Mortality and survival from childhood to old age in rural Ethiopia

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Dedicated to Bethelhem, Dawit, Tzion, and Lemlem

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ABSTRACT

This thesis examines ways of establishing cause of death, assessing trends in mortality, and identifying factors that affect mortality and survival among the different population groups in rural and semi-urban Ethiopia. These data are important for health care planning; however, such vital data are unavailable in many developing countries. The study was conducted in Butajira Rural Health Program Demographic Surveillance Site, Ethiopia, where data collection on vital events and related research has been conducted for the last 20 years. This thesis used a cohort and a case referent study preceded by Focus Group Discussion. It also employed a verbal autopsy procedure to identify causes of death. The cohort component used 18 years of surveillance data (1987-2004). The prospective case referent study, carried out in the years 2003-2005, was used to complement the mortality analysis and focused particularly on issues related to household decision making, social capital, and economic status. The main subgroups included were children under-five years old, adults 15-64, and the elderly 65 years and above. Cause of death was ascertained using the Physicians’ Review and InterVA methods.

Food shortage and epidemics affected the modest downward trend of mortality. There was a general similarity between the Physicians’ Review and InterVA methods in identifying the major causes of death. About 60% of the deaths were due to pneumonia/sepsis, pulmonary tuberculosis, malaria, and diarrhoea disease/malnutrition. The InterVA method was cheaper and more consistent. Higher rates of HIV/AIDS (11%), tuberculosis (18%), and cardiovascular (9%) mortality were noted in urban areas compared to rural areas. Consistent higher mortality was found in rural areas. Women were disadvantaged by residence and advanced age. Place of residence, illiteracy, widowhood, and not owning a house affected men and women differently, indicating a possible need for gender-specific interventions. Children and women survival is affected by household decision-making; this means efforts to improve women’s involvement in household decision-making (women empowerment) might improve child and women survival in poor settings. Many factors that significantly affect mortality can only be controlled by concerted efforts to improve health and overall development.

Key Words. Mortality, survival, children, adults, elderly, cause of death, determinants, Ethiopia.
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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ARI</td>
<td>Acute Respiratory Infections</td>
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<td>ALRI</td>
<td>Acute Lower Respiratory Infections</td>
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<td>BRHP</td>
<td>Butajira Rural Health Programme</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
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<td>CoD</td>
<td>Cause of Death</td>
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<td>CSMF</td>
<td>Cause Specific Mortality Fractions</td>
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<td>DHS</td>
<td>Demographic and Health Survey</td>
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<td>DSS</td>
<td>Demographic Surveillance Sites</td>
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<td>EHSP</td>
<td>Essential Health Service Programme</td>
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<tr>
<td>GNI</td>
<td>Gross National Income</td>
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<td>GNP</td>
<td>Gross National Product</td>
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<td>HDSS</td>
<td>Health and Demographic Surveillance Site</td>
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<td>HEP</td>
<td>Health Extension Package</td>
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<tr>
<td>HIV/AIDS</td>
<td>Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome</td>
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<td>HMIS</td>
<td>Health Management Information System</td>
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<td>HSDP</td>
<td>Health Sector Development Programme</td>
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<tr>
<td>IEC</td>
<td>Information, Education and Communication</td>
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<tr>
<td>INDEPTH</td>
<td>International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries</td>
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<td>MDGs</td>
<td>Millennium Development Goals</td>
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<td>MOH</td>
<td>Ministry of Health</td>
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<td>NCD</td>
<td>Non communicable Diseases</td>
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<tr>
<td>PASDEP</td>
<td>Plan for Accelerated and Sustained Development to end Poverty</td>
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<tr>
<td>PHCU</td>
<td>Primary Health Care Unit</td>
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<td>SRS</td>
<td>Sample Registration System</td>
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<td>U5MR</td>
<td>Under-five mortality rate</td>
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<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
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<td>VA</td>
<td>Verbal Autopsy</td>
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<td>WHO</td>
<td>World Health Organization</td>
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This thesis is mainly based on the following four papers:


IV. Fantahun M, Berhane Y, Högberg U, Wall S, Byass P. Ageing of a rural Ethiopian population: "Who are the survivors"? In manuscript.

Papers I and II are reprinted with permission from the publishers.
INTRODUCTION

Mortality is the most basic health outcome indicator. In particular, age specific and adjusted mortality rates are widely used to measure health status and to compare it across population groups. Three of the eight Millennium Development Goals directly deal with mortality or health. MDG 4 aims to reduce the mortality rate by two-thirds for children under-five years old. MDG 5 aims to reduce the maternal mortality ratio by three-quarters. Goal 6 deals with combating HIV/AIDS, malaria, and other diseases. HIV/AIDS and malaria are major killer diseases in developing countries.

Globally, remarkable decreases in mortality have been observed in the last century. This decrease, however, is variable among regions and nations. Sub-Saharan Africa has had the least success. Epidemiologic transition theory, the change from high level of mortality to low level, was developed by Omran. Initially Omran proposed a three stage process of epidemiologic transition; 30 years later he increased the stages to five for western countries: 1) the age of pestilence and famine, 2) the age of receding pandemics, 3) the age of degenerative and man-made disease, 4) the age of declining cardiovascular mortality, ageing, lifestyles, modifications, emerging and resurgent diseases, and 5) the age of aspired quality of life with paradoxical longevity and persistent inequities. The classification of these stages was based on mortality trends, occurrence of epidemics, and life expectancy at birth.

Since the conception of the epidemiologic transition theory, many attempts have been made to summarize, apply, and update it. It was evident that non-western countries will not take the same path as western countries. Poverty, limited education, low status of women, and slow pace of development have been major constraints to successful transition in most developing countries. For non-western societies, Omran proposed three stages: age of pestilence and famine, age of receding pandemics, and age of triple health burden.

The third stage of the transition in non-western societies includes at least three major overlapping health burdens: the unfinished old health problems (communicable diseases, reproductive morbidity and mortality, and malnutrition); new set of health problems (increase in degenerative diseases such as heart diseases, stroke, cancer, metabolic disorder, stress,
INTRODUCTION

and man-made diseases); and ill-prepared health systems and medical training.  

In general, the epidemiologic transition theory considers systematic variations in pattern, pace determinants and consequences, survival, and population changes. This led to the following transition classifications: western transition, semi-western/accelerated transition, non-western transition, rapid transition, intermediate transition, and slow transition. The complexity of epidemiologic transition and new phenomena that occur or are discovered from time to time has resulted in several other stages and has raised issues such as whether countries will face a re-emergence of infectious diseases and whether there will be similarities between different population groups. Some challenged the use of the theory in modern times as imposing limitations on understanding and explaining the epidemiological profile and designing a public health policy.  

In most developing countries, because deaths are unregistered and most take place outside health facilities, it is difficult to identify the causes of death among different population groups, to provide appropriate interventions, and to evaluate them. Verbal autopsy (VA) – the interviewing of family members or caregivers about the circumstances of death – is a useful tool in areas where routine death registration is non-existent or inadequate. It establishes medical causes of death using the information gathered – such as symptoms, signs, and circumstances preceding death – during the interview. Early on, VA was more widely used for establishing cause of death in children. Later its use expanded to the whole population and to different contexts such as disease surveillance, registration systems, investigations of risk factors for certain diseases, and measuring the effect of public health interventions. Over 35 Demographic Surveillance Sites (DSS) in 18 countries, the Sample Registration System (SRS) sites in India, and the Disease Surveillance Points (DSP) system in China, regularly use VA on a large scale primarily to assess the cause-of-death structure of a defined population.  

In general, verbal autopsies allow identification of major health problems, comparisons of local and national differences in mortality ratios, the monitoring of trends over time, and the evaluation of interventions and health programmes. However, the usefulness of verbal autopsies depends on quality and standardization. If poorly conducted, they can produce
misleading results. Moreover, because the VA process has several stages, many factors can influence the estimated cause-specific mortality fractions.\textsuperscript{24-26} VA can use physician review, predefined expert algorithms, and data-driven algorithms to derive cause of death.\textsuperscript{27-28} Each method to assign cause of death has different validity and demand for resources. Physicians review may have higher validity compared to using algorithms\textsuperscript{27} although the latter is less costly.

In Vietnam, a new approach of interpreting verbal autopsies, InterVA – has been used with promising results,\textsuperscript{29} a method that also addresses some of the limitations associated with other methods. This approach accepts a range of “indicators” relating to a particular death, processes them in a mathematical model based on Bayes’ theorem, and produces as its output likely cause(s) of death. Running the model with these inputs generates up to three likely causes of death for each case together with the respective probabilities and an overall certainty factor. “Indicators” is the blanket term used by InterVA to describe the whole range of items of information about the circumstances of a death, including basic background characteristics, details of any illness (signs and symptoms) leading to death, and previous medical history. Indicators are posed as questions, and the only significant answer to each as far as the model is concerned is “yes”. No distinction is made between “no” or “unknown” responses. The main criterion for including an indicator in the model is that it should represent something that might reasonably be elicited during the VA process that gives some kind of clue as to possible cause of death. In Vietnam, the approach showed high concordance with physicians’ review and its simplicity and less demand for resources makes it attractive. InterVA has also been tested for determining specific mortality causes such as maternal mortality and has been regarded as a potentially valuable new tool for measuring maternal mortality in an efficient, consistent, and standardized way.\textsuperscript{23}

Validity is an important aspect of a VA tool. Several attempts have been made to validate VA tools to assess whether determined causes of death closely reflect the actual causes and determine the factors that affect validity.\textsuperscript{26,28,30-31} Moreover, there has been a growing concern internationally with respect to the application of VA. Efforts have largely been uncoordinated and consensus has not been reached in critical issues such as what to cover in the interview and how to analyze the results despite previous attempts to promote standard tools.\textsuperscript{14,32-34} The main consequence
of this failure is the difficulty to compare results from different countries. On the other hand, assessment of MDG performance of countries requires collecting cause specific mortality data to evaluate the impact of disease control programs; VA is the only option for many countries in tracking progress towards achieving the MDG goals. Efforts are underway at the international level to ameliorate this problem.

When a death occurs, the immediate cause is a medical phenomenon, which is usually identified as diseases or injuries. However, these diseases or injuries are often the result of other factors (intermediate) or the lack of such factors (e.g., exposure to certain conditions and agents, unsafe water supply, accessibility of health services, inappropriate nutrition, and poor personal and environmental hygiene). Other underlying factors can be poor health knowledge, low educational status, poor economy, and inequality although the distinctions between the intermediate and the underlying factors may sometimes be difficult to identify.

Thus the cause of death in the broad sense of the term is a chain of factors that have given rise to an immediate medical condition. Such conceptualization has important implications in terms of health promotion – the prevention and treatment of diseases by intervening at different levels of factors. Understanding these levels of factors helps to identify the type of intervention needed to avoid unnecessary death. For the sake of clarity, we will use the term cause for medical causes and risk factors or determinants for other factors that are associated with mortality.

Age-specific mortality

The thesis deals with mortality or survival of all age groups, but the 5-14 age group will be briefly explored. A review of general issues pertaining to each study group and the medical causes and risk factors (determinants) for each population group follows.

Children

The under-five mortality rate has been chosen as the best indicator of human development by UNICEF. First, it measures an end result of the development process rather than an “input”. Second, the U5MR is known to be the result of a wide variety of inputs: the nutritional health and the health knowledge of mothers; the level of immunization and oral rehydration therapy use; the availability of maternal and child health services
(including prenatal care); income and food availability in the family; the availability of safe drinking water and basic sanitation; and the overall safety of the child’s environment. Third, it is less susceptible to the fallacy of the average than, for example, per capita gross national income (GNI). Because it is much more difficult for a wealthy minority to affect a nation’s U5MR, it presents a more accurate, if far from perfect, picture of the health status of the majority of children (and of society as a whole). Reduction of child mortality is one of the eight Millennium Development Goals with specific monitoring and evaluation targets. Under-five deaths can be classified as infant (0-11 months) and "child" (1-4 years) and most of the deaths take place during infancy and the proportion of infant deaths that occur during the neonatal period is estimated to be around 40%. The prevention of infant death is now considered possible with low cost intervention.

While developed countries have substantially improved child health and decreased mortality and some developing countries have progressed well, the situation in several developing countries remains very grave. Although survival prospects have improved in every region, 10.5 million children died before their fifth birthday in 2004. It has been reported that 7 out of 10 of the causes of death in under-five children are due to one or a combination of five preventable and treatable conditions: pneumonia, diarrhoea, malaria, measles, and malnutrition. Sub-Saharan Africa, with only 20 per cent of the world’s young children, accounted for half of the total deaths, a situation that has shown only modest improvement.

It is estimated that about 330,000 [310,000–380,000] under 15 year old children died of AIDS in 2007 while 2.5 million [2.2–2.6 million] children live with HIV globally and nearly 90% of children infected with HIV live in Sub-Saharan Africa. There are an estimated 11.4 million [10.5 million–14.6 million] orphans due to AIDS in this region. The vast majority of these children will have become infected with HIV as foetuses, during delivery or when breastfed as a result of their mother being HIV-positive. Mother to child transmission of HIV is not inevitable. Without interventions, there is a 20-45% chance that a HIV-positive mother will pass infection on to her child. If a woman is supplied with antiretroviral drugs, however, this risk can be reduced significantly. With the administration of a short course of antiretroviral drugs to the mother and baby around the time of delivery and not breastfeeding, the risk of transmission can be reduced by 50%. Before these measures can be taken,
the mother must be aware of her HIV-positive status, so testing also plays a vital role in the prevention of mother to child transmission. Fewer than 6% of pregnant women received services in 2005.\textsuperscript{42,45}

Previous studies in Butajira Rural Health Program Demographic Surveillance Site (1987-89) found that acute respiratory tract infections, measles, and diarrhoea were the most common causes of death. For infants, neonatal tetanus and preterm were also major causes and accidents were important cause of death for children 1-4 years old.\textsuperscript{46} In northwest Ethiopia, acute respiratory infections and diarrhoea were the most frequent causes of death.\textsuperscript{43} In Zimbabwe, diarrhoea, acute lower respiratory infections (ALRI), and measles were the most important causes of death.\textsuperscript{48}

Several intermediate and underlying factors have been identified as determinants of under-five mortality. The effect of maternal education on child mortality has been documented in many studies. A study in Nicaragua reported that in poor households female education may contribute to preventing infant mortality.\textsuperscript{49} Another study that used data from 22 developing countries also reported that maternal education was generally associated with child survival. However, only primary education did not increase or reduce mortality in some countries when adjusted for other factors and this decline of impact was particularly marked in sub-Saharan African countries.\textsuperscript{50} Similarly, the 2005 WHO report on MDG stated that survival rates for children of mothers with at least a secondary education were twice as high as those for children with less educated mothers.\textsuperscript{36} Maternal secondary education also had greater effect on the reduction of infant mortality in another study in Cameroon.\textsuperscript{51} Likewise, a study that used DHS data from 18 African countries reported female education, especially secondary level or higher, had positive benefits for child survival and that this effect is the result of socio-economic advantage, use of health-care services, and better reproductive behaviour. This study also reported that tackling gender inequality by raising the ratio of female-to-male literacy will have positive impacts for child health.\textsuperscript{52} Thus while maternal education has generally been associated with decreased child mortality, the effect is marked for those who have secondary education and above and education can improve child survival through several mechanisms.
Paternal literacy was also reported to be an important factor in child survival. In a study in Nigeria, one of the variables found to exert significant independent effects on child mortality included husband’s education. A study in Mozambique reported that low paternal education was associated with high child mortality. A previous study in Butjira has also found that paternal illiteracy was one of the predictors of child mortality.

Both absolute and relative poverty have been shown to impact child mortality. A study in Nicaragua concluded that apart from absolute level of poverty social inequity may be an independent risk factor for infant mortality in developing countries.

According to a WHO report, children living in the wealthiest 20 percent of households are twice as likely to survive as those in the poorest 20 percent of households. Addressing these disparities and reaching the most disadvantaged groups is the greatest challenge to achieving the child mortality target by 2015. Poverty, rural residence, lack of sanitation and pipe water are the most important explanatory factors of under-five mortality. The urban-rural difference might be highest for vaccine preventable diseases.

According to the 2007 UNICEF report, using data from Demographic and Health Surveys, in only 10 out of the 30 developing countries surveyed half or more of the women participated in all household decisions, including decisions regarding major household spending, their own health care, and their visits to friends or relatives outside the home. Furthermore, a study conducted by the International Food Policy Research Institute reported that if men and women had equal influence in decision-making, the incidence of underweight children under three years old in South Asia would decrease by as much as 13 percent, resulting in 13.4 million fewer undernourished children in the region and in sub-Saharan Africa. This means an additional 1.7 million children would be adequately nourished, indicating the relationship between household decision making and child mortality as malnutrition is one of the most important causes of child mortality. The strong link between female education and child survival suggests that empowering women through education will improve child survival perhaps through better income and good childcare practices.
The effect of social capital on health has been documented, but only one study identified the relationship between social capital and child health and asserted that social capital is an important independent predictor of child health.\textsuperscript{60} Other factors that were associated with under-five mortality were maternal death,\textsuperscript{61} lack of access to maternal health services,\textsuperscript{62} short birth interval,\textsuperscript{63} and young maternal age.\textsuperscript{54}

Avoidable factors were defined as situations in which alternative course of action could have prevented or reduced the risk of mortality. The concept of avoidability was introduced to identify negative indicators based on unnecessary episodes of disease, disabilities, and untimely deaths as part of the whole chain of possible unfortunate factors on the road to death.\textsuperscript{64} In a broader sense, it can be used at the community/household level and health service levels and includes factors such as the delay in recognizing and seeking care and health worker’s delay of diagnosis and treatment and suboptimal care. The concept of avoidability serves as a measure of accessibility and quality of health care.

Previous studies in Butajira (1991-92) found that parental factors – including paternal education, urban residence, and child feeding practices – were related to under-five mortality where the effect was stronger in infants compared to children 1-4 years.\textsuperscript{46,55,65} This part of the thesis deals with under-five mortality and mainly addresses factors associated with under-five mortality that have not been addressed adequately by previous and current studies in the project area.

Rural children have a lesser chance of going to school than urban children
Adults

Adults comprise the great majority of the labour force, and it is to be expected that adult ill health and death would have deleterious effects on the productivity and well being of other population groups. For example, it has clearly been documented that the death of mother, very important on its own, is associated with a markedly higher risk of death for the child.\textsuperscript{66-67}

However, reports indicate that adult mortality issues are not given much attention partly due to a widespread impression that mortality in adults is low. It is believed that once a child reaches the age of 2 he or she will “likely live almost as long in an African country as in an industrialised country.”\textsuperscript{68} However, evidence suggests that this may not be true and people in low-income countries can be vulnerable to death due to different risk factors. A study in rural Tanzania reported that age specific mortality for adults was as much as 43 times higher than rates in England and Wales.\textsuperscript{69} Earlier research reported that the risk of a 15-year-old dying before reaching 60 years of age is 25% for men and 22% for women in developing countries, more than double that in the industrialized market economies where the respective figures are 12% and 5%. In some African countries (e.g., Sierra Leone), the adult mortality risk is more than 50%.\textsuperscript{70}

Moreover, studies have shown that adult mortality has been stagnating or increasing in sub-Saharan Africa.\textsuperscript{71} A study in a Senegalese DSS reported that adult mortality level has increased since the beginning of the demographic surveillance in 1985.\textsuperscript{71} Similarly, data from South Africa showed that mortality was increasing in children and young adults.\textsuperscript{73} Furthermore, adult mortality rates varied widely in developing countries in a study where 30 countries were included. In Mongolia, over 50% of the females who survive to 15 die before 60, whereas the corresponding risk for females in the Republic of Korea is only 7%. In all countries except one, female probabilities of dying between the ages of 15 and 60 are lower than for males. Adult mortality has been declining in the developing countries included in this study at about the same rate as observed in England and Wales in the 20th century. However, sub-Saharan Africa was not represented in the sample and hence it was difficult to make conclusions about all developing countries.\textsuperscript{74}

Causes of adult mortality varies widely even among developing countries. WHO estimates of causes of adult mortality (15-59) show that in sub-Saharan Africa communicable diseases and maternal deaths are much
higher than non-communicable diseases, whereas in southeast Asia deaths due to non-communicable diseases are higher than communicable diseases. Sub-Saharan Africa continues to be the region most affected by the AIDS pandemic. Of the 2.1 million estimated number of deaths due to AIDS in 2007, 76% occurred in sub-Saharan Africa. A study in Tanzania Demographic surveillance sites reported that HIV/AIDS, acute febrile illnesses including malaria, maternal deaths, acute diarrheal diseases, pulmonary tuberculosis, and cancer were the most common causes of death among females in the years 1992-1998 in the age group 15-59. Among males HIV/AIDS, injuries, acute febrile illnesses, pulmonary tuberculosis, and acute diarrheal diseases were the most common causes of mortality. Some differences were noted in age group and urban rural residence. HIV/AIDS had relatively higher prevalence in the urban site, and deaths due to acute illness were more prevalent in rural areas. Cancer and stroke deaths were more prevalent in the urban site among older people (45-59 years).

Injuries and poisoning accounted for a large share of male mortality (37%) in Senegal. Women were victims of maternal deaths (25% of the mortality rate). Neoplasms, and particularly those of the digestive system, constituted 20% of the deaths in this age group for both women and men while infectious and parasitical diseases also remained important. South Africa’s health transition was reported to be “protracted”, consisting of simultaneous emergence of HIV/AIDS and an increase in non-communicable diseases in older adults. A study in rural India reported that chronic diseases with similar proportions of deaths attributable to ischaemic heart disease and stroke followed by injuries and accidents while infectious and parasitic diseases occupied the third most prevalent diseases. In rural Vietnam, the most common causes of mortality among adults were cardiovascular diseases followed by neoplasms and external causes.

In high- and middle-income countries, mortality among adult females is generally lower than for their male counterparts. However, in low-income countries, gender differences in mortality tend to be smaller and national averages may hide important variations. In low-income countries, social and cultural norms that discriminate against women result in high female mortality although females are said to be better biologically protected compared to males. A study in Cameroon reported that burden of illness rests disproportionally on economically disadvantaged women and on
women with low social status. The long-term effects of social disadvantage were apparent in the consistently documented excesses of morbidity among women who were not employed, women living in poor areas, and those living in households without modern amenities. These results remained robust even after controlling for other measured factors.

Adult women in developing countries carry almost all burden of global maternal mortality. Almost half of the 600,000 pregnancy-related deaths recorded worldwide occur in Africa, which has only 12% of the world’s population and only 17% of the global annual births. In our study area, 10-year surveillance showed mortality rate of 6.85/1000 and 6.23/1000 person years in females and males respectively. Maternal mortality ratio was estimated between 440-665/100000 live birth.

Given the necessary attention in terms of creating awareness and infrastructure, maternal deaths are basically avoidable. The motto should be “No women should die giving birth.”

A critical component for the improvement of maternal health is political commitment. The importance of generating political will for improving maternal health has been emphasized by a study in Indonesia. Such a commitment requires the right policies and appropriate implementation strategies. A study that assessed four global maternal health initiatives, concluded that priority areas have generally been identified and incorporated into policies and recommended that the implementation efforts should focus on specific steps for strengthening the capacity of the district health system to convert inputs into functioning services that are accessible to and used by all segments of the population.

Enabling women to participate in household decision-making is a major component of empowering women, although the latter has a more broad perspective. A report by the World Economic Forum identified five dimensions of female empowerment and opportunity that included economic participation, economic opportunity, political empowerment, educational attainment, and health and wellbeing. A WHO sponsored study that emphasized the process it generated and its effect in improving health and reducing health disparities reported that empowerment strategies should improve decision-making skills and advocacy within or adapt these to local contexts. Health promotion should address effective empowerment strategies such as increasing skills, control over resources, and access to information relevant to public health development.
Several studies have reported on the effect of socio-economic status on overall or cause specific adult mortality in various settings. A study in Vietnam found that education and financial stability were important factors for survival, but the latter benefited men more than women. In a study in Korea, educational attainment was related to mortality in most causes of death. In rural Italy, men with college education were found to have significantly higher survival rates after controlling for confounders compared to men who have no formal education, whereas no significant difference was observed among women and by occupation.

Although mortality was higher in males, illiterate women in rural areas had the highest mortality rate in Butajira. Rural residence is associated with high workload and low decision-making for women. With rural residence being relatively disadvantageous for women survival, it would be important to assess the relationship of these factors with women mortality. Although the effect of literacy was explored in earlier studies, the relationship between decision-making (women’s status in general) and mortality has not been assessed.

In this thesis, we examined the mortality experience of adults through middle age (15-64) over a period of 18 years. Our study was supplemented by a two-year study of socioeconomic determinants of mortality.
INTRODUCTION

Elderly

The world’s population is generally growing older, although the extent differs by region and country. In developed countries, the very old (age 80+) is the fastest growing population group. The rate of growth is somewhat lower in the developing world, but about two-thirds of all older people are living in developing countries. It is expected that the elderly population in the slowest aging region of sub-Saharan Africa will more than double between 2000 and 2030. Thus aging is a global concern and requires improving survival among the elderly since the potential for living into older age has been demonstrated to be high, an elderly population that is healthy and productive is important, and the lessons to be learned are important for the population to survive into old age. However, knowledge on these issues is relatively scarce particularly in developing countries.

In Ethiopia, 2.8% of the population lives to be 65 and above and no studies were found that dealt with the ageing or survival in the elderly. A recent study in the Butajira Rural Health Program Demographic Surveillance Site suggested that the elderly population is increasing, and the adult population (15-64) is likely to produce a large number of elderly. In Ethiopia as well as in most of sub-Saharan Africa, there are no universal pension plans and organized systems to care for the elderly. The available pension schemes are mostly for government employees and the pension payment is so low that other sources of support are necessary. In settings like this, support for the elderly usually comes from their children and other relatives. However, there are signs of weakening of traditional life, social ties, and obligations perpetuated by modernization and the HIV epidemic in sub-Saharan Africa. Thus it is possible that a gap in the mechanism of support might be created with grave consequences for the elderly and the society at large.

On the other hand, relatively few people survive into old age in this high mortality society of Butajira. The determinants of mortality during infancy and childhood and later during adulthood are better known. The factors that keep few people living longer are unknown. Old age is a distinct stage of the human life cycle – biologically, socially, and economically – that directly or indirectly affects survival or mortality. While, for example, factors that lead to mortality due to the process of child birth in women are avoided and people are often less engaged in risky activities (e.g. wars), most degenerative and chronic diseases are known to occur to a greater extent among the elderly. Studies have documented that social support,
household economy, being married, educational status, and place of residence affect survival among the elderly.\textsuperscript{99-104} Other factors that enhanced survival include being involved in meaningful roles and proper nutrition.\textsuperscript{99,105} Thus assessment of the survival status and the factors associated with survival in this community will be important in order to prepare the ground for interventions that affect the growing number of older people and the society at large.

The elderly – A growing population. The need to stay healthy and productive and support by others also grows
Ethiopia

General profile

Ethiopia is located on the horn of Africa and covers around 1.1 million square kilometres, bordered by Eritrea in the North and North East, Djibouti and Somalia in the East, Kenya in the South, and Sudan in the West and South West. Ethiopia is the oldest independent country in Africa and among the most ancient and historical countries in the world. It is the second most populous country in Africa and has diverse cultures and traditions. The population is estimated to be around 77 million people, over 50% of whom are under 20 years. The average number of inhabitants per square kilometre is 49. The annual population growth rate is about 2.7%.

Ethiopia could be the origin of mankind. Archaeologists have discovered remains of early hominids in Ethiopia’s Rift Valley, including Australopithecus afarensis, or “Lucy,” thought to be 3.5 million years old. Herodotus, the fifth century B.C. Greek historian, describes ancient Ethiopia in his writings. The Old Testament records the Queen of Sheba’s visit to Jerusalem. According to legend, Menelik I, the son of King Solomon and the Queen of Sheba, founded the Ethiopian Empire.

The country is characterized by diversified topography with varied climatic conditions. Its topography ranges from high peaks of 4,550 meters above sea level to a low depression of 110 meters below sea level; more than 50% of the country is above 1,500 meters. This topography has resulted in different climate zones ranging from the hot lowlands called ‘Qolla’ found below 1,500 meters above to the cool highlands called ‘Dega’ that lie above 2,400 meters with the mid temperature zones called ‘Weyna dega’ coming in between.

The Ethiopian economy is based on agriculture, which contributes 47% to GNP and more than 80% of its exports and employs 85% of the population. The per capita income is about USD 130.

Ethiopia uses the Julian calendar. The public holidays are celebrated according to the Julian calendar, which consists of twelve months of thirty days and a thirteenth month of five days (six days in a leap year). The calendar is seven years behind the western or Gregorian calendar, with New Year falling on the month of September. September 11 (or 12 in a leap
year) is Ethiopian New Year. Ethiopia’s millennium was (2000) celebrated on 12 of September 2007 GC.

The current administrative division of the country consists of 9 regions and two city administrations/councils. The regional states and city administrations are sub-divided into 580 administrative Woredas (districts). The Woreda is the basic decentralized administrative unit and has an administrative council composed of elected members. The 580 Woredas are further divided into about 15,000 Kebeles organized under urban dwellers associations in towns and peasant associations in rural areas.

More than 85% of the Ethiopian population lives in rural areas. The age structure of the population is pyramidal with the under 15-years population comprising 46% and only 4% above the age of 65. Women in the reproductive age group constitute 24% of the population.

Ethiopia has one of the worst health and development indicators in the world. According to the recent Ethiopian Demographic and Health survey, IMR is about 77/1000 while the under-five mortality rate is 123/1000 and maternal mortality ratio of 673/100,000 live births. Life expectancy at birth for 2001 was estimated at 54 (53.4 for males and 55.4 for females). Primary Health service coverage has been recently estimated to be 64%. The UNDP Human Developments Index for Ethiopia shows an index of 0.309, which falls to 0.297 when adjusted for gender differences, and is ranked 169 among 175 countries. According to the Ethiopian 2000 Demographic Health Survey, 20.7% (61.3% of urban and 12.8% of rural) households had a radio, and 1.9% (11.7% urban and none of the rural) had television. The overall school enrolment ratio in 2003 for children aged 7-14 years was 64.4% (74.6% for males and 53.8% for females). Table 1 shows some health and socio-economic indicators for Ethiopia.
Table 1. Selected Health Status and Socio-economic Indicators for Ethiopia by different sources, 2005

<table>
<thead>
<tr>
<th>Indicator</th>
<th>UNICEF$^{35}$</th>
<th>DHS$^{107}$</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Mortality rate</td>
<td>109/1000 live births</td>
<td>77/1000 live births</td>
<td>97 PASDEP$^{*110}$</td>
</tr>
<tr>
<td>Under-five mortality rate</td>
<td>164/1000 live births</td>
<td>123/1000 live births</td>
<td></td>
</tr>
<tr>
<td>Maternal mortality ratio</td>
<td>870/100000 live births</td>
<td>673/100000</td>
<td></td>
</tr>
<tr>
<td>Crude death rate</td>
<td>16/1000 people</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total population (000)</td>
<td>77431</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population growth rate</td>
<td>2.7%</td>
<td>2.7%</td>
<td></td>
</tr>
<tr>
<td>Total Fertility Rate</td>
<td>5.7</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>Crude birth rate</td>
<td>40/1000 people</td>
<td>35.7/1000 people</td>
<td></td>
</tr>
<tr>
<td>Under-five mortality rank</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life expectancy at birth</td>
<td>48</td>
<td>51.8 UNDP$^{109}$</td>
<td></td>
</tr>
<tr>
<td>(years), 2005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net enrolment ratio in primary education</td>
<td>Male: 42.2%</td>
<td>Female: 42.4%</td>
<td>Total: 42.3%</td>
</tr>
<tr>
<td>Literacy rate of 15-24-year olds</td>
<td>Male: 67.2%</td>
<td>Female: 41.6%</td>
<td>Total: 54.4%</td>
</tr>
<tr>
<td>GDP per Capita</td>
<td>1055 (rank 162)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP per capita average annual growth rate (%), 1990-2005</td>
<td>1.5%</td>
<td>2.3%(PASDEP)</td>
<td></td>
</tr>
<tr>
<td>HIV infection rate</td>
<td>1.4%</td>
<td>3.5 (FMoH)$^{108}$</td>
<td></td>
</tr>
</tbody>
</table>


Health care organization

The health service delivery is arranged in a four-tier system. The lowest level is the Primary Health Care Unit (PHCU), which is a health centre with five satellite health posts, followed by the 1st referral level, a district hospital, then a zone hospital and specialized referral hospital. The health sector strategy used to implement the Health Policy focuses on giving comprehensive and integrated PHC in health institutions with a major emphasis on community level services. Its emphasis is on preventive and promotive components, yet without neglecting the basic curative care. The main focus is on communicable diseases, common nutritional deficiencies, and environmental health and hygiene. Maternal and child health, control of major infectious diseases, and control of epidemics deserve special attention.$^{111}$
Ethiopia adopted a sector-wide approach to implement a 20-year sector program and strategy, broken into 5-year rolling programs, beginning in 1997/98. Accordingly, the first Health Sector Development Program (HSDP) took place from 1997/98 – 2001/02 and the second HSDP, which was designed for a period of three years (2002/03- 2004/05), was recently completed. HSDP I and II address eight major areas or components. These components are health services delivery and quality of care, health facilities construction and rehabilitation, human resources development, strengthening pharmaceutical services, Information, Education and Communication (IEC), health care financing, health management, health management information system (HMIS), and monitoring and evaluation.

In 2004, Health Extension Package (HEP) is a new initiative included in the HSDP II. It is an innovative community-based health care delivery system aimed at creating healthy environment as well as healthy living. The main objective of HEP is to improve access and equity to preventive essential health intervention through community (Kebele) based health services with a strong focus on sustained preventive health actions and increased health awareness. The health extension service is a package that focuses on preventive health measures targeting households particularly women/mothers at the Kebele level. Two female workers are assigned per Kebele.

Sources of health information
Access to and use of timely and reliable health information is essential for ensuring adequate monitoring and evaluation of health and related programs. Health information systems should support the decision-making process at all levels of the health system.
Sources of health information in Ethiopia include:

- Household surveys (e.g., Demographic and Health Surveys).
- Disease surveillance and outbreak notification.
- Censuses.
- Data collection based on patient and service records and reporting from community health workers, health workers, and health facilities.
- Facility surveys.
- Programme-specific monitoring and evaluation (e.g., TB, HIV/AIDS, EPI, etc).
- Research and special studies.

A number of constraints in data collection and use have been identified and include the following:

- Poor quality of data;
- Duplication and waste among parallel health information systems;
- Lack of timely reporting and feedback;
- Poor use of information;
- Centralization of information management without feedback to lower levels;
- Variation in quality and completeness of reporting;
- Timeliness of reporting;
- Does not provide coverage estimates; and
- May only cover government facilities.

According to the Federal Ministry of Health of Ethiopia, the most common causes of mortality among the general population were malaria, tuberculosis, and pneumonia. In females, the most common causes of death were similar to the general population and complications of pregnancy ranked 10th. The cause of death was based on health facility statistics and not stratified by age and sex groups. Of the non-communicable diseases, hypertension occupied 6th place. In spite of a relatively high prevalence of adult HIV/AIDS, it was not reported as the main cause of death in this basic FMOH report.

Thus improvement in the health of the population requires information systems that are accurate, comprehensive, and can provide coverage estimates and assess changes through time using different variables. Data from demographic surveillance sites can fill some of the gaps.
INTRODUCTION

The Rationale for the studies

The Butajira Rural Health project (BRHP) was established in 1986 with the objectives of providing a base population, sampling frame, and infrastructure for problem-oriented community based studies in addition to providing epidemiological information that contributes to improved health management and decision-making. 82,113 A number of community based studies have been conducted since its establishment. The rationale for undertaking the current mortality and survival studies in the BRHP can be divided into the following interrelated areas.

Assessment of changes in status through time

BRHP has been operating for about two decades. There have been several research outputs in terms of mortality experience of the study population in the past. On the other hand, a number of social, political, and environmental phenomena have taken place since the establishment of the project. It is important to assess the trends in mortality and their association with other changes/factors in order to understand factors that affect mortality and survival among the different population groups and suggest interventions.

Areas where vital information is inadequate

Assessment of cause has been done by asking a relative or caretaker a single question about the perceived cause of death except on some occasions when a systematic assessment was done using a standardized instrument. Although relatives’ perceived cause of death gave some gross clues about the pattern of causes of mortality (e.g., communicable and non-communicable), it was difficult to interpret the perceived causes of death because a large proportion of causes of death were unknown or attributed to other causes. There was a need to continuously ascertain cause of death using a valid and sustainable instrument.

Determinants of mortality

Previous studies had identified some determinants of mortality. 55,65,93 However, not all important determinants and their interactions were addressed. (Indeed, this study does not address all determinants). Attempts have been made to include new variables or strengthen existing ones (e.g., household decision-making, social capital, and household economy).
STUDY OBJECTIVES

This thesis examines ways of establishing cause of death and assesses the trends in mortality and factors that affect mortality and survival among the different population groups of the BRHP.

Specifically, this thesis addresses the following issues:

1. The performance of VA methods in ascertaining cause of death in BRHP DSS.
2. The influence of household decision-making, social capital, socio-economic factors, and health service use on under-five mortality.
3. Patterns of adult mortality in a rural Ethiopian population over time, by gender, urban or rural lifestyle, household economic status, and decision-making.
4. The growth in number, relative size, and survival among the elderly and the factors associated with survival.
MATERIALS AND METHODS

The setting

The Butajira Woreda (district) is organised into 82 Peasants’ Associations (PAs) and 4 Urban Dwellers’ Associations (UDAs). The altitude ranges from 1,500 to 3,400 m above sea level. The total population was estimated at 257,000 by 1999. Currently, the study district has a district hospital and a health centre. In addition, eleven low level private clinics and eight community health posts provide health services to the study population. The health posts were established as part of the DSS intervention activities. The hospital was established in 2002 with the contribution of the community and outside aid. The hospital and the health centre provide both curative and preventive services such as expanded program of immunization (EPI), antenatal care, and delivery care. The hospital also provides surgical and emergency obstetric care services. The low level private clinics provide mainly non-surgical uncomplicated curative services and are staffed either by health assistants or nurses. Community health posts staffed by community health agents provide health education, serve as outreach services for EPI, and treat some childhood illnesses such as uncomplicated malaria and pneumonia using only oral medications.

The Butajira Rural Health Program is an Ethio-Swedish collaborative research program associated with the departments of community health, AAU (now School of Public Health) and Epidemiology and Public Health Sciences, Department of Public Health, and Clinical Medicine, Umeå University. It is located 130 km south of Addis Ababa in one of the districts (Woreda), Meskan, and Mareko and includes nine PAs and one UDA that were randomly selected using probability proportionate to size technique.
A census was performed in the area in 1986 and has been followed by continuous demographic surveillance of vital events. Monthly registration of vital events has been on-going since 1987 with periodic census surveys. Since 1999, surveillance data collection has been conducted quarterly. Recensuses were conducted in 1995 and in 1999. Based on the experiences gained in previous censuses, a new strategy is being implemented instead of a census that took place five years or more since 2003. According to this strategy, known as “Reconciliation”, separate evaluation data confirmation visits are undertaken for the different components of the surveillance at different times of the year. This essentially replaces the census and is done on a yearly basis thereby improving the quality check up mechanism through more frequent check systems and by decreasing the amount of data to be collected and analyzed. Since its establishment, many research projects with a training component have been conducted using the study base; 13 PhDs at Addis Ababa University, Ethiopia and Umeå University, Sweden and 30 MPH candidates at Addis Ababa University have conducted their research project in Butajira. A number of other research projects have also been affiliated to the base in the last several years.

BRHP has been a leading DSS site in Ethiopia. Its importance was recognized by researchers in other universities and colleges and health and related sector ministries. Following the footsteps of Butajira, other universities have started to establish a demographic surveillance site in north, southwest, south, and eastern Ethiopia.
BRHP is a member of a network of collaborating Demographic Surveillance Sites, INDEPTH, with about 40 member sites in Africa, Asia, and Latin America. This network was established with a mission to harness the collective potential of the world’s community-based longitudinal demographic surveillance initiatives in resource-constrained countries to provide a better and empirical understanding of health and social issues and to apply this understanding to alleviate the most severe health and social challenges.\textsuperscript{33} One of the products of INDEPTH is a standardized verbal autopsy tool,\textsuperscript{116} which has been adapted and used in this study.

Study Design

This thesis work used a cohort and a case referent study that was preceded by a focus group discussion to design part of the study instrument and a verbal autopsy procedure to identify causes of death.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{study_components.png}
\caption{Study components by design and time}
\end{figure}
Focus Group Discussion

The Focus Group Discussion provides information on appropriate and acceptable information for the community questionnaire with emphasis on those issues that need a local context to be defined accurately (e.g., social capital, economic status, household decision-making). A total of 12 FGDs were conducted that consisted of two women’s and two men’s groups in each of the three residence strata (rural lowland, rural highland, and urban). The participants were selected with the help of community leaders with criteria that made knowledge of the general socio-economic situation of the population central in the selection process.

The discussions were tape-recorded and transcribed verbatim. After reading the transcripts several times, we made and refined codes, focusing on type of household decision-making, what assets (items) indicate economic status, and which social capital items are important and how they rate them. There was a general agreement to include all items that were used in the Ethiopian Demographic and Health Survey on household decision-making and how to define them. This included making big decisions (decisions to change place of residence, buy, sell or reconstruct a house, rent land, etc.), routine household decisions that include decisions on buying and selling food items and day-to-day activities in the household, decisions to visit family and friends, and decisions to take a sick family member to a health institution.

Regarding social capital items, focus group participants were presented with a questionnaire recommended by the World Bank[117] and asked to give their opinions on the items that are useful in their local context and discuss the possible adaptation to each question. The most important items identified by all groups were the ability to borrow money in case of need, membership of the Kebele (smallest administrative unit) leadership, and membership of community organizations, trusting people, and thinking that people can hurt. Certain items were considered by most FGD participants as unreliable or even as possibly compromising the study aims. An example of such item was a question on trusting or not trusting politicians. Some items were considered too rare to be useful (e.g., making telephone calls).
With respect to household economic status, the participants were asked to mention items that were important when measuring household economic status. They were then presented with items used in the Ethiopian Demographic and Health Survey and asked to identify which items were important in their area and how important these items were. First items that can reflect wealth (household economy) were identified for urban and rural areas. These were similar by all groups. Considering the responses of the first two groups on how the respondents presented the importance of each item in comparison with categories of each item (e.g., having different land sizes) and with other items (e.g., having oxen), participants were asked to score identified items out of a total of 4 (scale of 0-4). These classifications are shown in Annex 1. In addition to helping in scoring important variables of the study, the results of the FGD were used to adapt the study instrument in terms of phrasing certain questions.

**Verbal Autopsy**

A verbal autopsy questionnaire was prepared to assess the cause of death based on instruments prepared by INDEPTH/WHO. The questionnaire consisted of specific sections for neonates (less than 28 days), children 29 days–11 years and 12 years and above. The questionnaire included both open narrative and closed questions. The narrative was used to record free explanations of the circumstances of death while the closed questions dealt with specific symptoms and conditions. It was pre-tested on a sample of retrospective deaths. The causes of death were assessed by physicians’ review and the InterVA method. Two physicians reviewed each VA form independently to assign causes of death and later met to reach consensus for cases where there were differences. The physicians and the principal investigator agreed on an abridged list of ICD-9 classification to classify the cause of death. The physicians were given an orientation on key issues concerning establishing cause of death by verbal autopsy. It was agreed to assign more than one cause of death if necessary and focus on the underlying cause(s) of death.

Identifying cause of death by the InterVA (probabilistic model) requires the extraction of a defined set of indicators (signs, symptoms, history, circumstances) as the input to the model and can be derived from both the open narrative and the closed questions in the VA interview. Running the model on these indicators then generates a database with up to three likely causes of death for each case together with the respective likelihood. For cause-specific mortality for each important CoD in the community, individual cases
that were assigned more than one cause were taken to represent two or three fractional causes. For the Physician Review, when deaths were assigned two causes, each was allocated a weight of 0.5. This was possible because the physicians did not assign more than two causes for a death. Causes of death assigned by both methods were aggregated to arrive at the respective CSMF at the community level. Initially it was planned to assess the validity of the physicians’ review by comparing to hospital cause of death, but this was not possible even for a small number of cases as people often died at home.

Cohort study

The cohort component used the 18 years surveillance data (1987-2004) to assess possible cause of death, the trends in mortality, and distribution by background characteristics: urban or rural residence, literacy (often as presence of literate person in the household), time trend, marital status and house ownership as appropriate.

Cohort study

The reported causes of death were grouped as communicable (including maternal) (e.g., diarrhoea, malaria, and TB) and non-communicable (e.g., heart disease, injury, and sudden death) and unknown. The unknown and “other” categories were included as non-communicable causes for the adult age group because people in these communities are more familiar with and find it easier to recognize communicable causes of death.

Prospective Case Referent Study

A prospective case referent study was carried out between 2003-2005 to complement the analysis on the determinants of mortality and focused particularly on issues related to household decision-making, social capital, economic status, and some behavioural factors such as health care seeking. Deaths were prospectively included in the study as they occurred. For every case, three referents were randomly selected and matched for age, sex, and place of residence. The referents should have survived the cases, but belonged to the same age categorization and lived within the selected Kebele. The referents were selected according to the following age categorizations: under one, 1-4, 5-9, 10-19, 20-59, and 60 and above. In the elderly population, some of the selected referents were found to be younger than the cases and the number of appropriate cases and referents became too small; this prohibited analysis in this age group and hence case referent analysis was dropped.
**Study Population**

The study population consisted of the people in the BRHP study base in the period 1987-2004, stratified by sex and place of residence as appropriate. The main subgroups included in this study were children under-five years old, adults 15-64, and the elderly 65 years and above. For the case referent study, under-five children and adults (15-64) that died or survived in the period 2003-2005 formed the study population.

A sample size of 169 cases (and 507 controls) gives 80% power for 20% of the expected frequency of exposure in the controls and odds ratio of 1.8. Assuming a total population of about 43,800 and infant mortality rate of 100/1000, 192 infant deaths were expected in a year. Thus a one-year data collection would give the required power for infant mortality. For child mortality (about 142 deaths), 80% power would be achieved at one and a half years. For adults, the same or greater power was expected after one and a half years.

**Data Collection**

*Demographic Surveillance*

Data collection for each vital event takes place on specially prepared forms for each household. Each form contains several questions that are pertinent to adequately characterize the event. The household interviews are conducted by trained village based enumerators (around 20 who live in the respective study villages) with a formal education of 10 years or above. Each village is divided into four zones for the sake of simplicity. The enumerator in the village spent one week in each zone and was not allowed to continue onto the next zone before the allotted time even on completing one zone in order to ensure that each household is visited at regular intervals. Completed questionnaires were submitted by the data collectors to their field supervisors on a weekly basis. Field supervisors (4 persons) each designated to 2-3 villages and a project coordinator at Butajira performed the immediate supervision of data collection procedures on a daily basis.
Case referent study

A core questionnaire was prepared on main socio-economic characteristics for all age groups. In addition, questionnaires containing relevant variables for each age group were prepared. Questionnaires were first prepared in Amharic, the Ethiopian official national language, and translated into English by two public health experts with good knowledge of both languages and then back-translated to Amharic. The questionnaire was pre-tested, standardized, and administered to close relatives of cases and the referents at their homes. Five data collectors who had completed 10 years of schooling or above with previous experience in community-based data collection administered the questionnaire to those who witnessed the death and took care of the deceased and the selected referents. A supervisor coordinated the activities of the data collectors, checked the questionnaires for completeness and consistency, and conducted random checks by re-interviewing about 5% of the respondents. Training was given with emphasis on issues such as preferred respondents, period of interviews, approaching grieving respondents, and compiling narrative material (ensuring duration, frequency, severity, and sequence). Pre-test was conducted and resulted in small modifications to facilitate better understanding by the study population.

Each interviewer was assigned two Kebeles (smallest administrative units) based on his/her previous place of work and experience. All interviewers and their supervisors actively sought information and were notified by the respective DSS data collector and supervisor on any death as soon as it occurred. They also regularly reviewed death registration forms and BRHP registration book and noted identification numbers to be clear on where and about whom data would be collected. Identification and other relevant characteristics of the deceased (Id No, Kebele, age, and sex) were sent or handed to the principal investigator who randomly selected three referents matched for sex, age, and place of residence (Kebele) using SPSS version X. Data were collected from 45 to 60 days after death considering the usual mourning period in the study area. Collecting data two months after death minimized recall bias concerning details of symptoms and circumstances of death. Quality control activities included regular discussions among data collectors, supervisors and researchers and allowed for a review of database information and random field re-checks of filled questionnaires by the supervisor and researcher. Questionnaires with inconsistent or missing data would be returned to the data collectors for correction as necessary.
Data management and analysis

Surveillance data were entered using a modified dBase software that could be exported to various statistical packages including EPI INFO, SPSS, and STATA. During the first years of the surveillance, data were entered at Addis Ababa University. Later data entry was started in Butajira town by training local data clerks. This helped to shorten the time for feedback for field workers. Distribution of person years and mortality rate by sex, place of residence, and life expectancy were analyzed using the Cohort software (Cohort, Umeå University). For the study on adult mortality, crude and adjusted rate ratios and their 95% confidence intervals were computed to assess the relationships between mortality and background variables using a Poisson regression model in which person-time under surveillance was the rate multiplier. The standard errors were adjusted for clustering at the Kebele level using STATA 9. For the elderly, Cox regression analysis was used to assess the hazard ratio on mortality by different factors for the whole age group 65 years and above.

Social capital scores consisted of the ability to borrow money in case of need, membership of the Kebele (smallest administrative unit) leadership, membership of community organizations, trusting people, and thinking that people can hurt. Each of these was coded as 1 when answered positively and 0 when answered negatively, except the response for ‘people can hurt’ for which the reverse was coded. The maximum score was 5, categorized into three equal categories as 0–1 low, 2–3 average, and 4–5 good.

The decision-making scores were initially categorized as decision only by the head (which was generally the husband), by spouse (mainly the wife), both husband and wife, and other family members. Analysis of decision-making scores showed a higher proportion of childhood deaths when the husband alone decided. Wives alone decided in only 5% of the cases. Subsequently, decision-making by the husband alone was given a 0 score and by both or the wife a 1 for all four variables. A summary variable was created. A score of 0–2 was compared against a score of 3–4. A composite variable of economic status was created by summing scores for the urban and rural areas separately. The composite score was classified into two categories. The lowest quartile scores were categorized as low and the rest as better.
To assess the concept of avoidability of deaths in under-five children, all deaths were first classified as having resulted from potentially avoidable causes (e.g., respiratory tract infections, diarrhoea, etc.) or possibly unavoidable causes (accidents, congenital conditions, etc.) based on the assessment of the prevailing conditions in the study area (availability of mechanisms and resources) and the present capacity of the health system. Then potentially avoidable causes were assessed for the presence of avoidable factors and were classified as avoidable or unavoidable by the two clinicians and the principal investigator. Avoidability was classified as household and health service factors based on criteria developed by considering classification by other authors\textsuperscript{119-121} by the two physicians and the investigator. Household level avoidability was entertained when health services were not sought at all for a possibly avoidable cause or there was undue delay in seeking care. Health service avoidable factors were related to possible failure to make appropriate diagnosis, poor management and/or follow up, and lack of referral.

Case-referent data were entered and analysed using SPSS Version XI. Crude and matched adjusted odds ratios and their 95% confidence intervals were used to assess effects of risk factors on mortality using conditional logistic regression analysis.

**Ethical considerations**

This study was approved by the Medical Faculty of Addis Ababa University. Ethical clearance was also obtained from the Ethiopian Science and Technology Commission, the highest body for approving research undertaken in the country. Permission for the study was also obtained from local authorities. Individuals provided informed verbal consent. Individual information was accessible only to the research team and was kept confidential.
RESULTS

Population development by age group

Person years of observation increased for all age groups from 1987-1992 to 1999-2004. However, the percentage increase was highest for the age group 15-64 and lowest for the under fifteen children. Correspondingly, the proportion of the under fifteen year olds decreased while that of the adults increased. The proportion of the elderly population remained more or less the same (Table 2).

Table 2. Distribution of person years and proportion from the general population by calendar year

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>0-14</td>
<td>95443.89</td>
<td>49.8</td>
<td>107369.14</td>
<td>47.4</td>
<td>(11.2)</td>
</tr>
<tr>
<td>15-64</td>
<td>90891.29</td>
<td>47.4</td>
<td>113026.66</td>
<td>49.9</td>
<td>(12.4)</td>
</tr>
<tr>
<td>65-</td>
<td>5347.4</td>
<td>2.8</td>
<td>5911.74</td>
<td>2.6</td>
<td>(11.1)</td>
</tr>
</tbody>
</table>

* - Proportion from all age groups in the time period
** % Increase compared to 1987-92

Mortality and survival

Causes of death and their ascertainment

Among 9161 deaths between 1987 and 2004, 4861(53%) were classified as communicable and 793 (9%) as non-communicable deaths based on the responses of caretakers or relatives. The causes for remaining 3507 (38%) were unknown. Verbal autopsy interviews were completed for 289 VA deaths between 2003 and 2004. Ascertaining cause of death by physicians’ review and the InterVA model came up with similar results. Four major causes accounted for more than 60% of all mortality as determined both by the Physicians’ review and the InterVA model (Paper I). These were pneumonia/sepsis, pulmonary tuberculosis, malaria and diarrhoea, and disease/malnutrition. Some differences were noted between the Physicians’ review and the InterVA model. The physicians assigned more frequently meningitis and malaria and perinatal problems while HIV/AIDS was less frequently diagnosed by the physicians than the model.
As ascertained by the InterVA model, higher rates of HIV/AIDS (11%), tuberculosis (18%), and cardiovascular (9%) mortality were detected in the urban area compared to rural areas.

**Under-five mortality**

*Under-five mortality in 1987-2004*

The mortality rate between 1987 and 2004 was 37.9 per 1000 person years. The estimate for urban areas was 17.9 per 1000 person years and for rural areas it was 42.3 per 1000 person years. The infants had a higher mortality rate compared to 1-4 year mortality. Infant mortality was estimated to be 88.1 per 1000 person years while that of child (1-4 years) mortality was about 24 per 1000 person years. Peaks of high mortality occurred from time to time. The highest mortality rates were observed in rural areas in 1999 where infant mortality was 181.7 per 1000 person years and child mortality (1-4 years) was 76.8 per 1000 person years.

*Causes, determinants and avoidability of under-five mortality in 2003 -2005 (Paper II)*

The most common causes of death as identified by the Physicians’ review were pneumonia (29%), diarrhoeal diseases (23%), perinatal deaths (18%), malnutrition (16%), and meningitis (10%). Lack of immunization had a strong association with mortality in under-five children (adj OR 9.8 (6.0–16.1)) and infants (adj OR 26.2 (12.0–57.3)). Mortality of children was about three times higher in families with low decision-making scores compared to those with high decision-making scores. Low social capital and low economic status were associated with higher under-five mortality compared with those with better economic situations, but economic status did not maintain statistical significance when controlling for other factors. The impact of low social capital scores was higher for infants compared to all under-five children. First pregnancies, adolescent mothers, and children with both parents illiterate had higher odds of dying, although the associations were not statistically significant when adjusted for other factors.

The association of different factors with under-five mortality is shown in Annex 2. Avoidable factors were identified in more than 70% of the cases in the form of delayed health seeking, not seeking (modern) health care at all, and possible poor management and referral of patients. Difficulty in
finding transport was reported by about half of the respondents. The types of household and health service avoidable factors identified among the cases are shown in Annex 3.

**Fertility and Under-five mortality**

A fertility survey conducted in 1995 compared the relationship between under-five mortality adjusted for other factors. Accordingly, women who had 4 or more child deaths had 1.7 times higher live birth rates and those who had 1–3 child deaths had 1.3 higher birth rates compared to women who had no child deaths adjusted for place of residence, immigration, mother’s literacy, and women’s age at interview. Under-five mortality was strongly and independently associated with fertility in all the three residential strata – i.e., urban, rural highland, and rural lowland areas (Figure 4).
**Mortality in children 5-14 years old**

This group of children had a relatively lower mortality rate. In particular, children 10-14 years old had the lowest mortality ranging from 4 per 1000 (max) to 1 per 1000 (min) in urban areas. However, the urban rural difference appears to influence mortality to a greater extent than the age difference. Children in the age group 10-14 in rural areas had a higher mortality compared to children 5-9 in urban areas (Figure 5). For both age groups the risk of death for rural residents was about 3 times higher than those of the urban dwellers [RR 3.4 95% CI (2.74, 4.23)]. Males had a slightly higher mortality rate, but the difference was not statistically significant [RR 1.21 95% CI (1.08,1.35)].
Figure 5. Incidence of mortality among children 5-14 by calendar year and place of residence in Butajira 1987-2004

Adult mortality (Paper III)

Trend, causes, and determinants in 1987-2004

There was a modest downward trend in adjusted mortality over the 18-year period. However, substantial epidemic peaks were observed. Considerable excess male mortality was evident in the urban area up to 1991. The rural area experienced a sizeable peak in mortality from 1998 to 2000.

One thousand five hundred and thirteen (53%) deaths were attributed to communicable diseases and the remaining 1,342 (47%) to non-communicable diseases (NCD) with males having slightly higher rates of NCD mortality than females (adjusted rate ratio 1.14 (95% CI 1.03, 1.27)). The effect was stronger in the urban area (adjusted rate ratio 1.65 (95% CI 1.24 to 2.21)).

The divide between urban and rural lifestyles was an important factor of mortality with consistently higher mortality for rural dwellers. Analysis of the relationship between source of water supply and distance from a hospital and mortality as some of the underlying differences between urban and rural residence showed a strong association with adult mortality (Table 3).
Table 3. Association of distance from hospital/health centre and source of water supply with adult mortality, Butajira 1987-2004

<table>
<thead>
<tr>
<th>Distance from hospital/health centre</th>
<th>Crude rate ratio 95% CI</th>
<th>Adjusted rate ratio* 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 km</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2-4 km</td>
<td>1.99 (1.65, 2.39)</td>
<td>1.89 (1.55, 2.30)</td>
</tr>
<tr>
<td>5 Km</td>
<td>1.99 (1.76, 2.25)</td>
<td>1.90 (1.64, 2.20)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of water supply</th>
<th>Crude rate ratio 95% CI</th>
<th>Adjusted rate ratio* 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Other source (river, well, spring)</td>
<td>1.92 (1.68, 2.18)</td>
<td>1.78 (1.54, 2.07)</td>
</tr>
</tbody>
</table>

*Adjusted for sex, age group, time period, house ownership, and presence of literate person in the household.

Urban rural difference was a strong predictor of mortality.
Absence of literate person was another important factor and its effect was particularly strong in rural areas (rate ratio 3.16 (95% CI 2.92 to 3.41)) and among men (rate ratio 3.19 (2.88 to 3.54)). Similarly, non-ownership of the house where people lived was strongly associated with higher mortality and the association was stronger in rural areas (rate ratio 3.23 (95% CI 2.99 to 3.49)).

**Determinants of mortality in the years 2003 – 2005**

Marital status, lower household economic status, and absence of joint household decision-making were significantly associated with adult mortality. Marital status was strongly associated with male mortality in the age group 15-44. Unmarried men (single, divorced, and widowed) were about 3 times more likely to die (odds ratio 3.56 (95% CI 1.86, 6.83)) compared to the married men. The differences were not statistically significant among females or in the age group 45-64. Lower household economic status was strongly related to mortality in both males and females in rural areas. In the urban area, economic status had a greater effect on female mortality. Lack of joint household decision was a strong predictor of female mortality in rural areas (OR 1.93 (95% CI 1.11, 3.36)), but not in urban areas. For women, participation in routine household decision-making and decisions to visit relatives and health facilities were strongly associated with mortality (Paper III, Table 3).
Elderly survival and mortality (Paper IV)

The total number of person years observed among the elderly increased during the study period. Compared to the first six years, the number of years increased by about 48% in the years 1999-2004, although the proportion from the general population did not increase as this was offset by the decrease in under fifteen year old population and the increase in the adult (15-64 years) population. Increase was higher in rural areas where net migration was higher. Female mortality was lower than male mortality, but the difference was minimal in rural areas. Remaining life expectancy at 65 years ranged between 15 years in rural men to 19 years in urban women. As expected from the mortality experience, rural women and men had similar remaining life expectancy.

Survival graph by sex showed overlapping curves for men and women in almost all years (Paper IV, Figure 3). Widowhood (OR 2.18, 95% CI (1.63, 2.92) and illiteracy (OR 2.15, 95% CI (1.71, 2.70)) had very strong effects on mortality in men. Widowhood also had strong association with female survival although to a lesser extent illiteracy was not associated with female survival. Male survival curves by widowhood and literacy status indicated a much lower survival for the widower and the illiterate, whereas such curves for females did not show differences by literacy and widowhood status (Paper IV, Figures, 4 & 5). A very steep decline in survival was observed among widowers in the first few years after 65 years.

Urban residence had a large protective effect (OR= 0.58, 95% CI (0.54, 0.63)) compared to rural residence among women but was weak for men. Similar to adult mortality, source of water supply predicted survival hazard among the elderly. Not having a pipe water was associated with about 1.7 times lower survival rate (95% CI (1.6, 1.9)) adjusted for illiteracy, widowhood, and time period. Distance from hospital/health centre was also related to lower chance of survival although the relationship did not appear to be linear. Hazard ratio of survival at a distance of 2 km or more, but less than 5 km, was 1.92 (95% CI (1.76, 2.08)) and at a distance of 5 km and above it was 1.51 (95% CI (1.40, 1.62)).
Communicable diseases consisted of 53% of the perceived causes of death with a large proportion unknown in the whole study period; pneumonia/sepsis, pulmonary tuberculosis, malaria, and diarrhoea disease/malnutrition contributed to 60% of the deaths according to the verbal autopsy and the category non-communicable diseases, and HIV was shown to have a higher prevalence in urban areas. Decrease in mortality was modest with certain peaks. Low decision-making, low social capital, and immunization were associated with high mortality. Factors that affected mortality among adults were the divide between urban and rural lifestyles, absence of literate person in a household, not owning a house, being unmarried, and household decision-making. There were variations between men and women and urban and rural areas. The elderly population is growing in numbers but not in proportion. Survival was higher in females in urban areas, but the difference in survival in rural areas was negligible. Place of residence, illiteracy, and widowhood showed differences between men and women.

This study mainly used the Butajira Surveillance data of 18 years duration, data that provides a unique opportunity to understand the mortality and survival experiences in a country where vital registration does not take place. Alternative sources such as cross-sectional studies would not allow making conclusions about trends and cause and effect relationships and hence are less robust.

The quality control methods instituted at the field, data entry, and analysis levels coupled with a periodic census ensure the validity of the results. Although the ability to generalize all findings to other districts in Ethiopia or other developing countries may be questioned, several basic results can be generalized to areas with similar socioeconomic status as is also evidenced by the similarities of findings of national reports and some studies. For example, the basic health and related indicators are similar to those of the Ethiopian Demographic Health Survey. A more detailed study that compared DSS and DHS approaches in the specific instance of child and adolescent mortality in Ethiopia using data from the Butajira DSS 1987-2004 and the Ethiopia DHS rounds for 2000 and 2005 reported that patterns of mortality over time were broadly comparable. These can complement each other with DSS data being more susceptible to
local epidemic variations, while DHS data tended to smooth out local variation, but was more subject to recall bias. Studies in other DSS sites have also come up with similar conclusions. A study in Burkina Faso reported that similar results were obtained when assessing risk factors for childhood mortality using a DHS Data and DSS. In Bangladesh, DHS and DSS findings for the Matlab site and the country were comparable in infant mortality and fertility rates, while the country contraceptive prevalence rate was said to be underestimated by the DHS. The Manhica DSS was reported to be an adequate tool to report demographic measures for southern rural Mozambique. It is important to identify areas where the findings of a DSS site can be generalized and where they are not to effectively use the continuous supply of information from DSS sites.

The analysis of surveillance data have been supported by case referent studies in this thesis work and has allowed the identification of certain factors that are important but were not (could not be) included in the ongoing surveillance data collection. A focus group discussion has supplemented the research to identify certain factors that could otherwise not have been defined in the context of the study area.

An obvious limitation of the surveillance data is that all the important predictors of mortality were not included in regular data collection and some parameters, such as cause of death, were imprecise. Classification between communicable and non-communicable death among adults (15-64 years) was based on the responses to simplified questions and probably introduced some misclassification bias. However, analysis of cause of death data among adults using the VA conducted in 2003 showed that about 50% of deaths for communicable and non-communicable diseases each did not show a large difference to what we found in the surveillance data analysis.

A limitation of the case referent component is the potential for recall bias. Less than 10% of the interviews were conducted after 3-4 months. However, there was no appreciable difference in the distributions of important determinants and causes of death between those who were interviewed around two months and later. In addition, studies have reported that mothers’ recall over a six-month period was similar to one month after death. With valid results, some DSS sites have undertaken data collection on a yearly basis.
This study tried to measure avoidable factors in the household and in the health services. Since health services have not been assessed by observing activities of health facilities other than the caretaker’s response about the management, follow-up, or referral of the child, the assessment of the health services quality and avoidability of the deaths may be incomplete. However, the information provided by this study gives important clues about the prevailing problems in health provision.

A person answering questions about a deceased person may not know all the relevant information. For example, factors that were used to assess social capital did not show differences between the cases and referents in adults and the elderly whereas associations were revealed for under-five mortality. These factors may affect children and adults differently. On the other hand, for children the questions were directly related to the caretaker or family, and the caretaker is the best respondent although she/he may not have accurate information about the deceased person when it comes to adults. In addition, a relatively small sample size did not allow comparisons of mortality effects in subgroups.

Measurement of socioeconomic status is a difficult issue globally and more so in a rural developing country setting. In Vietnam, local classification of household economic status was used to assess its relationship with mortality. Our study attempted to use the community’s perspective and community involvement to classify people into different groups combined with instruments used in national surveys. While this approach has the advantage of knowing the local context and is useful particularly if validated, it may pose some difficulties in comparing with other settings.

It was assumed that a 1-2 years data collection would provide a sample size adequate for each group for the case referent study. However, where there are several strata and the absolute number in the group is small, the size may not be adequate enough to provide the necessary power.

**Verbal Autopsy and Cause of death**

While the simplified question of asking the cause of death provided useful information, the need for systematized data collection (VA) to identify cause of death became obvious. The Physicians’ review method and the InterVA have similar yield although the InterVA is less costly and less time consuming.
The most common causes of death are communicable diseases. Our finding of a higher prevalence of communicable causes is commensurate with prevailing socio-economic conditions. In addition, a study of risk factors for non-communicable diseases found a lower prevalence compared with some Asian sites.\textsuperscript{127} Nonetheless, we note that by comparison with a previous study\textsuperscript{114} there appears to be a higher occurrence of non-communicable disease, indicating the increasing double burden of communicable and non-communicable diseases.

Urban–rural differences in non-communicable and communicable diseases may be diluted by the emergence of HIV/AIDS and its relatively higher prevalence in urban areas. Thus, while deaths due to “traditional” communicable diseases remain high, increases in non-communicable diseases and HIV/AIDS indicate the need for preparedness to deal with this “triple” burden, particularly in urban areas.

The pattern of mortality in Butajira more or less indicates “delayed stage of epidemiologic transition”, although the appropriateness of the use of the classical transition stages is being challenged.\textsuperscript{9-10,128} We have been observing episodes of famine and epidemics, some rise in the non-communicable diseases overlapping with increase in new communicable problems (HIV/AIDS) particularly in urban areas, and relatively greater decline of mortality in the last three years.

**Magnitude and trends of mortality**

Overall the study population experiences high mortality. Mortality rates are highest for under-five children and lowest for the age group 5-14 followed by young adults (15-44 years old). This pattern matches the overall socio-demographic situation of the study area and the country. The group 5-14, which has the lowest mortality, has not been studied in detail. This age group is likely to be less affected by diseases that affect early childhood because of the better development of the body’s defence mechanisms and is perhaps a selected group that has survived the difficult period of early childhood. On the other hand, it is too early for the group to be affected by health problems affecting adults and older adolescents, although the age group 10-14 may tend to fall in the latter category. The age group 5-14 had a more linear downward trend in mortality than any other group not being greatly affected even during epidemics and famines. However, the age group needs further attention. The formative stage of the group
requires attention in overall development and health promotion and prevention of risky behaviours. In this era of HIV/AIDS, educating the age group 5-14 has been named as the “window of hope” as a great majority of the children who had acquired HIV by mother to child transmission would not live and children 5-14 years would unlikely be exposed to the risk of acquiring HIV/AIDS through risky behaviours such as unprotected sexual intercourse. Education before they reach the peak vulnerable years will protect them, and this protection will be reinforced by early training that promotes healthy life styles and avoidance of risky behaviors. 129

A hospital-based study in southwest Ethiopia reported that childhood accidents have become the leading cause of morbidity and mortality and of the total 452 cases of accidents observed in the hospital, 79 (17.5%), 271 (60.0%), and 102 (22.6%) of the subjects were within age group of 0-4, 5-9, and 10-14 years, respectively. 130 A 15-year retrospective study of mortality in the US reported that among adolescents a distinct pattern was observed between the age group 10-14 years and 15-19 years; the former mainly died of accidents while the latter died of violent deaths. 131

The overall modest trend in mortality in the study area has been affected by periods of drought and epidemics. The fall in rates following the period of epidemics may partly be due to a shadow effect of “early mortality for the vulnerable” during the epidemic period. The period also partly coincided with a new hospital being built in Butajira. Relatively high death rates were selectively observed among adult urban men in the period 1987-91, rates that may be attributed to a civil war between the current and the previous governments, which included recruitment of men to the war.

**Factors associated with mortality and survival**

Place of residence and literacy status or (either individual literacy status or presence/absence of literate person in the household) have been associated with mortality in children, adults, and the elderly. In some instances, however, non-significant associations have been observed with individual literacy status. Possible reasons are small number of literate persons and the level of education that may not enhance better knowledge, better job opportunities, and empowerment. The relative advantage of living in urban areas include better access to health services, access to clean and safe water as shown by the strong relationship between distance to hospital/health centre and poor water supply with mortality.
Some of the differences in factors associated with mortality or survival among the different population groups may be due to the different effects of these factors. It is plausible to think that some factors affect women and children to a greater extent. Women are culturally dominated by men and they are generally responsible for household activities such as the provision of water, care for children and other family members, and working in food production. A previous study has reported that rural residence is associated with high workload and low decision-making for women.\textsuperscript{94}

The ability to make decisions at a household level may be protective for child and adult female mortality as a result of behavioural changes following improved health knowledge and care and increased use of health services. Decision-making is a key indicator of women’s status and interventions to empower women have shown great impact on their quality of life, autonomy and authority, on policy changes, and possible improvement in infant and maternal survival.\textsuperscript{35,88,132} The relatively higher rural female mortality where there was no joint household decision-making pinpoints the effect of lower status for rural women. Other studies have also reported the effect of household decision-making on child survival.\textsuperscript{133-134} On the other hand, in many countries in sub-Saharan Africa joint household decision-making has been found to be low with large variation. In 2006, a UNICEF report indicated that husbands alone decide on the health of women in about 9% of the cases in Eritrea and 75% in Burkina Faso. Similarly, husbands alone decided on visiting relatives in 9% of the cases in Madagascar and 62% in Malawi.\textsuperscript{35}

The centrality of decision-making within the concept of empowerment suggests empowerment’s great effect on lowering untimely, unnecessary mortality. This is particularly interesting when considering the wide scope that empowerment entails,\textsuperscript{88-89} given the relatively smaller effect of other determinants and the need for a comprehensive approach to deal with high burden of mortality in the study community. People with high social capital may have greater opportunities both for preventing illnesses and getting help during illness and hardships and it appears that child/infant survivorship heavily depends on social relationships and interactions in such communities.
During the 1995 survey, child death and fertility were strongly associated. Several mechanisms have been identified in which mortality can influence fertility. These include a shortened duration of lactation and postpartum abstinence, the desire of parents to have additional births to make up for a dead child, the response of fertility to the expected mortality of the offspring (insurance effect), and cultural values for having a high number of children. It is likely that all these mechanisms may affect the relationship of child mortality and fertility in this traditional community of high fertility and high mortality rates. However, a more detailed study is needed.

Several avoidable factors were identified in child deaths, which included delayed health care seeking or not seeking care at all and possible poor management in health institutions. This is similar to findings about maternal and perinatal mortality in developing countries and might indicate the influence of other factors such as the level of health awareness, the capacity to use the services and functions, and the quality of health services.

Illiteracy and absence of a literate person in a household appears to particularly affect mortality among males and rural residents. Literacy and presence of a literate person may be more advantageous for men than for women in terms of improving awareness. This issue needs to be explored further.

The minimal mortality differences between adult and elderly males and females in rural areas, in particular if the apparent war-time effects on male mortality are discounted, might reflect the difficult situation women are in; that is, women are expected to have a lower mortality because of their biological advantages. Although the proportion of the elderly population has not changed, the number has increased and it is expected that a large number and a greater proportion of the adult population will increase the elderly population in the future with its consequences on the support and care of this group of population. A possible reason for the different effects of widowhood between men and women is that men lose the care and support they get from their wives. A study further argued that marriage could lead to women’s suffering due to restricted roles available to them within marriage.
CONCLUSIONS

The mortality trend over 18 years was influenced by epidemics, drought, and war. Assessment of cause of death by VA gave a better understanding of the cause of death. Physicians’ review and the InterVA model provided similar results of cause of death whereas the latter was less labour intensive and offers consistency, which is important for comparing cause of death across populations. The initiative to ascertain causes of death from several sites in the country (or a country-wide initiative) using the VA method should be encouraged. Communicable diseases are the main causes of mortality while non-communicable diseases and HIV/AIDS are becoming growing concerns particularly in urban areas. Place of residence (urban–rural life style) and literacy (individual or presence of literate person in a household) affected mortality or survival of almost all the groups. Rural women were disfavoured Some factors seem to affect certain population groups. Child and woman survival were affected by household decision-making; efforts to improve women’s involvement in household decision-making (women empowerment) can improve child and woman survival in poor settings. Many factors that significantly affect mortality can be controlled by concerted efforts to improve health and overall development and multidimensional interventions should be undertaken including women empowerment strategies and improved educational status with focus on the rural population.

Recommendations for future research

This study measured household economic status based on nationally used indicators and the community’s perception. However, there is a need for further development and validation of instruments because economic status is one of the most important predictors of health.

The study has shown high prevalence of household avoidable factors among under-five children including delayed or no health care seeking. The reasons for the delay or not seeking care need to be explored in detail. Likewise, problems of patient management and referral were identified in health facilities from the responses of clients. The nature of the problems and their causes should be identified in order to develop relevant solutions. Social capital can be a valuable predictor of health conditions if a knowledgeable respondent and the right outcome are identified. Measurement and effects of social capital need to be studied further.
Research is also needed to understand the wider context of women empowerment including understanding the variables related to women’s status in the area and actions that need to be undertaken to empower women at different levels (household, community, and policy). Several factors – such as physical engagement, feeding and nutrition, and support – have been reported as enhancing survival among the elderly. The effect of these factors in the context of BRHP needs to be explored.

Most studies in BRHP have focused on mortality. However, morbidity and risk factor studies have contributed in understanding and predicting mortality and taking preventive and measures.

Certain factors had different effects on mortality of males and females and possible explanations for such differences have been provided. However, studies have to be undertaken to assess whether these explanations or other reasons are responsible for the observed differences.
ACKNOWLEDGMENTS

“Mesganaw”! (Thanks to Him)! So be it, first and foremost for giving me the strength and the patience to go through the process and with Whose will I was able to complete this work. My late mother gave me the name “Mesganaw”, which means Thanks to Him (the Great Almighty God) in Amharic.

My deep appreciation goes to my primary supervisor Professor Ulf Högberg whose advice and all rounded support was instrumental throughout the process of this PhD work. I will always remember and admire his great patience, kindness, and hospitality.

I am also indebted to Professor Stig Wall, co-supervisor and head of Epidemiology, Umeå International School of Public Health, whose guidance and support has always been with me during the many years I have been in Umeå. He has always found time to attend to every detail of this thesis work. I am also grateful for his great hospitality. With his enormous skills of leadership and enthusiasm, he has "put on the world map not only Umeå, but also Butajira".

My deep gratitude also goes to Professor Peter Byass, a co-supervisor whose role was simply indispensable in many areas including preparing data files for the whole BRHP surveillance analysis, guiding analysis, insightful comments, and editorial revisions. I wonder how he coped with the enormous amount of work he was doing with a large number of PhD candidates in addition to other responsibilities. I remember the numerous discussions with Stig, Peter and Ulf at Stig’s office where I learned a lot on how to conceptualize, think, and work differently. Every session came up with something new.

Professor Yemane Berhane, another co-supervisor, is perhaps the main reason for me joining this program. I am grateful for his unfailing support throughout the process of this PhD work as an advisor, friend, colleague, and Department Head.

I am thankful to Anders Emmelin for the fruitful collaboration we had in coordinating BRHP activities and his immense efforts to keep the BRHP DSS running. I highly appreciate Anders and Maria Emmelin for their friendship and unfailing support. I admire Anders’ and Maria’s commitment to have me in their home in spite of their extremely busy schedule and other inconvenient circumstances.
ACKNOWLEDGMENTS

The support, encouragement, and hospitality that I got from other staff members of Epidemiology, International School of Public Health was enormous. Susanne Walther’s help in organizing the thesis work and defence is greatly appreciated. I also enjoyed the generous support of Anna-Lena Johansson, Birgitta Åström, Karin Johansson, Jerzy Pilch, Göran Lönnberg, Miguel San Sebastian, and others whose names I could/did not mention, but otherwise deserved to.

In Umeå I met a wonderful couple, Abebe and Addis, whom I was bringing something from Ethiopia. I never knew this would be a start of a great friendship. Every time I came to Umeå, they did their best to make me feel at home. I could turn to them for any help. Thank you Abe and Addi! I am also grateful to other friends I made in Umeå for their help and encouragement.

At the Department of Community Health (now School of Public Health), Addis Ababa University, colleagues and friends have contributed a lot to the success of this endeavour. They have encouraged me at times of frustration, have taken over some of my duties in my absence, and given me a hand whenever needed. Many staff members have contributed in some way or another, but just to mention a few, my appreciation goes to Dr. Alemayehu Worku, Mr. Wubegzer Mekonnen, Dr. Yima Melkamu, Dr. Nigussie Deyessa, Professor Ahmed Ali, Dr. Abera Kumie, Dr. Assefa Sime, and last but not least the current School Head Dr. Fikre Enquselliasie.

Photos included in this thesis paper were provided by Axel Emmelin, Anders Emmelin, and Ulf Högberg for which I am grateful. In the final year of my work, I was fortunate to be a neighbour of a very dear friend, Dr. Kassahun Mitiku, on whom I could rely to take care of my family while I was away. Kassesh, please accept my greatest appreciation!

My wife (Lemlem) and children (Bethelhem, Dawit, and Tsion) paid a high price for this work, missed me a lot and I missed them too. I dedicate this work to them.

Lastly, I would like to forward my appreciation to all friends and relatives whom I have not mentioned by name (some may not want to) and who have given me the support and encouragement to bring this work to an end.
## ANNEX 1

Community classification of economic status of families in rural and urban areas of Butajira and allocated economic scores. August 2003 – July 2004

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Better-off</th>
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<td>2</td>
<td></td>
</tr>
<tr>
<td>3 and above</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Number or cows</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>X</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3 and above</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Radio</strong>&lt;sup&gt;a, b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>X</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Monthly salary (birr)</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;200</td>
<td>X</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>300-499</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>500 and above</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Hotel/Big shop or “Grocery”</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>X</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Electricity in the house</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>X</td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> economic indicator only for rural areas

<sup>b</sup> economic indicator only for urban areas

<sup>a, b</sup> economic indicator for both urban and rural areas

<sup>c</sup> A *timad* is a measure of land size that is approximately equal to 0.5 hect
## ANNEX 2

### Association of variables with under-five mortality in Butajira, August 2003 – July 2004

<table>
<thead>
<tr>
<th>Background Factors</th>
<th>Cases (n=209)</th>
<th>Referents (n=627)</th>
<th>All under-five children Crude OR 95% CI</th>
<th>All under-fives adjusted** OR 95% CI</th>
<th>Infants Cases n=144</th>
<th>Infants Adjusted* OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windows</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>145 (70)</td>
<td>391 (62)</td>
<td>1.72 (1.11, 2.68)*</td>
<td>1.46 (0.86, 2.49)</td>
<td>2.05 (1.16, 3.62)</td>
<td>1.68 (0.80, 3.57)</td>
</tr>
<tr>
<td>Present</td>
<td>63 (30)</td>
<td>236 (38)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Mothers age and decision making</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-19</td>
<td>17 (8)</td>
<td>21 (3)</td>
<td>2.83 (1.44, 5.58)*</td>
<td>1.63 (0.62, 4.30)</td>
<td>3.13 (1.50, 6.55)*</td>
<td>3.11 (0.96, 10.11)</td>
</tr>
<tr>
<td>20-34</td>
<td>137 (66)</td>
<td>462 (74)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>35-49</td>
<td>53 (25)</td>
<td>143 (23)</td>
<td>1.28 (0.88, 1.88)</td>
<td>1.15 (0.69, 1.92)</td>
<td>0.97 (0.60, 1.57)*</td>
<td>0.80 (0.39, 1.62)</td>
</tr>
<tr>
<td><strong>Parents' educational status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one literate</td>
<td>90 (43)</td>
<td>322 (51)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Both illiterate</td>
<td>119 (57)</td>
<td>305 (48)</td>
<td>1.44 (1.03, 1.99)*</td>
<td>1.13 (0.75, 1.69)</td>
<td>1.27 (0.87, 1.88)</td>
<td>1.24 (0.72, 2.12)</td>
</tr>
<tr>
<td><strong>Number of pregnancies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>37 (18)</td>
<td>46 (7)</td>
<td>2.82 (1.72, 4.63)*</td>
<td>1.90 (1.00, 3.72)</td>
<td>2.32 (1.31, 4.12)*</td>
<td>0.83 (0.33, 2.06)</td>
</tr>
<tr>
<td>2-5</td>
<td>105 (50)</td>
<td>396 (63)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 and above</td>
<td>67 (32)</td>
<td>185 (30)</td>
<td>1.35 (0.94, 1.96)</td>
<td>1.38 (0.86, 2.23)</td>
<td>1.14 (0.71, 1.74)</td>
<td>1.42 (0.74, 2.72)</td>
</tr>
<tr>
<td><strong>Child vaccinated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>72 (40)</td>
<td>459 (73)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>No</td>
<td>137 (66)</td>
<td>168 (27)</td>
<td>10.40 (6.51, 16.52)*</td>
<td>9.78 (5.93, 16.12)*</td>
<td>24.05 (11.58, 49.97)*</td>
<td>26.19 (12.00, 57.30)*</td>
</tr>
<tr>
<td><strong>Total social capital score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>98 (47)</td>
<td>212 (34)</td>
<td>2.36 (1.42, 3.93)*</td>
<td>1.93 (1.06, 3.50)*</td>
<td>2.56 (1.40, 4.68)*</td>
<td>2.41 (1.11, 5.23)*</td>
</tr>
<tr>
<td>2-3</td>
<td>81 (40)</td>
<td>281 (45)</td>
<td>1.44 (0.88, 2.35)</td>
<td>1.37 (0.77, 2.44)</td>
<td>1.53 (0.84, 2.78)</td>
<td>1.79 (0.84, 3.78)</td>
</tr>
<tr>
<td>4-5</td>
<td>30 (14)</td>
<td>134 (21)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Economic status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>73 (35)</td>
<td>163 (26)</td>
<td>1.55 (1.10, 2.19)</td>
<td>1.41 (0.90, 2.20)</td>
<td>1.50 (0.99, 2.27)</td>
<td>1.42 (0.80, 2.54)</td>
</tr>
<tr>
<td>Better</td>
<td>136 (65)</td>
<td>464 (74)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Decision making score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>81 (39)</td>
<td>148 (24)</td>
<td>3.20 (2.01, 5.00)*</td>
<td>2.48 (1.44, 4.27)*</td>
<td>2.53 (1.49, 4.28)*</td>
<td>2.05 (1.02, 4.14)*</td>
</tr>
<tr>
<td>3-4</td>
<td>128 (61)</td>
<td>479 (76)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*P<0.05  ** - adjusted for all other variables in the table
## ANNEX 3

Types of household and health facility avoidable factors* in under-five children deaths (n=209) in Butajira, August 2003 – July 2004

<table>
<thead>
<tr>
<th>Household factors</th>
<th>Frequency</th>
<th>Percent from all household factors</th>
<th>Percent from all factors (n=282)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed health care seeking</td>
<td>64</td>
<td>32.8</td>
<td>22.7</td>
</tr>
<tr>
<td>Did not visit health institutions (modern)</td>
<td>47</td>
<td>24.1</td>
<td>16.7</td>
</tr>
<tr>
<td>Untrained delivery</td>
<td>43</td>
<td>22.1</td>
<td>15.2</td>
</tr>
<tr>
<td>No prenatal care during pregnancy</td>
<td>25</td>
<td>12.8</td>
<td>8.9</td>
</tr>
<tr>
<td>Problems related to feeding</td>
<td>9</td>
<td>4.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Sought only traditional care</td>
<td>3</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Did not go to referral</td>
<td>3</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Was not vaccinated for a specific cause of death preventable by the vaccine</td>
<td>1</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>195</strong></td>
<td><strong>100.0</strong></td>
<td><strong>69.1</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Health service factors</th>
<th>Frequency</th>
<th>Percent from all health service factors</th>
<th>Percent from all factors (n=282)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible poor management and/or referral</td>
<td>62</td>
<td>71.2</td>
<td>22.0</td>
</tr>
<tr>
<td>Possible poor management and follow up</td>
<td>11</td>
<td>12.6</td>
<td>3.9</td>
</tr>
<tr>
<td>Lack of referral</td>
<td>10</td>
<td>11.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Delayed referral</td>
<td>4</td>
<td>4.6</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>87</strong></td>
<td><strong>100.0</strong></td>
<td><strong>30.9</strong></td>
</tr>
</tbody>
</table>

* More than one avoidable factor could be identified per death.
REFERENCES


REFERENCES


43. AVERT. HIV and infant feeding. 2007; Available from: http://www.avert.org/hiv-breastfeeding.htm


