unemployed	2.09 (1.55, 2.83)	**<0.001**	1.30 (0.86, 1.98)	0.069
Household size	1.30 (1.29, 1.31)	**<0.001**	1.02 (0.97, 1.39)	0.341
Entry Type				
Enumeration	Reference		Reference	
In-migration	1.41 (1.14, 1.75)	**0.001**	1.70 (1.37, 2.11)	**<0.001**

Results from the multivariate hazard model showed age, socioeconomic status and entry type were significantly associated with communicable causes of adult deaths in the IHDSS from 2003 to 2007. The hazards of dying from communicable cause were statistically significant for all the age groups with a significant increased trend as one move from lower age group to a higher age group having adjusted for SES, level of education, employment status of heads of household, household size and entry type.

The adults aged 30-44years were 2.6 times more likely to die from communicable cause than young adults aged 15-29 years (aHR=2.56, p<0.001, 95%CI: 2.05, 3.19). This had increased significantly, with those aged 45-59 years having 3.2 times higher risk for communicable cause of deaths than the young adults aged 15-29 years (aHR=3.19,

p<0.001, 95%CI: 2.49, 4.10). The adult in-migrants were 1.7 times more likely to die from communicable causes than those who were enumerated at the baseline (aHR=1.70. p<0.001, 95%CI: 1.37, 2.11). SES in the multivariate model was significant in only two SES groups and not significant in the rest of the SES groups having adjusted for age, level of education, employment status of heads of household, household size and entry type. The adjusted hazard ratios across the SES quintiles from the lowest to the highest fluctuated and were not in any particular trend. In the poorer category, adults were 0.27 times less likely to die from a communicable cause compared to the poorest. This reduction was statistically significant (aHR=0.73, p=0.030, 95% CI: 0.55, 0.97). Among the poor group, adults were 0.29 times less likely to die from a communicable cause compared to the poorest group. This reduction was also statistically significant (aHR=0.71, p=0.023, 95% CI: 0.53, 0.94).

The overall model was assessed and it showed that the proportional hazard assumption was not violated (p-value of 0.1808). A pairwise correlation and a Bonferroni test indicated significantly a positive correlation between Household size and SES (r=0.14, p=0.03), a negative correlation between Employment status of the head of household and age of an adult (r= -0.10, p=0.04) and also a negative correlation between household size and Employment status of the head of household (r= -0.22, p=0.01). This could have explained the differences and behavior of factors like level of education, Employment status of the head of household and household size in the multivariate model.

3.4.2 Risk Factors of Non-communicable Cause of Deaths

Table 3.7 presents the univariate and multivariate analysis of socio demographic factors that were associated with non-communicable cause of adults' deaths. The study revealed that adult women were 1.3 times more likely to die from non-communicable cause than adult men. This was statistically significant (uaHR=1.34, p=0.030, 95%CI: 1.03, 1.76). Age was found to be associated statistically with non-communicable cause of death among adults. Risk of non-communicable cause of death increased with age.

Table 3.7: Univariate and Multivariate Analysis of Adult Non-communicable Cause Mortality in the IHIDSS, 2003-2007

Factors	Univariate analysis		Multivariate Analysis	
	HR (95% CI)	**p-value**	**HR (95% CI)**	**p-value**
Sex				
Male	Reference		Reference	
Female	1.34 (1.03, 1.76)	**0.030**	1.21 (0.92, 1.59)	0.173
Age (in years)				
15-29	Reference		Reference	
30-44	1.59 (1.14, 2.23)	**0.007**	1.98 (1.44, 2.71)	<**0.001**
45-59	2.78 (1.91, 4.03)	**<0.001**	2.69 (1.90, 3.80)	**<0.001**
SES				
Poorest	Reference			
Poorer	0.76 (0.50, 1.14)	0.187		
Poor	0.91 (0.61, 1.36)	0.645		
Less poor	0.93 (0.63, 1.37)	0.709		
Least poor	0.79 (0.52, 1.19)	0.258		
Level of Education				
No Education	Reference		Reference	
Primary Education	0.55 (0.41, 0.75)	**<0.001**	0.67 (0.49, 0.92)	**0.014**
Beyond Primary	0.09 (0.23, 0.38)	**0.001**	0.11 (0.03, 0.44)	**0.002**
Employment status (head of household)				
Employed	Reference	0.106		
Unemployed	1.50 (0.92, 2.47)			
Household size	1.03 (0.97, 1.12)	0.299		
Entry Type				
Enumeration	Reference			
In-migration	1.15 (0.83, 1.59)	0.406		

Adults aged 30-44 years were nearly two times more likely from non-communicable cause than those aged 15-29 years (uaHR=1.97, p<0.001, 95%CI: 1.44, 2.69). The 45-

59 years old adults were 2.8 times more likely to die from non-communicable cause than those who were 15-29 years old (uaHR=2.85, p<0.001, 95%CI: 2.03, 4.00). Education was also found to be statistically associated with non-communicable cause of adult death. A change in educational level from no education to a primary level of education reduced the hazards of dying from a non-communicable cause by 45% whereas it reduced by 91% for those who had beyond primary level of education.

In the multivariate analysis, age and level of education were found to be statistically significantly associated with non-communicable cause of deaths in the IHDSS among adults 15-59 years old. By age group, hazards of death from non-communicable causes were 2 times more among those within age of 30-44 years compared to those aged 15-29 years (aHR=1.98, *p*<0.001, 95%CI: 1.44, 2.71) having adjusted for sex and level of education. As the age group increased to age group 45-59 years, persons within this age group category were 2.7 times more likely to die from non-communicable cause than person aged 15-29 years (aHR=2.69, *p*<0.000, 95%CI: 1.90, 3.80) having adjusted for level of education and sex. This showed an increase in the hazard for non-communicable death of over 160% for adults who were in the age grouping 45-59 years. The hazard from a non-communicable cause of death decreased by 33% for adult persons with primary level of education compared to those who had never attended school having adjusted for age and sex. This was found to be statistically significant (aHR=0.67, p=0.014, 95%CI: 0.49, 0.92). Also it reduced significantly by about 89% for adults who had beyond primary level of education compared to those who never attended school (aHR=0.11, *p*<0.001, 95%CI: 0.03, 0.44) after adjusting for age and sex.

The global test for the factors associated with non-communicable causes of death model for adults 15-59 years within the IHDSS proved that the proportional hazards model assumption was not violated (p=0.1238) hence the model is fit.

3.4.3 Risk Factors of Accident/Injury Cause of Deaths

Table 3.8 presents the univariate and multivariate analysis of socio demographic factors that were associated with adult deaths from accident/injury cause.

Table 3.8: Univariate and Multivariate Analysis of Adult Accident/Injury Cause Mortality in the IHIDSS, 2003-2007

Factors	Univariate Analysis		Multivariate Analysis	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Sex				
Female	Reference			
Male	2.61 (1.69, 4.02)	**<0.001**	2.29 (1.47, 3.55)	**<0.001**
Age (in years)				
15-29	Reference			
30-44	1.21 (0.79, 1.87)	0.377		
45-59	0.92 (0.51, 1.68)	0.801		
SES				
Poorest	Reference		Reference	
Poorer	0.68 (0.39, 1.20)	0.188	0.55 (0.31, 0.98)	**0.042**
Poor	0.61 (0.33, 1.12)	0.110	0.48 (0.26, 0.89)	**0.019**
Less poor	0.52 (0.28, 0.97)	**0.040**	0.45 (0.24, 0.85)	**0.013**
Least poor	0.63 (0.35, 1.15)	0.131	0.12 (0.05, 0.29)	**<0.001**
Level of Education				
No Education	Reference		Reference	
Primary Education	0.55 (0.34, 0.87)	**0.011**	0.64 (0.39, 1.05)	0.078
Beyond Primary	0.43 (0.15, 1.25)	0.121	0.63 (0.21, 1.87)	0.406
Employment status (Head of household)				
Employed	Reference			
Unemployed	1.19 (0.52, 2.73)	0.678		
Household size	1.31 (1.29, 1.33)	**<0.001**	1.36 (1.32, 1.40)	**<0.001**
Entry Type				
Enumeration	Reference			
In-migration	1.33 (0.83, 2.12)	0.234		

An independent investigation of the socio demographic factors and death due to accident/injury revealed that age, SES, level of education and size of the household were the factors associated with death due to accident/injury. From this analysis, male adults had 2.6 times more hazards of accident/injury cause of deaths than females (uaHR=2.61 95%CI: 1.69, 4.02 $p<0.001$).

Risk of dying from accident/injury cause among adults decreased across the SES groups but was significant in only one group. Adults in the poorer SES category were 32% less likely to die from accident/injury compared to adults in the poorest SES category (uaHR=0.68, p=0.188, 95% CI: 0.39, 1.20). The poor SES category was 39% less likely to die from an accident/injury cause compared to the poorest SES category (uaHR=0.61, p=0.110, 95%CI: 0.33, 1.12). Adults in the less poor SES category were significantly 48% less likely to die from an accident/injury cause compared to adults in the poorer SES group (uaHR=0.52, p=0.040, 95% CI: 0.28, 0.97). And adults in the least poor category were 37% less likely to die from an accident/injury cause compared to adults in the poorest SES group (uaHR=0.63, p=0.131, 95% CI: 0.35, 1.15). Education was also found to be associated with adult death due to accident/injury. There was a reduction in risk from one category of educational level to the other. The higher an adult person acquired education in life the less likely the person would die from accident/injuries. It was revealed that an adult person who had only primary level of education had a 45% reduction in hazards of death from accident/injury cause compared to those who had never attended school (uaHR=0.55, p=0.011, 95%CI: 0.34, 0.87). The study further found that an increase in the household size by one person led to a significant increase in the hazard for accident/injuries cause of deaths by 30% (uaHR=1.31, p<0.001, 95%CI: 1.29, 1.33). –

In the multivariate Cox proportional hazard model, sex, SES and household size were the only factors found to be associated with accident/injury cause of adult death. The model showed that males were 2.3 times more likely to die from accident/injury than females. This difference was found to be statistically significant with p-value<0.001 (aHR=2.29, 95%CI: 1.47, 3.55) after adjusting for SES, level of education and household size. There were significant reductions across all the SES groups having adjusted for sex, level of education and household size. In the model, the hazard of accident/injury cause of adult death was 45% less among the poorer SES group (aHR=0.55, p=0.042, 95%CI: 0.31, 0.98), 52% less among the poor SES group (aHR=0.48, p=0.019, 95%CI: 0.26, 0.89), 55% less among the less poor SES group (aHR=0.45, p=0.013, 95%CI: 0.24, 0.85) and 88% less among the least poor SES group (aHR=0.12, p< 0.001, 95%CI: 0.05, 0.29) compared with the poorest SES groups respectively after adjusting for sex, level of education and household size.

It also revealed that an increase in the household size by one person lead to a significant increase in the hazard for accident/injury cause of adult death by 1.4 (aHR=1.36, p<0.001, 95%CI: 1.32, 1.40) having adjusted for SES, level of education and sex.

The proportional hazard rule was investigated and the models showed not to have violated the assumption rule with the global test of p=0.8441.

CHAPTER FOUR: DISCUSSION AND CONCLUSSION

The focus of this study was to use a longitudinal data to estimate adult mortality and identify risk factors and causes of adult mortality over a five year period of follow-up. The study identified risk factors that were associated with adult cause specific deaths. The results showed some trends and some socio demographic factors associated with the broad classifications of adult causes of deaths. Levels of adult mortality varied across different categories of the socio demographic factors investigated. This chapter therefore presents a comprehensive discussion and conclusion on the findings of this study.

4.1 Causes of Adults Deaths

Of the 65,548 adults that were followed over the 5 year period, 1,352 deaths were reported out of which 1,132 were assigned cause of death through verbal autopsy.

The HIV/AIDS menace has gained and continues to gain root particularly in the Sub Saharan Africa (SSA). The results from this study confirms that among adults, HIV/AIDS related deaths have taken over from malaria which used to be the leading cause of death among residents in the rural area of Tanzania(60-62). According to the VA in our study, 20% of the 1132 deaths were attributed to HIV/AIDS related causes. In a study conducted in the same area, HIV/AIDS contributed most to the causes of adult deaths in the area (63) and it has also been shown in other studies that it contributed significant percentage of deaths among adults in different rural areas of Tanzania (4;64). In a different African country among similar adult population, 17% of deaths were HIV/AIDS related (65) which is comparable to what was found in our study. The results from this study confirm the importance of HIV/AIDS as leading

cause of death among adults in high HIV prevalence areas of SSA (10;44;66) and comparable to what was found in studies by Adjuik et al (2006) and Eijk et al (2008) (19;43). The study found that HIV/AIDS related deaths were most frequent among both sexes and across all age groups with the exception of male adults aged 15 to 29 years. Among the male adults aged 15-29, HIV/AIDS was the third most common cause (12%) with unintentional injuries and malaria as first and second most frequent cause respectively. The alarming HIV/AIDS deaths in a rural area could partly be explained by the fact that many adults of the study area returned from urban centers with higher HIV prevalence rates (67), where they went to work (11;68). The results also confirm that malaria as a cause of death in the rural endemic areas of SAA is still a public health problem as recognized before (40;42;51;65;69-73). Malaria was found to be number two cause of death among both males and females. It accounted for 15% among males that died and 11% among females. Overall, 13% of the deaths were attributed to malaria cause. The change in malaria related deaths frequency from first to second leading causes of deaths among adults could possibly be explained by the changes in the malaria treatment policies. Tanzania changed its malaria treatment policy from Chloroqiune (CQ) to Sulphadoxine-Pyrimethamine (SP) as a first line drug in 2001 and further changed to an efficacious and effective fixed-combination (Artemisinin Combination Therapy - ACT) anti-malarial therapy in 2006. Other studies conducted in similar settings found malaria as the second (43) and the third most frequent cause of death among adults (65). Although our study showed high percentage of death due to malaria causes contrary to other studies, on the whole our findings are similar to what Adjuik et al found in the analysis of HDSS datasets from several countries in Africa (19). But this differences could come due to difficulties in malaria diagnosis because of the non-specificity of the symptoms (53). Overestimation of malaria deaths as a result

of misclassification might also be due to the tendency of VA physicians working in areas of high malaria transmission to assign most fevers to malaria (65) as Reyburn et al found an over-diagnosis of malaria in patients with severe febrile illness in Tanzania (73).

Both malaria and HIV/AIDS are a problem in most SSA including Tanzania where this study was done. To address these two problems, the Government of Tanzania, through the Ministry of Health and Social Welfare, initiated a number of interventions that are currently being implemented. The aim is to reduce the prevalence of both malaria and HIV/AIDS in the country.

Besides HIV/AIDS and malaria, Cerebrovascular disease was reported as one of the significantly common cause of death among men, whereas pneumonia was common among women. Unintentional injuries and acute abdominal condition were also significantly common. The values obtained are consistent with the global estimates and support the views that these diseases are among the neglected but contribute significantly to the burden of diseases (10;44) and needed attention.

According to the study, communicable disease accounted for the majority (40%) of the deaths among the adults. Eijk et al (2008) found in a longitudinal study that communicable disease form three-quarters (74%) of deaths among adolescents (12 years and above) and adults (43). This difference compared to our study could be accounted for by the differing target groups of the studies and or from the proportion that were assigned undetermined. Epidemiological studies saw higher deaths due to communicable diseases among younger people. But what is worth noting from these two studies is that besides the observed increase in non-communicable diseases, communicable diseases are still a leading cause of death in SSA. The Adult Morbidity

and Mortality Project in Tanzania also found communicable diseases accounting for the most of the deaths in areas of Tanzania (18). About half (50%) of the communicable cause of deaths were attributed to HIV/AIDS related causes followed by malaria (32%) and then pneumonia (6%). More than half (57%) of these communicable diseases causes of deaths occurred among adults 30-44 years. Tollman et al concluded from their study in rural South Africa that deaths from chronic communicable diseases are on the increase (38). In this study, non-communicable diseases accounted for 20% of which acute abdominal conditions were most common (22%). Accident and Injury cause also contributed 9% to the adult deaths of which most people died from Unintentional injuries (61%). Between 1999 and 2003, data from another HDSS in Mwanza, Tanzania indicated that communicable cause of death was leading followed by non communicable and then accident and injury (63). The pattern had essentially remained the same.

4.2 Levels and Trends in Adult Mortality

The adult mortality rates and patterns identified in our study are largely consistent with the general pattern identified in most studies conducted in SSA. For example, Kitange et al reported a crude all-cause adult mortality rate of 6.1 per 1000 a year for females in Hai and 15.9 per 1000 a year for males in Morogoro rural area of Tanzania (30), Sankoh et al reported a crude AMR of 7.3 per 1000 adults; an average of 6.9 per 1000 for men and 7.5 per 1000 for women from 39 villages around Nouna town in Burkina Faso (11). In this study, we found the overall AMR to be 7.3/1000 PYO with a steady increase trend in annual AMR over the 5 year period. The trend was not statistically significant ($p>0.05$). The annual AMRs fluctuate over the years from 7.3 per 1000 person years in 2003 to 8.1 per 1000 person years in 2007. The rates showed a trend with age

($p<0.001$), mortality increased with age where the oldest age group had highest mortality rates. This is actually to be expected since vulnerability to diseases increases with advance age. We reported an overall AMR of 7.4 for males and 7.2 for females. Although this overall rate by sex showed that males die at slightly higher rate of 3% more than females, females on the other hand were found to have died more than males within the age group 15 to 44. But as age advanced to 45 to 59 men were found to die more than women. This is consistent, considering that women within child bearing age (15 to 49) usually experience higher risks of death compared to their male counterparts due to maternal causes. The revelation that there was a statistically significant decreasing trend in adult mortality rate across the level of education ($p<0.001$) has been shown in other studies (74;75). The highest mortality rate was found among those who had never attended school (AMR= 12.4 per 1000 PYO), followed by those who had had only primary education (AMR= 6.6 per 1000 PYO) and then those who had beyond primary level of education (AMR= 3.5 per 1000 PYO). This is consistent with many studies. The higher one acquires education, the more such person become abreast with health issues and improved health seeking behavior.

The poorest to the least poor ratio of 1.12 revealed that adult mortality in the poorest quintile was 12% higher than for those in the least poor category although the difference was not statistically significant ($p=0.533$). This presupposes that the rates recorded for SES therefore showed that AMR does not change significantly over level of SES. However, adult mortality rate by employment status of the head of household indicated that, an adult whose head of household was not employed (AMR=10.7 per 1000PYO) was 1.5 times more likely to die than an adult whose head of household was employed (AMR=7.1 per 1000PYO). The decrease in AMR by head of household employment status was found to be statistically significant ($p=0.001$). With this finding, it would

have been interesting to look at the employment status of the individuals in our cohort because according to Lulu et al who investigated socio-demographic differentials of adult death in a rural population, not having gainful employment is one of the important factors found to influence adult death with a significant odds ratio of 1.4 (76). But such data for the period studied was not available.

The findings showed that specific causes (communicable, non communicable and accident/injury) of deaths over the observation period seem to have increased. The decrease of 52% seen in the proportion of deaths assigned Undetermined from year 2003 to 2007 could have been as a result of improved and more efficient VA tools.

4.3 Communicable Disease Deaths and Predictors

Higher proportion of the broad cause of deaths was due to communicable diseases and most of them were specifically HIV/AIDS related causes followed by malaria. Mortality due to communicable causes increased in year 2007 by 32.9% over year 2003 with an overall rate of 2.49 per 1000 person years. A study in rural Kenya based on VA data found that, communicable deaths contributed highest proportion of which 75% were due to HIV/AIDS related diseases being the most common causes of deaths among adults (43), this consistent with our findings.

Fantahun et al who conducted a study on young adults and middle age mortality in Butajira demographic surveillance site, Ethiopia found that the association between communicable cause of death and sex did not differ significantly (77). They also found significantly higher rate ratio of 2.05, (RR= 2.05, 95% CI: 1.73, 2.44) in the rural area for communicable disease deaths compared to urban area after adjusting for gender, age and period. In our study, we also found that the association between communicable cause of death and sex did not differ significantly. Our study occurred in a purely rural

area and we found age, SES and entry type to be significantly associated with adult communicable causes of deaths. An in-migrant was 70% (aHR=1.7, 95%CI: 1.37, 2.11) times more likely to die from a communicable cause than a resident having adjusted for age and sex. Consistent to these findings, Walaga et al who conducted a study to assess association between migration and mortality in rural South Africa found that in-migrants were 28% more likely to die than residents (aHR= 1.28, 95%CI: 1.16, 1.41) (39). Terminally ill people preferred to travel to their hometown to die. More so with the HIV/AIDS as a leading cause of death in the area, people who become terminally ill would prefer going back to their rural communities for family care and eventually dying at home (37;39). Walaga et al found that the odds of dying from AIDS was nea1ly twice for in-migrants compared to residents and concluded that in-migrants have a higher risk of dying, especially from HIV related causes, than residents.

4.4 Non-Communicable Disease Deaths and Predictors

The proportion of deaths due to non communicable disease is projected to rise from 59% in 2002 to 69% in 2030 (78;79). According to a WHO report, despite non communicable disease having being the leading cause of death in the world, the situation is pretty different in Africa (80). Nevertheless, NCD should be of much concern now to policy makers of health in Africa as it is becoming increasingly high. Duthe and Pison found non-communicable causes of deaths to be predominant among adults in Mlomp in the rural area of Senegal (12). Although this study did not find non-communicable diseases to be predominant causes of death in the study population, the observed increase rate (1.21 per 1000 person years) of such causes for the period (2003 to 2007) is suggestive that in near future the burden will be significant.

Of the non communicable cause of deaths reported in the IHDSS, the prevalence of Acute Abdominal Conditions, blood pressure and epilepsy that accounted for significant causes of deaths are of concern. Van Eijk et al found in their study which was to establish causes and patterns of deaths among adolescents and adults in a rural area of western Kenya where malaria and HIV are common, that high blood pressure was also of concern as cardiovascular disease was the most common cause of death among the non communicable diseases (43). Like van Eijk et al, on the other hand the burden of non communicable diseases in this rural area of Tanzania is of a small amount compared with the communicable causes.

Most studies including global burden of diseases study found lifestyle as the main risk factors for adult deaths (15;81-83). This study could not investigate lifestyle factors and NCD but socio economic and demographic factors of the adults. As expected, this study showed that NCD deaths increased by age among the adults. Older adults were found to have a higher hazard for NCD death than younger adults. An adult who was between the age 30 to 44 was 2 times more likely to die from a NCD than the one between 15 to 29 years (aHR=1.98, 95%CI: 1.44, 2.71). Also there was 169% chance for an adult aged 45 to 59 years to die from a NCD cause than a young adult 15 to 29 years. Some studies also found that NCD deaths increased with age (81;82). Also Kengne et al in their study in urban Cameroon found that NCD notably Blood pressure and hypertension increased among adult as age increased (84). We also found cerebrovascular disease which is linked with blood pressure and hypertension as a significant cause of adult death among the cohort. Studies have proven aging population to experience more NCD morbidity and mortality and developing countries are currently experiencing aging population (85-87); such is also the case of our study population.

In our study, having primary education reduced the hazards for a NCD significantly by 37% after adjusting for age and sex. A further improvement in education to beyond primary level was associated with 90% reduction of the hazard for NCD death (aHR=0.10, p<0.000, 95%CI: 0.02, 0.40) having adjusted for age and sex. Our findings are consistent with a study conducted by Huong et al to analyze the associations between cause-specific mortality in adults aged 20 years and above and socio-economic status in a rural setting of Vietnam during a time of economic transition which found that education was an important factor for survival among adults from NCD deaths (88). Huong et al further concluded that policies to decrease exposure to risk factors for non communicable diseases are needed among people with low education. These in effect generally mean that an improvement in education can potentially protect an adult from dying from an NCD since most of the NCDs are associated with lifestyle.

4.5 Accident/Injury Deaths and Predictors

Globally, accident/Injury deaths are on the increase (89) and it was confirmed from our findings with a 9% increased in AMR due to accident/Injury from the years 2003 to 2007 at a rate of 0.53 per 1000 person years.

Our study established that social economic status was associated significantly at all levels with death from accident or injury. This finding concur with a study by Seedat et al who examined violence and injuries in South Africa where they found, among other factors poverty to be a strong determinant of accident/injury cause of death among adults (90). An improvement in the SES reduced accident/injury deaths among adults after adjusting for sex and household size.

In this study, males were 2.3 times more likely to die from accident/injury than females. This difference was found to be statistically significant (aHR=2.29, p<0.001, 95%CI: 1.47, 3.55) after adjusting for SES, level of education and household size. Other studies have reported similar results – a male to female ratio of 2.1:1 for adult deaths from accident/injury was reported by Nzegwu et al in a study to evaluate patterns of morbidity and mortality among drivers and passengers of cars involved in road traffic accidents in rural Nigeria (91). Also, a male to female ratio of 2.5:1 was found for trauma deaths in a study conducted by Solagberu et al (92). We also found from this study that an additional member in the household led to a significant increase in the hazard for accident/injury cause of adult death by 36% (aHR=1.36, p<0.001, 95%CI: 1.32, 1.40) having adjusted for SES, level of education and sex.

4.6 Implications of Findings

The global burden of disease is said to be shifting from communicable diseases to non communicable diseases. Non communicable diseases are now world's biggest killers.

> *"We tend to associate developing countries with communicable diseases, such as HIV/AIDS, tuberculosis and malaria. But in more and more countries the chief causes of death are non communicable diseases, such as heart disease and stroke. We are definitely seeing a trend towards fewer people dying of communicable diseases across the world,"*
>
> *Dr Ties Boerma*
> *(Director, WHO Department of Health Statistics and Informatics)*

Unlike developed countries, African countries have a triple burden; the highest mortality in the world from communicable diseases, increasing non communicable diseases and considerable number of accident/injuries deaths (80).

The findings of this study clearly indicate that the rural areas in African countries are in the process of facing the triple burden. Of the communicable diseases reported, HIV/AIDS related and malaria is of great concern. There are many ongoing interventions by the Government of Tanzania to combat HIV/AIDs and malaria. The development of the National Guideline on Prevention and Control of HIV/AIDS in the public sector is an achievement of the Government that shows its commitment to fight the epidemic and to improve the well-being of the people (55).

For example, currently, male circumcision which was found from epidemiological evidence and biological plausibility as an effective intervention for HIV prevention (93-95) was found in a situational analysis to be accepted by traditionally non-circumcising communities in Tanzania (96). The situational analysis study was to investigate the context, extent and pattern of male circumcision practices in selected areas of Tanzania and to provide recommendations to the government of Tanzania on the effective roll-out of male circumcision services in the country as prevention and control measure.

Our study showed that many deaths occurred outside health facilities which imply that health seeking behavior among adults in the rural area is poor.

In recent times, cost-effective interventions have been put in place for governments to consider for reducing the national burden of non-communicable diseases (97). All the same, the problem of non communicable diseases in rural area is of a small scale compared with communicable causes of deaths among adults.

A problem compounding the measurement of mortality in longitudinal studies is the mobility of sick persons before death. This problem is likely to become larger because AIDS is a chronic illness and gives many sick persons sufficient time to choose a place of dying (18). In a study in Morogoro district, Tanzania, the homecoming sick constituted 11% of all deaths, and in Hai district this proportion almost doubled, 19% (30)

It is clear that in this rural area, immediate gain in delaying mortality would be achieved from effective interventions towards preventing and providing treatment for HIV infected persons. Also scaling up educational campaigns among low-educated adults in the rural area, regarding good health seeking behavior and in the area of minimizing risks of accidents and injuries is essential.

4.7 Limitations of Study

This study has some limitations. Firstly, a drawback in this study is the high proportion of undetermined causes in our data. This is due to missing information or insufficient data to assign a specific cause of death in the VA procedure. Most studies conducted in similar manner faced similar problem (43;98). It was difficult to assume and assign specific causes to the undetermined.

Secondly, the verbal autopsy method for ascertaining causes of deaths relies on data gathered from a standardized interview with a relative or caretaker of the deceased and it is well known to have some limitations. The main among the rest is recall bias. Although this could be minimized if the VA interview followed closely after the event and the right respondent was met but such timing may not be culturally approved. In the IHDSS, a minimum delay of forty days was agreed with the community for VA to be

conducted. Within the forty days is considered as the mourning period and it is unacceptable to discuss such issues. Another limitation of the VA is the method itself (98). Over-diagnosis and misclassification of some causes could also result in the tendency of some physicians working in areas where specific causes are known to be on the increase to attribute most causes to such specific cause. In Tanzania for instance, it has been shown in hospital records that people with severe febrile illness were mostly diagnosed with malaria (73). Chandramohan et al (1994) showed that questionnaire design, choice of interviewers and procedure for coding may also affect the outcome of the VA (31).

Thirdly, although lifestyle variables have been found to be associated with causes of deaths among adults in other studies (77;83), we could not explore these variables in our study. One problem with the HDSS is lack of data on lifestyle for all members. Lifestyle data are collected for people who died and nested studies. This study was restricted and made use of the available variables in the dataset and therefore could not explore other important variables.

Finally, the study was carried out on the assumption that the independent variables were time invariant and thus they were not treated as time varying covariates; the covariates used were those measured at the recruitment into the study.

4.8 Strengths of the Study

The study was a prospective cohort and longitudinal over a follow-up period of 5 years from 2003 to 2007. This long period of follow-up and time to event analysis makes the measurements in the study quite reliable and precise.

The use of PCA to classified individuals into SES gives the study an advantage over the use of income and consumption expenditure. Most of the errors associated with measuring income and expenditure were to a large extent minimized if not eliminated.

More importantly the study showed that the needed data and knowledge on adult cause specific mortality in African region are obtainable through Health and Demographic Surveillance Systems.

4.7 Conclusion

The causes of deaths in the rural area of southern Tanzania were largely due to potentially preventable communicable diseases. HIV/AIDS related and malaria causes are the leading causes of adult deaths in IHDSS area. Adult mortality in the rural area with HIV/AIDs prevalence of 4.7 according to the Tanzania HIV/AIDS and Malaria Indicator Survey 2007-08 (55), is quite high.

At present the risk of dying from non communicable diseases during adulthood (15-59 years) are still relatively minor, but it is increasing as a result of demographic and epidemiological transitions. Although it is said that AIDS epidemic may put forth further delay on the onset of the epidemiological transition in most part of African countries (4), there is the likelihood of further increase in HIV/AIDS deaths likewise non communicable disease deaths.

Most adults dying outside health facility suggest low health care seeking from the formal system among the adults in the rural area.

Without preventions, the rural community in Tanzania will soon face increased triple disease burden since accident/injury causes of adult deaths are also in the increase. This

suggests that the future, in effect, has already arrived and that we should not wait until we have conquered communicable cause before taking action against non communicable diseases (18) and accident/injury causes. A further study into lifestyle activities among these adults is necessary to delaying adult age at death in Africa.

Health ethicists argued that good education and health lead to true development in an underprivileged society. Based on the study findings, we put forward that improving educational status which is a major social determinant of health, can lead to appropriate health related behaviours and prevent early deaths among the economically active population from preventable diseases in developing countries.

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area of West Africa. American Journal of Tropical Medicine and Hygiene 2008;78(1):106-13.

APPENDICES

Appendix 1: Permission Letter from IHI to use IHDSS data

IFAKARA HEALTH INSTITUTE
research | training | services

Solomon Ayertey Narh-Bana
University of Witwatersrand, SA
School of Public Health
Johannesburg

20th January 2010

Re: PERMISSION TO USE PART OF THE IFAKARA HDSS DATA

The above heading refers

Ifakara Health and Demographic Surveillance System data is owned by Ifakara Health Institute. Data sharing policies are in place Sharing of data is solely guided by specific policies.

Your application to use dataset for your study entitled "**Risk factors and causes of adult deaths in the Ifakara HDSS population, 2003-2007"** has been accepted. You will work with the IHDSS data manager to extract the dataset that is needed to address your study objectives.

The following conditions apply:

1. You will use the dataset only for the purpose of your Msc report
2. The analysis will specifically address your objectives and not beyond that
3. You will have to report your findings to Ifakara Health Institute
4. Any publications from the dataset will be co-authored with your IHI supervisor

Sincerely

Dr Rose Nathan on behalf of the IHI director

Appendix 2: Human Research Ethics Clearance Certificate from Wits

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mr Solomon A Nath-Bara

CLEARANCE CERTIFICATE	**M090949**
PROJECT	Risk Factors and Causes of Adult Deaths in the Ifakara Health and Demographic Surveillance Site Population, 2003-2007
INVESTIGATORS	Mr Solomon A Nath-Bara.
DEPARTMENT	School of Public Health
DATE CONSIDERED	2009/10/02
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 2009/10/02 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr T F Chirwa

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix 3: Faculty Approval – School of Public Health

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2745

Reference: Ms Tania Van Leeve
E-mail: tania.vanleeve@wits.ac.za
03 November 2009
Person No: 0517614N
PAG

Mr SA Narh-Bana
Darigme West District Health Administration
Ghana Health Service
PO Box DD1
Dodowa, GT. Accra Region
0000
Ghana

Dear Mr Narh-Bana

Master of Science in Medicine (Population-Based Field Epidemiology): Approval of Title

We have pleasure in advising that your proposal entitled "*Risk factors and causes of adult deaths in the Ifakara HDSS population, 2003 - 2007*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 4: Detailed Tables

Appendix 4a: Top five narrow specific-causes of deaths: Overall and also presented for males and females in IHDSS, 2003 – 2007

Rank	Overall		Sex			
			Male		Female	
	Cause	n (%)	Cause	n (%)	Cause	n %
1	HIV/AIDs Related	231 (20.4)	HIV/AIDs Related	107 (19.6)	HIV/AIDs Related	124 (21.2)
2	Malaria	149 (13.2)	Malaria	82 (15.0)	Malaria	65 (11.1)
3	*OSU Injuries	60 (5.3)	*OSU Injuries	43 (7.9)	**AA cond.	21 (3.6)
4	**AA cond.	49 (4.3)	**AA cond.	28 (5.1)	Pneumonia	18 (3.1)
5	Pneumonia	28 (2.5)	†Cerebro.	14 (2.6)	*OSU Injuries	17 (2.9)
	Others	264 (23.3)	Others	108 (19.7)	Others	154 (26.3)
	Undetermined	351 (31.0)	Undetermined	165 (30.2)	Undetermined	186 (31.8)
	Total	**1132 (100)**	**Total**	**547 (100)**	**Total**	**585 (100)**

Appendix 4b: Top Five Narrow Specific-Causes of Deaths by Age Group and Sex in IHDSS, 2003-2007

Rank	15 – 29 years				30 – 44 years				45 – 59 years			
	Male		Female		Male		Female		Male		Female	
	Cause	n (%)	Cause	n (%)	Cause	n (%)	Cause	n (%)	Cause	n (%)	Cause	n (%)
1	*OSU Injuries	25 (18.8)	HIV/AIDs Related	42 (19.1)	HIV/AIDs Related	61 (24.9)	HIV/AIDs Related	55 (24.7)	HIV/AIDs Related	30 (17.7)	HIV/AIDs Related	25 (18.2)
2	Malaria	20 (15.0)	Malaria	27 (12.0)	Malaria	36 (14.7)	Malaria	23 (10.3)	Malaria	26 (15.4)	Malaria	17 (12.4)
3	HIV/AIDs Related	16 (12.0)	*OSU Injuries	11 (4.9)	*OSU Injuries	14 (5.7)	Carcinoma Cervix/ uterus	6 (2.7)	**AA cond.	9 (5.3)	Carcinoma Cervix/ uterus	8 (5.8)
4	**AA cond.	7 (5.3)	**AA cond.	10 (4.4)	**AA cond.	12 (4.9)	Meningitis	6 (2.7)	†Cerebro.	8 (4.73)	Pneumonia	7 (5.1)
5	Epilepsy	6 (4.5)	Eclampsia	9 (4.0)	Homicidal Injuries	7 (2.9)	**AA cond.	6 (2.7)	Pneumonia/ *OSU inj.	4 (2.37)	**AA cond.	5 (3.6)
	Others	21 (15.8)	Others	55 (24.0)	Others	47 (19.2)	Others	58 (26.0)	Others	30 (17.7)	Others	30 (21.9)
	Undeter.	38 (28.6)	Undeter.	77 (31.6)	Undeter.	68 (27.8)	Undeter	70 (30.9)	Undeter	34 (34.3)	Undeter	45 (32.8)
	Total	**133 (100)**	**Total**	**225 (100)**	**Total**	**245 (100)**	**Total**	**223 (100)**	**Total**	**169 (100)**	**Total**	**137 (100)**

**Other specified unintentional injuries; **Acute Abdominal condition*

****All other specified communicable disease; †Cerebrovascular disease*

INDEPTH- NETWORK

Standard Verbal Autopsy Questionnaire

Adapted from the WHO standard verbal autopsy questionnaire for infants and children (*WHO/CDS/CSR/ISR/99.4)* and pre-existing site-specific questionnaires.

This work is part of INDEPTH-MTIMBA project activities

PART 3: ADOLESCENT AND ADULT DEATHS (persons of the age of 12 years and above)

I. IDENTIFICATION & DEMOGRAPHIC DATA OF THE DECEASED

1.1 Name of child:…….…… ID: | | PERMID

1.2 Village name:…….. ID: | | VILLGID

1.3 Compound/household number | | | | | | COMPID

1.4 Age of deceased: | | AOD

1.5 Sex of deceased: | 1. Male | 2. Female | SEX_D

1.6 Interviewer Code: | | FW

1.7 Date of Interview: (dd/mm/yy) | | | | | | | DINT

1.8 What was the marital status of the deceased?

1. Unmarried	3. Divorced/separated	4. Widowed	MSD

1.9 Number of years of formal education of the deceased.

	NK	EDUC

1.10 Highest level of education of deceased:

1. Primary	2. Secondary	3. Tertiary	4. No	HEDUC_D

1.11 Occupation of deceased:

1. Farmer	2. Trader	3.Gov't/Priv't comp. Employee	OCC_D
4. Other (specify): ……			

II. IDENTIFICATION OF RESPONDENT

2.1 Name of respondent: _____

2.2 Relationship of respondent to the deceased:

1. Spouse	2. Daughter	3. Son	4. Mother	5. Father	ROR
6. Other (specify): ……					

2.3 Number of years of formal education of the respondent: | | EDUC_R

2.4 Highest level of education of respondent:

1.Primary	2. Secondary	3. Tertiary	4. No	HEDUC_R

III. BACKGROUN INFORMATION ON THE DEATH

3.1 Date of death: (dd/mm/yy)							DOD

3.2 For how long (days) was s/he ill before s/he died?		999. NK ILLD

4.0 OPEN HISTORY QUESTION

4.1 Could you tell me about the r illness/events that led to her/his death?

Prompt: Was there anything else?

Instructions to interviewer - Allow the respondent to tell you about the illness in his or her own words. Do not prompt except for asking whether there was anything else after the respondent finishes. Keep prompting until the respondent says there was nothing else. While recording, underline any unfamiliar terms.

4.2 Summary of symptoms & signs reported by Respondent

Symptoms	Day since start of illness	Duration (Days)	Severity Mild/Moderate=1 Severe=2
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

4.3 list of hospitalizations (hospital admission) in the past 2 years (begin with more hospitalisations in descending ordert)

Name of Health facility	Date (Month/year)	Reasons for hospitalization
1.	/ /	
2.	/ /	
3.	/ /	
4.	/ /	
5.	/ /	

4.4 Place of death:

1. Home	2. Hospital/clinic	3. Other (specify) ……	POD

(If the answer is 1 or 3 proceed to Q5)

4.5 Name of the hospital/health facility where s/he died: _____

4.6 Did anyone from the hospital tell you the cause of death?

1. Yes	2. No	9. NK	8. NA	RIF

If not yes skip to 4.9

4.7 Who told you?

1. Nurse	2. Doctor	8. NA	SOURC
3. Other (specify) ……			

4.8 What did the person say was the cause of death?

……..

……..

If not told cause of death please at hospital, ask what the respondent thing caused the death

4.9 Do you know the cause(s) of his/her death?	1. Yes	2. No	9.NK	RKC

4.10 If the answer is YES probe to specify the cause(s):

Cause (1) _____

Cause (2) _____

4.11 (Ask whether s/he had any of the following illness)

Hypertension:	1. Yes	2. No	9. NK	HYP
Other heart diseases	1. Yes	2. No	9. NK	OHEA
Diabetes:	1. Yes	2. No	9. NK	DIAB
Epilepsy:	1. Yes	2. No	9. NK	EPI
TB:	1. Yes	2. No	9. NK	TB
HIV/AIDS:	1. Yes	2. No	9. NK	HIV
Asthma	1. Yes	2. No	9. NK	ASTH
Other diseases (specify)	1. Yes	2. No	9. NK	ODIS

V: LEADING QUESTIONS TO ELICIT SYMPTOMS & SIGNS OF THE FINAL ILLNESS

5.1 FEVER:

5.1.1 Did s/he have fever?	1. Yes	2. No	9. NK	FEV

(If the answer is 2 or 9 proceed to Q 5.2)

5.1.2 How many days s/he had fever?		888 NA	999.NK	DFE

5.1.3 Was the fever:	1.Mild/moderate	2. Severe	8. NA	9. NK	SFE

5.1.4 Was the fever:	1. Continuous	2. On & Off	8. NA	9. NK	TFE

5.1.5 Did s/he have chills/rigor	1. Yes	2.No	9. NK	RIG

5.2 RASH:

5.2.1 Did s/he have rash?	1. Yes	2. No	9. NK	RAS

(If the answer is 2 or 9 proceed to Q5.2.7)

5.2.2 Where was the rash located?	1. Face	2.All body	3.Other	9. NK	LCRAS

		888. NA	999. NK	DRA

5.2.3 How many days s/he had rash?				
5.2.4 Did the rash have blisters containing clear fluid?.	1. Yes	2. No	9. NK	BLIRAS
5.2.5 Did the skin crack/split or peel after the rash started?	1. Yes	2. No	9. NK	SKIRAS

5.2.6 What did the rash look like?

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

5.2.7 Did s/he have sore eyes?	1. Yes	2. No	9. NK	SEY
5.2.8 Did s/he have itching of skin?	1. Yes	2. No	9. NK	ITC

5.3 WEIGHT LOSS:

5.3.1 Had s/he lost weight recently before death?	1. Yes	2. No	9. NK	LOW

(If the answer is 2 or 9 proceed to Q5.4)

5.3.2 How long before death (in days)?		888.NA	999. NK	DLOW

5.3.3 Was the loss of weight:	1. Mild/Moderate	2. Severe	8. NA	9. NK	SLW

5.4 PALLOR/JAUNDICE

5.4.1 Did s/he look pale (anaemic)?	1. Yes	2. No	9. NK	PAL
5.4.2 Did s/he have yellow discoloration of the eyes?	1. Yes	2. No	9. NK	JAU

5.5 OEDEMA/SWELLING:

5.5.1 Had s/he have swelling around ankle?	1. Yes	2. No	9. NK	SAA

(If the answer is 2 or 9 proceed to Q5.5.3)

5.5.2 How many days s/he had the swelling:		888.NA	999.NK	DSA
5.5.3 Did s/he have puffiness of the face?	1. Yes	2. No	9. NK	PUF
5.5.4 Did s/he have swelling in the neck?	1. Yes	2. No	9. NK	SWN
5.5.5 Did s/he have swelling in the armpit?	1. Yes	2. No	9. NK	SWA
5.5.6 Did s/he have swelling in the groin?	1. Yes	2. No	9. NK	SWG
5.5.7 Did s/he have any other swelling or ulcers?	1. Yes	2. No	9. NK	ULC

(If the answer is YES probe for the site and duration)

5.6 COUGH:

5.6.1 Did s/he have cough? (If the answer is 2 or 9 proceed to Q5.6.5)	1. Yes	2. No	9. NK	COU
5.6.2 How many days s/he had cough:		888.NA	999. NK	DCO
5.6.3 Was the cough productive (sputum)?	1. Yes	2. No	8. NA	9. NK	PCO
5.6.4 Did s/he cough blood?	1. Yes	2. No	8. NA	9. NK	BCO
5.6.5 Did s/he have night sweats?	1. Yes	2. No	9. NK	NCOU
5.6.6 When was the cough worse?	1.Day	2.Night	3. Same	9. NK	COUW
5.6.7 Did s/he have shortness of breathing?	1. Yes	2. No	9. NK	DIB
(If the answer is 2 or 9 proceed to Q5.7)				
5.6.8 How many days s/he had breathlessness?		888.NA	999.NK	DDB
5.6.9 Did s/he have noisy breathing?	1. Yes	2. No	9. NK	CHP

5.7 CHEST PAIN:

5.7.1 Did s/he have chest pain?	1. Yes	2. No	9. NK	CHP
(If the answer is 2 or 9 proceed to Q 5.8)				
5.7.2 Where was the pain?	1. Over the sternum	2. Over the heart	8. NA	SCP
	3. Ribs	4.Other (specify) ……	9. NK	
5.7.3 Was the pain:	1. Continuous	2. On & Off	8. NA	9. NK	TCP
5.7.4 When s/he had an attack of severe pain, how long did it last?	1. <30min	2. >30min but <24hrs	3. 24 hours	8. NA	9. NK	DCP

5.8 DIARRHOEA:

5.8.1 Did s/he have diarrhoea?	1. Yes	2. No	9. NK	DIAR
(If the answer is 2 or 9 proceed to Q5.9)				
5.8.2 How many days s/he had diarrhoea?		888.NA	999.NK	DDI

5.8.3 Was the diarrhoea:

1. Continuous	2. On & Off	8. NA	9. NK	TDI

5.8.4 What was the consistence of stools?

1. Normal	2. soft	3.Watery	9. NK	CSDIA

5.8.5 When the diarrhoea was severe, how many times did s/he pass stool in a day?

	88.NA	99. NK	FDI

5.8.6 Did s/he pass blood in the stool?

1. Yes	2. No	8. NA	9. NK	BTS

5.8.7 Did s/he have sunken eyes?

1. Yes	2. No	9. NK	SUNK

5.9 VOMITING:

5.9.1 Did s/he have vomiting?

1. Yes	2. No	9. NK	VOM

(If the answer is 2 or 9 proceed to Q5.10)

5.9.2 How many days s/he had vomiting?

	88.NA	99. NK	DVO

5.9.3 Was the vomiting

1. Continuous	2. On & Off	8. NA	9. NK	TVO

5.9.4 When the vomiting was severe, how many times did s/he vomit in a day?

	88.NA	99.NK	FVO

5.9.5 What did the vomit look like?

1. Watery fluid	2. Yellowish fluid	3. Coffee coloured fluid	4. Blood	CVO
5. Faecal matters	6. Other	8. NA	9. NK	

5.10 ABDOMEN:

5.10.1 Did s/he have abdominal pain?

1. Yes	2. No	9. NK	ABP

(If the answer is 2 or 9 proceed to Q5.10.6)

5.10.2 How was the type of pain?

1. Cramp	2. Dull ache	3. Burning pain	4. Other	8. NA	9. NK	CAP

5.10.3 How many days s/he had the pain

	88.NA	99.NK	DAP

5.10.4 Where exactly was the pain?

1. Lower abdomen	2. Upper abdomen	3. All over the abdomen		SAP
4. Other (specify): ……		8. NA	9. NK	

5.10.5 What was the severity of the pain?

1. Mild/moderate	2. Severe	8. NA	9. NK	TAP

5.10.6 Was s/he unable to pass stool for some days before death?

1. Yes	2. No	CON

5.11 ABDOMINAL DISTENSION:

5.11.1 Did s/he have distension of abdomen?

1. Yes	2. No	9. NK	ABD

(If the answer is 2 or 9 proceed to Q5.12)

5.11.2 How many days s/he had abdominal distension?

	88.NA	99.NK	DAD

5.11.3 Did the distension develop rapidly within days or slowly over weeks?

1. Rapid	2. Slow	8. NA	9. NK	TAD

5.12 SWALLOWING:

5.12.1 Did s/he have difficulty in swallowing?

1. Yes	2. No	9. NK	DSW

(If the answer is 2 or 9 proceed to Q5.13)

5.12.2 How many days s/he had difficulty in swallowing?

	88. NA	99.NK	DDS

5.13 MASS:

5.13.1 Did s/he have any mass in the abdomen?

1. Yes	2. No	9. NK	ABM

(If the answer is 2 or 9 proceed to Q5.14)

5.13.2 Where exactly was the mass?

1. Rt upper abdomen	2. Lt upper abdomen	3. Lower abdomen		SAM
4. Other (specify) ……			8. NA	9. NK

5.13.3 How many days s/he had the mass?

	888.NA	999.NK	DAM

5.14 HEADACHE:

5.14.1 Did s/he have headache?

1. Yes	2. No	9. NK	HEA

5.15 STIFF NECK:

5.15.1 Did s/he have stiff neck?

1. Yes	2. No	9. NK	STN

(If the answer is 2 or 9 proceed to Q5.16)

5.15.2 If YES, for how many days?		888.NA	999.NK	DSN

5.16 LEVEL OF CONCIOUSNESS/CNS:

5.16.1 Did s/he experience any change in the level of consciousness? *(If the answer is 2 or 9 proceed to Q5.17)*	1. Yes	2. No	9. NK	LUC

5.16.2 What was the level of his/her consciousness?

1. Confused	2. Unconscious	3. Other	8. NA	9. NK	TUC

5.16.3 If confused or unconscious, for how many days?		888.NA	999.NK	DUC

5.16.4 How did it start?

1. Suddenly	2. Rapidly within a day	3. Slowly over few days		FFI1
4. Others:		8. NA	9. NK	

5.17 FITS:

5.17.1 Did s/he have fits? *(If the answer is 2 or 9 proceed to Q5.18)*	1. Yes	2. No	9. NK	FIT
5.17.2 How many days s/he had fits		888.NA	999.NK	DFI

5.17.3 When fits were most frequent, how many per day? (NA=88; NK=99)		FFI2

5.17.4 Between fits was s/he	1. Awake	2. Unconscious	8. NA	9. NK	BFA

5.17.5Did s/he have difficulty in opening the mouth?	1. Able to open	2. Unable to open	9. NK	LOC

5.17.6 Did s/he have stiffness of the whole body? *(If the answer is 2 or 9 proceed to Q5.18)*	1. Yes	2. No	9. NK	OPI
5.17.7 How many days s/he had stiffness?		888.NA	999.NK	DSTIF

5.18 PARALYSIS:

5.18.1 Did s/he have paralysis of one side of the body?	1. Yes	2. No	9. NK	HEM
(If the answer is 2 or 9 proceed to Q5.19)				
5.18.2 How many days s/he had the paralysis		888.NA	999.NK	DHE
5.19 Did s/he have paralysis of lower limbs?	1. Yes	2. No	9. NK	PAR
(If the answer is 2 or 9 proceed to Q5.20)				
5.19.1 How many days s/he had the paralysis?		888.NA	999.NK	DPA

5.20 URINE COLOUR:

5.20.1 Was there any change in the colour of urine?	1. Yes	2. No	9. NK	BIU
(If the answer is 2 or 9 proceed to Q5.21)				

5.20.2 What was the colour of urine?

1. Dark yellow	2. Coffee like	3. Blood stained	8. NA	9. NK	URC

5.20.3 How many days s/he had the change in colour?	888.NA	999.NK	DBU

5.21 URINE AMOUNT:

5.21.1 Was there any change in the amount of urine s/he passed daily? *(If the answer is 2 or 9 proceed to Q5.22)*	1. Yes	2. No	9. NK	CQU

5.21.2 How much urine did s/he pass in a day?

1. Too much	2. Too little	3. No urine at all	8. NA	9. NK	AQU

5.21.3 How many days s/he had the change in amount of colour? (NA=888; NK=999)				DQU

5.22 Did s/he have difficulty in passing urine?	1. Yes	2. No	9. NK	DPU
(If the answer is 2 or 9 proceed to Q6.1)				

5.22.1 What type of difficulty did s/he have?

1. Unable to pass urine	2. Continuous dribbling of urine		
3. Burning sensation while passing urine	4.Intense pain		TDP
5. Other (specify)		8. NA	9. NK

6.1 SURGERY/OPERATION:

6.1.1 Did s/he have any operation before death?	1. Yes	2. No	9. NK	HOP
(If the answer is 2 or 9 proceed to Q7.1)				
6.1.2 How many days before death did s/he had the operation?		888.NA	999.NK	OPD

6.1.3 (Ask for the site of operation)	1. Abdomen	2. Other	8. NA	9. NK	SYT

NOTE: **If the deceased is a female and >50 years old proceed to Q7.13**
If the deceased is a male, proceed to Q8

7.0: PREGNANCY/DELIVERY

7.1 Was she pregnant at the time of death?	1. Yes	2. No	9. NK		PRE
(If the answer is 2 or 9 proceed to Q7.8)					
7.2 Did she attend antenatal care during the pregnancy?	1. Yes	2. No	8. NA	9. NK	ANCCU
7.3 How many times did she attend antenatal care during the pregnancy?		88. NA	99. NK		FQANC
7.4 Was she taking malaria prophylaxis or intermittent treatment of malaria during the pregnancy before she died?	1. Yes	2. No	8. NK		PROPH
7.5 Did attend antenatal care during the previous pregnancies?	1. Yes	2. No	8. NA	9. NK	ANCPR
7.6 Did she have antenatal health card?	1. Yes	2. No	8. NA	9. NK	CARD
7.7 How many months was she pregnant?		88.NA	99.NK		MPR
7.8 Did she deliver within 42 days (6 weeks) before death?	1. Yes	2. No	8. NA	9. NK	DEL
(If the answer is 2 or 9 proceed to Q7.11)					
7.9 How many days before her death did she deliver?		888.NA	999.NK		EDD

7.10 Where did she deliver?	1. Home	2. Clinic	3. Hospital	8. NA	9. NK	PDE
7.11 How long was she in labour?	1. <24hrs	2. >24HRS	8. NA	9. NK		DDE
7.12 Did she have too much bleeding during delivery?	1. Yes	2. No	8. NA	9. NK		BDE

7.13 (If YES, probe to find out whether the bleeding started before or after the delivery of foetus)

1. Before	2. After	8. NA	9.NK	HDE

7.14 What was the mode of delivery?

1. Vaginal delivery	2. Vacuum or forceps	3. Abdominal Operation	8. NA	9. NK	MDE

7.15 Was baby born alive?

1. Alive	2. Stillborn	8. NA	9. NK	BALV

7.16 Did she have any previous complicated delivery?	1. Yes	2. No	8. NA	9. NK	PCD
7.17 Did she have an abortion within 45 days before death?	1. Yes	2. No	8. NA	9. NK	ABO
7.18 Did she have irregular bleeding per vagina?	1. Yes	2. No	8. NA	9. NK	ABV
7.19 Did she have any swelling or ulcer in the breast?	1. Yes	2. No	8. NA	9. NK	BTU

8. INJURY/ACCIDENTS:

8.1 Did s/he sustain any injury which led to his/her death?

1. Yes	2. No	9. NK	INJ

(If the answer is 2 or 9 proceed to Q9)

8.2 (*If yes ask:*) What kind of injury or accident? Allow respondent to answer spontaneously.

1. Transport accident (pedestrian)	2. Transport accident (passenger)	3.Fall	4. Drowning	5. Poisoning (specify) …….	TINJ
6. Bite or sting	7. Burn	8. Firearm	9. Sharp object- e.g. knife	10. Circumcision	
11. Assault/abuse (specify): ……..	12. Other (specify):				

8.3 Did S/he die at the site where the accident or injury occurred?

1. Yes	2. No	9.NK	DSPOT

(Skip to 8.6 if 8.3 = No)

8.4 How many days did s/he survive before s/he died?

1<24 hours	2.>24 hours	9. NK	INJDU

8.5 Did s/he receive medical care before death?

1. Yes	2. No	9.NK	MDCARE

8.6 Did S/he have an ongoing chronic illness or was sick in the month before the accident or injury?

1. Yes	2. No	9.NK	OILL

8.7. Do you think that s/he committed suicide?

1. Yes	2. No	9. NK	SUI

(If the answer is 2 or 9 proceed to VI)

8.8 How did s/he commit suicide?

1. Hanging	2. Poisoning	3. Burns	4. Others	8. NA	TSU

9.0: TREATMENT AND RECORDS

9.1 Treatment

9.1. 1Did s/he receive any drug during the illness?	1. Yes	2.No	8.NA	9. NK	TREAT

(If 9.1.1 is not yes, please skip to 9. 2)

9.1.2 Did s/he receive any antibiotics during the illness?	1. Yes	2.No	8.NA	9. NK	ANTIB

9.1.3. Did s/he receive any anti-malarial drug during the illness?	1. Yes	2.No	8.NA	9. NK	ANTIM

(If yes to 9.1.3, please specify in 9.1.4 otherwise skip to 9.1.5)

9.1.4 Which anti-malarial drug did s/he receive?	1.Choroquine	2.Fansidar	3.Quinine	
	4.Other	9.NK		ANTIM_T

9.1.5 Did s/he receive any anti-pyrethic during the illness?	1.Yes	2.No	9.NK	ANTIP

9.1.6 Which antipyretic did s/he receive?	1.Paracetamol	2.Asprin	ANTIP_T
	3.Other	9.NK	

9.2 HEALTH RECORDS

9.2.1 Is there any health record that belongs to her/him?	1. Yes	2.No	9. NK	HREC

If No go to 9.2.6

9.2.2 Can I see the health record	1. Yes	2.No	8. NA	RECSEE

If respondent allows you to see the health records, transcribe all the entries within the 12 months before the child died.

9.2.3 Record the dates of most recent two weights (start by most recent)	Date 1 dd/mm/yy	DATEW1
	Weight1	WEIG1
	Date 2 dd/mm/yy	DATEW2
	Weight	WEIG2

Record date and medical notes

9.2.4 DATE *(dd/mm/yy):*_____/_____/_____

9.2.5 Transcribe the note

_____

_____

_____

9.2.6 Was a death certificate issued? | 1. Yes | 2.No | 9. NK | DCERT

9.2.7 Able to see death certificate? | 1. Yes | 2.No | 8. NA | SEEDC

9.2.8 Record immediate cause of death appearing in death certificate? …… Code [ ] IMCAU

9.2.9 Record the first underlying cause of death? …… Code [ ] UCAU1

9.2.10 Record the second underlying cause of death? …… Code [ ] UCAU2

9.2.11 Record the third underlying cause of death? …….. Code [ ] UCAU3

9.2.12 Record the contributing cause(s) of death? …….. Code [ ] CCAU

10.0 LIFE STYLE (OPTIONAL)

10.1 ALCOHOL ABUSE

10.1.1 Did the deceased ever drink alcohol? | 1. Yes | 2.No | 8. NK | ALC

10.1.2 If yes how long had s/he been drinking alcohol ? | **1**.Less than a year | **2**. 1-5 years | **3**. 6-10 years. | **4.** 11-15 years | **5**. All his/her adult life | **6**. NK | ALCD

10.1.3 How often did he/she drink alcohol? | **1**.Daily | **2**. Weekly | **3**.Fortnightly | **4.** Once in a while | **5**. NK | ALCOF

10.1.4 How often did he/she get drunk? | **1**.Daily | **2**. Weekly | **3**.Fortnightly | **4.** Once in a while | **5**. NK | ALCDK

10.1.5 How in your opinion, do you suppose the deceased started drinking alcohol ?

1.Peer influence	**2**.It was fashionable to drink		ALCRS
3. Curiosity	**4**. To forget problems (economic, social etc.)	**5**. NK	

10.1.6 Why in your opinion, did s/he continue to drink ?

1.Forget problems	**2**. He was addicted		ALCCO
3. For entertainment	**4**. To maintain social status	**5**. NK	

10.1.7 Which kind of alcohol did the deceased consume ?

1.Beer	**2** Spirits	**3**. Wines		TALC
3. Traditional brews	**4**. Traditional & illicit brews	**5**. NK		

10.1.8 What was the source of the alcohol s/he drank ?

1.Bar	**2**. Brewed it himself/herself at home		ALCS
3. Friends and/or relatives	**4**. Local traditional brewer	**5**. NK	

10.1.9 Was the deceased ever in trouble as a result of drinking alcohol?

1. Yes	2.No	8. NK	ALCTR

10.1.10 If yes what kind of trouble was s/he in?

1.Trouble with the law	**2**. Violence (domestic rape etc?)			TALCTR
3. Got ill (type of illness)	**4**. Neglect of responsibility (family break-ups, job loss etc.	**5**. NK		

10.2. CIGARETTE SMOKING

10.2.1 Did the deceased ever smoke cigarette?

1. Yes	2.No	8. NK	SMOK

10.2.2 If yes how long had s/he been smoking?

1.Less than a year	**2**. 1-5 years	**3**. 6-10 years.		DSMOK
4. 11-15 years	**5**. All his/her adult life	**6**. NK		

10.2.3 How often did he/she smoke?

1.Chain-smoked	**2**. Hourly	**3** Daily	SMOKOF
4. Weekly	**5**. Fortnightly		
6. Once in a while	**7.** NK		

10.2.4 How in your opinion, do you suppose the deceased started smoking?

1.Peer influence	**2**.It was fashionable to smoke		SMOKRS
3. Curiosity	**4**. To forget problems (economic, social etc.)	**5**. NK	

10.2.5 Why in your opinion, did s/he continue to smoke?

1.Forget problems	**2**. He was addicted		SMOKCO
3. For entertainment	**4**. To maintain social status	**5**. NK	

10.2.6 How much cigarette did s/he smoke per day/week/fortnight/month?

1.Less that 5 sticks		**2**. Less than 1 packet	
3. 2-5 packets	**4**. More than 5 packets		**5**. NK

NSMOK

10.2.7 Which type of cigarette did the deceased consume?

1Filtered cigarette	**2**. Unfiltered cigarette	
3. Pipe	**4**. Cigar	**5**. NK

CIGTYP

10.2.8 What was the source of the cigarette s/he smoked?

1. Bar	2. Local retailer	**3**. Importation	
3. Home-made pipe	**4**. Friends and/or relatives		**5**. NK

CIGSOUR

10.2.9 Was the deceased ever in trouble as a result of smoking?

1. Yes	2.No	3. NK

SMKTR

10.2.10 If yes what kind of trouble was s/he in ?

1.Trouble with the law	**2**. Violence (domestic rape etc?)
3. Got ill (specify)	**4**.Neglect of responsibility (family break-ups, job loss etc.
6. NK	

TSMKTR

10.3. DRUG ABUSE

10.3.1 Did the deceased ever used drugs?

1. Yes	2.No	3. NK

UDRG

10.3.2 If yes how long had s/he been using drugs ?

1.Less than a year	**2**. 1-5 years	**3**. 6-10 years.	
4. 11-15 years	**5**. All his/her adult life		**6**. NK

DDRG

10.3.3 How often did he/she get drunk?

1.Daily	**2**. Weekly	**3**.Fortnightly	
4. Monthly	**5.** Once in a while		**6**. NK

DRGOF

10.3.4 How in your opinion, do you suppose the deceased started using drugs ?

1.Peer influence	**2**.It was fashionable to use drugs	
3. Curiosity	**4.** To forget problems	**5.** NK

DRUGRS

10.3.5 Why in your opinion, did s/he continue to take drugs?

1.Forget problems	**2**. He was addicted	
3. For entertainment	**4**. To maintain social status	**5**. NK

DRGCO

10.3.6 Which type of drugs did the deceased consume?

1. Heroine	**2.** Cocaine	**3**. Ecstasy
4. Marijuana	**5.** Prescription drugs *	**6**. Anabolic steroids
7. Inhalants**	**8**. Other	**9**. NK

TDRG

*Specify (e.g amphetamines, hallucinogens, diazepam, phethidine, etc)……
** Specify (eg glue, correction fluid, paint thinner, etc)…….

10.3.7 What was the source of the drugs s/he took?

1. Bar	**2**. Pharmacist	**3**.Local retailer	DRGS
3. Importation	**4**.Home-made pipe		
5. Friends and/or relatives	**6.** NK		

10.3.8 Was the deceased ever in trouble as a result of taking drugs?

1. Yes	2.No	3. NK	DRGTR

10.3.9 If yes what kind of trouble was s/he in?

1.Trouble with the law	**2.** Violence (domestic rape etc?)	TDRGTR
3. Got ill (specify) ……	**4**.Neglect of responsibility (family break-ups, job loss etc)	
5. NK		

END OF INTERVIEW

THANK RESPONDENT FOR THEIR COOPERATION

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11. Interviewer's comments and observations

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Certify correct on: | | | | | | | **By:** | | **CCB**