Adult mortality in Zambia: An ecological model

By

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ABSTRACT

Background: Adult mortality has largely remained a major health concern and an under-researched area thus it does not feature prominently on the national development agenda of Zambia, even in development plans, health policy, national health strategic plan, consequently there are no specific programmes to address adult mortality in the country. Equally, the past Millennium Development Goals (MDGs) did not have a specific focus on adult mortality; the Sustainable Development Goals (SDGs) as well have a broader health agenda but no specifics on adult mortality. Adult mortality just like child mortality is also linked to the socioeconomic development of a country. In Zambia, adult mortality has remained among the highest in southern Africa as noted by the National Population Policy of Zambia. The probability of dying between ages 15 and 60 years for the period 2010-2015 was estimated at 306.5 deaths per 1,000 persons alive at age 15 and above. Yet the adult population in age group 15 to 59 years constitutes about 50 per cent of Zambia's total population of over 13 million. Adult mortality has been an issue of public health concern for several decades now because of its impact at individual, household, community and national level in development terms as the consequences are immense to be neglected. Studies have shown that the community context plays a mediating role by influencing the type of life style which eventually determines individual outcomes like adult mortality. Previous studies have also argued that adult mortality is associated with factors such as education, income, marital status, religion, age, sex, neighbourhoods, smoking, and alcohol among others. However, these studies did not adequately address some of the contextual factors such as place of death, community health care utilisation, and community illness treatment received as they relate to adult mortality. This study addresses these issues with special attention to their effects on adult mortality at community level by applying an ecological model to reveal the previously unexamined associations between contextual factors and adult mortality variations. The study set out to achieve four specific objectives: (i) establish the level of adult mortality situation in Zambia; (ii) examine the causes of adult mortality in Zambia; (iii) explore the age- and cause-specific mortality contributions, and differentials in adult mortality; and (iv) determine the extent to which individual-, household-, and community-level factors influence adult mortality variations in Zambia.

Methodology: The study utilised two datasets, the 2010 census (10 per cent sample) and 2010-2012 Sample Vital Registration with Verbal Autopsy survey (SAVVY). The 2010 census reported 16,445 total deaths of which 6,693 occurred in age group 15-59; whereas the 2010-2012 SAVVY recorded

2,759 total deaths of which 1,078 were adult deaths in age group 15-59. The 2010 census data were utilised in deriving adult mortality rates in objective one as they were more appropriate with the methods applied. The 2010-2012 SAVVY dataset was utilised in addressing all the study objectives. Objective one was achieved by employing direct (life table and siblinghood), and indirect (Hill's Generalized Growth Balance (GGB), Bennett and Horiuch's Synthetic Extinct Generations (SEG)) demographic methods of adult mortality estimation to establish the level of adult mortality at national and sub-national levels in Zambia, that is, the probability of dying between ages 15 and 60 years ($_{45}q_{15}$). Objective two was achieved by computing proportions of causes of death, age-sex and cause-specific mortality rates to examine the causes of death among adults in the age group 15-59 years. Objective three was achieved by constructing cause-deleted life tables to determine the impact of cause of death elimination on adult mortality. In addition, decomposition analysis was performed to determine the age- and cause-specific adult mortality rates' contributions to widening the life expectancy gap between males and females. Multivariate multilevel survival analysis was employed to determine the extent to which individual-, household-, and community-level factors influence adult mortality variations in Zambia, to achieve objective four. Multivariate multilevel survival analysis was employed because it is the appropriate method for the nature of time-to-event data, that is, the risk of dying between ages 15 and 60 years. The unit of analysis was deceased adults in age group 15-59 years. The dependent variable is adult mortality operationally defined as the risk of dying between ages 15 and 60 years and was measured as "1" mortality of deceased persons in age group 15 to 59, and "0" deaths of persons in other ages. Independent variables at individual-, household-, and community-levels were selected based on the literature reviewed and the study conceptual framework. Analysis was performed at univariate, bivariate and multivariate levels. The study hypothesized that place of death, community health service utilisation, and community illness treatment received were associated with the risk of adult mortality. Data analysis was performed using Stata 14 and Microsoft Excel.

Key findings: The results show that the level of adult mortality in Zambia remains high and varies by province. Adult mortality is concentrated in age group 25-39 years, with higher mortality for females than males. Western province had the highest adult mortality rate ($_{45}q_{15}$) for males, 59% while North-western had the lowest, 36.7%. For females, Copperbelt province had the highest mortality rates, 47.9% and North-western province had the lowest, 34.8%. The top five leading causes of death among adults are HIV/AIDS (40.7%), Injuries and accidents (11.2%), tuberculosis (7.9%), malaria (6.6%), and diseases of the circulatory system (5.5%). HIV/AIDS is the leading cause of death for both males and females. The second leading causes of death among males are injuries and accidents while for females it is tuberculosis. The causes of death among adults vary by sociodemographic, socioeconomic and ecological factors, except HIV/AIDS. The epidemiological transition is underway in Zambia as the proportion of deaths attributable to non-communicable diseases is on the increase especially in age group 40 and above. Eliminating HIV/AIDS will have the most impact in additional years of life and a significant reduction in the rate of adult mortality. Age-and cause-specific adult mortality rates contributed about 50 per cent to widening the life expectancy gap between males and females. Injuries and accidents were the major contributor to the gap in life expectancy.

The risk of adult mortality was significantly lower among the married/living with partner [Hazard Ratio (HR) = 0.28; 95%, CI: 0.182, 0.445] compared with the never married decedents. Marital status is, therefore, an important predictor of adult mortality risk. Adult mortality risk decreased with an increase in the level of educational attainment. Higher level of educational attainment [HR = 0.50; 95%, CI: 0.382, 0.659] lowered the hazards of adult mortality. This shows that education is a strong predictor of adult mortality risk. Low status occupation types, craft and trade related [HR = 2.28; 95%, CI: 1.542, 3.372] and elementary occupations [HR = 2.36; 95%, CI: 1.647, 3.376] had an elevated risk of adult mortality compared with high status occupation types among the decedents. This result confirms what previous studies found.

Adult mortality risk was significantly lower among female decedents who had no HIV/AIDS [HR = 0.85; 95%, CI: 0.735, 0.976]. Male decedents who did not drink alcohol had significantly higher adult mortality risk [HR = 1.39; 95%, CI: 1.017, 1.909]. Previous studies equally found mixed results with respect to alcohol consumption. Unexpectedly, non-smoking of tobacco elevated the risk of adult mortality among deceased persons, males [HR = 1.68; 95%, CI: 1.286, 2.200] and females [HR = 3.29; 95%, CI: 2.001, 5.400]. This result is unusual; however, the wide confidence intervals point to the small numbers effect in the sample size. The risk of adult mortality was significantly lower for decedents who had a spouse [HR = 0.29; 95%, CI: 0.214, 0.378] and sibling [HR = 0.67; 95%, 0.474, 0.959] as a family relation. This is consistent with previous studies and confirms the protective effect of family relations against the risk of mortality.

In multilevel survival analysis, living in a community with a high proportion of educated individuals was associated with lower risk of adult mortality [HR = 0.59; 95%, CI: 0.491, 0.718]. For males, living in a community with a high proportion of individuals receiving treatment for their health conditions was associated with a significantly elevated risk of adult mortality [HR = 1.32; 95%, CI: 1.053, 1.664] whereas for females the hazard of adult mortality was statistically insignificantly. For females, residing in a community with a high proportion of health care utilisation was associated with a significantly lower risk of adult mortality [HR = 0.76; 95%, CI: 0.592, 0.974]; conversely for males it significantly increased the hazard of mortality [HR = 1.32; 95%, CI: 1.049, 1.658]. Gender differences in health seeking behaviour as well as sociocultural socialisation in communities between males and females may explain these disparities. Place of death was associated with the risk of adult mortality. Other place of death had significantly higher risk of adult mortality compared with health facility place of death [HR = 1.47; 95%, CI: 1.218, 1.767]. Ecological factors influenced adult mortality besides the individual effect.

Ecological factors at community level, therefore, contributed to lowering the risk of adult mortality for females while they elevated the risk of adult mortality for males. This reaffirms the socioecological theory and the ecological argument that societal context has an influence on individual health outcomes. A higher proportion of female (85.2%) than male (76.9%) decedents sought and received treatment prior to their death. Typically, in a Zambian society, the socialisation process by gender is such that men are socialised to be strong even when they are not in good health, hence will only seek health care in the late stages of an ailment when the disease has progressed and by then it may be too late. Men's wait and see attitude towards symptoms of illness and health seeking behaviour is shaped by powerful internalised societal and cultural factors based on gender norms of masculinity.

Conclusion: The study has shown that ecological factors contribute to the risk of adult mortality as well as mortality variations in addition to the individual factors in Zambia. The study findings on ecological factors influencing adult mortality in Zambia that have not been examined before provide evidence and are a valuable resource for health policy planning, programmes and interventions. The study derived adult mortality rates at regional level which were previously not available and has also shown the emerging disease burden of non-communicable diseases in line with the epidemiological transition in Zambia. Investment in education is a long-term solution to health problems as an educated population has lower morbidity and mortality. Deliberate government policies and

programmes targeted at promoting family welfare will guarantee that the family continues to play the protective effect of providing good health, longevity and ultimately lower adult mortality. Increasing personal healthcare access at community level through health infrastructure development and health promotion programmes around leading causes of death among adults will contribute to a reduction in adult mortality. Future research should investigate the influence of sociocultural, religious, and ethnic factors on adult mortality in Zambia using a life course approach.

Key words: Adult mortality, Zambia, Ecological model, Multilevel survival analysis, Demographic mortality estimation, Life tables, Cause of death, Decomposition analysis, Proximate determinants, Verbal autopsy

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DEDICATION

I dedicate this work to my children; may it be your inspiration to aim for greater heights.

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DECLARATION

I, Vesper Hichilombwe Chisumpa, declare that this thesis is my own original work. It is being submitted for the degree of Doctor of Philosophy in Demography and Population Studies of the University of Witwatersrand, Johannesburg. To the best of my knowledge, it has not been submitted before in part or in full for any degree or examination at this or any other University.

4th day of June 2018

CHAPTER 1: INTRODUCTION TO THE STUDY

> "A complex web of elements shapes adult mortality patterns, risks, and causes. As such, demography has arisen as an interdisciplinary field that derives insights from sociology, geography, economics, history, biology, epidemiology, and medicine to better understand the multidimensional forces that shape mortality in the contemporary world" (Weinstein et al., 2001).

1.1 Background of the study

Adult mortality has largely remained a major health concern. Since it is concentrated in the reproductive and productive age group (15-59 years) it has far reaching implications which are multidimensional socio-economically at household and national level. The economically active age group (15-59 years) plays a significant role in driving the socio-economic development of a country as well as in determining population growth. Therefore, any diseases or premature deaths that significantly affect this segment of the population will ultimately have adverse consequences on national development. Several studies have shown the adverse social and economic impact of adult mortality on households, health, agriculture, and education (Ntozi 1997; Mutangadura and Webb 1998; Rugalema 2000; Ainsworth, Beegle and Koda 2005; Gray, Van Niekerk, Struthers *et al.* 2006).

In addition, information on adult mortality is useful in understanding mortality patterns as well as the pace of mortality decline in countries experiencing high HIV prevalence. It is also a useful ingredient in the formulation and assessment of the performance of social and health interventions as well as policies aimed at reducing mortality to improve adult survivorship.

The International Conference on Population and Development (ICPD) beyond 2014 observed that "in the developing world, illness and deaths from non-communicable diseases are occurring at earlier ages and affecting adults in the prime income generating years" (United Nations 2014: 128).

Demographically, adult mortality is measured by the probability of dying between ages 15 and 60 years per 1,000 population ($_{45}q_{15}$). At global level, adult mortality rates have generally been declining mostly due improvements in health technologies as well as in living standards of populations. The global adult mortality rate declined from 198 deaths per 1,000 population in the period 1990-1995 to 157 deaths per 1,000 population in the period 2010-2015 (United Nations, 2013).

There are, however, variations in the decline of adult mortality rates with respect to major development regions and countries of the world. Least developed countries experience the highest adult mortality rates while the most developed countries have the lowest mortality rates. North America and Oceania have the lowest adult mortality rates; while some parts of Europe have reported stagnated adult mortality rates, but, with increasing male adult mortality (United Nations, 2013). In Asia, adult mortality rates are generally slightly lower than those of Europe. Africa as a region has the highest adult mortality rates when compared to the other development regions of the world. Adult mortality rates peaked in Africa in the period between 1990s and 2000s, and this is mostly attributed to the impact of the Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) epidemic (Murray and Lopez 1997; Bradshaw and Timaeus 2006; Reniers, Masquelier and Gerland 2011; United Nations 2013a; Rajaratnam, Markus, Rector *et al.* 2010; Murray, Ortblad, Guinovart *et al.* 2014).

Adult mortality rates have, however, generally declined in sub-Saharan African countries following the introduction of health interventions targeted at the AIDS epidemic such as Antiretroviral Therapy (ART) programmes. Some studies have shown this, for example, in Ethiopia (Sanders, Araya, Schaap *et al.* 2003; Reniers, Araya, Davey *et al.* 2009), Botswana (Stover, Fidzani, Moloma *et al.* 2008), Malawi (Jahn, Floyd, Crampin *et al.* 2008; Floyd, Molesworth, Dube *et al.* 2010), South Africa (Hosegood, Vanneste and Timaeus 2004; Nyirenda, Hosegood, Barnighausen *et al.* 2007; Herbst, Cooke, Barnighausen *et al.* 2009; Sartorius and Sartorius 2013), and Zimbabwe (Dlodlo, Fujiwara, Hwalima *et al.* 2011; Walker, Prendergast, Mugyenyi *et al.* 2012). Additionally, the impact of HIV development assistance on adult mortality in Africa shows that all-cause adult mortality declined more in countries that received assistance from the US President's Emergency Plan for AIDS Relief (PEPFAR) than those that did not (Bendavid, Holmes, Bhattacharya *et al.* 2012). These declines in adult mortality, however, are not substantial as adult mortality has remained relatively high posing as a development challenge in sub-Saharan African countries with high HIV prevalence.

In sub-Saharan Africa, adult mortality rates are higher in southern African countries with high HIV prevalence than in those countries that experienced civil wars (D. de Walque and D. Filmer 2012). The probability of dying between ages 15 and 60 for the period 2010-2015 in Botswana was estimated at 719.9 deaths per 1,000 persons alive at age 15 and above; Lesotho at 583.7 deaths per 1,000; Malawi at 383.8 deaths per 1,000; Namibia at 285.8 deaths per 1,000; South Africa at 434.4 deaths per 1,000; Swaziland at 567.6 deaths per 1,000; and Zimbabwe at 368.7 deaths per 1,000 persons alive at age 15 and above (United Nations 2013a).

In Zambia, the probability of dying between ages 15 and 60 years was estimated at 306.5 deaths per 1,000 persons alive at age 15 and above (United Nations 2013a). The adult population in age group 15 to 59 years constitutes about 50 per cent of the total population of over 13 million (Central Statistical Office [Zambia] 2012) . The HIV prevalence was estimated at 13.3 per cent, in 2014, in the reproductive age group 15-49 years (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014) , and it is the leading cause of death in this age group (Mudenda, Kamocha, Mswia *et al.* 2011; Central Statistical Office [Zambia] 2014; Murray, Ortblad, Guinovart *et al.* 2014).

Previous studies show that several sub-Saharan African countries do not only have to deal with the AIDS epidemic but also with the emerging epidemic of Non-Communicable Diseases (NCDs) such as hypertension, cardiovascular diseases, diabetes, and others (Strong, Mathers, Leeder *et al.* 2005; Saikia, Jasilionis, Ram *et al.* 2011; Saikia, Singh, Jasilionis *et al.* 2013; Murray, Ortblad, Guinovart *et al.* 2014). In 2012, 68 per cent (38 million) of the 56 million global deaths were attributed to NCDs, and the main killers were cardiovascular diseases, cancers, diabetes and chronic lung diseases (World Health Organization 2014). The NCDs have been attributed to affluent lifestyles and as developing countries modernise more disposable income will be available to individuals, more will adopt lifestyles that lead to NCDs, which according to the epidemiological transition theory are degenerative and man-made (Omran 1971). The segment of the population that is at most risk of suffering from NCDs is in the adult mortality age range of 15-59 years (Murray and Lopez 1996; United Nations 2015). Zambia has also reported an increase in NCD cases for which the country is ill prepared to deal with as evident from the NCD needs assessment conducted in 2009 (Ministry of Health [Zambia] 2011). For instance, NCD mortality attributed to cardiac diseases increased from about 400 deaths in 2008 to nearly 910 deaths in 2009; whereas mortality due to diabetes rose from 100 deaths in 2008 to about 190 deaths in 2009; and mortality attributed to hypertension also doubled from about 190 deaths in 2008 to 400 deaths in 2009 (Ministry of Health [Zambia] 2011, 2014). The national health policy as well as the Ministry of Health strategic plan for 2011-2015 despite prioritising the NCDs there are no clear comprehensive and implementable strategies on how to reduce the incidence of NCDs in the population (Ministry of Health [Zambia] 2011, 2012).

The Zambian government has implemented several health interventions that focus on infant and child mortality as well as maternal mortality in the country. On the other hand, however, there has been little attention paid to health interventions addressing adult mortality specifically. Yet adult mortality experiences are different from infant and child mortality. Overtime, infant and child mortality has been declining significantly in Zambia whereas adult mortality has declined marginally. Some of the reasons for less attention to adult mortality can be attributed to lack of a complete and efficient civil registration and vital statistics system in the country to provide good quality data for further research on adult mortality and inform policy. Nevertheless, the government of the Republic of Zambia together with cooperating partners realised the dearth of mortality data in Zambia and embarked on efforts to improve the situation by implementing the Sample Vital Registration with Verbal Autopsy (SAVVY) between 2010 and 2012 (Central Statistical Office [Zambia] 2014). The SAVVY collected information on deaths which were later followed up by verbal autopsy. Additionally, the 2010 population and housing census also collected information on household deaths in the last 12 months.

Not much has been done, however, in terms of published research on determinants of adult mortality in the country compared to infant and child mortality to provide information and guide the policy formulation process and devise specific targeted health interventions to reduce adult mortality. The levels of adult mortality in Zambia vary by socio-demographic, behavioural, socio-economic and geographic characteristics of the population, however, the effect of individual and contextual determinants, and how they have influenced these levels of adult mortality remain largely unclear and unexplained. From previous studies conducted in developed countries on determinants of adult mortality, it is also not clear whether the results of these studies will vary from those obtained by this study because of the differences in the social and economic environment. This has implications on how adult mortality health intervention strategies are designed and implemented. It is, therefore, imperative that the determinants of adult mortality and how they are associated to the outcome are understood in Zambia through a multilevel analysis that considers individual-level and contextual-level factors.

1.2 Problem Statement

In Zambia, adult mortality has remained among the highest in southern Africa as noted by the National Population Policy of Zambia (Ministry of Finance and National Planning [Zambia] 2007). Adult mortality has been an issue of public health concern for several decades now because of its impact at individual, household, community and national level in development terms as the consequences are immense to be neglected. With the already existing HIV/AIDS epidemic and the emerging NCD epidemic in Zambia, some of the impacts of adult mortality are poverty, orphans, loss of skilled personnel, and financial burden on the household as well as the national health system (Mutangadura and Webb 1998; Ainsworth, Beegle and Koda 2005; Gray, Van Niekerk, Struthers *et al.* 2006; United Nations 2015).

Previous studies on adult mortality have revealed variations in mortality by demographic, behavioural, and socioeconomic characteristics of the population (Elo and Preston 1996; Ellison, Hummer, Cormier *et al.* 2000; Elo, Martikainen and Smith 2006; Hummer and Lariscy 2011; Montez, Hummer and Hayward 2012; Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013). Demographically, adult mortality varies by age and it progressively increases with age (Shryock and Siegel 1976; Newell 1997; Preston, Heuveline and Guillot 2001; Rogers, Hummer and Krueger 2005). Generally, adult mortality is higher among males than females in most populations, and globally, it is 1.5 times higher in males than females (World Health Organization 2007; United Nations 2013a; World Health Organization 2014; United Nations 2015). In sub-Saharan African countries experiencing high HIV prevalence, adult mortality rates are much higher for men than women. In Zambia, overall male mortality (53.4 per cent) was higher than female mortality (46.5 per cent) (Central Statistical Office [Zambia] 2014). Adult mortality rates also vary by region of residence, some studies reveal that mortality is higher in rural areas than urban areas (Lulu, Berhane and Tesfaye 2002; Weldearegawi, Spigt and Berhane 2014). General mortality was also higher in rural areas than urban areas in Zambia (Central Statistical Office [Zambia] 2014). Geographical locations have also revealed variations in adult mortality, studies show that the effect on individual mortality by larger geographical areas is only seen when community neighbourhoods are taken in consideration (Saikia and Ram 2010; Saikia, Jasilionis, Ram *et al.* 2011; Meijer, Rohl, Bloomfield *et al.* 2012). Implying that the community neighbourhood effect impacts more on the individual than the larger geographical area in which the neighbourhood is located. Studies have also observed that adult mortality varies by educational attainment (Elo and Preston 1996; Hummer and Lariscy 2011; Montez, Hummer, Hayward *et al.* 2011; Masters, Hummer and Powers 2012; Montez, Hummer and Hayward 2012;

Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013; Masquelier and Garbero 2016; Rogers, Everett, Zajacova *et al.* 2010). Evident from these studies is that the higher the level of education attainment, the lower the risk of adult mortality. This variation in adult mortality is mainly explained by family income and health behaviour (Rogers, Hummer and Everett 2013). The more educated adults have access to income and make informed decisions on health matters, in addition to accessing better health services than the less educated adults. Evidently, this shows an inverse relationship between education and adult mortality. In the same vein, other studies have also found an inverse relationship between socioeconomic status and mortality (Waitzman, Smith and Stroup 1999; Rogers, Hummer and Nam 2000; Lochner, Pamuk, Makuc *et al.* 2001; Crimmins 2005; Dahl, Elstad, Hofoss *et al.* 2006; Elo, Martikainen and Smith 2006; Backlund, Rowe, Lynch *et al.* 2007). In most cases, it has been found that education is closely related to socioeconomic status. On the contrary, others have found no relationship between income and mortality (Blakely, Atkinson and O'Dea 2003; Blomgren, Martikainen, Mäkelä *et al.* 2004; Henriksson, Allebeck, Weitoft *et al.* 2006). In sub-Saharan African countries, there was no clear relationship between national income and adult mortality rates; unexpectedly, countries with higher national income had the highest mortality rates (D. de Walque and D. Filmer 2012).

Other studies have shown that there is a relationship between marital status and adult mortality. The widowed and divorced experienced higher mortality than the married individuals (Hu and Goldman 1990; Lillard and Waite 1995; Rogers 1995; Lillard and Panis 1996; Rogers, Hummer and Nam 2000; Birditt and Antonucci 2007; Ikeda, Iso, Toyoshima *et al.* 2007; Kalediene, Petrauskiene and Starkuviene 2007; Dupre, Beck and Meadows 2009; Liu 2009; Antonucci, Birditt and Webster 2010; Holt-Lunstad, Smith and Layton 2010; Weldearegawi, Spigt and Berhane 2014). Marriage offers some form of emotional and social support.

Furthermore, there are also studies that have shown that there is a relationship between religion and adult mortality. Individuals that are more religious have lower mortality than those who are less religious (Hummer, Rogers, Nam *et al.* 1999; Ellison, Hummer, Cormier *et al.* 2000; Musick, House and Williams 2004). Adult mortality variations have also been observed with respect to behavioural factors such as smoking cigarettes, drinking alcohol, which have been identified as high risk factors for mortality. Individuals who smoke cigarettes and/or drink alcohol have higher mortality than those who do not (Lantz, House, Lepkowski *et al.* 1998; Liao, McGee, Cao *et al.* 2000; Rogers, Hummer and Nam 2000; Krueger, Huie, Rogers *et al.* 2004; Rogers, Hummer, Krueger *et al.* 2005; Klatsky and Udaltsova 2007; Rogers, Everett, Saint Onge *et al.* 2010; Lantz, Golberstein, House *et al.* 2010). Other studies have examined social relations or social capital and adult mortality, and have revealed that individuals with strong social relations experienced lower mortality than those who had weak social relations (Berkman and Syme 1979; Fuhrer, Dufouil, Antonucci *et al.* 1999; Lyyra and Heikkinen 2006; Antonucci, Birditt and Webster 2010; Gele and Harsløf 2010; Holt-Lunstad, Smith and Layton 2010). Social relations are considered as some form of capital, hence social capital, that individuals can rely on for social support in times of need or when they are not well.

Most of the previous studies on determinants of adult mortality as can be inferred from above have only examined predictors of mortality at individual and household level; however, the potential effect of the community context has not been extensively considered. Studies have shown that community context plays a mediating role by influencing the type of life style which eventually determines individual outcomes like adult mortality (Diez-Roux 2000; Kawachi 2001; Kawachi and Berkman 2003; Winkleby and Cubbin 2003; Winkleby, Cubbin and Ahn 2006; Diez Roux, Green Franklin, Alazraqui *et al.* 2007; Kravdal 2007; Krueger and Burgard 2011; Montez and Hayward 2011; Nandi and Kawachi 2011). There are, however, few studies that have examined and explained determinants of adult mortality by considering the community or neighbourhood context in which individuals live (Hummer, Rogers and Eberstein 1998; Rogers, Hummer and Nam 2000; Winkleby and Cubbin 2003; Dahl, Elstad, Hofoss *et al.* 2006; Winkleby, Cubbin and Ahn 2006; Wen and Gu 2011; Meijer, Rohl, Bloomfield *et al.* 2012). There is growing research interest in examining community level factors associated with adult mortality as it has been noted that focusing only on individual (micro) level factors related to mortality ignores the context or community (macro level) within which individuals exist and interact, that could determine individual level health outcomes (Diez-Roux 2000; Dietz 2002 ; Montez and Hayward 2011; Nandi and Kawachi 2011). Therefore, drawing conclusions based on only individual (micro) level data and inferring to the community or country (macro) level leads to committing the individualistic fallacy or atomistic fallacy as these conclusions may not be applicable at macro level (Diez-Roux 2000; Dietz 2002). A multilevel approach is paramount in understanding differences in adult mortality and imperative for policy formulation (Hummer, Rogers and Eberstein 1998).

Additionally, studies that have examined the association between community level factors and adult mortality have not considered all aspects of macro level factors at the community and their moderating effect on the micro level factors of the individual with respect to adult mortality. For example, these studies have not included the aspect of behavioural risk factors related to HIV and AIDS, health service use, community place of death, community education, community health service use, and community illness treatment received in their models. In addition, these studies have mainly focused on explaining determinants of adult mortality in the United States of America and other developed countries.

In Zambia, currently there are no published existing studies that examine multilevel or contextual determinants of adult mortality, hence, the research gap which this study intends to fill. There is need to know whether community level effects impact on individual adult mortality in Zambia. Studies available on adult mortality in Zambia have largely concentrated on estimating the levels and trends by mainly applying indirect demographic techniques (Gakidou, Hogan and Lopez 2004; Timaeus and Jasseh 2004; Chisumpa 2010; Obermeyer, Rajaratnam, Park *et al.* 2010; Chisumpa and Dorrington 2011; Central Statistical Office [Zambia] 2012; Masquelier 2013; Masquelier and Dutreuilh 2014; Chisumpa and De Wet 2017). Other existing studies on adult mortality in Zambia focus on simple descriptive analysis of individual socioeconomic factors (Central Statistical Office [Zambia] 2012, 2014), while researchers have expanded the discourse to examine how community structures affect adult mortality (Cubbin, LeClere and Smith 2000; Winkleby and Cubbin 2003; Marmot 2005; Winkleby, Cubbin and Ahn 2006; Diez Roux, Green Franklin, Alazraqui *et al.* 2007; Nandi and Kawachi 2011).

Some of the available data that have been used in mortality analysis are hospital based, however, emerging population based data such as the 2010-2012 SAVVY provide an opportunity for detailed investigation of what drives adult mortality at different levels in Zambia.

Therefore, this study aims at examining the determinants of adult mortality in the population aged 15-59 years in Zambia at individual-, household- and community-levels. The results of this study are relevant and beneficial to the National Health Policy and National Health Strategic Plan that aim at reducing adult mortality at different levels by developing specific targeted interventions addressing factors that expose certain adult groups to high mortality risks.

1.3 Purpose Statement and Scope of the Study

The purpose of this study is to examine the relationship between individual, household and community level factors and adult mortality as an outcome, controlling for health behaviours, health conditions, and physiological influences among the population aged between 15 and 59 years in Zambia. The guiding theoretical framework is the social ecological theory (Bronfenbrenner 1979, 1994) which states that individual outcomes such as adult mortality are influenced through interrelationships at household and community level by ecological factors. The theoretical framework is complemented by the proximate determinants of adult mortality conceptual framework which states that proximate factors, that is, health behaviours, health conditions and physiological influences mediate the effect of demographic and distal factors on mortality (Rogers, Hummer and Krueger 2005). The independent variables at individual level are socio-demographic (age, sex, marital status) and socio-economic (education, employment and occupation) characteristics; at household level: household composition (family relations), and at community level: province of residence, type of residence, community place of death, community illness treatment received, and community education. The dependent variable is adult mortality defined as the probability of a person dying between ages 15 and 60 years ($_{45}q_{15}$), and the control and intervening variables are, health behaviour (smoking, drinking), health condition (tuberculosis, cancer, HIV/AIDS), and physiological influences (diabetes and injury). By examining macro level factors, such as, community place of death, community health service use, and community illness treatment, that have not been considered in other studies, the study contributes to the assessment of these factors and their effect at community level with respect to adult mortality literature in developing countries and Zambia, in particular.

1.4 Research Questions

Main research question: What individual-, household-, and community-level factors influence adult mortality in Zambia?

The following are the specific research questions that the study seeks to answer:

(i) What is the level of adult mortality in Zambia?;

(ii) What are the causes of adult mortality in Zambia?;

(iii) How does age- and cause-specific mortality contribute to changes in adult mortality?; Are there any differentials by cause of death among adults in Zambia?; and

(iv) How do the individual-, household-, and community-level factors influence adult mortality?

1.5 Research Objectives

The objectives of the study are as follows:

1.5.1 General Objective

The general objective of this study is to examine the determinants of adult mortality variations at individual-, household-, and community-levels in Zambia.

1.5.2 Specific Objectives

(i) Establish the level of adult mortality situation in Zambia;

(ii) Examine the causes of adult mortality in Zambia;

(iii) Explore the age- and cause-specific mortality contributions, and differentials in adult mortality; and

(iv) Determine the extent to which individual-, household-, and community-level factors influence adult mortality variations in Zambia.

1.6 Definitions and Delimitations

The study utilises data from the 2010 population and housing census, and the 2010-2012 SAVVY. The target population are adults aged 15-59 years and their mortality experiences. The following are the definitions of key concepts used in the study:

Mortality: this concept refers to deaths that occur in a population.

Death: this concept is defined by (World Health Organization 2007) as the permanent disappearance of all evidence of life at any time after a live birth has taken place.

Cause of death: this concept refers to all diseases or morbid conditions or injuries that either resulted in or contributed to death, and the circumstances of the accident or violence which produced any such injuries (MEASURE Evaluation 2009).

Adult mortality: in demographic analysis, this concept refers to the probability of an adult dying between the age of 15 and 60 years ($_{45}q_{15}$). It is expressed as deaths of persons under age 60 per 1,000 alive at age 15 (United Nations 2013a, 2015). That is, the probability that a person who celebrates their 15th birthday dies before their 60th birthday. This study confines itself to mortality of persons in the age group 15 to 59 years. This means that old-age mortality which refers to deaths of persons aged 60 years and above is outside the realm of the study.

Ecological model: is a model that "encompass an evolving body of theory and research concerned with the process and conditions that govern the lifelong course of human development in actual environments in which human beings live" (Bronfenbrenner 1994: 1643).

Drivers: this concept refers to proximate determinants through which independent variables (demographic, socioeconomic) operate to affect the dependent variable (adult mortality).

Household level: this concept refers all factors (family relations, household head sex, household size) at the household level which influence health outcomes, that is, adult mortality.

Community level: the concept refers to determinants (type of residence, province of residence, community health service utilisation, community illness treatment, place of death, community education) at cluster or primary sampling unit level that influence adult mortality as an outcome.

SAVVY: Sample Vital Registration with Verbal Autopsy is a data collection system developed by MEASURE Evaluation, a programme under the University of North Carolina, to accurately document vital events, that is, births, deaths and causes of deaths in countries that have deficient civil and vital registration systems, such as Zambia. The system provides nationally representative information on levels and causes of mortality from selected sample small areas (MEASURE Evaluation 2009).

Verbal Autopsy: the concept refers to an interview that is conducted with family members or care-givers of the deceased person in order to ascertain the probable causes of death, based on their knowledge of the symptoms, signs, lifestyle behaviours and circumstances leading to death of the deceased (World Health Organization 2007; MEASURE Evaluation 2009). Misganaw et al., (2013) used verbal autopsy in their study to establish the association of socioeconomic and behavioural factors with adult mortality in Ethiopia. This method of interviewing was used in the SAVVY conducted in Zambia.

1.7 Significance of the Study

With declining infant and child mortality in most countries of the world, including Zambia, this implies that more and more children are surviving to adulthood thereby increasing the proportion of adults in the total population of a country. As noted earlier, the decline in infant and child mortality has been due to a focus and attention of public health programmes to reduce morbidity and mortality of under-five children with respect to the achievement of previously Millennium Development Goal (MDG) and now Sustainable Development Goals (SDGs). However, Zambia did not achieve the target for MDG 4 on reducing infant and child mortality.

On the other hand, there has not been much attention paid to reduce adult mortality in most developing countries including Zambia. Adult mortality linked interventions are those which focus on improving maternal health among women in the age group 15-49 years. Other interventions that adult mortality has benefited from are those that focus on combating HIV/AIDS, Malaria and other diseases. HIV and Tuberculosis are leading killers of adults aged

15 years and above. There has also been interest in reducing adult mortality through initiatives such as the Global Fund on HIV/AIDS, Malaria and Tuberculosis; the US President's Emergency Plan on HIV/AIDS (PEPFAR) and others. Despite these initiatives, adult mortality in its totality has not received much attention to be addressed comprehensively in most developing countries. The International Conference on Population and Development (ICPD) beyond 2014 recognizes that "in Africa, deaths from non-communicable diseases exceed those caused by maternal, perinatal, communicable and nutritional disorders combined, and related mortality and...occur among people younger than 60 years of age" (United Nations 2014: 128).

Globally, however, there has been a decline in adult mortality rates in many countries, including Zambia, through the mentioned initiatives. However, adult mortality in Zambia remains high when compared to the sub-region average mortality rates. As noted earlier, the population segment (15-59 age group) affected by adult mortality constitutes about half of the total population of Zambia. This population segment is the productive and reproductive part of Zambia's socioeconomic development as well as a driver of population growth. Therefore, the impact of adult mortality has far reaching consequences at many levels.

There is need, therefore, for research to understand all aspects of adult mortality, such as the contribution of sociodemographic, socioeconomic, and behavioural factors; causes of death as well as the influence of individual, household and community level factors on adult mortality. There is a growing interest in that adult mortality cannot be understood in isolation from the social context. Studies conducted in developed and some developing countries provide evidence that the social and economic environment influences adult mortality outcomes. By recognizing the interrelationships between individual mortality outcomes and the environment through the social ecological theory adult mortality interventions at policy level can be designed to target specific levels and achieve the most desired results. Through this approach there is an opportunity to comprehensively understand the multiple influences of the interrelationships between the environment and individual health outcome throughout the various stages of the life course and design appropriate interventions.

In Zambia, available studies have only estimated the levels and trends of adult mortality by applying indirect methods, there is a gap in knowledge about factors explaining adult mortality variations. The influence of community and contextual factors on adult mortality remains unclear and largely unexplored in Zambia.

This study contributes to the understanding of determinants of adult mortality variations in Zambia to the existing body of knowledge on adult mortality by applying an ecological model approach. The study focuses on these determinants: place of death, community health service use, and community illness treatment in relation to the other variables and proximate factors in the conceptual framework. The relevance and importance of the mentioned community variables is explained in the methodology section. The study is of significance to the Sixth National Development Plan, National Health Policy, National Health Strategic Plan, and the Vision 2030 Development Plan that aim at reducing adult mortality at different levels, that is, individual, household and community, by developing specific targeted interventions addressing factors that expose certain adult groups to high mortality risk.

1.8 Overview of the Study

This thesis is composed of an additional six chapters. In the next chapter (Chapter 2), the study is situated in related literature. The chapter discusses the pertinent literature on adult mortality ranging from estimation of mortality rates, analysis of causes of death, social and epidemiological determinants of adult mortality to multilevel analysis. The theoretical and conceptual frameworks in which the study is anchored are elaborated. Chapter 3 presents the methodology of the study. The chapter elaborates the research design, data sources, demographic and statistical methods used in the study.

Chapters 4, 5 and 6 present the results of data analysis of adult mortality. Chapter 4 presents the estimation of the levels of adult mortality at national and sub-national levels. The chapter derives adult mortality rates from census and survey data using both direct and indirect demographic estimation methods to establish the levels and show variations. Chapter 5 presents an in-depth analysis of causes of death among adults in age group 15-59 years in Zambia. The chapter examines the leading causes of adult mortality and how they vary by demographic and socioeconomic background characteristics of the deceased adults. The age-and cause-specific mortality patterns of the causes of death are further analysed to understand ages where the causes of death are concentrated and would be specific targets for public health interventions. The chapter also explores the elimination of causes of death to show the gain in the number of additional years of life. The percentage reduction in the probability of dying at each age because of eliminating a cause of death is also examined. The impact of eliminating a cause of death on adult mortality—the probability of dying between ages 15 and 60 years—is also explored. The chapter also performs decomposition analysis of age-and cause-specific mortality rates to assess the contribution of adult mortality to the widening of the life expectancy at birth between males and females. Chapter 6 examines the extent to which individual and community level factors influence adult mortality variations from an ecological perspective within the theoretical framework of the socioecological model and the proximate determinants framework of adult mortality. This is achieved by applying a multilevel survival analysis approach.

Chapters 7 and 8 contain the discussion, conclusions and recommendations of the study. Chapter 7 discusses the key findings of the study based on the estimation of the levels of adult mortality rates, causes of death analysis, and ecological analysis of the determinants of adult mortality variations. Finally, Chapter 8 contains the conclusions and recommendations of the study and suggests areas of future research.

CHAPTER 2: LITERATURE REVIEW AND THEORIES AND CONCEPTUAL MODELS

2.1 Literature Review

The review of literature on adult mortality is divided into three parts: global overview of adult mortality; adult mortality in sub-Saharan Africa; and adult mortality in Zambia. Several studies have been conducted on adult mortality and they have covered a wide range of issues such as estimation of levels, trends, patterns, differentials, and determinants. Adult mortality studies in developed countries have benefited from the availability of good quality mortality data and thus they have been able to explore more associations. However, this not the case with most developing countries whose civil and vital statistical registrations systems are incomplete and deficient, as such they do not provide good quality mortality data for in-depth study of adult mortality. As result of this paucity in mortality data, there are more adult mortality studies that have been conducted in developed countries than in developing countries. This study builds on and contributes to literature on adult mortality by Rogers *et al.,* (2000; 2005; 2010; 2013); Hummer *et al.,* (1998; 2011; 2013); Hosegood *et al.,* (2004); Montez *et al.,* (2011; 2012); Masquelier *et al.,* (2011; 2013; 2017), Hill, (1987); Bennett and Horiuchi (1981, 1984), Saikia *et al.,* (2010; 2011); Dorrington, Moultrie, Timaeus *et al.*, (2004; 2007; 2013), Bradshaw and Timaeus, (2006); Crimmins, (2005); Elo and Preston, (1992; 1996); Timaeus *et al.*, (1997; 2004); Reniers et al., (2011), Nandi and Kawachi (2011), to mention but a few.

2.2.1 Global overview of adult mortality

The 2013 World Mortality Report published by the United Nations (2013a) estimates that at global level the probability of dying between ages 15 and 60 (${}_{45}q_{15}$) is 157 deaths per 1,000 persons in the period 2010-2015. The more developed countries experience lower adult mortality, 121 deaths per 1,000, than least developed countries with mortality rate of 251 per 1,000. At continental level, Africa has the highest probability of dying between ages 15 and 60 of 296 per 1,000 and it is lowest in North America with 99 per 1,000. The ratio of male to female probability of dying at global level it is 1.5 times. This ratio is 2.2 times in developed countries and 1.2 times in developing countries. It is highest in Europe at 2.4 times (United Nations 2013a). Except for Africa, adult male mortality is higher in Europe when compared to other regions, 199 deaths per 1,000. In all cases, male mortality is higher than female adult mortality. It is also evident from the report that adult mortality is generally higher in Europe than in North America. The estimates from the report evidently show that adult mortality is still a challenge in most countries of the world and that there is need to address this issue through further research.

Besides estimating the probability of dying between ages 15 and 60, other studies have suggested that there is need to go beyond and examine adult mortality variations by either sociodemographic or socioeconomic characteristics of the individuals, while others have proposed incorporating life course or lifestyle experiences when examining determinants of adult mortality. Such studies have been predominantly conducted in the United States; Elo and Preston, (1996) examined the relationship between education attainment and adult mortality. They found that U.S adults with more years of education were less likely to die than those with fewer years of education. Several studies have been conducted on this relationship most of these studies have also found that highly educated U.S. adults have lower mortality rates than less educated ones by sex, age, race, ethnic (Rogers, Hummer and Nam 2000; Hummer and Lariscy 2011; Masters, Hummer and Powers 2012; Montez, Hummer and Hayward 2012; Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013). Montez et al., (2012) while examining how educational attainment is associated with adult mortality found that mortality risk reduction increased with additional years of education especially after attaining a high school diploma and not before. Rogers et al., (2013) also studied the mediating factors between educational attainment and adult mortality; they found that educational differences in mortality are mediated by family income and health behaviours.

Other studies have examined the effect of social relations such as family, marital status, friendships, religion, neighbours and community on adult mortality. Studies that investigated the relationship between religious involvement and adult mortality found that religious attendance is associated with adult mortality (Hummer, Rogers, Nam *et al.* 1999; Ellison, Hummer, Cormier *et al.* 2000; Hummer, Ellison, Rogers *et al.* 2004; Musick, House and Williams 2004). People who do not attend or participate in religious services are more likely to adopt unhealthy practices which eventually lead to their death. Therefore, religion regulates individuals to adopt healthy life styles. Regarding marital status, some studies have revealed that married individuals have lower mortality than unmarried ones because of the social support and care they receive from their spouses (Lillard and Waite 1995; Rogers 1995; Waite 1995; Lillard and Panis 1996; Dupre, Beck and Meadows 2009; Choi and Marks 2011; Zheng and Thomas 2013). Studies have also revealed that the type of neighbourhood or community also has an influence of adult mortality. People in neighbourhoods or communities that have social order and support are likely to live longer than those that are in disorderly, crime ridden, drug and alcohol, overcrowded neighbourhoods (Robert 1999; Cubbin, LeClere and Smith 2000; Winkleby and Cubbin 2003; Winkleby, Cubbin and Ahn 2006; Nandi and Kawachi 2011).

Studies have also revealed that lifestyles that individuals adopt through the life course can influence adult mortality. These lifestyles may lead to certain health behaviours, health conditions, or physiological influences which eventually impact on adult mortality. Cigarette smoking, for instance, has been found to increase the risk of death through respiratory diseases, lung cancer, and heart disease (Rogers and Powell-Griner 1991; Kaplan, Wingard, McPhillips *et al.* 1992; Nam, Hummer and Rogers 1994; Nam, Rogers and Hummer 1996; Rogers, Hummer and Nam 2000; Kawachi 2001; Rogers, Hummer, Krueger *et al.* 2005). Excessive drinking of alcohol also does increase the risk of death through diseases and eventually impact on adult mortality (Liao, McGee, Cao *et al.* 2000; Rogers, Hummer and Nam 2000; John and Hanke 2002; Gajalakshmi, Peto, Kanaka *et al.* 2003; Klatsky and Udaltsova 2007; Rogers, Everett, Saint Onge *et al.* 2010; Ikeda, Inoue, Iso *et al.* 2012; Guillot, Gavrilova, Torgasheva *et al.* 2013). Health conditions such as tuberculosis, cancer and HIV/AIDS impact on adult mortality, and these are a result of health behaviours adopted by individuals (Hosegood, Vanneste and Timaeus 2004; Dzekedzeke, Siziya and Fylkesnes 2008; Dlodlo, Fujiwara, Hwalima *et al.* 2011; Chihana, Floyd, Molesworth *et al.* 2012; Kanjala, Michael, Todd *et al.* 2014; Chipungu, Corbett, Kaswaswa *et al.* 2016; Murray, Ortblad, Guinovart *et al.* 2014). The physiological influences, that is, blood pressure, diabetes, injury, disability are a consequence of lifestyles and precipitate adult mortality (McLarty, Unwin, Kitange *et al.* 1996; Miura, Daviglus, Dyer *et al.* 2001).

There are studies that have examined the association between contextual factors and mortality to assess the contribution of these factors. Jaffe *et al.*, (2005) investigated the effect of living in religiously affiliated and unaffiliated neighbourhood on mortality risks in Israel using multilevel analysis. The study found that living in a religiously affiliated neighbourhood had lower mortality rates that those living in unaffiliated areas. Kravdal (2007) examined how community family structure affects individual mortality in Norway in a multilevel analysis. The study did not find a clear relationship with individual mortality. This could be mainly because the contributions of contextual factors are sometimes weak. Kibele (2014) examined the effects of individual- and area-level effects on mortality risks in Germany using multilevel Poisson models. The study found that district-level factors contribute to explanation of mortality inequalities, and that mortality was higher in more economically deprived districts. Furthermore, Turrell *et al.*, (2007) also examined the association between area-level disadvantage and all-cause mortality using multilevel analysis in Australia. The study found that living in a disadvantaged area-level was associated with higher all-cause mortality. Other studies have examined contextual factors like neighbourhood unemployment rates and mortality, van Lenthe *et al.*, (2005)examined this association in six countries and found that living in more deprived neighbourhoods with high unemployment rates is associated with increased all-cause mortality. In addition, Winkleby and Cubbin (2003) also examined the influence of individual and neighbourhood social economic status on mortality among black, Mexican-American, and White women and Men in the US. They found that living in a low socioeconomic status neighbourhood is associated with higher mortality risk beyond individual socioeconomic status. Furthermore, Winkleby et al., (2006) examined whether the influence of neighbourhood-level socio-economic status (SES) on mortality differed by individual-level SES. They found that there were disparities in mortality by neighbourhood of residence among men and women of low socioeconomic status.

An examination of adult mortality relationships in such a way enables us to further understand that mortality is affected by many factors and that policy makers should devise interventions based on researched factors that impact more on adult mortality.

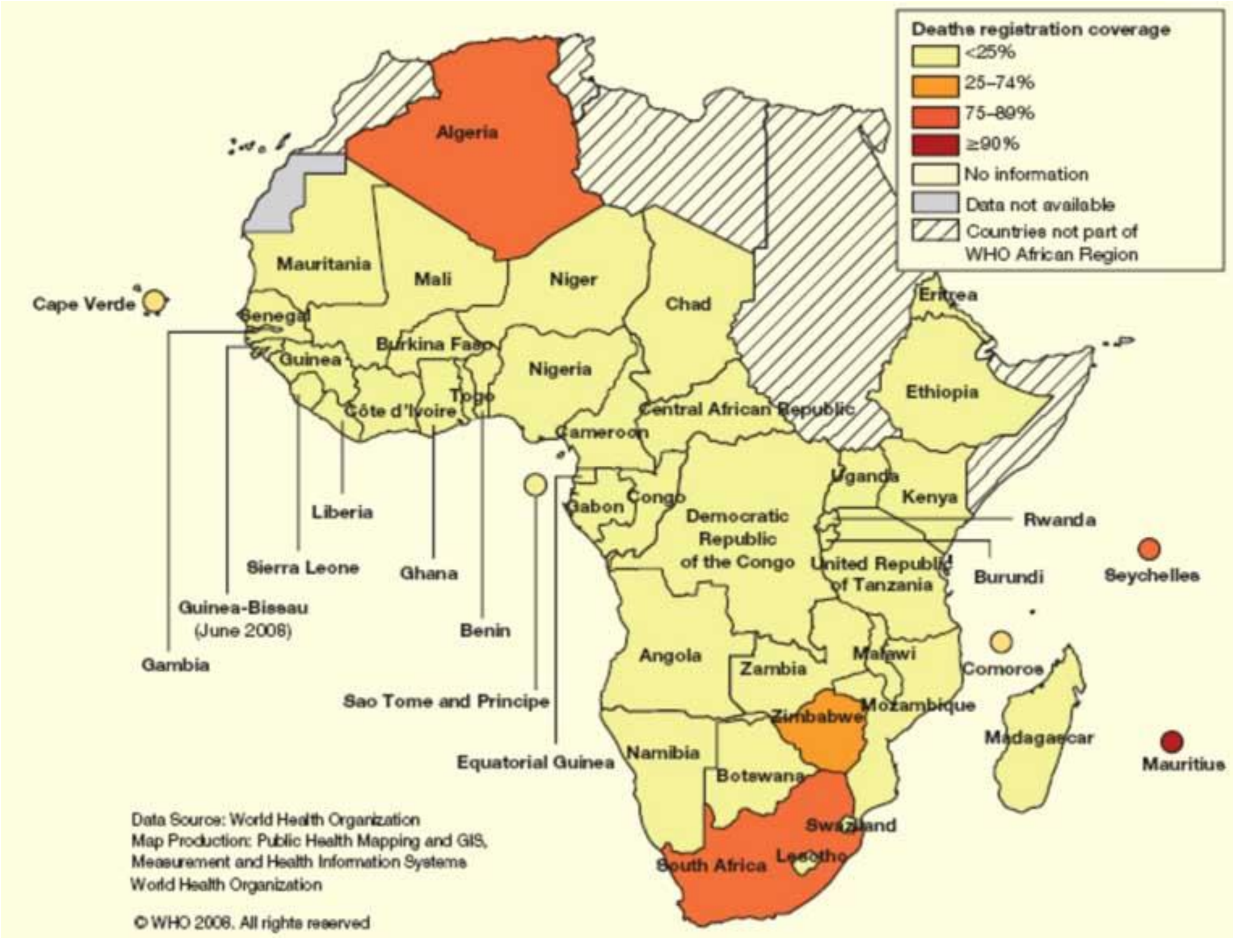
2.2.2 Adult mortality in sub-Saharan Africa

Of all regions in the world, Africa has the highest adult mortality rates. Prior to the 1990s, most African countries registered declines in adult mortality between the 1950s and late 1980s. Over the years, however, the decline in mortality experience reversed as the 2013 World Mortality Report clearly shows the rise in adult mortality from the 1990s through the 2000s reflecting the impact of the AIDS epidemic (United Nations 2013a). According to the report, adult mortality rates were highest in the mid-1990s. There are indications in the 2000s that there is a gradual decline in mortality but still higher than the global average. This decline could be attributed to health interventions in HIV/AIDS through the introduction of antiretroviral therapy (ART) between the year 2003 and 2004 in many African countries (Reniers, Araya, Davey *et al.* 2009; Dlodlo, Fujiwara, Hwalima *et al.* 2011; Bendavid, Holmes, Bhattacharya *et al.* 2012; Sartorius and Sartorius 2013; Mberu, Wamukoya, Oti *et al.* 2015). The probability of dying between ages 15 and

60 in sub-Saharan Africa for males is 317 per 1,000 while that of females is 275 per 1,000 for the year 2010-2015 (United Nations 2013a).

Reniers, Masquelier, & Gerland (2011) studied adult mortality experience in Africa. They noted the estimation methods, data deficiencies and difficulties associated with studying adult mortality in Africa as shown in Figure 2.1. They extended the adult mortality estimates derived by Timaeus and Jasseh (2004) to the year 2010 for 30 African countries using Demographic and Health Survey (DHS) sibling history survival data. They computed the probabilities of dying between exact ages 15 and 60 years ($_{45}q_{15}$) for the years 1990, 1995, 2000 and 2005. Their estimates, though lower than those of the United Nations, showed a similar trend in adult mortality pattern in African countries. In west Africa, adult mortality estimates show a stagnation tending towards an increase. An increase in adult mortality is characterised throughout the 1990s, in central Africa, attributed to the HIV/AIDS epidemic (Reniers, Masquelier and Gerland 2011). The highest increase in adult mortality was experienced in southern Africa where the prevalence of HIV/AIDS was the epi centre on the continent in the 1990s (Reniers, Masquelier and Gerland 2011). Following the introduction and availability of antiretroviral therapy in a number of African countries, modest declines in adult mortality have been observed (Reniers, Masquelier and Gerland 2011). The study by Reniers, Masquelier and Gerland, (2011) did not consider the effect of community level variables on adult mortality as an outcome, the focus was more on estimation of adult mortality rates. They, however, noted the increasing burden of non-communicable diseases in several African countries as observed from routine verbal autopsy data collected from demographic surveillance sites. Renier, Masquelier and Gerland, (2011) concluded that the high levels of adult mortality especially in southern African countries are attributed to the burden of infectious diseases, non-communicable diseases, and external injuries.

Figure 2.1 Death registration coverage, WHO African Region, 2000-2006



Source: World Health Organization, (2010)

Murray *et al*, (2014) in the Global Burden of Disease study on mortality and cause of death for 2013 found that, between 1990 and 2013, in most sub-Saharan African countries there was a steady increase in deaths attributable to non-communicable diseases such as cardiovascular diseases, diabetes, chronic kidney disease, and injuries. The study also found that HIV/AIDS, tuberculosis, diarrhoea, and lower respiratory infections were leading causes of death in several sub-Saharan African countries. It was observed that in west Africa, the probability of death from liver cancer was high (Murray, Ortblad, Guinovart *et al.* 2014).

Studies that have examined the relationship between adult mortality and socio-demographic or socio-economic factors in Africa are limited. Misganaw *et al.*, (2013) examined the association between socio-economic and behavioural factors with adult mortality in Ethiopia using verbal autopsy data. They found that low educational status, being female, and being within the age range 25-44 years were positively associated with HIV/AIDS related mortality. Individuals aged 45 years and above were 3 to 6 times more likely to have died of cardiovascular diseases. They also found that non-communicable diseases caused 51 per cent of the adult deaths.

In South Africa, Sartorius and Sartorius, (2013) in their study to develop a generic mortality framework for sub-Saharan Africa examined the contextual factors and found that HIV and low socioeconomic status were important determinants of adult health and mortality in the region. Using data from the demographic surveillance site, Mayosi *et al.*, (2009) observed an increase in the burden of non-communicable diseases especially among the poor in rural and urban areas of South Africa. Tollman *et al.*, (2008) also observed a modest increase in deaths attributable to chronic non-communicable diseases. In the same vein, Seedat *et al.*, (2009) also noted an increase in violence and injuries becoming the second leading cause of death in South Africa. They attributed this to contextual factors such as gender-based violence, poverty, unemployment, societal norms and beliefs, alcohol and drug abuse, and weak law enforcement. These studies examined the causes of death, however, they did not statistically analyse the effect of community factors in a multilevel analysis.

In Burfina Faso, Rossier et al., (2014) examined the relationship between non-communicable disease (NCD) mortality and risk factors in formal and informal neighbourhoods in Ouagadougou. They found higher NCD mortality in formal neighbourhoods and high adult mortality from communicable diseases in informal neighbourhoods.

2.2.3 Adult mortality in Zambia

Adult mortality in Zambia has been mainly estimated using indirect demographic methods. This is because the civil and vital statistical registration system is incomplete and deficient to provide high quality data that can be used to produce direct estimates of adult mortality. The national population censuses and demographic and health surveys have been the main sources of mortality data. These are cross sectional data and provide estimates at particular time points. Mortality data were collected through the sample vital registration with verbal autopsy from 2010 to 2012. These data provide an opportunity to examine relationships between adult mortality and sociodemographic or socioeconomic factors; health behaviours, health conditions; household and community contexts, as they are detailed. These data have not been used before to examine such associations and this study investigates these relationships and relates them to the existing literature.

Estimates of adult mortality in Zambia show that mortality rates were initially low before the advent of the AIDS epidemic. However, from the late 1980s to early 2000s adult mortality increased rapidly (United Nations 2013a). There are indications that with the introduction of antiretroviral therapy between 2003 and 2004 a decline in mortality has been observed (Bendavid, Holmes, Bhattacharya *et al.* 2012). However, adult mortality still remains high and a health concern. The United Nations Population Division estimates the probability of dying between ages 15 and 60 to have declined from 603.4 deaths per 1,000 in the period 1990-1995 to 306.5 deaths per 1,000 in the period 2010-2015 (United Nations 2013a). Adult mortality estimates by Reniers, Masquelier and Gerland, (2011) based on sibling history survival data show that the probability of dying between ages 15 and 60 year was 0.67 for males and 0.61 for females around the year 2000. They do note a modest decline in adult mortality after the introduction and availability of antiretroviral therapy. Direct adult mortality estimates from demographic and health surveys for the reproductive age group 15-49 show that mortality rates increased from 10.9 deaths per 1,000 person-years of exposure in 1996 to 14.1 deaths per 1,000 person-years of exposure in 2002, declined to 12.5 deaths per 1,000 person-years of exposure in 2007 and 8.4 deaths per 1,000 person-years of exposure in 2014 (Central Statistical Office

[Zambia], Ministry of Health [Zambia] and ICF International 2014). However, the limitation of the adult mortality estimates from the demographic and health surveys is that they can only be computed by age and sex. This implies that associations between adult mortality and socioeconomic factors cannot be examined unless one is using siblings' background characteristics as a proxy for the deceased, which has its own limitations.

The Global Burden of Disease study on mortality and cause of death for 2013 also found that HIV/AIDS was the leading cause of death in Zambia, followed by malaria (Murray, Ortblad, Guinovart *et al.* 2014). The study found that HIV/AIDS and tuberculosis were the leading causes of death in adults aged 15-49 years. Tuberculosis mortality had increased by 59 per cent between 1990 and 2013. The study confirmed that malaria was the leading cause of child mortality in Zambia (Murray, Ortblad, Guinovart *et al.* 2014). It was also observed that NCD related deaths attributable to Ischematic heart disease and stroke increased by more than 100 per cent among adults since 1990. The life expectancy was estimated at 55.7 years for females and 58 year for males in 2013 (Murray, Ortblad, Guinovart *et al.* 2014). It is unusual that the life expectancy of males is higher than that of females demographically and in comparison, to other existing estimations from other sources. The study, however, did not analyse community level effects on mortality by applying multilevel survival analysis.

Studies from developing countries have shown mixed results of the income inequality and mortality. A study by Nilsson and Bergh (2012) on income inequality and individual health in Zambia found that higher income inequality was associated with better child health. The study also found that greater income inequality was correlated with better nutritional status whether measured at provincial, district or constituency level. Evidently, this study presents findings that are very different from the predominant conventional view of existing literature; clearly an indication that there could be other factors that influence these relationships.

Adult mortality studies in developed countries have been able examine effects of life course or life style experiences on mortality, for example, social economic status, education, marital status, religion, gender, and others (Rogers 1995; Elo and Preston 1996; Hummer, Nam and Rogers 1998; Hummer, Rogers and Eberstein 1998; Rogers, Hummer and Nam 2000; Kawachi 2001; Hummer, Ellison, Rogers *et al.* 2004; Lleras-Muney 2005; Rogers, Hummer, Krueger *et al.* 2005; Klatsky and Udaltsova 2007; Turra and Goldman 2007; Rogers, Everett, Saint Onge *et al.* 2010; Hummer and Lariscy 2011; Naess, Hoff, Lawlor *et al.* 2012; Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013; Rogers, Everett, Zajacova *et al.* 2010). However, there are few parallel studies in developing countries more especially in sub-Saharan Africa (Masquelier and Garbero 2016), and particularly in Zambia that have examined such relationships. With data that allow such analyses being available, this study examines individual-level (micro-level) and macro-level (multilevel or ecological) determinants of adult mortality variations in Zambia.

2.3 Deficiencies in the existing literature

An examination of relevant literature shows that adult mortality studies in sub-Saharan Africa, especially in Zambia have some weaknesses. The data sources used are deficient and limited. There is little analytical rigor as most of the studies are merely descriptive. Additionally, the focus is on individual factors. There is a lack of studies that focus on community or ecological factors in Zambia. Studies have neglected critical variables such as behavioural risk factors related to HIV/AIDS, health service use, place of death and community education. Emerging literature in health, demography, and social epidemiology have drawn attention to the need to examine comprehensively the whole gamut of factors at individual, household and community levels associated with adult mortality.

The findings of these studies in terms of the association of adult mortality with the determining factors have been consistent but in some cases, there are inconsistencies. The few studies conducted in developing countries on determinants of adult mortality have yielded mixed results. Some studies have shown inverse/negative relationships between socio-economic factors and adult mortality while others show a positive relationship (Robert 1999; Turra and Goldman 2007; Nilsson and Bergh 2012). In addition, others have even produced contrary results to those obtained by studies conducted in developed countries (Waitzman, Smith and Stroup 1999; Nandi and Kawachi 2011). As pointed out already, previous studies have not considered, community health seeking behaviour of the deceased, community place of death, community illness treatment received prior to death (Rogers, Hummer and Nam 2000; Winkleby and Cubbin 2003; Rogers, Everett, Saint Onge *et al.* 2010; Reniers, Masquelier and Gerland 2011; Rogers, Hummer and Everett 2013).

There have been variations as well in the theoretical frameworks guiding previous studies, for example, Rogers et al., (2013) used the human capital theory to examine the relationship between education and adult mortality; whereas Montez et al., (2012) utilised functional forms as a conceptual framework to examine the association between education and adult mortality. Furthermore, Hummer and Hernandez, (2013) applied the life course approach as their conceptual framework to study education and adult mortality.

Despite the different theoretical directions used by these studies, the findings were very similar that education was negatively associated with adult mortality. There are also other studies that have not used theoretical frameworks (Reniers, Masquelier and Gerland 2011; Meijer, Rohl, Bloomfield *et al.* 2012). This study adapts the social ecological theory (Bronfenbrenner 1979, 1994) and the proximate determinants of adult mortality conceptual framework (Rogers, Hummer and Krueger 2005) to anchor the linkages between individual- and community-level factors with adult mortality.

In Zambia, while available studies on adult mortality have focused on estimation of levels and trends, however, little is known about the determinants of adult mortality variations at individual-, household- and community-levels. This study intends to fill the gap by examining the effect of the above mentioned neglected community-level factors on adult mortality through the application of multilevel analysis on a unique dataset the 2010-2012 SAVVY.

2.4 Theoretical Frameworks

There is no single theory that predicts and explains determinants of adult mortality in demography that can be used to guide this study. Determinants of adult mortality have been studied using different theoretical frameworks or approaches derived from the field of public health or social epidemiology. Most studies have used ecological approaches frequently used in public health and social epidemiology to examine factors affecting individual health outcomes in relation to the social environment context in which individuals live (Adedini 2013; De Wet 2013; Ononokpono 2013). The social ecological model, derived from the social ecological theory (Bronfenbrenner 1979, 1994), has been the most frequently used. Other studies have used the life course approach by following-up individual life experiences from early life to old age in order to understand individual and environment factors that affect individual health outcomes. This approach, however, requires longitudinal data which this study does not have access to, as they are not readily available in Zambia. The study uses cross-sectional data instead and the ecological approach therefore becomes more appropriate.

Due to lack of a theory on adult mortality, this study is anchored in two theoretical frameworks, the social ecological theory (Bronfenbrenner 1979, 1994) and the proximate determinants of adult mortality framework (Rogers, Hummer and Krueger 2005). The social ecological theory by Bronfenbrenner (1979, 1994) is a theory on the interrelationship between human development and the environment; whereas the proximate determinants of adult mortality framework by Rogers and colleagues (2005) relate demographic characteristics, distal causes, and proximate factors to adult mortality as an outcome. The two theoretical frameworks enable the study to perceive individual adults as nested in households, and households nested in the community. This implies that individual adults from different households will share same life experiences and mortality risks at community level as they are exposed to the same environment. Therefore, the relationship between individual-, household- and community-level determinants of adult mortality has been conceptualised based on the two theoretical frameworks.

2.4.1 Social Ecological Theory

The social ecological theory is based on the premise that there are interrelationships between an individual and their environment. An individual's interaction with the environment (e.g. family relations, community structures, religion, societal customs, economy) influence personal outcomes like behaviour, health, mortality, etc (Bronfenbrenner 1979, 1994). The theory enables us to understand why there are variations in individual behavioural or health outcomes like mortality across different community environments. The social ecological theory evolved originally from Bronfenbrenner's (1979, 1994) ecological systems theory which posits that for one to understand human development the entire ecological system in which growth takes place has to be taken into account as individual behaviour and health outcomes are influenced by the different environments they live in.

Bronfenbrenner (1979, 1994) identified five components of the ecological system for the interrelationships between the individual and the environment at various nested hierarchical levels in a circle: first innermost circle, the *microsystems* (family, friends, neighbours), is the direct or immediate environment in which the individual lives and socially interacts in sharing life experiences. it is the most influential component; second inner circle the *mesosystems* (family relationships, social support) consists of interactions between the individual and others in the *microsystem* with an indirect influence on the individual; third inner circle, the *exosystem* (social relationships, community interrelations, health care institutions) here the individual is not an active participant, but is affected by decision-making process. An individual adult's health may be affected by decisions made by the health facility in the community on its provision of certain health services; fourth outer circle, the *macrosystems* (cultural values, life styles, social conditions, economy, political systems, opportunities, hazards) here an individual is affected by the attributes of this component either positively or negatively on his or her development with respect to their socioeconomic status, ethnicity or race. An adult living in a low socioeconomic status community is likely to experience higher mortality risks than one who lives in a wealth community; and fifth outermost circle, the *chronosystems* (social economic status, employment, place of residence) here individuals transition from one status to another and their effects in the process during the life course. The effects of the transitions later in an individual's life influence behaviour or health outcomes (Bronfenbrenner 1979, 1994).

Other authors have contributed to the refinement of the theory, for example, McLeroy's (McLeroy 1988) ecological model of health behaviours contributed to the classification of different levels of influence on health behaviour; but did not include the physical environment, and Stokol's (1996) social ecological model of health promotion contributed by bringing to the fore the core assumptions in the social ecological theory. There are variations in the adaptation of the levels of the social ecological theory that have been applied by different studies (Rogers, Hummer and Nam 2000; Rogers, Everett, Saint Onge *et al.* 2010; Meijer, Rohl, Bloomfield *et al.* 2012). The social ecological theory is adapted as a social ecological model and tailored to suit the behavioural or health outcome and population segment being studied as it relates to the environment. The most common adaptations of the levels are individual level that is personal factors that influence directly individual outcomes (age, sex, education level, socioeconomic status, employment); social environment level, that is, the relationships (family, peers), cultural values and norms, socioeconomic status of the community, institutions and organisations, access to social support, influence of health and other professionals, and society overall in which the individual interacts; physical environment level, that is, the natural and built environments; and policy level, that is, legislation and policies (health, education, environmental policies). The levels allow the design of appropriate strategies and interventions that do not target only the individual but go beyond the specific levels where the need is required. The social ecological theory has been applied in a number of studies in demography to examine community socioeconomic conditions and variations in individual health outcomes like mortality (Kawachi and Berkman 2003; Wen and Gu 2011).

The social ecological theory though developed to understand human development and interrelationship with the environment; it has aspects which are adaptable to examine determinants of adult mortality variations at individual-, household- and community-levels in this study. At the first level is the individual and adaptable elements include variables: age, sex, marital status, education, employment and occupation. At the second level are household, adaptable elements include variables: social relations (relatives or family). At the third level is community, adaptable elements include- variables: health care institutions and other organisations. At the fourth level, adaptable elements include variables: province of residence, and type of residence. At the fifth level, the interrelationships between individuals and the environment become dynamic, as policy influence individual behaviour. The social ecological theory facilitates the application of multilevel statistical analysis at individual, household and community levels and thereby shows the interrelationships between the individual and the environment, and consequently determining the outcome variable (adult mortality).

2.4.2 Proximate Determinants Framework for Adult Mortality

Based on the social ecological theory, Rogers, Hummer and Krueger (2005) proposed a framework that can be used to relate adult mortality as an outcome with demographic characteristics, distal causes, and proximate factors (determinants). In the framework, demographic characteristics, that is, age, sex, race/ethnicity are related to overall and cause-specific adult mortality. Distal factors, that is, socioeconomic status, social relations, geographical factors, and human and environmental hazards, indirectly influence adult mortality whereas proximate factors, that is health behaviours, health conditions, and physiological influences directly impact on mortality (Rogers, Hummer and Krueger 2005). Rogers, Hummer and Krueger (2005: 284) posit that "proximate factors mediate the effect of demographic and distal factors on mortality, and include health behaviours, health conditions, and physiological influences."

In the framework, demographic characteristics, that is, age is a significant factor affecting mortality and cannot be ignored in any demographic analysis. Mortality varies by age. Sex is another factor that is associated with mortality. Generally, females have lower mortality experience than males (Preston and Taubman 1994). Sex differentials in mortality are affected by other factors such behaviour, health, socioeconomic status among others (Heuveline and Slap 2002; Rogers, Everett, Saint Onge *et al.* 2010; Stringhini, Dugravot, Kivimaki *et al.* 2011; Wisser and Vaupel 2014). Race/ethnicity is associated with mortality. Mortality differentials have been observed by race as well as ethnic groups, more especially in the United States (Winkleby and Cubbin 2003; Hummer and Chinn 2011; Hayward, Hummer, Chiu *et al.* 2014; Masters, Hummer, Powers *et al.* 2014).

The distal causes are associated with adult mortality. High socioeconomic status (education, income) is associated with lower adult mortality risks through proximate factors such as health behaviours (Lantz, House, Lepkowski *et al.* 1998; Rogers, Hummer and Nam 2000; Rogers, Hummer, Krueger *et al.* 2005; Rogers, Everett, Saint Onge *et al.* 2010; Hummer and Lariscy 2011; Montez, Hummer and Hayward 2012; Hummer and Hernandez 2013; Hayward, Hummer and Sasson 2015). Social relations (family composition, marital status, social support) are also associated with mortality (Helweg-Larsen, Kjoller and Thoning 2003; Denney, Rogers, Krueger *et al.* 2009; Antonucci, Birditt and Webster 2010; Holt-Lunstad, Smith and Layton 2010; Umberson, Crosnoe and Reczek 2010). Married individuals have lower mortality risks compared to the unmarried because the adopted health behaviours (Hu and Goldman 1990; Lillard and

Waite 1995; Lillard and Panis 1996; Ikeda, Iso, Toyoshima *et al.* 2007; Dupre, Beck and Meadows 2009; Liu 2009; Choi and Marks 2011; Zheng and Thomas 2013). Religion through social control and adopting healthy behaviours also lowers mortality risks (Hummer, Rogers, Nam *et al.* 1999; Ellison, Hummer, Cormier *et al.* 2000; Hummer, Ellison, Rogers *et al.* 2004; Musick, House and Williams 2004; Jaffe, Eisenbach, Neumark *et al.* 2005).

Geographical factors such as region and urban/rural residence are associated with mortality variations (Ali, Jin, Kim *et al.* 2007). Regional differences in physical and social environments contribute to variations in mortality. Urban residence has been mostly associated with lower mortality risks than rural residence. However, within urban residence the mortality risks do vary as well through neighbourhood or contextual effects (Kawachi and Berkman 2003; Krueger, Huie, Rogers *et al.* 2004; van Lenthe, Borrell, Costa *et al.* 2005; Diez Roux, Green Franklin, Alazraqui *et al.* 2007). These variations arise due to community-level poverty, high rates of crime, overcrowding, illiteracy, unemployment, infectious diseases (AIDS and tuberculosis), drug and alcohol abuse, marital disruption, poor housing, inadequate environmental amenities which in turn influence adult health and mortality risks (Winkleby and Cubbin 2003; Krueger, Huie, Rogers *et al.* 2004; Rogers, Everett, Saint Onge *et al.* 2010; Krueger and Burgard 2011; Meijer, Rohl, Bloomfield *et al.* 2012).

Human and environmental hazards like natural disasters, technological risks, acts of terrorism and war are associated with adult mortality but are rare events; however, sometimes the number of deaths attributed to these events may be very high (Browning, Bjornstrom and Cagney 2011).

Proximate factors, that is, health behaviours, health conditions, and physiological influences are more directly and have a strong effect on adult mortality. Certain health behaviours such as cigarette smoking, drug abuse and alcohol consumption among others are associated with higher risks of mortality (Nam, Hummer and Rogers 1994; Nam, Rogers and

Hummer 1996; Liao, McGee, Cao *et al.* 2000; Lam, Ho, Hedley *et al.* 2001; Rogers, Hummer, Krueger *et al.* 2005; Preston and Wang 2006; Klatsky and Udaltsova 2007; Zaridze, Brennan, Boreham *et al.* 2009).

A link is established with the social ecological theory by acknowledging that the proximate factors are acquired in the course of a person's lifetime, and directly impact on adult mortality risk unlike demographic and social factors (Rogers, Hummer and Krueger 2005). Rogers and colleagues (2005) note the growing research interest among demographers to examine behavioural, health and genetic factors associated with adult mortality. The Rogers and colleagues (2005) framework for depicting factors related to adult mortality is presented below.

Table 2.1 Framework depicting factors related to adult mortality

Demographic Characteristics	Distal Causes	Proximate Factors	Outcomes
Age	**Socioeconomic status**	**Health behaviours**	
	Education	Cigarette smoking	
Sex	Income	Alcohol drinking	
	Employment status	Diet	
Race/ethnicity	Occupation status	Exercise	
	Health insurance	Sleep	
	Wealth	Seat belt use	
		Use of violence	
	Social relations		
	Family relations	**Health conditions**	
	Marital status	Childhood health status	**Mortality**
	Family composition	Parent/sibling health status	Overall mortality
	Relatives	Self-reported health status	Underlying cause
	Friends	Functional limitations	Multiple cause
	Neighbors	Mental and addictive disorders	
	Community ties		
	Religion	**Physiological influences**	
		Height	
	Geographical factors	Weight	
	Region	Cholesterol	
	Urban/rural	Blood pressure	
	Migration	Stress	
	Neighborhood effects	Diabetes	
		Genetic markers	
	Human and environmental hazards		
	Natural disasters		
	Technological risks		
	Acts of terrorism and war		

Source: Rogers, Hummer and Krueger (2005)

The proximate factors approach has been applied in a number of studies in demography, epidemiology, public health, and medicine because of the direct biological links to mortality

(Robert 1999; Rogers, Everett, Saint Onge *et al.* 2010; Saikia and Ram 2010; Lantz, Golberstein, House *et al.* 2010).

The Rogers, Hummer and Krueger (2005) proximate determinants adult mortality conceptual framework is relevant to this study and most of its components are adaptable. The demographic characteristics, that is, age, sex, and ethnicity are adapted. The distal causes that are adapted are: socioeconomic status (education, occupation status); social relations (marital status, family relations); geographical factors (region, rural/urban, neighbourhood or contextual effects). Adaptable proximate factors are: health behaviours (cigarette smoking, alcohol drinking); health conditions (self-reported health status) and physiological influences (diabetes).

2.4.3 The relevance of the theoretical frameworks to the study of adult mortality in Zambia

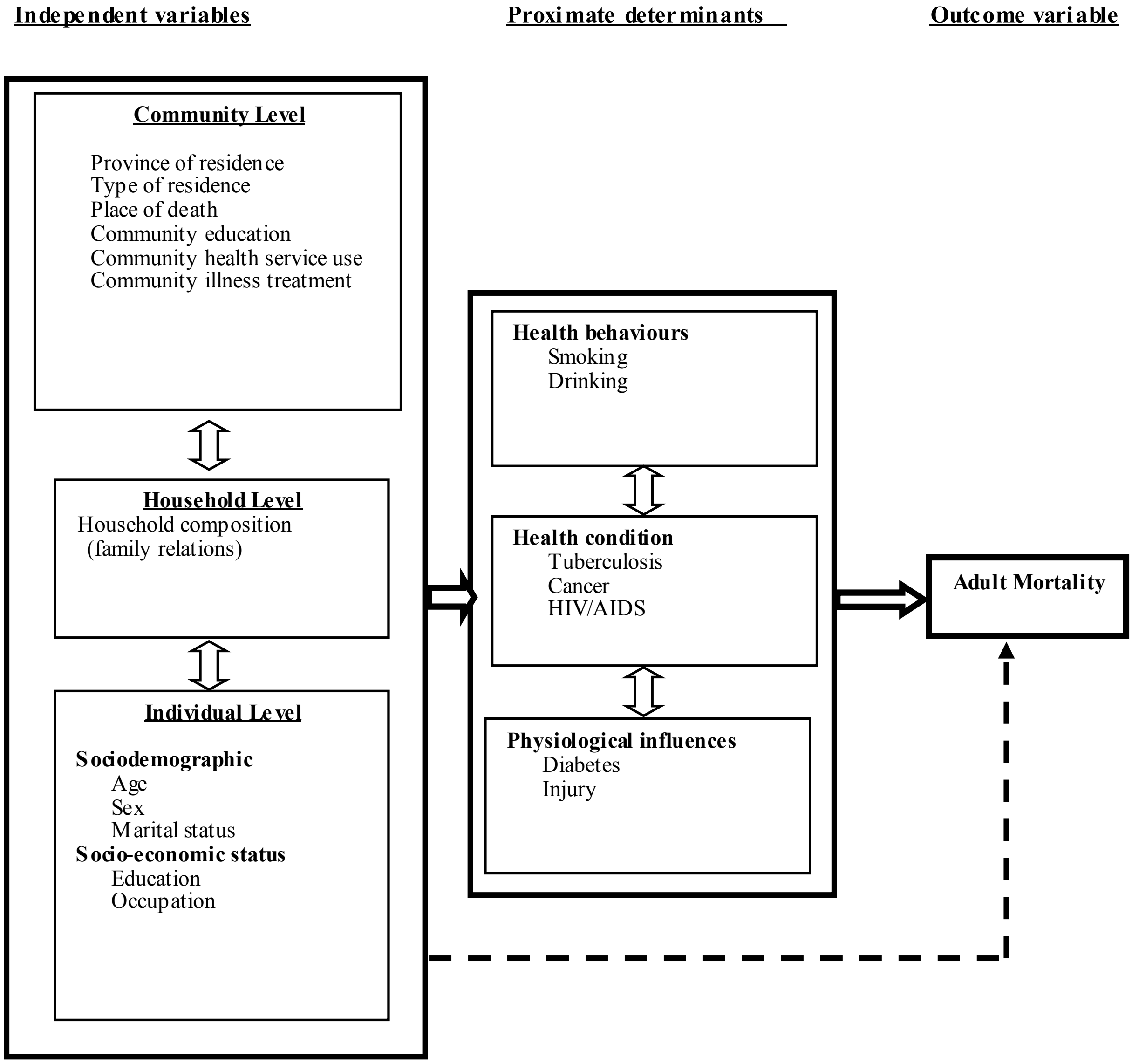
Zambia is a country of diversity with varied levels of development across the country. The socioeconomic development indicators also vary by region/province, some regions/provinces have high poverty levels while others do not. The health indicators of the country also vary by region and other characteristics. For example, HIV prevalence is highest in Copperbelt province (18 per cent) and lowest in Muchinga province (6 per cent). In urban areas, HIV prevalence is higher (18.2 per cent) than in rural areas (9 per cent). Among men and women, HIV prevalence is higher in women (15 per cent) than men (11 per cent) (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). In terms of mortality, in 2010, males experienced higher mortality rates than females. The age pattern of illness/disease by sex is the same as the mortality pattern, a higher percentage of females in ages 15-34 died as a result of illness/disease whereas for males the percentage is higher for ages 35 and above (Central Statistical Office [Zambia] 2012). Mortality rates were higher in rural than urban areas. By region, Luapula province had the highest mortality rate (17.3 death per 1,000) and Southern province had the lowest (10 deaths per 1,000) (Central Statistical Office [Zambia] 2012). With these variations in health indicators, it can be hypothesised that there is some influence of the community context on the individual health outcomes. It is, therefore, imperative to apply the social ecological theory and the Rogers, Hummer and Krueger (2005) proximate determinants of adult mortality conceptual framework to study and understand that adult mortality is not only influenced by individual-level factors, but by household-level as well as community-level factors.

The conceptual framework adapted from the two theoretical frameworks shows the variables at individual, household and community levels obtained. The two theoretical frameworks have common variables at individual-, household-, and community-levels, this is so because the Rogers, Hummer and Krueger (2005) proximate determinants for adult mortality conceptual framework is derived from the social ecological theory. However, the social ecological theory does not indicate the mediating role of the proximate factors on mortality. Therefore, in this study's conceptual framework the proximate determinants are adapted from the Rogers, Hummer and Krueger (2005) framework. The two theoretical frameworks, however, did not incorporate these variables: place of death, injury, disability, health care utilisation, and treatment for illness. At community level, the study examined these variables that had not been looked at in relation to adult mortality as indicated in the literature reviewed: place of death, community health service use, community illness treatment received, community population density, and community household headship.

2.5 Conceptual Framework

The conceptual framework for the study presented below has been adapted based on the literature reviewed and the social ecological theory (Bronfenbrenner 1979, 1994) and the Rogers, Hummer and Krueger (2005) proximate determinants for adult mortality conceptual framework. The social ecological theory facilitates the adaption of individual-, household-, and community-level variables for multilevel analysis in determining factors for adult mortality variations, whereas the Rogers, Hummer and Krueger (2005) framework provides the proximate determinants directly affecting adult mortality. The conceptual framework shows that at individual-level (level 1) the variables to be examined which are background characteristics of adults are sociodemographic (age, sex, marital status, place of death) and socioeconomic status (education and occupation), these interact with household-level (level 2) variables in which individual adults are nested. The variables at this level are household composition/family relations. Individual adults in households then interact with community-level (level 3) variables in which households are nested. The variables at community level are province of residence, type of residence, community place of death, community health service use, community illness treatment, and community education. The arrows between individual-level, household-level and community-level indicate interactions within the levels. The thick black box encompassing the three levels represents the hierarchical structures and the context or environment. The arrow connecting the independent variables and proximate determinants show the direction of interaction that individual-, household-, and community-level factors operate through the proximate factors to affect the outcome variable, adult mortality. The proximate factors are in three groups: heath behaviour (smoking and drinking); health condition (tuberculosis, cancer, and HIV/AIDS); and physiological influences (diabetes and injury). The arrows between the proximate factors represent interactions within the factors. The proximate determinants have a direct influence of the outcome, adult mortality. The independent variables at all the three levels, and proximate determinants were incorporated based on the reviewed literature. The definitions, measurement and importance of the variables are presented in the methodology chapter.

Figure 2.2 Conceptual framework for determinants of adult mortality



Adapted from Rogers, Hummer and Krueger (2005) and Bronfenbrenner (1979, 1994)

2.6 Research Hypotheses

The following are the research hypotheses of the study based on the literature reviewed, theoretical and conceptual frameworks:

$H_0$1(Null): There is no association between adult mortality risk and residence in communities with a low proportion of deaths taking place at health facility;

H_A1(Alternative): High adult mortality risk is associated with residence in communities with a low proportion of deaths taking place at health facility;

$H_0$2 (Null): There is no association between adult mortality risk and living in communities with a high proportion of health service utilisation

H_A2 (Alternative): Lower adult mortality risk is associated with high proportion of health service utilisation;

$H_0$3 (Null): High adult mortality risk is associated with type of residence with low proportion who received treatment for illness;

H_A3 (Alternative): High adult mortality risk is associated with type of residence with low proportion who received treatment for illness.

Significance level: α=0.05/0.01/0.001

CHAPTER 3: METHODOLOGY

> Quantitative studies are anchored in the post positivist worldview premised on that "there are laws or theories that govern the world, and these need to be tested or verified and refined so that we can understand the world" (Creswell 2014: 7). Under this worldview, there is need to "identify and assess the causes that influence outcomes.........reduce the ideas into small, discrete set to test, such as variables that comprise hypotheses and research questions" (Creswell 2014: 7).

3.1 Introduction

This chapter presents the methodology of the study. Section 3.2 describes the study setting by providing a background context. Section 3.3 provides information about the study design. The population and sample of the study is described in section 3.4. The instruments that were used to collect the data utilised in the study by the data sources are described in section 3.5. The variables used in the study are identified and described how they are measured in section 3.6. Data assessment and steps taken in preparing the data for analysis are described in section 3.7. The statistical analysis performed by the study to answer research questions and address the objectives is elaborated in section 3.8. Ethical considerations are described in section 3.9. The study dissemination plan is presented in section 3.10.

3.2 Study Setting

The study was conducted on Zambia, a landlocked country located in the southern African region. Zambia has eight neighbouring countries, these are: Angola, Botswana, Congo DRC, Malawi, Mozambique, Namibia, Tanzania, and Zimbabwe. The country has a land area of 752, 612 square kilometres. The population of Zambia was about 13,092,666 according to the latest census of population and housing conducted in 2010. Forty-nine per cent (6,454,647) of the population comprised of males while 51 per cent (6,638,019) were females. In 2016, the population was projected to 15,933,885 with 49 per cent (7,884,009) of the population being male and 51 per cent (8,049,874) being female (Central Statistical Office [Zambia] 2013). The population in age group 15-59 was 6,257,842 in 2010 and it was projected to 8,005,534 in 2016, which is about half of the total population (Central Statistical Office [Zambia] 2012, 2013). About 60 per cent (7,919,216) of the population resided in rural areas while 40 per cent (5,173, 450) lived in urban areas in 2010 (Central Statistical Office [Zambia] 2012). The urban population was projected to 42 per cent in 2016, making Zambia one of the urbanised countries in the sub-region (Central Statistical Office [Zambia] 2013). The population growth rate, between 2000 and 2010, was 2.8 per cent per annum and it was projected to 2.9 per cent in 2016 (Central Statistical Office [Zambia] 2012, 2013). The life expectancy at birth for both sexes was 51.2 years (males, 49.2 years and females, 53.4 years) in 2010 (Central Statistical Office [Zambia] 2012) and projected to 53.7 years for both sexes, 51.1 years for males and 56.1 years for females in 2016 (Central Statistical Office [Zambia] 2013). The crude death rate (CDR) was 13.1 deaths per 1,000 persons in 2010 (14.3 deaths per 1,000 persons for males and 12.0 deaths per 1,000 persons for females) (Central Statistical Office [Zambia] 2012). In 2016, the CDR was projected to 12.8 deaths per 1,000 persons (Central Statistical Office [Zambia] 2013). The total fertility rate (TFR) was 5.9 children per woman; higher in rural areas (7.0) than urban areas (4.6) in 2010 (Central Statistical Office [Zambia] 2012). Recent estimates from the 2013/14 Zambia Demographic and Heath Survey indicate a TFR of 5.3 at national level; 3.7 in urban areas and 6.6 in rural areas (Central Statistical Office [Zambia] 2012; Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). In 2010, approximately 61 per cent of the Zambian population live below the poverty line of 1 dollar a day while in 2015 the proportion declined to 54 per cent. Poverty is more endemic in rural areas (77.9 per cent in 2010 and 76.6 per cent in 2015) than urban areas (27.5 per cent in 2010 and 23.4 per cent in 2015) (Central Statistical Office [Zambia] 2012, 2016). The country is divided administratively into 10 provinces[1], then into 104 districts which are further divided into 156 constituencies and then 1,430 wards at the lowest level.

Figure 3.1 Map of Zambia

Source: Central Statistical Office et al., 2014

Adult mortality in Zambia remains high and is one of the major health problems with far reaching adverse repercussions on the country. The AIDS epidemic is one of the contributors to high adult mortality. Although HIV prevalence has decreased over time in the age group 15-49 from 15.6 per cent as reported by the 2001/2002 Zambia Demographic and Health Survey (ZDHS) to 14.3 per cent in the 2007 ZDHS and to 13.3 per cent in the 2013/2014 ZDHS, the

[1] In 2011, a 10th province was created named Muchinga by splitting Northern province into two and annexing two districts from Eastern province, and a number of districts and constituencies were also created. The 2010 Census made adjustments to the number of provinces but the 2010-2012 SAVVY did not as this was not possible since the sample selected was based on the 2000 census sampling frame. Muchinga province is therefore not included in the analysis but its existence is acknowledged.

HIV prevalence remains high and in some segments of the population higher than the national average. Of course, HIV prevalence in the country varies by residence, age, sex, socioeconomic and other characteristics of the population. HIV prevalence as reported by the 2013/2014 ZDHS was twice as high in urban areas (18.2 per cent) than in rural areas (9.1 per cent). It was higher among females (15.1 per cent) than males (11.3 per cent). By age, HIV prevalence was at its peak in age group 35-39 (24.2 per cent) and 40-44 (24.1 per cent) among females and age group 40-44 (21 per cent) among males. Interestingly, HIV prevalence increased by education level, those with more than secondary education had the highest prevalence of 16.7 per cent compared to 13.4 per cent for those with no education. The same applies to employment status; the employed had higher HIV prevalence (17.3 per cent) than the unemployed (12.6 per cent). HIV prevalence also increased by wealth quintile, it was highest in the fourth quintile at 20.9 per cent. By marital status, HIV prevalence was highest among the widowed (46.3 per cent), then followed by the divorced or separated at 27.4 per cent. There was a difference in HIV prevalence by type of union in polygynous union the prevalence was lower than in non-polygynous union, 11.8 per cent and 14.7 per cent, respectively. Females and males with more than two sexual partners in the last 12 months had higher HIV prevalence of 35.2 per cent and 15.1 per cent, respectively compared to those who had one sexual partner (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014).

Furthermore, it is estimated that in 2014 about 1,000,000 [980,000-1,100,000] adults aged 15 years and above were living with HIV in Zambia, of these 540,000 [510,000-580,000] were women. There were about 19,000 [15,000-24,000] deaths and 380,000 [290,000-680,000] orphans aged 0-17 due to AIDS (UNAIDS 2015). In addition, the 2013/2014 ZDHS adult age-specific mortality rates showed that mortality levels rapidly increased with age for both men and women. Age-specific mortality rates continuously increased up to age group 40-49. Between age groups 15-19 and 35-39, there is no much difference in female and male mortality age-specific mortality rates. Male mortality is only higher than female mortality after age group 35-39 to 45-49. Both male and female age-specific mortality rates plateau at high rates in age group 45-49 (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). This pattern of mortality is reflective of the AIDS epidemic being experienced in the country.

The variations in HIV prevalence by various sociodemographic and socioeconomic characteristics are to some extent linked to adult mortality variations in Zambia. As noted earlier, there are no published studies in the public domain that have investigated the drivers of these variations in adult mortality in Zambia. This makes the country an interesting area to conduct such an investigation considering that the data are available now that can be used to do so, which were previously not there.

3.3 Study Design

The study is quantitative and cross-sectional in nature as it used data from the 2010 Zambia census of population and housing, and the 2010-2012 sample vital registration with verbal autopsy (SAVVY).

The use of already existing data is advantageous for several reasons. First, there is no need to plan for fieldwork to collect the detailed information on, for example, deaths and causes of death. Second, it is expensive to conduct a census or survey, this study did not have neither funding nor capacity to collect the required information at national level. Third, several studies have noted that information on deaths and causes of death is not easy to collect because of the nature of the event of death, which may be emotional and in some African cultures it is almost taboo to talk about death.

3.4 Population and Sample

Two data sets were utilised in this study: the 10 per cent sample of the 2010 census data and the 2010-2012 SAVVY data; in each case the target population are men and women in the age group 15 to 59, which is used to refer to adult mortality in demographic analysis (United Nations 2002; Moultrie, Dorrington, Hill *et al.* 2013; World Health Organization 2014; United Nations 2015). It must be noted that in terms of the scope and depth of information collected by the two data sources, they are different.

A census is different from a survey in that it is a complete enumeration of the population, households, housing units within the confines of borders of a country whereas a survey uses the sampling frame of the census to systematically draw a segment of the total population that is studied. The census by its nature and magnitude is limited when it comes to depth of information collected. This means that the 2010 census did not collect as much detailed information on deaths and causes of death compared to the 2010-2012 SAVVY. However, the coverage of the census geographically is more comprehensive as the whole country is enumerated at every level than the 2010-2012 SAVVY that collected a sample from each province of Zambia. The 2010 census reported 16,445 total deaths of which 6,693 occurred in age group 15-59; whereas the 2010-2012 SAVVY recorded 2,759 total deaths of which 1,078 were adult deaths in age group 15-59.

The 10 per cent sample of the 2010 census is available in public domain at Central Statistical Office [Zambia] and on the website of the International Use Micro data Sample (IPUMS). The 10 per cent sample of the census was selected and prepared by IPUMS on behalf of the Central Statistical Office [Zambia]. The sample was randomly selected out of every 10 households enumerated by the census which constituted a 10 per cent sample of the households and the individuals in the selected households represent 10 per cent of the total population. The 10 per cent individual records include sample weights which can be used to expand the sample to represent the total population. Just like the SAVVY the 10 per cent sample of the census also suffers from randomly errors as it was selected randomly.

3.4.1 2010 Census

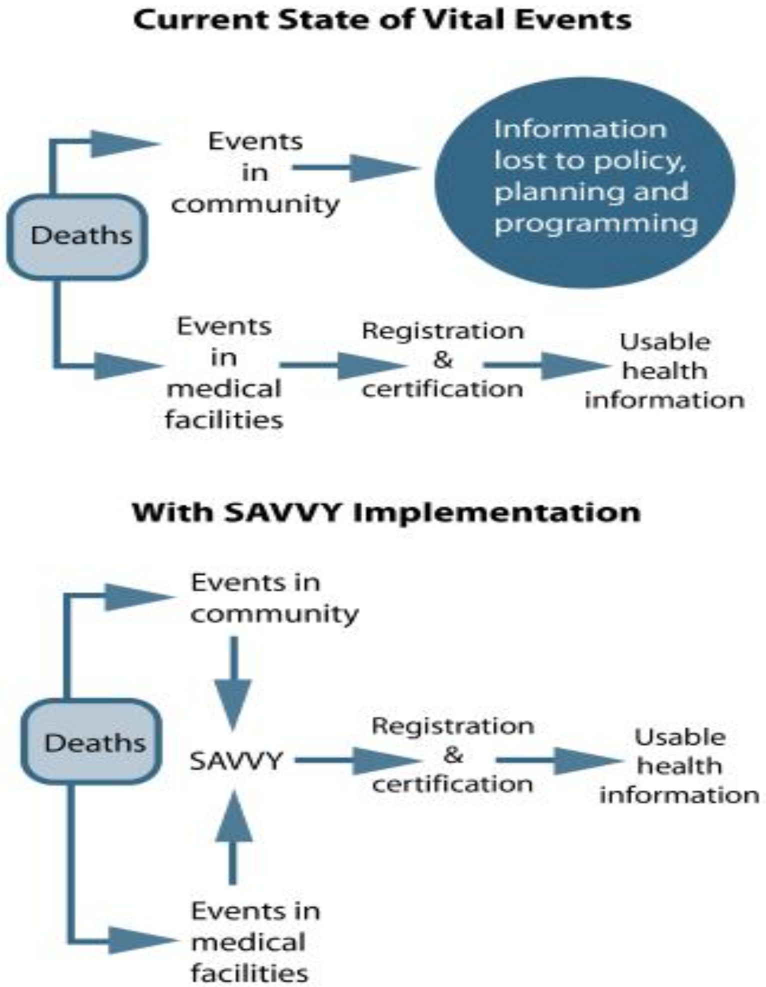
The 2010 Zambia census of population and housing was conducted between 16th October and 15th November, 2010. Among the objectives of the 2010 census was to provide as comprehensive as possible information on demographic, social and economic characteristics of the population at all levels of the country for use by government, organisations, researchers and individuals. However, complete enumeration of the whole country was only achieved on 30th November, 2010. The census employed 25,000 school leavers as field census enumerators; 8,400 teachers and civil servants worked as census supervisors; and 400 civil servants from different government ministries were recruited and trained as master trainers, assistant master trainers, and provincial census officers (Central Statistical Office [Zambia] 2012). The 2010 census used geographical information system (GIS), global positioning system (GPS) and high-resolution satellite imagery for mapping the country. Rural areas were mapped using GPS while urban areas were mapped using satellite imagery. Data capturing and processing of the questionnaires started in April, 2011 and was completed in August, 2011, using optical mark reading (OMR) and intelligent character recognition (ICR) technology. This process was followed by editing, tabulation and analysis of data (Central Statistical Office [Zambia] 2012).

The census population age data were assessed in terms of their quality using methods such as the United Nations age-sex accuracy index, age ratios, sex ratios, Whipples' and Myer's indices (Siegel and Swanson 2004). The United Nations age-sex accuracy index showed that the quality of the data had improved when compared to the 2000 census. Therefore, the data were of reasonable quality. However, in this study the population data were subjected to further assessments as explained later.

3.4.2 2010-2012 SAVVY

The 2010-2012 sample vital registration with verbal autopsy survey was conducted in Zambia arising out of the need for accurate and reliable mortality indicators at provincial and national level to assess the impact of health programmes. The current civil registration and vital statistics system (CRVS) in Zambia has inadequate capacity to provide such information because it is not fully functional and its coverage is very limited in terms of capturing vital events. The 2010-2012 SAVVY was therefore designed to contribute the development of an effective and efficient CRVS and it has the advantage of being cost-effective when compared to a fully functioning CRVS. However, a successful sample based system requires strong commitment at national, regional and community levels backed up by government and cooperating partners funding. Figure 3.2 shows how information on vital events is lost to policy, planning and programming when it is not collected from the communities in Zambia. The Figure also shows how SAVVY complements the existing system by collecting information on vital events from the communities to fill the gap. The objective of the SAVVY was to collect detailed, accurate and timely data on births and deaths at national level, and produce annual nationally representative estimates of vital statistics and mortality by cause of death.

Figure 3.2 SAVVY Contribution to data systems



Source: MEASURE Evaluation (2009)

The SAVVY was undertaken using the World Health Organisation standard questionnaires and methodology of reporting causes of death. The survey was implemented by the Central Statistical Office (CSO), Ministry of Health (MoH), and the Department of National Registration, Passport and Citizenship (DNRPC) with financial support from the United States Government and Government of the Republic of Zambia. A pilot SAVVY was conducted from 2009 to 2010, in thirty-three (33) selected census supervisory areas (CSAs) of four provinces: Central, Luapula, Lusaka, and Southern. In 2010, the SAVVY was expanded to cover all provinces of Zambia, hence, covering the entire country. Data collection was conducted from

2010 to 2012, thereby providing mortality information for years 2010, 2011 and 2012. The SAVVY used a nationally representative sample of CSAs and standard enumeration areas (SEAs) selected from the 2000 census of population and housing sampling frame. Seventy-six (76) homogeneous CSAs were selected, 46 in rural areas and 30 in urban areas of each province for vital registration with verbal autopsy. The target population were all individuals living in households in the selected CSAs. In rural areas, the target was 1,200 households and urban areas, 1,800 households. A total sample population of 109,200 was targeted. The CSAs were first stratified by province, rural and urban, and then by infant and mortality rates for rural and urban areas at district level. Two types of substratum were created, first those with infant mortality rates below the national estimate, and second, those with infant mortality rates above the national estimate. The CSAs were then selected systematically using probability proportion to size within each stratum (Central Statistical Office [Zambia] 2014).

Field staff were recruited and trained on administering the verbal autopsy questionnaire, assignment of immediate and underlying causes of death using the World Health Organization International Classification of Diseases version 10 (ICD-10) and production of death certificates. The Staff included nurses, environmental health technicians, and other medical personnel who were trained as verbal autopsy interviewers (VAIs); mostly members of community health committees served as community key informants (CKIs) who reported deaths that occurred to VAIs and facilitated appointments with households that experienced a death; and medical doctors and clinical officers (nosologists) from the Ministry of Health whose role was to classify and code the causes of death using ICD-10 guidelines and coding practice. They also issued death certificates for each completed verbal autopsy of the deceased persons where they were not available (Central Statistical Office [Zambia] 2014).

A baseline census was conducted in each SEA of the selected CSAs to collect key demographic and socioeconomic characteristics of the population and households as well as to identify deaths that occurred in the last 12 months. This was followed by the surveillance of vital events; births and deaths that occurred in the CSAs were captured as identified by community key informants. Verbal autopsy interviews were then conducted for all deaths recorded in the CSAs using a structured verbal autopsy questionnaire suitable for the age of the deceased. The next of kin or an adult respondent knowledgeable about the deceased person responded to the verbal autopsy questionnaire. After the verbal autopsy interview, the probable cause of death was ascertained; a death certificate was produced as well as the ICD-10 code was assigned for the cause of death.

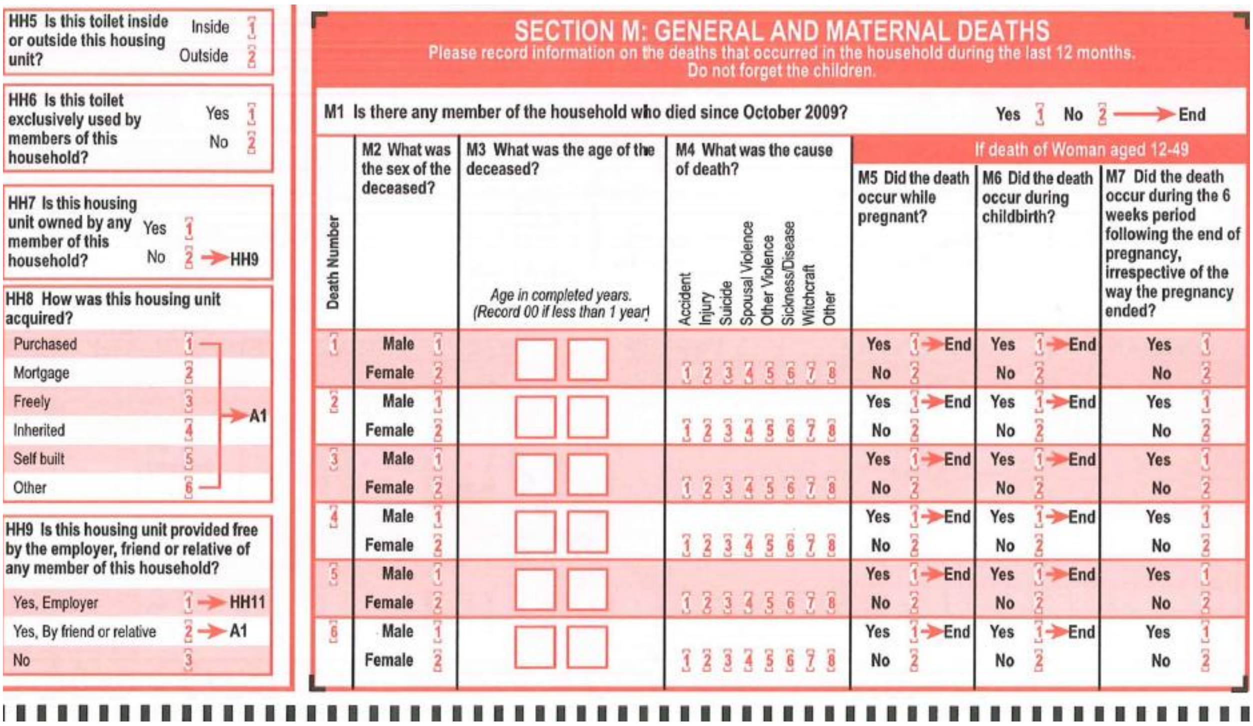
3.5 Instruments

This section highlights the instruments that were used to collect the data utilised by this study. Since, the study did not apply these instruments or modify them for field work the presentation is limited to what is appropriate to the study and not about pilot testing of the questionnaire or how they have performed in terms of reliability and validity from other researches.

3.5.1 2010 Census questionnaire

A single questionnaire was used to capture individual, household and housing characteristics from the population. The 2010 census collected information on household deaths in the last 12 months prior to the census interview. A question was asked: "Is there any member of the household who died since October 2009? If yes, follow-up questions were asked to establish the sex and age of the deceased: "What was the sex of the deceased?" and "What was the age of the deceased?" To establish the causes of death a question was asked: "What was the cause of death?" For female deaths in the age group 12-49, additional questions were asked to establish if the death was because of maternal causes. A total of 3.2 million questionnaires were used to collect data from every individual and household in the country (Central Statistical Office [Zambia] 2012).

Figure 3.3 Questionnaire extract of mortality questions from the 2010 Census



HH5 Is this toilet inside or outside this housing unit? Inside 1 Outside 2

HH6 Is this toilet exclusively used by members of this household? Yes 1 No 2

HH7 Is this housing unit owned by any member of this household? Yes 1 No 2 → HH9

HH8 How was this housing unit acquired?
Purchased 1
Mortgage 2
Freely 3
Inherited 4
Self built 5
Other 6
→ A1

HH9 Is this housing unit provided free by the employer, friend or relative of any member of this household?
Yes, Employer 1 → HH11
Yes, By friend or relative 2 → A1
No 3

SECTION M: GENERAL AND MATERNAL DEATHS
Please record information on the deaths that occurred in the household during the last 12 months.
Do not forget the children.

M1 Is there any member of the household who died since October 2009? Yes 1 No 2 → End

Death Number	M2 What was the sex of the deceased?	M3 What was the age of the deceased? Age in completed years. (Record 00 if less than 1 year)	M4 What was the cause of death? Accident, Injury, Suicide, Spousal Violence, Other Violence, Sickness/Disease, Witchcraft, Other	M5 Did the death occur while pregnant?	M6 Did the death occur during childbirth?	M7 Did the death occur during the 6 weeks period following the end of pregnancy, irrespective of the way the pregnancy ended?
				If death of Woman aged 12-49		
1	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2
2	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2
3	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2
4	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2
5	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2
6	Male 1 Female 2	☐☐	1 2 3 4 5 6 7 8	Yes 1 → End No 2	Yes 1 → End No 2	Yes 1 No 2

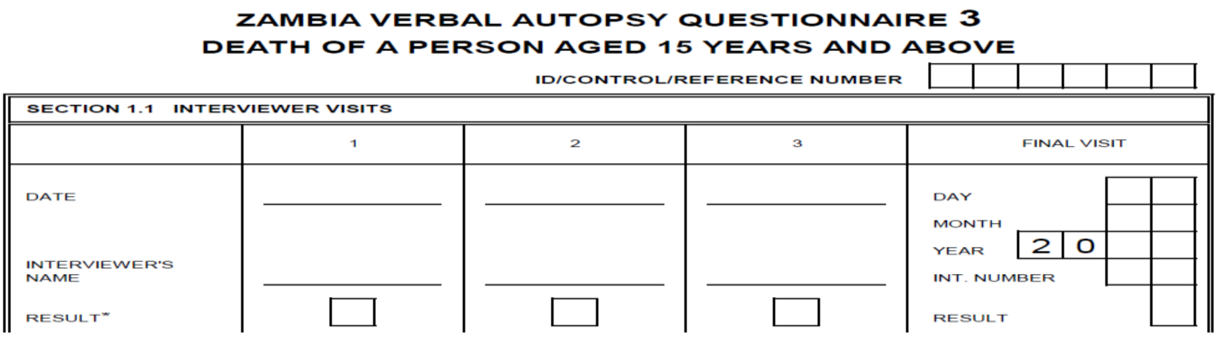
Source: Central Statistical Office [Zambia] (2012)

3.5.2 2010-2012 SAVVY questionnaire

The SAVVY used four types of World Health Organization standardized data collection instruments: Baseline Census Questionnaire for households; Verbal Autopsy Questionnaire for death of a child aged under 4 weeks; Verbal Autopsy Questionnaire for death of a child aged 4 weeks to 14 years; and Verbal Autopsy Questionnaire for death of a person aged 15 years and above. The household questionnaire asked the following questions as a basis for verbal autopsy interviews: "Is there a usual member of this household who died in the last 12 months?"; "Was this person male or female?", and "How old was this person?" For all deaths that were identified, the verbal autopsy questionnaire for death of a person aged 15 years and above - which is the questionnaire is of interest to the study - then collected more detailed information about the deceased person on age at death, sex, marital status, occupation status at time of death, education level, cause of death, history of illness, risk factors, health service utilisation, place of death, and relationship to the deceased among others.

It should be noted that there are limitations with verbal autopsy data, for instance, cause of death data from verbal autopsy are not the same as cause of death data from clinical records. In addition, the certainty of cause of death data from verbal autopsy is less when compared to cause of death reported from medical records. The quality of the information from the verbal autopsy is dependent on the expertise of the interviewers. With the passage of time, there is recall bias on the part of the respondents to provide reliable information about events that led to the deceased dying. Also, when determining the cause of death by clinicians based on verbal autopsy data, there could be misclassifications.

Figure 3.4 Questionnaire extract of death of a person aged 15 years and above, 2010-2012 SAVVY


ZAMBIA VERBAL AUTOPSY QUESTIONNAIRE 3
DEATH OF A PERSON AGED 15 YEARS AND ABOVE

ID/CONTROL/REFERENCE NUMBER

SECTION 1.1 INTERVIEWER VISITS

	1	2	3	FINAL VISIT
DATE				DAY MONTH YEAR 2 0
INTERVIEWER'S NAME				INT. NUMBER
RESULT*				RESULT

Source: Central Statistical Office [Zambia] (2014)

3.6 Variable Identification

3.6.1 Dependent variable

The dependent variable is adult mortality measured as a time-to-event representing the probability that a person who celebrates their 15th birthday dies before celebrating their 60th birthday (${}_{45}q_{15}$), assuming that the age-specific mortality conditions for a particular year remain constant during the life of the individual. The adult mortality measure ${}_{45}q_{15}$ has been used by previous studies (Timaeus and Jasseh 2004; Masquelier 2013; Moultrie, Dorrington, Hill *et al.* 2013) and international organisations and agencies that use it as a summary measure of young and middle-aged mortality (United Nations 2013b; World Health Organization 2014).

To measure the dependent variable information on household deaths was collected in both the 2010 census and 2010-2012 SAVVY on the sex, age and cause of death of the deceased person as elaborated earlier. A mortality file containing only detailed information of all deceased cases which in survival or time-to-event analysis is considered as uncensored data and all cases are treated as fail which equates to the value of 1 (all fail). The survival status or failure variable, that is, the risk of dying between age 15 and 60 years was measured as "1" mortality of deceased persons in age group 15 to 59, and "0" deaths of persons in other ages. Age at death in completed single-years was modelled as a time variable. The baseline household file with information on the household characteristics and other variables could not be linked with the individual mortality file as the two files were rendered anonymous by the Central Statistical Office for confidentiality reasons.

3.6.2 Independent variables

This section describes the independent variables used in this study at individual-, household- and community-level.

3.6.2.1 Individual level variables

At individual level, there are sociodemographic and socioeconomic variables as presented in the study conceptual framework. The sociodemographic variables are: age, sex, and marital status. The socioeconomic variables are: education and occupation. These variables were chosen based on the literature reviewed. Studies reviewed show that adult mortality varies by sociodemographic and socioeconomic characteristics of individuals.

Age is one of the crucial variables in mortality analysis as demographically, mortality has an age pattern that it follows and expected as observed in most populations (Brass, Coale, Demeny *et al.* 1968; Preston, Heuveline and Guillot 2001; Bradshaw and Timaeus 2006; Reniers, Masquelier and Gerland 2011). Adult mortality in this study is, therefore, expected to vary by age. Age is hence accounted for, as ignoring it would introduce biases. Sex is also another critical variable in the demographic analysis of mortality. Mortality analysis, historically, shows that there are differences between males and females in terms of the risk of dying. Mortality tends to favour females than males dues to several reasons that have been advanced such as biological, behavioural and socioeconomic factors (Kelly, Feldman, Ndubani *et al.* 1998; Cubbin, LeClere and Smith 2000; Crimmins 2005; Preston and Wang 2006; Rogers, Everett, Saint Onge *et al.* 2010; Lantz, Golberstein, House *et al.* 2010 ; Crimmins and Vasunilashorn 2011; Heuveline and Clark 2011; Nikoi and Odimegwu 2013; Masquelier, Eaton, Gerland *et al.* 2017). In this study, it is expected that adult mortality varies by sex.

Marital status is included in this study as previous studies found that married persons had a mortality advantage over the unmarried persons (Waite and Gallagher, 2000; (Lillard and Waite 1995; Rogers 1995; Waite 1995; Lillard and Panis 1996; Dupre, Beck and Meadows 2009; Liu 2009; Hummer and Lariscy 2011). Marital status contrasts deceased persons who were married/living with a partner; divorced, separated and widowed with those who were never married.

Studies have documented that education attainment is a strong predictor of adult mortality. Education attainment has an inverse relationship with mortality as the less educated have higher mortality than the most educated (Preston and Elo 1995; Lleras-Muney 2005; Hummer and Lariscy 2011; Masters, Hummer and Powers 2012; Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013; Manzelli 2014; Rogers, Everett, Zajacova *et al.* 2010). Educational attainment affects mortality directly through altered positive health behaviours, cognitive behaviour and knowledge to access health care, and indirectly through its impact on earnings in form of income as well as type of occupation.

Previous studies have also revealed that type of occupation matters when it comes to adult mortality. Lower status occupations (labourers, service workers, private household workers) are associated with higher mortality risk compared with high status occupations (professionals and managers) (Preston and Taubman 1994; McDonough, Duncan, Williams *et al.* 1997; Rogers, Hummer and Nam 2000; Kawachi 2001). Information on sociodemographic and socioeconomic variables of deceased persons was collected by 2010-2012 SAVVY. Table 3.1 below presents the definitions and measurement of each individual level variable.

Table 3.1 Individual level variables

No.	Variable	Definition	Measurement
	Sociodemographic		
1.	Age	Age in completed years of the deceased	Years
2.	Sex	Sex of deceased person	(1) Male (2) Female
3.	Marital Status	Marital status of deceased person	(1) Never Married (2) Married/Living with a partner (3) Divorced/Separated/Widowed
	Socioeconomic		
4.	Education	Education attainment of a deceased person	(1) None (2) Primary (3). Secondary (4) Higher
5.	Occupation	Type of occupation of a deceased person	(1) Legislators/Senior Officials/Managers (2) Professionals (3) Technicians/Associate professionals (4) Clerks (5) Service/Shop/Market Sales Workers (6) Skilled Agriculture/Fishery Workers (7) Craft and Related Trade Workers (8) Plant and Machine Operations/Assemblers (9) Elementary occupations/other

3.6.2.2 Household level variables

The household level variable considered in this study is family relations as a proxy for household composition (Table 3.2). Studies have shown that adult mortality is associated with household level variables such as family relations. Family relations influence mortality in a comparable manner as well-established mortality risks. Studies have found that individuals with closer family relationships have lower risk of dying compared with those with weaker family relationships (Rogers 1992; Lillard and Panis 1996; Rogers, Hummer and Nam 2000).

Table 3.2 Household level variables

No.	Variable	Definition	Measurement
1.	Household composition (family relations)	Family composition of persons in a household	(1) Spouse (2) Father (3) Mother (4) Siblings (5) Child (6) Other relative

3.6.2.3 Community level variables

Community level variables that influence adult mortality variations considered in this study are: province of residence, type of residence, place of death, community health service use, community illness treatment received and community education (Table 3.3). Community variables were constructed from individual compositional variables by aggregation at primary sampling unit (PSU) or cluster level which is the Census Supervisory Areas (CSAs) in this case, and applied proportions for categorisation. The community is defined at CSA level this is because adult mortality is a rare event, a large sample is required to have a reasonable number of adult deaths to produce plausible estimates. Community variables were constructed using 2010-2012 SAVVY data.

Studies have shown that region of residence is associated with adult mortality variations. Regional differentials in mortality may reflect inherent inequalities in livelihoods, access to health care, social amenities, and poverty in populations (Khosravi, Taylor, Naghavi *et al.* 2007; Saikia, Jasilionis, Ram *et al.* 2011). The type of residence, that is urban-rural residence, has also been found to be related to mortality. Studies show that mortality is higher in rural areas than urban areas. This is because urban areas have the health infrastructure within proximity and access to health services compared to rural areas (Goodridge, Lawson, Rennie *et al.* 2010; Weldearegawi, Spigt and Berhane 2014). Place of death is associated with adult mortality and has been used as a proxy indicator of health access and health care utilisation (Costantini, Balzi, Garronec *et al.* 2000; Currow, Noel and Sullivan 2003; Costa 2014; Black, Waugh, Munoz-Arroyo *et al.* 2016).

Community education influences adult mortality in a similar way as education at individual level. Past research found a negative association between community education and mortality (Kawachi and Berkman 2003; Krueger, Huie, Rogers *et al.* 2004; Nandi and Kawachi 2011; Naess, Hoff, Lawlor *et al.* 2012; Hummer and Hernandez 2013; Adedini, Odimegwu, Imasiku *et al.* 2015). Community utilisation of health services has been found to be associated with health outcomes like mortality. This occurs through the availability of health services and positive attitudes towards health (MacIntyre, Maciver and Sooman 1993; Diez-Roux 1998; Duncan, Jones and Moon 1998). Proportion of the community that receive treatment for their health conditions prior to death is associated to adult mortality. Previous studies show that persons are more likely to seek medical attention for their conditions in resource limited settings if they are sure of the availability of medicines in the health facilities, otherwise they seek treatment from informal sources which further pose a risk to their health (Cohen, Bilsen, Hooft *et al.* 2006; Gysels, Pell, Straus *et al.* 2011; Anteneh, Araya and Misganaw 2013).

There is a limitation in aggregating community level variables from individual level variables in that it may lead to multicollinearity between individual level variables and the created community level variables. It is, therefore, relevant to test for multicollinearity prior to performing a regression analysis.

Table 3.3 Community level variables

No.	Variable	Definition	Measurement
1.	Province of residence	Geographical province or region	(1) Central (2) Copperbelt (3) Eastern (4) Luapula (5) Lusaka (6) Northern (7) North-western (8) Southern (9) Western
2.	Type of residence	Urban or Rural residence	(1) Rural (2) Urban
3.	Place of death	Place where the deceased died	(1) Health facility (2) Home (3) Other
4.	Community health service use	Proportion in the community who used health facility for care prior to death	(1) Low (2) High
5.	Community illness treatment received	Proportion in the community who received treatment for the illness prior to death	(1) Low (2) High
6.	Community education	Proportion in the community with at least secondary education	(1) Low (2) High

The study introduced new community variables that have not been examined in the literature reviewed. The relevance of the variables is explained as follows: first, place of death, this variable is an indicator of access to modern health services and is important for health planners and decision-makers. A high proportion of deaths occurring at home indicate that there are challenges in accessing modern health facilities for segments of the population. Second, community health service utilisation prior to death, similarly like place of death, this variable indicates the actual health service use before an individual dies. It equally shows access to modern health facilities. Third, community illness treatment received prior to death, this variable is important as it is an indicator of the availability of medicines in health facilities. Clearly, a high proportion of individuals dying without receiving treatment imply that health facilities may be out of stock of essential medicines, for example.

3.6.3 Proximate determinants/Intervening variables

The independent variables at either individual or household or community level may not directly influence adult mortality but do so through proximate determinants or intervening variables; and these have been identified in the study as those related to health behaviour (smoking tobacco and drinking alcohol) and health condition (injury, diabetes, tuberculosis, cancer, and HIV/AIDS) from the Rogers, Hummer and Krueger (2005) proximate determinants for adult mortality conceptual framework (Table 3.4). Studies have revealed that cigarette smoking is associated with the risk of mortality. Cigarette smoking is detrimental to a person's health as it is linked to multiple causes of illness and contributes to premature mortality with the highest risk associated with heavy smoking (Rogers 1992; Nam, Hummer and Rogers 1994; Hummer, Nam and Rogers 1996; Rogers, Hummer and Nam 2000; Gajalakshmi, Peto, Kanaka *et al.* 2003; Rogers, Hummer, Krueger *et al.* 2005; Frosch, Dierker, Rose *et al.* 2009; Rogers, Everett, Saint Onge *et al.* 2010; Fenelon and Preston 2012; Fenelon 2013).

Alcohol use is another risk factor associated with adult mortality because of its morbidity and mortality impact on both the individual and community at large. Previous studies have found that alcohol use increases the risk of mortality through accidents and injuries, interpersonal violence and certain health conditions more especially for heavy drinkers (Liao, McGee, Cao *et al.* 2000; Rogers, Hummer and Nam 2000; Klatsky and Udaltsova 2007; Rogers, Everett, Saint Onge *et al.* 2010). Health conditions injury (Mayosi, Flisher, Lalloo *et al.* 2009; Matzopoulosa, Prinslooa, Pillay-van Wyka *et al.* 2015), diabetes (McLarty, Unwin, Kitange *et al.* 1996; Allen, Williams, Townsend *et al.* 2017), tuberculosis (Mberu, Wamukoya, Oti *et al.* 2015; Murray, Ortblad, Guinovart *et al.* 2014), cancer (Holmes, Dalal, Volmink *et al.* 2010; Dalal, Beunza, Volmink *et al.* 2011), and HIV/AIDS (Dzekedzeke, Siziya and Fylkesnes 2008; Herbst, Cooke, Barnighausen *et al.* 2009; Dlodlo, Fujiwara, Hwalima *et al.* 2011; Kanjala, Michael, Todd *et al.* 2014; Kharsany and Karim 2014) are associated with increased adult mortality risk.

Table 3.4 Proximate determinants/intervening variables

No.	Variable	Definition	Measurement
	Health behaviour		
1.	Smoking	Smoking of tobacco or cigarettes	(1) Yes (2) No
2.	Drinking	Drinking of alcohol	(1) Yes (2) No
	Health condition		
3.	Tuberculosis	Suffered from tuberculosis	(1) Yes (2) No
5.	Cancer	Suffered from cancer	(1) Yes (2) No
6.	HIV/AIDS	Suffered from HIV/AIDS	(1) Yes (2) No
	Physiological influences		
7.	Injury	Suffered any injuries	(1) Yes (2) No
8.	Diabetes	Suffered from diabetes	(1) Yes (2) No

3.7 Data assessment

Descriptive statistics of dependent (outcome variable) and independent (explanatory) variables were produced in form of tables and in some cases where appropriate graphs. The descriptive statistics include frequencies, means, cross-tabulations, chi-square or tests of association. This preliminary stage was important as it helped to identify and prepare variables that were used in inferential statistics for hypothesis testing in order to answer the research questions.

Demographic data were subjected to data quality assessments and adjustments - where appropriate - normally performed in demographic analysis. The standard methods of demographic evaluation and adjustment of the data were applied (Arriaga, Johnson and Jamison 1994). Population age data collected by census and surveys often suffer from problems such as age misreporting, age heaping, age exaggeration, and age digit preference (0 and 5) among others. Household deaths data are also inherently affected by quality issues such as under-reporting, reference-period errors, age misreporting, and recall lapse. Studies in sub-Saharan Africa have documented challenges in collecting information on household deaths and causes of death mainly due to the nature of the event of death as it may invoke some emotions and in some African settings talking about death is almost taboo (Brass, Coale, Demeny *et al.* 1968; Brass 1975; Hill 1975; Hill 1985; Hill 2003; Timaeus and Jasseh 2004; Chisumpa and Dorrington 2011; Moultrie, Dorrington, Hill *et al.* 2013; Chisumpa and De Wet 2017). In addition, deaths in dissolved households are also rarely captured in censuses and surveys (Brass, Coale, Demeny *et al.* 1968; Moultrie, Dorrington, Hill *et al.* 2013).

To minimise some of the age misreporting errors in the population age data of the censuses and surveys used, Arriaga light smoothing method was utilised (Arriaga, Johnson and Jamison 1994). The assumption of the method is that a second degree polynomial passes by the mid-point of each three consecutive 10-year age groups and then integrates the 5-year age group (Arriaga, Johnson and Jamison 1994). The Arriaga light smooth method does not modify the total population figures. It combines the initial 5-year age group population distribution into 10-year age groups, and then split them back again into 5-year age groups thereby redistributing the populations in each 5-year age group to correct for the age misreporting in the data.

The Arriaga light smoothing method was used as opposed to the strong smoothing method because the age misreporting was not severe; there were slight irregularities in other ages as shown by the computed percentage age distributions, United Nations age-sex accuracy index, age and sex ratios, Whipples and Myers' indices (Siegel and Swanson 2004).

Household death data were evaluated for completeness in reporting of deaths by applying death distribution methods, that is, the Brass Growth Balance method (Brass 1975), Generalized Growth Balance method (Hill 1987), and the Synthetic Extinct Generations method (Bennett and Horiuchi 1981, 1984). The methods estimate the completeness of reporting of deaths relative to an estimate of the population. These methods are described in the subsequent sections.

3.8 Statistical analysis

The statistical analysis performed pertains to answering the research questions and thereby addressing the research objectives.

To address objective 1: *Establish the level of adult mortality in Zambia.* As far as the estimation of adult mortality is concerned, using the 2010 census data, the census analytical report shows that computations only ended at determining the completeness of death reporting and no estimates of adult mortality were produced. This study went beyond this point and derived the levels of adult mortality using the 2010 census dataset. Indirect demographic methods of estimating adult mortality were applied. The methods used are Hill's (1987) Generalized Growth Balance (GGB) method, which is an extension of Brass' (Brass 1975) Growth Balance Method. The method estimates mortality from age distribution of deaths, which are assessed for completeness in reporting, and then adjusted for constructing a relational logit model life table, based on a standard model life, from which estimates of the probability of dying between ages 15 and 60 years are inferred, hence establishing the level of adult mortality.

In the case of Zambia, the AIDS model life tables (Moultrie, Dorrington, Hill *et al.* 2013) were used as a standard to allow for the HIV/AIDS epidemic, which the country has been experiencing. Hill (1987) modified the Brass growth balance method by relaxing the assumption of stability by using data from two censuses to estimate age-specific growth rates (varying at all ages) to make the method applicable to non-stable populations. In the discrete form, Hill (1987) shows that:

$$\frac{({}_5N1_{x-5} * {}_5N2_x)^{0.5}}{5*(N1_{x+} * N2_{x+})^{0.5}} - \frac{1}{t}\ln\left(\frac{N2_{x+}}{N1_{x+}}\right) \approx \frac{1}{t}\ln\left(\frac{k_1}{k_2}\right) + \frac{(k_1 * k_2)^{0.5}}{c} * \frac{D^o(x+)}{t*(N1_{x+} * N2_{x+})^{0.5}},$$

where $N1$ and $N2$ are population enumerations at two time points; t is the time interval in years between the two population enumerations; D^o is the number of reported intercensal (inter-survey) deaths; and k_1, k_2, and c are coverage of the first and second population enumerations, and completeness of the intercensal (inter-survey) deaths, respectively.

Assumptions of the method are that the population is closed, the ages for death and population are accurately reported, and no age exaggeration. When assumptions of the GGB are met points for successive age segments $x+$ should lie on a straight line. The slope ($(k_1 * k_2)^{0.5}/c$) serves as the adjustment factor for reported deaths to bring them into consistency with the population enumeration (Hill 1987). The adjustment factor (slope) is estimated by using a method of fitting a straight line, such as, the robust straight-line fitting method.

The second method that was used is the Synthetic Extinct Generations (SEG) method based on the original idea that in a closed population with complete reporting of deaths, the population aged x at a certain time t can be estimated by cumulating all deaths pertaining to that cohort until the last person in the cohort has died. Bennett and Horiuchi (1981, 1984) extended the method so that it is applicable to non-stable populations. It requires data on reported deaths by age, and age distributions at two points in time (2000 and 2010 Census data for Zambia). The method assumes that the population is closed, the ages for death and population are accurately reported, and no age exaggeration. The Bennett-Horiuchi method also assesses the completeness of death reporting and adjusts the level. The adjusted age distribution and deaths are then used to construct a relational logit model life table for estimating the level of adult mortality. Bennett and Horiuchi's method is expressed as,

$$N(a) = \int_a^\infty D^o(x) \exp\left[\int_a^\infty r(u)du\right]dx,$$

where $r(u)$ is the growth rate of the population aged u. $D^o(x)$ is the number of reported deaths.

The two methods are known as death distribution methods and are suitable for use with census data and preferred because they provide age-period specific estimates of mortality which produce reasonable estimates of adult mortality (Hill 2001). The limitation of the two methods is that they are sensitive to differential coverage of the two censuses which affects the growth rates. Hill and Choi (2004) and Hill, You and Choi (2009) propose that the solution to this is to combine the two methods (GGB+SEG) whereby the GGB method estimates the differential and adjustments are made with respect to the affected census, thereafter the SEG method is applied.

The GGB and SEG methods were applied to 2000 and 2010 census population and death data. Intercensal deaths between 2000 and 2010 were estimated by taking into account of the growth rates between the two periods and applying the geomean to come up with a death inflation factor. The use of the 2000 and 2010 censuses catered for the assumption of stability. To minimise the risk of violating the assumptions, the study fit the straight line to the best possible points at national, rural-urban and provincial levels in order to estimate the level of completeness of death reporting, perform adjustment and subsequently deriving the adult mortality rates at these levels. In fitting the straight line, the study ensured that the chosen age ranges resulted in a level of completeness of death reporting that was not less than 60 per cent as a level below this acceptable threshold could introduce a lot of uncertainty in the plausibility of the mortality estimates (Dorrington 2013: 197). The straight line was fit to the partial birth and death rates from the age range 5+ to 75+ years at national and sub-national levels. Ages above 75 years were avoided because of age exaggeration. Hill, You and Choi (2009) recommend fitting the straight line to age ranges 5+ to 65+ while Dorrington (2013: 197) recommends fitting to age trims 35+ to 75+ in order to avoid migration ages if not accounted for as well as age exaggeration at older ages. The choice of age trims ensures that plausible mortality estimates are obtained. The residuals of the fitted points were kept within the acceptable limits of less than 1 per cent; any points with residuals above this threshold were excluded. In addition, a good fit straight line lessens concerns about the violation of the assumption on migration despite allowing for it. The probabilities of dying between age 15 and 60 years were estimated as follows from a fitted life table: ${}_{45}q_{15} = 1 - \left(\frac{l_{60}^{fitted}}{l_{15}^{fitted}} \right)$ as elaborated by Dorrington (2013: 196-204).

The Brass Growth Balance (BGB) method was also applied as part of the validation process. The method estimates completeness of reporting of deaths relative to an estimate of the population. The BGB method is based on the assumption that in a stable and closed population where data on age and deaths are correctly reported, the growth rate is equal to the birth rate less the death rate, which is expressed as $N(x) = r(x).N(x+) + D(x+)$, where $N(x)$ is the number of persons at age *x*; $r(x)$ is the rate of growth of the population aged $x+$; $N(x+)$ is the population aged $x+$; and $D(x+)$ are the deaths in the population aged $x+$. The final expression for adjusting completeness of reporting of deaths is: $\frac{N(x)}{N(x+)} = r + \frac{1}{c} \times \frac{D^{'}(x+)}{N(x+)}$, where $\frac{1}{c}$ is the reciprocal of completeness of death reporting. A detailed elaboration of the method can be found elsewhere (Brass 1975; United Nations. Department of Economic and Social Affairs. Population Division. 2002; Moultrie, Dorrington, Hill *et al.* 2013).

Migration is another limitation that affects the estimates. At national level, it was assumed that migration did not play a significant role in determining population dynamics at national level as an estimate of net migration rate of -0.6 migrants per 1,000 population in the period 2010-2015 is negligible (United Nations 2013b). However, it is at sub-national level were migration mattered in estimating adult mortality rates. The study accounted for migration at sub-national level by estimating interprovincial net migration as well as rural-urban net migration by age and sex using information on place of enumeration and place of previous residence. The methodology utilized for estimating regional migration is elaborated elsewhere (Moultrie, Dorrington, Hill *et al.* 2013). The net migration estimates were added to the age and sex population distributions.

Direct estimates of adult mortality rates were derived by constructing life tables using standard demographic methods utilising 2010 census data and 2010-2012 SAVVY data at national and sub-national levels for both males and females. Direct sibling estimates were also derived for comparison and validation purposes using 2013/2014 demographic and health survey data. The methodology of the direct sibling method is elaborated elsewhere (Moultrie, Dorrington, Hill *et al.* 2013). The estimates were derived by direct computation of number of deaths and person-years of exposure in the last 7 years (0-6 years: 2007-2013) of siblings. To ensure accuracy of the estimates, the strategy used was to first reproduce the survey's reported probabilities of dying between age 15 and 50 years (${}_{35}q_{15}$) and then extend the method to derive the ${}_{45}q_{15}$ adult mortality estimates. For mortality estimates at sub-national level, the study used the respondent sibling's region of residence as a proxy for the deceased siblings' region to derive the estimates. The mortality estimates derived from sibling survival information are used for validation of the other estimates. The direct methods of estimating adult mortality do not require assumptions of stability and migration to be accounted for.

The estimated adult mortality rates are presented in two parts: first, those derived by direct methods and second, those obtained by indirect estimation methods. It should be noted that unlike in infant and child mortality or maternal mortality estimation, there is no gold standard method of adult mortality estimation in the absence of complete and accurate data from the civil and vital registration system. This is the reason why there is an assortment of adult mortality estimation methods. There are over 10 types of estimation methods that can be used depending on the data type available. However, there are two common groups of methods that are used, one, those that use age-sex population and death data known as death distribution methods, and two, those that use information on survivorship of close relatives.

Adult mortality estimates derived from these methods are not always exactly the same in magnitude but will be within acceptable limits of each other if the methods are applied correctly and the assumptions are satisfied. The quality of data used also affects the results of the estimation methods, for example, the death distribution methods work well when there is less uncertainty. As noted by Hill and Choi (2004) data limitations affect the GGB and SEG methods differently. The SEG method is strongly affected by changes in census coverage while the GGB handles well the systematic errors compared to SEG. Therefore, the adult mortality estimates derived from these methods should be examined, analyzed and interpreted with caution considering the given context.

To address objective 2: *Examine the causes of adult mortality in Zambia*. This objective was achieved by computing descriptive statistical analysis of percentages and correlations of causes of death against demographic, socioeconomic and geographical variables using 2010-2012 SAVVY dataset. The associations between explanatory variables and causes of death were established by performing Chi-Square tests. The Chi-Square test statistic is computed by using the formula:

$X^2_c = \Sigma (O_i - E_i)^2/E_i$, where c are degrees of freedom; O_i is the observed value and E_i is the expected value.

To address objective 3: *Explore the age - and cause-specific mortality contributions, and differentials in adult mortality*. This objective was addressed by computing cause specific mortality rates using standard methods where the numerator is the number of deaths attributed to a specific cause, and the denominator is the population at a specified time interval of the year. The all cause and cause-specific mortality rates were computed by demographic, socioeconomic and geographical variables using 2010-2012 SAVVY dataset. The SAVVY baseline census population adjusted to the national population was used as the denominator. This was done in order to describe the distribution of the causes of death by background characteristics of the deceased persons.

(i) Age Specific Death Rate (ASDR) = (Number of deaths in a specific age group/Population in that age group)*1000

(ii) Age-Cause-Specific Death Rate (ASDRate) = (Number of deaths due to a specific cause in an age group/Population in the corresponding age group)*1000

(iii) Age-Cause-Specific Death Ratio (ACSDRatio) = Number of deaths due to a specific cause in an age interval/Total number of deaths in the same age group)*100.

Life tables for males and females were constructed by using household deaths by age and sex from the 2010-2012 survey data (weighted sample). Standard life table techniques were applied to derive the estimated life expectancies at birth and each age (Preston, Heuveline and Guillot 2001). Life tables were constructed separately for the census and survey data. Unadjusted household deaths by age and sex were computed into age specific mortality rates ($_nM_x$) by dividing with the respective populations for each age and sex. The age-specific mortality rates ($_nM_x$) were then converted into life table age-specific probabilities of dying ($_nq_x$) using the method by Greville, (1943). It was assumed that the observed age specific mortality rates ($_nM_x$) were equivalent to the life table age specific mortality rates ($_nm_x$) when converting to age-specific probabilities of dying. The conversion method: $_nq_x = \frac{n._nm_x}{1+(n-_na_x)_nm_x}$ was used, where

${}_{n}a_{x}$ is the average number of person-years lived in the interval by those dying in the age interval. The ${}_{n}a_{x}$ values were estimated using the age distribution of deaths in the life table as recommended by Keyfitz (1966) using the expression: ${}_{n}a_{x} = \frac{-\frac{n}{24}{}_{n}d_{x-n} + \frac{n}{2}{}_{n}d_{x} + \frac{n}{24}{}_{n}d_{x+n}}{{}_{n}d_{x}}$, where ${}_{n}d_{x}$ are life table deaths in the age interval. The ${}_{n}a_{x}$ values for ages below five (5), that is, ${}_{1}a_{0}$ (age 0) and ${}_{4}a_{1}$ (age 1-4) were computed as recommended by Preston, Heuveline and Guillot, (2001: 48). The age specific mortality rate at age 0 (${}_{1}m_{0}$) was less than 0.107 (<0.107) (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). Therefore, appropriate recommended expressions were used to estimate the ${}_{n}a_{x}$ values for the two under-five ages. The ${}_{n}a_{x}$ values for the open interval, that is, ${}_{\alpha}a_{80+}$ where adapted from the north model level 14 of the Coale, Demney and Vaughan (1983) family of model life tables. The choice of the north model of life table is based on previous studies that have used it on Zambia (Chisumpa and Dorrington 2011). Furthermore, the open interval is not affected by AIDS mortality. A probability of dying of 1 was assigned to the open-ended interval age group (${}_{\alpha}q_{80+} = 1$). The estimates of ${}_{n}a_{x}$ and ${}_{n}d_{x}$ were stabilized by performing three iterations. The other life table functions (l_{x}, ${}_{n}d_{x}$, ${}_{n}L_{x}$, T_{x} and e_{x}) were computed using the standard life table expressions (Preston, Heuveline and Guillot 2001). The constructed life tables for males and females served as inputs for the decomposition of age- and cause-specific mortality rates.

Life table techniques were employed to construct cause-deleted/associated single decrement life tables (ASDLT) as well as multiple decrement life tables (MDLT) to assess the contributions of the causes of death thereby establishing their relative significance to adult mortality. Probabilities of death from each cause were also be derived. The ASDLT and MDLT are constructed by relating observed deaths in the population in the age interval *x, x+n* (${}_{n}M_{x}$) to the deaths of the life table in the same age interval (${}_n m_x$) by assuming that they are equal, implying the force of mortality is constant (${}_n M_x = {}_n m_x$). Preston et al (2001) have a presented detailed explanation on this association elsewhere. According to Preston et al (2001) multiple decrement life tables can be constructed using the following equations: (1) ${}_n q_x^i = {}_n q_x \times \frac{{}_n M_x^i}{{}_n M_x} = {}_n q_x \times \frac{{}_n D_x^i}{{}_n D_x}$, which is the probability of dying from cause *i* (${}_n q_x^i$) while the probability of dying from all causes combined is (${}_n q_x$); ${}_n D_x^i$ and ${}_n D_x$ are observed number of deaths (decrements) from cause *i*, and from all causes (all decrements) between age x and *x+n* in the population, respectively; (2) ${}_n d_x^i = {}_n q_x^i \times l_x$, which are the deaths from cause *i* in the age interval *x, x+n* in the life table; (3) A summation of all deaths from cause *i* is used to obtain the number of survivors who eventually die of cause i: $l_{x^*}^i = \sum_{x=x^*}^{\infty} {}_n d_x^i$. The cause-deleted/associated single life table is also constructed by assuming that the force of mortality is constant (${}_n^* m_x = {}_n M_x^i = {}_n m_x^i$) and the associated single decrement probability of dying from cause *i* in the age interval *x, x+n* is computed as: ${}_n^* q_x = 1 - e^{-n \times {}_n M_x^i}$ (Preston et al., 2001). The other life table functions are computed as per standard life table relationships. The Arriaga method (Arriaga, 1984) as well as the Pollard method (Pollard, 1988) of decomposition was applied to assess the effects of cause-specific mortality with respect to the differences in life expectances by age. The method measures change in life expectancy and decomposes the change into components to show the contribution of each age group and causes of death to the total change. The Arriaga method consists of two decomposition components: direct and indirect effects with interaction effects which add up to the total effects which equate to the total change in life expectancy. The total effects represent the overall contributions in magnitude attributable to either age-specific mortality or cause-specific mortality rates responsible for changes in the life expectancy.

Therefore, through decomposition, components that contributed the most in magnitude to the change in overall life expectancy can be determined. The Arriaga method sums the direct and indirect effects across all age intervals to amount to total effects. The direct effects are changes in the number of life years in life expectancy due to mortality changes within each age interval while indirect effects are changes to the life expectancy attributed to number of people alive at the end of the age interval as a result of mortality change within the interval (Arriaga 1984: 87). Besides the direct and indirect effects, there is an interaction effect which results from overall mortality changes affecting the life expectancy but cannot be explained or assigned to particular age groups (Arriaga 1984: 88). According to Arriaga (1984: 88) the direct effect (DE) is computed as: ${}_{i}DE_{x} = \frac{l_x^t}{l_a^t}({}_{i}e_x^{t+n} - {}_{i}e_x^t) = \frac{l_x^t}{l_a^t}\left(\frac{T_x^{t+n} - T_{x+i}^{T+n}}{l_x^{t+n}} - \frac{T_x^t - T_{x+i}^t}{l_x^t}\right)$ where *l* and *T* are life table functions, x is the initial age of the age interval *i*, *a* is the age at which life expectancy is calculated; ${}_{i}e_{x}$ is the temporary life expectancy for the age interval, and *t* is the initial year of observation for a period of *n* years. And indirect effect (IE) is computed as: ${}_{i}IE_{x} = \frac{T_{x+i}^t}{l_a^t}\left(\frac{l_x^t l_{x+i}^{t+n}}{l_{x+i}^t l_x^{t+n}} - 1\right)$, where the life table functions are as defined above. The changes in life expectancies were computed as differences between age and sex, there were two groups: group 1 and group 2, for example, male life expectancy as group 1 and female life expectancy as group 2.

For comparison and validation, the Pollard method (1988) was applied as well to validate the results. Pollard's method introduces weights to decompose the differences in age- and cause-specific mortality that contribute to the life expectancies as a continuous process. This establishes an exact relationship between life expectancy and age-specific mortality.

The Arriaga method was applied in a two-step process, first step, computation of the age-specific mortality contributions to direct and indirect effects to obtain the total effects on the change in life expectancy. The age-specific change in mortality difference (${}_{n}\Delta_{x}$) between males and females within ages x and $x+n$ was computed as:

$$ {}_n\Delta_x = \left[\frac{l_x^{Male}}{l_0^{Male}} \times \left(\frac{{}_nL_x^{Female}}{l_x^{Female}} - \frac{{}_nL_x^{Male}}{l_x^{Male}} \right) \right] + \left[\frac{T_{x+n}^{Female}}{l_{x+n}^{Female}} \times \frac{\frac{l_x^{Male} l_{x+n}^{Female}}{l_x^{Female}} - l_{x+n}^{Male}}{l_0^{Male}} \right] $$

, where the life table functions are as earlier defined. The first component of the expression represents direct effects while indirect and interaction effects are represented by the second component (Preston, Heuveline and Guillot 2001; Auger, Harper, Barry *et al.* 2012; Auger, Feuillet, Martel *et al.* 2014). The second step involved computing the age-cause-specific mortality contributions to changes (${}_n\Delta_x^i$) in life expectancy within ages x and $x+n$ which were calculated as:

$$ {}_n\Delta_x^i = {}_n\Delta_x \times \frac{({}_nR_x^{i,Female} \times {}_nm_x^{Female}) - ({}_nR_x^{i,Male} \times {}_nm_x^{Male})}{{}_nm_x^{Female} - {}_nm_x^{Male}} $$

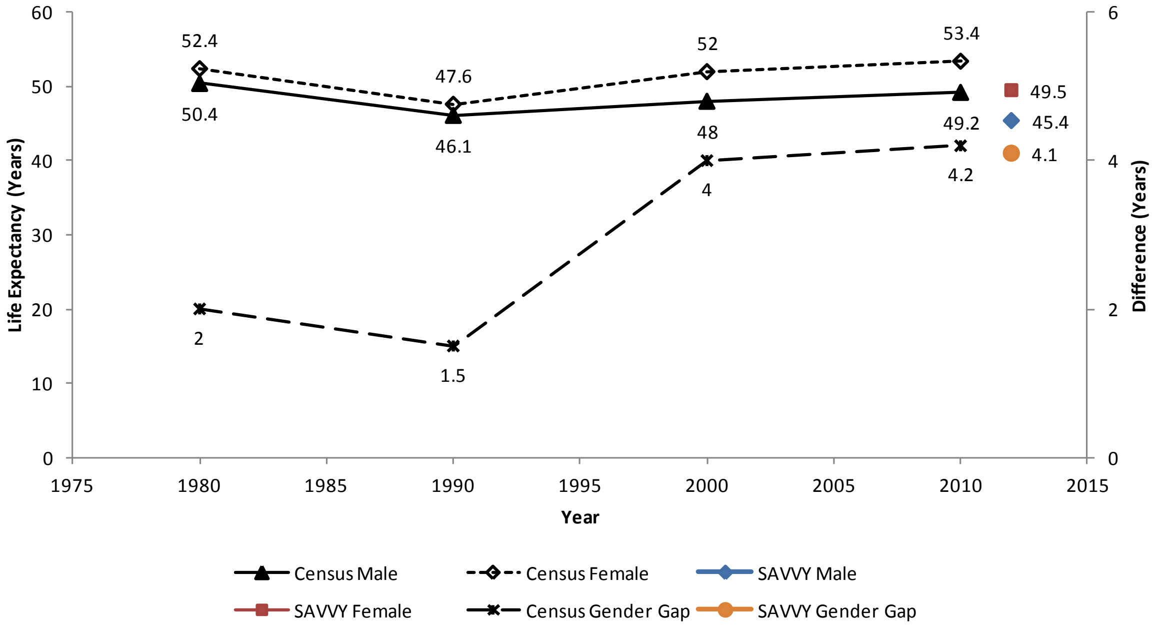
, where, ${}_nR_x^i$ is the proportion of deaths between ages x and $x+n$ due to cause i, and ${}_nm_x$ is all-cause mortality between ages x and $x+n$. The assumption is that contributions in each age group to the overall are partitioned by the cause of death and that the contribution of each cause to the change in life expectancy for each age group is proportional to the contribution of the difference in mortality between males and females (Arriaga 1989; Auger, Harper, Barry *et al.* 2012; Yang, Khang, Chun *et al.* 2012).

Therefore, decomposition analysis determines the contributions of adult mortality rates to changes in life expectancy and help focus health interventions to target specific causes of death that have more impact on mortality (Bah 1998; Beltran-Sanchez, Preston and Canudas-Romo 2008; Auger, Feuillet, Martel *et al.* 2014).

The life tables computed using 2010-2012 SAVVY data were utilised in examining the gap in life expectancy between females and males in Zambia (Figure 3.5) and to ascertain the contributions to differences in age- and cause-specific adult mortality changes. Stata version 14 and Microsoft Office Excel 2007 (Microsoft Corporation 2007) were utilised as statistical tools of analysis. Household deaths were extracted from the census and survey data using Stata version

14 and later exported to Microsoft Excel spreadsheets developed for the study for decomposition analysis.

Figure 3.5 Trend and gender gap in life expectancy at birth by sex, 1980-2012 Zambia



To address objective 4: *Determine the extent to which individual, household, and community level factors influence in adult mortality variations in Zambia.* Analysis of this objective required that the approach is in the realm of the socio-ecological theory premised on that individual outcomes are influenced by hierarchical environmental or ecological factors. Adult mortality differences between individuals can be attributed to the environment of the area in which they live. Individuals with similar attributes and live in different environments may experience different mortality outcomes because of the variations in influences from the socio-economic, socio-cultural, residential, or geographic environments. It is also possible that individuals with different characteristics may experience similar mortality outcomes because of the shared common environment they live in. In ecological analysis, this contextual phenomenon is known as clustering of individual outcomes within the environment; in this case adult mortality outcomes within communities.

Here the study is determining the effects of household- and community-level variables on the individual that eventually results in adult mortality variations. This was achieved by applying hierarchical multilevel statistical analysis. The assumption is that individuals (level 1) are nested within households (level 2) and households within communities (level 3). A multilevel model with three levels was fitted to ascertain the effect of the specified individual-, household- and community- level variables (fixed effects) on adult mortality variations.

Multilevel regression analysis was applied because of the clustering of individual adult mortality outcomes within the communities. Studies have shown that common regression analysis methods tend to underestimate the standard errors for results of individual outcomes that are clustered and correlated within communities thereby producing biased results (Pickett and Pearl 2001; Merlo, Chaix, Yang *et al.* 2005a, 2005b; Merlo, Yang, Chaix *et al.* 2005; Rabe-Hesketh and Skrondal 2008; Hox, Moerbeek and van de Schoot 2010). Multilevel regression analysis enables the provision of information on how adult mortality variations are distributed between the individual and the community levels; it also quantifies the clustering of individual mortality outcomes within the communities, thereby allowing for the examination of cross level interactions between the effects of the community and individual level factors (Snijders and Bosker 1999; Goldstein 2003; Merlo 2003; Subramanian, Jones and Duncan 2003; Merlo, Chaix, Yang *et al.* 2005a, 2005b; Merlo, Yang, Chaix *et al.* 2005).

The 2010-2012 SAVVY collected information on mortality in a hierarchical manner, that is, in stages thereby leading to clustering. The SAVVY selected CSAs in each province of the country, and then stratified them by rural and urban residence. Households in all the selected CSAs were interviewed if they experienced any deaths in the last 12 months as elaborated earlier. In this case, the clustering is such that the individuals are nested in households which are nested in CSAs. The SAVVY dataset was used to fit multilevel regression analysis models to assess the extent to which community level variables explain adult mortality variations in Zambia.

Multilevel Cox proportional hazards regression analysis was applied to community and individual level variables while controlling for mediating variables. The application of Cox proportional hazards model was guided by the literature reviewed as most studies that used adult mortality as an outcome applied this method (Rogers, Hummer and Nam 2000; Rogers, Everett, Saint Onge *et al.* 2010; Hummer and Chinn 2011; Hummer and Hernandez 2013; Zheng and Thomas 2013; Rogers, Everett, Zajacova *et al.* 2010). The Cox proportional hazards model (Cox 1972) is able to handle single record time to event uncensored observations well such as the nature of data for this study which is cross-sectional.

Other methods such as multilevel logistic regression do not handle well single record uncensored mortality data, hence the reason for not using them. The Cox proportional hazards model is part of a family of survival analysis models. It is semi-parametric and combines elements of the life table and regression analysis (Halli and Rao 1992). The model allows the establishment of a relationship between the independent variables and the survivor function as in multivariate regression. The survivor function facilitates the estimation of the probability of surviving at different ages for various characteristics of the adults. In the same vein, this can also be perceived from the hazard function perspective. The main assumptions of the model are: first, the ratio of the hazards (risk of dying) is the same or constant at all times (constant proportions over time), and second, the heterogeneity in the population being studied is reflected by the independent variables in the model. Testing of model assumptions was done prior to fitting of the Cox regression model to the survival data to determine the non-violation of the assumption of proportional hazards. This was done by graphical inspection of the proportionality assumption based on the plot of Kaplan-Meier survival curves for independent variables. The graphical plot should yield parallel lines of survival curves or proportional to each other and not cross (Cox 1972; Kay 1977). The limitation of this method is that the lack of parallelism in the plotted lines could be due to sampling differences (Halli and Rao 1992).

Another test is the Schoenfeld (1980) test which utilises partial residuals of the model. A statistically significant (p-value > 0.05 and correlation (rho) = 0) result of the Schoenfeld test means the proportional hazards assumption has been violated.

Interpretation of Hazard Ratios (HR), the HRs are computed by exponentiating the estimated regression coefficients (β_1, β_2, ...) for each explanatory variable. A hazard ratio value that is higher than 1 indicates an increased hazard (risk) of adult mortality relative to the baseline hazard. Similarly, a hazard ratio value that is less than 1 indicates a reduced risk of adult mortality relative to the baseline hazard. Whereas, a hazard ratio value that is equal to 1 indicates that the hazard or risk is the same as that of the baseline hazard. Kaplan-Meier survival curves were used to estimate the proportions of adults dying for the 35-year length of time, that is, from age 15 to age 60. The assumption being that the proportion dying remains unchanged between the events. Median survival time (failure probability of 0.5) was obtained using this method.

The outcome variable, adult mortality (probability of dying between ages 15 and 60 years) was measured as a time-to-event representing the survivorship between ages 15 and 60 years until an adult dies. Since the sample of the study is adults who were dead at the time of the survey they were treated as a single record uncensored data, that is, all cases failed. The Cox proportional hazards model (Cox, 1972) is represented by the equation:

$h(t) = h_0(t)\exp(\beta_1 X_1 + ... + \beta_k X_k)$, where $h(t)$ is the hazard function of the event (adult mortality) for individuals with other values of the predictors; $h_0(t)$ is the baseline hazard function for individuals having values of zero for all the explanatory variables. As stated earlier, it was assumed that the hazard ratio ($h(t)/h_0(t)$) depended only on the explanatory variables, and not on time t, and it was constant over time.

Six models were estimated for determinants of adult mortality variations at 5 per cent level of significance and 95 per cent confidence intervals. The first model (model 1) was the null or empty model with no independent or determinant variables included:

$h_{ij}(t) = h_0(t)\exp(\mu_{0j} + \varepsilon_{ij})$, Where: $h_{ij}(t)$ = hazard of outcome variable for i^{th} individual in j^{th} community; $h_0(t)$ = baseline hazard; μ_{0j} = random intercept/effects; ε_{ij} = individual level error.

The purpose of the empty or null model was to partition the total variance of adult mortality into a variance that occurs between individual factors and a variance that occurs between community level factors (*Total variance = Community variance + Individual variance*). The empty model also aimed at identifying possible contextual phenomena that could be quantified by the clustering of adult mortality within communities. The variance is a measure of variation that summarise differences, in this case adult mortality differences. Higher variance values reflect larger differences.

The second model (model II) expands the empty model (model I) and included all the individual level variables to determine the extent to which individual compositional factors explain the differences at community level. In this form of an equation:

$h_{ij}(t) = h_{0ij}(t)\exp(\beta_1 X_{1ij} + \beta_2 X_{2ij} + ...\beta_k X_{kij} + \mu_{oj} + \varepsilon_{ij})$, where: $h_{ij}(t)$, $\beta_0, \mu_{0j}, \varepsilon_{ij}$ are as defined earlier. β are coefficients; X_{ij} is the individual level variable for i^{th} individual in j^{th} community.

The third model (model III) included only the health condition/behaviour major determinant variables. The fourth model (IV) included only household-level variables to assess the extent to which household variables contribute to the variance in adult mortality at community level. The fifth model (V) included only community variables to ascertain the extent of contribution to the variance in adult mortality at community level. The sixth (VI) and full model included all the individual, household and community variables. The full model is expressed as:

$h_{ij}(t) = h_{0ij}(t)\exp(\beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 Z_j + \beta_4 X_{1ij} + \beta_5 X_{2ij} + \mu_{oj} + \mu_{1j} X_{1ij} + \varepsilon_{ij})$, where $h_{ij}(t)$, $\beta_0, \mu_{0j}, \varepsilon_{ij}$, β, X_{ij} are defined above. Z_j is the contextual or community level.

Measures of association were used to estimate the fixed effects while measures of variation were used to measure community level random effects. Since Stata has no multilevel Cox survival analysis module, adult mortality variations were estimated by applying the *mstreg* module for multilevel survival analysis with a Weibull distribution in Stata 14 (Weibull 1951; Carroll 2003; Carrasco, Ortega and Cordeiro 2008). Multilevel survival analysis with Weibull distribution has been applied in previous studies on adult mortality as it is efficient with small sample sizes and it is based on the same assumptions as Cox survival analysis. Both are proportional hazards models and produce comparable results (Prieto, Llorca and DelgadoRodriguez 1996; Sartorius, Kahn, Collinson *et al.* 2013; Sartorius and Sartorius 2013). The variance explained at community level was calculated using the Intra-Cluster Correlation (ICC)/Variance Partition Coefficient (VPC). $\rho = \frac{\sigma_\mu^2}{\sigma_\mu^2 + \sigma_\varepsilon^2}$ where: ρ is the Intra-Cluster Correlation/Variance Partition Coefficient; σ_μ^2 and σ_ε^2 are random parameters; $\sigma_\varepsilon^2 = \frac{\pi^2}{3}$, where $\pi = 3.14159$. The ICC or VPC quantifies clustering of individual outcomes within communities. It is the proportion of the total variation in the outcome that is attributable to the community level after accounting for the individual compositional factors of the communities.

An ICC or VPC equal to 1 implies there is no variance to explain at individual level, everybody is the same; differently stated that 100 per cent of the total individual differences are at the community level. Also, an ICC or VPC equal to 0 means the grouping of units is of no use; implying that individuals do not share common contextual experiences at community level. In this case, multilevel analysis may not be useful as this suggests that community context may not be significant in understanding differences in the outcome (Merlo, Chaix, Yang *et al.* 2005b). Therefore, a higher ICC or VPC value means that the community context is vital in understanding individual differences in the outcome.

On the other hand, Merlo et al., (2005b) caution that an ICC value equal to 0 does not obviously imply that the community context is not relevant compared with individual level factors as geographical boundaries used in defining the communities may not be appropriate in contextualising the environment that would impact on individual outcomes. Furthermore, in an empty model, an ICC value approaching 0 may conceal a great deal of community variability that could only be observed in more complex models. Therefore, a small value of the ICC may reveal the existence of significant associations between community level variables and individual outcomes (Merlo, Chaix, Yang *et al.* 2005b).

The fixed effects of the models were estimated at 95 per cent Confidence Interval (CI) using Hazard Ratios (HRs). The random effects of the models were estimated by calculating the variance of partition coefficients and the computed standard errors. The test of goodness-of-fit of the models was done by comparing the Akaike Information Criterion (AIC) (Akaike 1970) and Bayesian Information Criterion (BIC) (Schwartz 1978) of the models to each other as a way of validating the models. The presence of multicollinearity in the models was tested by performing the Variance Inflation Factor (VIF) test (Hox, Moerbeek and van de Schoot 2010).

The sampling weights in the dataset were applied to account for the under and/ or oversampling of the survey using the *svyset* and *svy* commands in Stata. This also ensured that the sample was representative at the national, provincial, rural and urban residence level. Sub-populations analysis of adult mortality ("1") and non-adult mortality ("0") was performed using Stata's *subpop* command.

3.9 Ethical Issues

The study utilised existing data from the 2010 census of population and housing and 2010-2012 sample vital registration with verbal autopsy survey. Both datasets were made available by the Central Statistical Office in Zambia. Permission was sought and granted to use these datasets. The Census and SAVVY datasets were stripped off personal identifiers before they were made available for public use. Since there was no fieldwork involved to collect additional data for this study, no ethical clearance was applied for.

3.10 Dissemination Plan: Specific manuscripts and conferences

No.	Title of paper	Conference	Journal
1.	Decomposition of age- and cause-specific adult mortality contributions from census and survey data in Zambia.		Social Science & Medicine-Population Health (Under-review, addressing reviewers' comments)
2.	Estimating regional variations in adult mortality in Zambia	Population Association of Southern Africa 2015 Conference; Union for African Population Studies (UAPS) 2015 Conference	Journal of African Population Studies (Published)
3.	Adult mortality in sub-Saharan Africa, Zambia: Where do adults die?	Union for African Population Studies (UAPS) 2015 Conference	Social Science and Medicine-Population Health (Published)
4.	Family relations and adult mortality in Zambia	Population Association of Southern Africa 2016 Conference; PAA 2017 and International Union for the Scientific Study of Population (IUSSP) 2017 Conference	Journal of family and marriage (Draft manuscript)
5.	Ecological determinants of adult mortality in Zambia	TBD	Tropical Medicine & International Health (Under review)
6.	Health seeking behaviour and adult mortality in Zambia: What do verbal autopsy data say?	International Union for the Scientific Study of Population (IUSSP) 2017 Conference, Cape Town, South Africa	Journal of Health and Social Behaviour/Global Health Action (Draft manuscript)
7.	The contribution of HIV/AIDS to adult mortality in Zambia: Evidence from verbal autopsy data	TBD	BMC (HIV/AIDS)/Global Health Action (To be drafted)
8.	What is the contribution of non-communicable diseases to adult mortality in Zambia; Is it a matter of concern?	TBD	Journal of Population Research (To be drafted)
9.	Mortality in sub-Saharan Africa: What is killing adults aged 15-59 years in Zambia?	International Seminar on Mortality Analysis and Forecasting, New Delhi, India, 6-7 April 2017 (Accepted but not attended). Population Association of Southern Africa 2017 Conference (Accepted) Asian Population Conference 2018 (Accepted)	BMC (Public Heath)/Global Health Action (Draft manuscript)

CHAPTER 4: ESTIMATION OF THE LEVEL OF ADULT MORTALITY IN ZAMBIA FROM CENSUS AND SURVEY DATA

4.1 Introduction

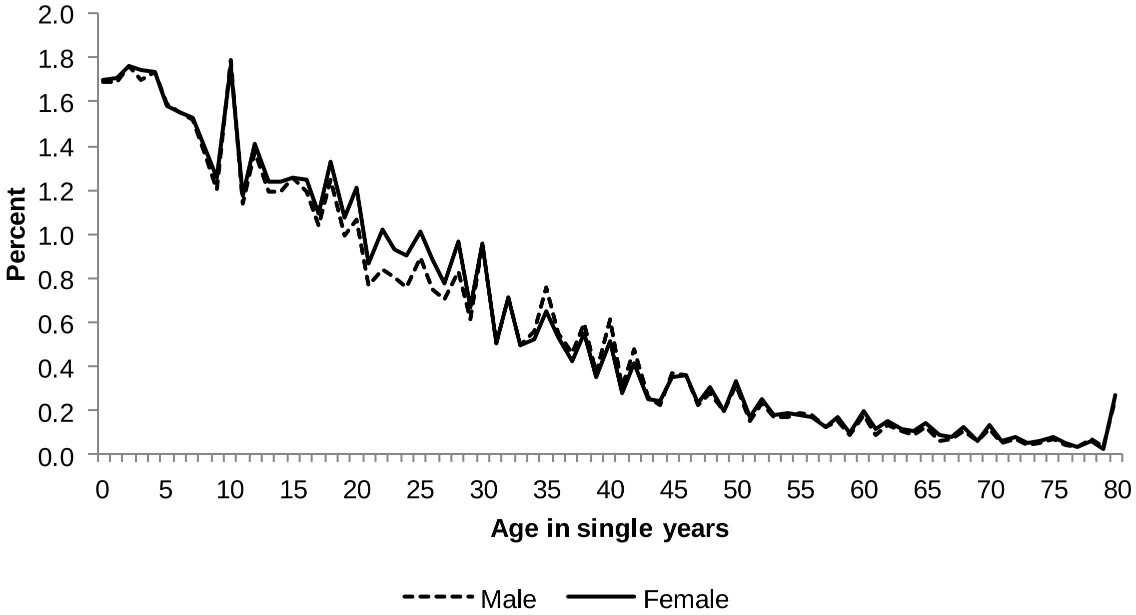
Chapter 3 presented the methods applied in this chapter in detail. This chapter presents the results of the estimation of the levels of adult mortality in Zambia obtained by the methods described in Chapter 3 using census and survey data. The levels of adult mortality rates are presented at national, rural-urban residence and regional (provincial) levels in form of the probability of dying between ages 15 and 60 years as indicated earlier. The aim of this chapter is to demonstrate adult mortality variations and that adult mortality remains high in Zambia in order to address objective one of the study.

The chapter first presents the results of data assessment of the age-sex population and deaths before the results of the estimation methods. Section 4.3 presents the levels of adult mortality at national and sub-national levels. Directly and indirectly estimated adult mortality rates are presented in Section 4.4. The summary of the chapter is presented in Section 4.5. The constructed life tables are presented in the appendix of the chapter.

4.2 Assessment of population and death data

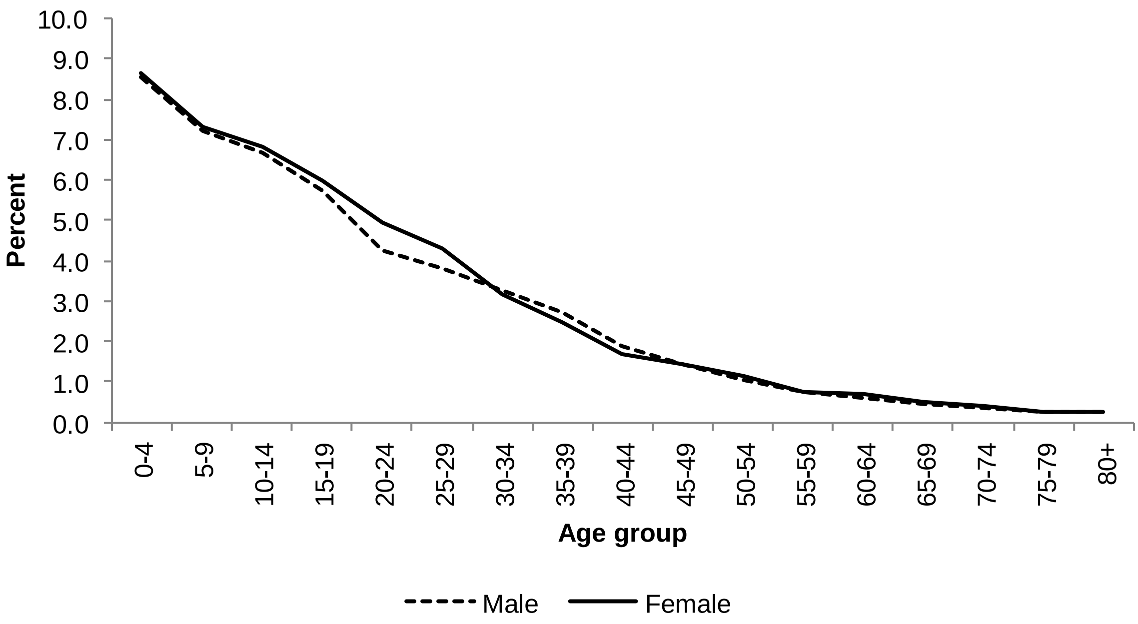
An assessment of the population age data in Figure 4.1 shows that the single-year age distribution fluctuates across ages indicating the presence of errors in reporting of age in form of age misreporting, age heaping, terminal age digit preference (0 and 5) and age exaggeration at older ages. Grouping the single-year population age distribution into 5-year age distribution acts as the first step of smoothing the age misreporting in the age data; it can be seen in Figure 4.2 that the 5-year grouped population age distribution is smoother than the single-year age distribution. This, however, does not clear the age distribution of age misreporting errors completely. The Arriaga (1994) light smoothing method was further applied to smoothen the age data to minimise the errors in age misreporting.

Figure 4.1 Single-year distribution of population by age and sex, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

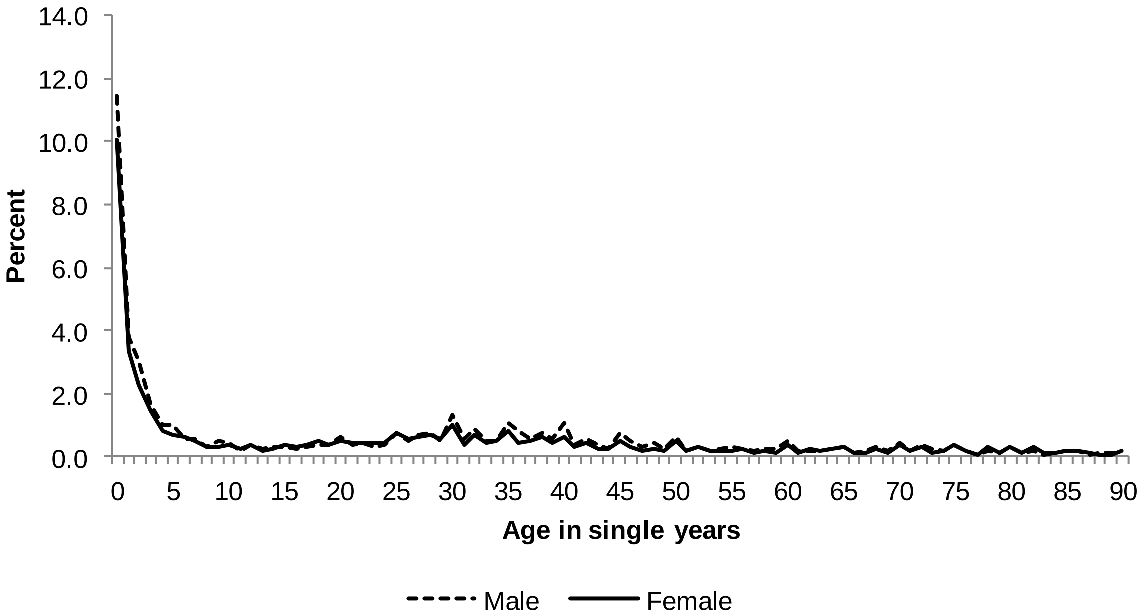
Figure 4.2 Five-year distribution of population by age and sex, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

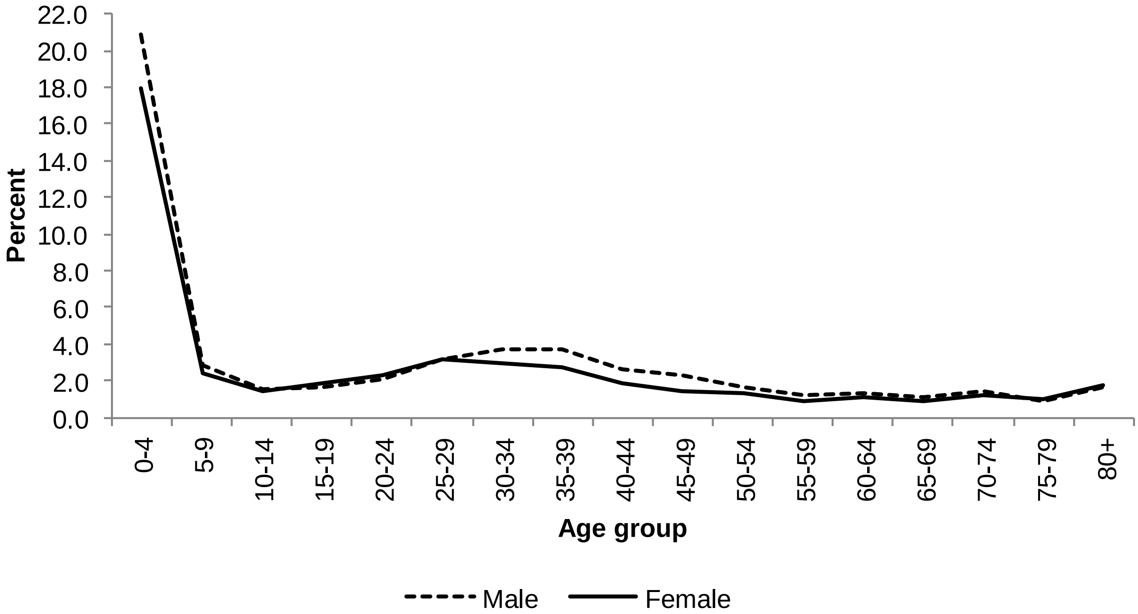
Reporting of household deaths in Figure 4.3 shows that for the single-year age distribution, the fluctuations are indicative of errors in the reporting of ages of the deceased persons. When the household deaths are grouped into 5-year age groups, the fluctuations smoothen out as seen in Figure 4.4. A clear picture of mortality by age group emerges. High under-5 mortality which steeply drops in age group 5-9, and further declines in age group 10-14, before gradually rising from age group 15-19 and reaching a peak in age group 25-29 for females, and for males in age group 35-39; thereafter, a gradual decline follows. The percentage of male deaths is higher between age group 30-34 and 45-49 than for females; also, known as the "HIV/AIDS hump" in populations with generalized HIV/AIDS epidemic.

Figure 4.3 Single-year distribution of deaths by age and sex, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Figure 4.4 Five-year distribution of deaths by age and sex, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Completeness of death reporting

In this section, the completeness of death reporting is presented as estimated by the indirect death distribution methods, the Brass Growth Balance (BGB), Generalized Growth Balance (GGB) and Synthetic Extinct Generations (SEG). The level of completeness of death reporting is determined so as to make appropriate adjustments to the reported deaths. Table 4.1 presents the estimated levels of completeness of death reporting.

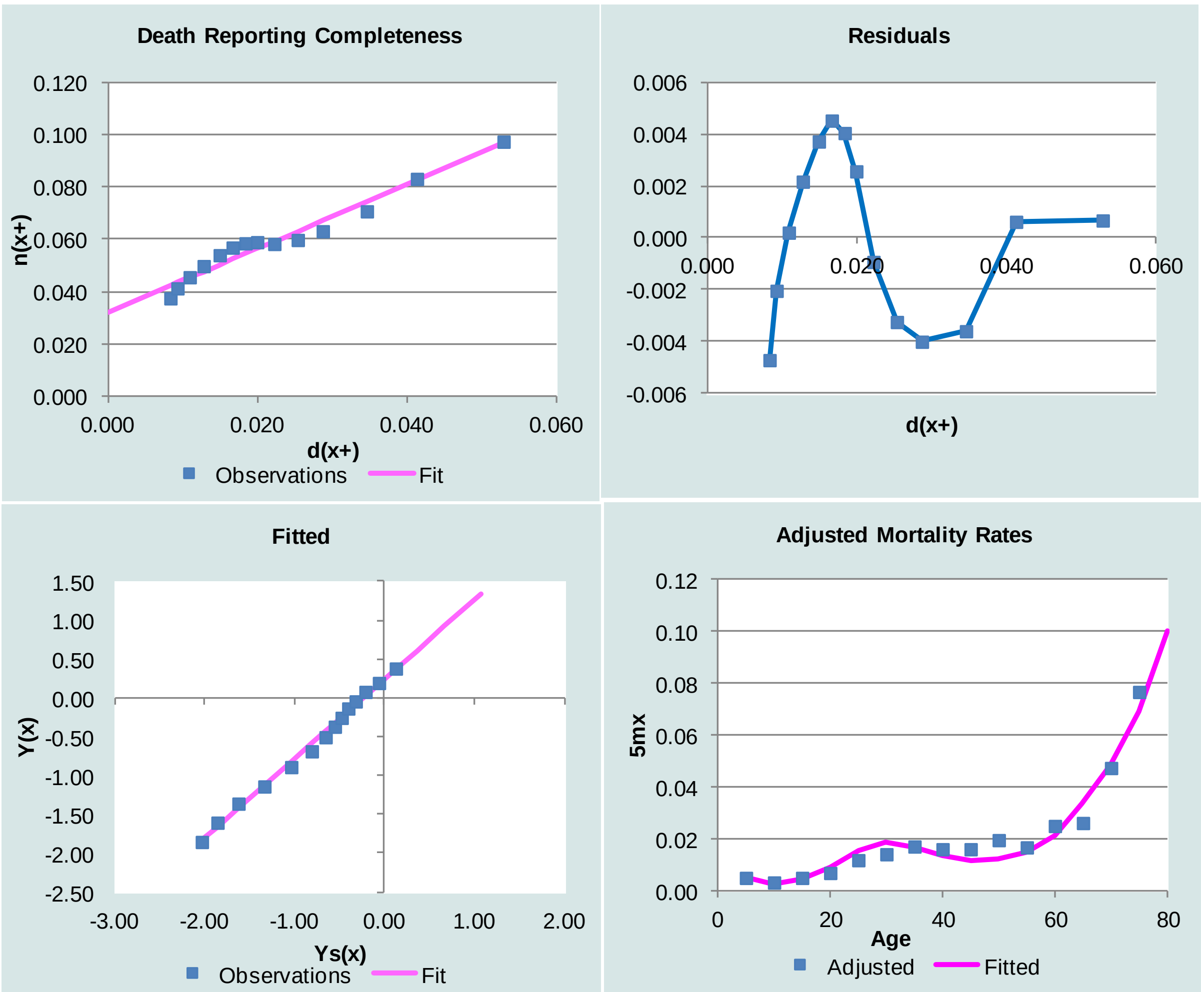
Table 4.1 Brass Growth Balance, Generalized Growth Balance, and Synthetic Extinct Generations methods estimates of Completeness of death reporting, Zambia 2010 Census

	Percent completeness of death reporting					
	Brass Growth Balance		*Generalised Growth Balance*		*Synthetic Extinct Generation*	
	Male	Female	Male	Female	Male	Female
Province						
Central	99.0	75.0	85.0	97.0	78.0	85.0
Copperbelt	91.0	91.0	99.0	95.0	97.0	79.0
Eastern	109.0	103.0	67.0	82.0	68.0	80.0
Luapula	89.0	71.0	75.0	85.0	81.0	82.0
Lusaka	87.0	89.0	82.0	91.0	92.0	81.0
Muchinga	100.0	68.0	99.0	68.0	76.0	90.0
Northern	106.0	85.0	94.0	91.0	61.0	74.0
North-western	135.0	109.0	77.0	93.0	67.0	88.0
Southern	101.0	96.0	75.0	64.0	70.0	64.0
Western	104.0	86.0	89.0	100.0	73.0	85.0
Residence						
Rural	116.0	96.0	110.0	85.0	72.0	77.0
Urban	87.0	98.0	90.0	109.0	87.0	105.0
Zambia	**99.0**	**82.0**	**70.0**	**96.0**	**72.0**	**91.0**

Source: Author computations from 2010 Zambia Census data files

Fitting of the straight line to the partial births and death rates enabled the assessment of the completeness of reporting of deaths at national, rural-urban, and provincial levels by sex. The levels of completeness of reporting of deaths ranged from 68 per cent to 109 per cent for females while that of males ranged from 87 per cent to 135 per cent for the BGB method. For the GGB method, the level of completeness ranged from 64 per cent to 109 per cent for females and 67 per cent to 110 per cent for males. The SEG levels of completeness were, 64 per cent to 105 per cent for females and 68 per cent to 97 per cent for males. It is evident that the reporting of deaths was either under reported or over reported for both males and females. Figures 4.5, 4.6 and 4.7 present examples of fitting of the straight line to assess the completeness of reporting of deaths for the respective estimation methods. Figure 4.5 shows the fitting of the straight line for females at national level using the BGB method. The Figure also shows the adjusted mortality rates after applying the Brass Growth Balance method. The completeness of death reporting for females at national level was estimated at 82 per cent. It can be seen from Figure 4.5 that the fit of partial birth and death rates before adjustment there are curvatures as the points lie on the straight line indicating that there some small numbers of migration that are not accounted for. The figure also shows that the residuals lie within the acceptable limits of 1 per cent. It can be observed from Figure 4.5 that after adjusting for completeness of death reporting all the points lie on the straight line and the adjusted mortality rates fit reasonably well.

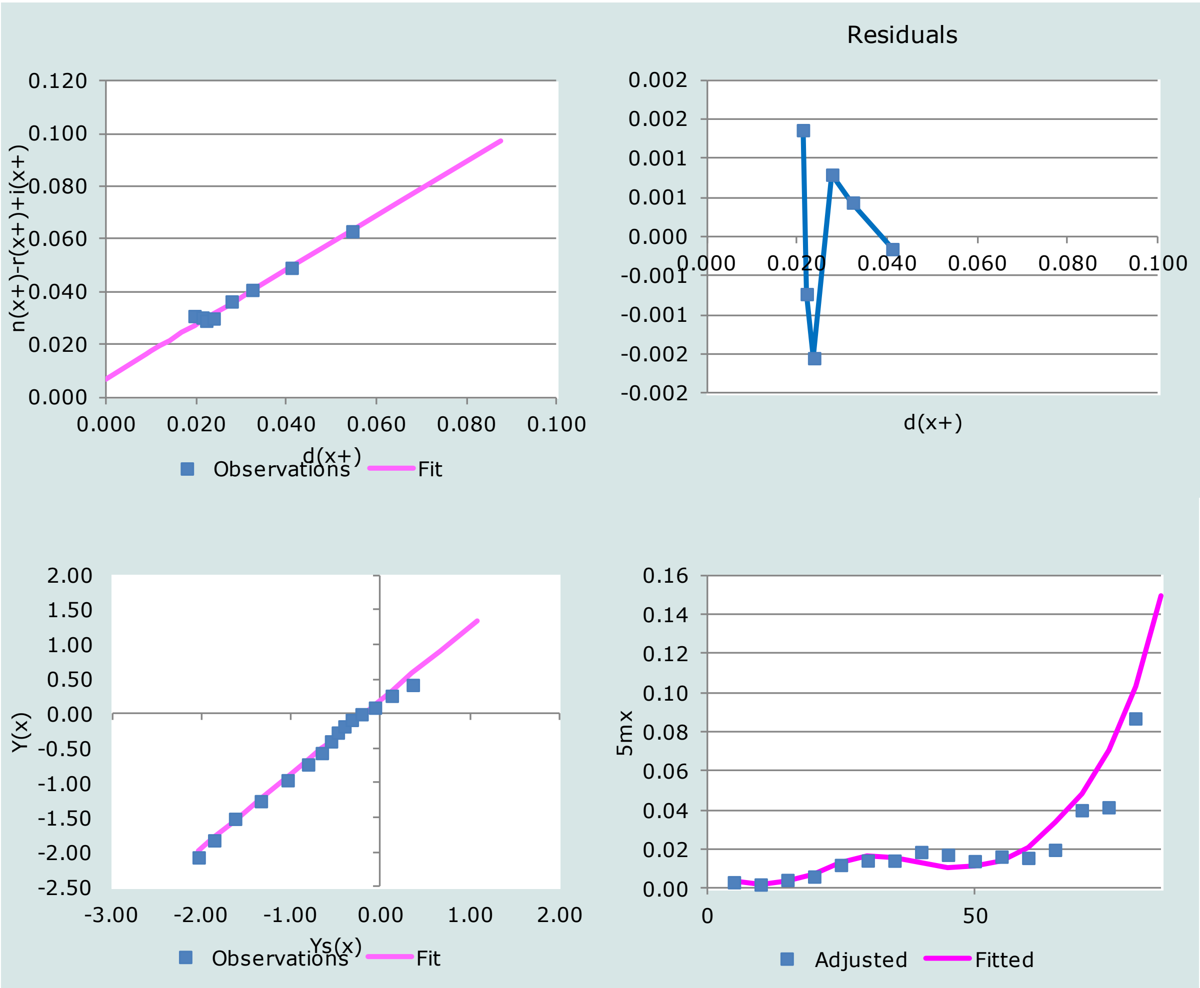
Figure 4.5 Fitting of straight line for completeness of reporting of deaths Brass Growth Balance Method, Females-Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Figure 4.6 shows the fitting of the straight line for females at sub-national level in Central province using the GGB method. The figure also shows the adjusted mortality rates after applying the GGB method. The completeness of death reporting for females in Central province was estimated at 97 per cent.

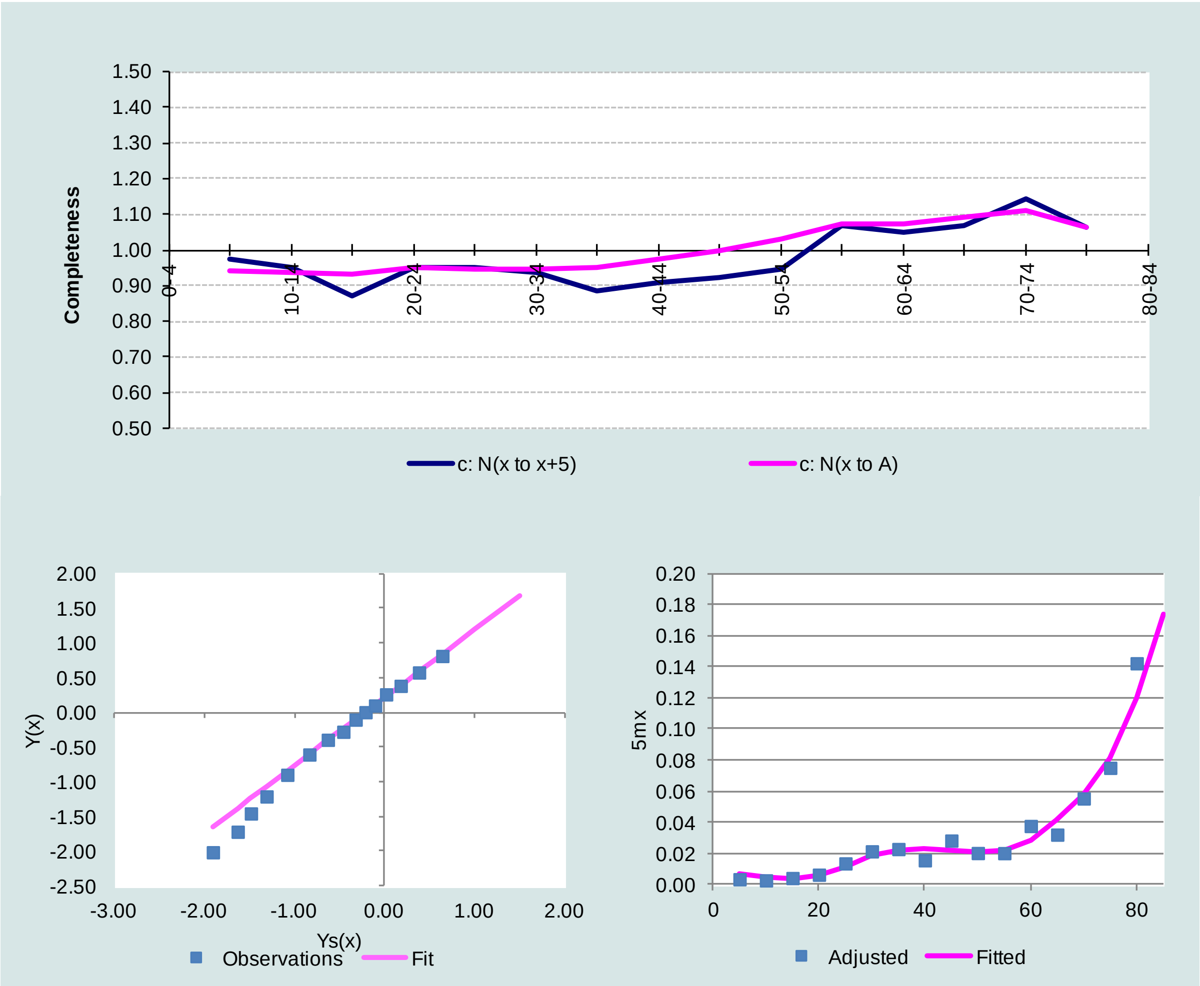
Figure 4.6 Fitting of straight line for completeness of reporting of deaths Generalized Growth Balance Method, Females-Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Figure 4.7 shows the fitting of the straight line for males at sub-national level in Copperbelt province using the SEG method. The figure also shows the adjusted mortality rates after applying the SEG method. The completeness of death reporting for males in Copperbelt province was estimated at 97 per cent.

Figure 4.7 Fitting of straight line for completeness of reporting of deaths Synthetic Extinct Generations Method, Males-Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

4.3 Levels of adult mortality

In this section, the levels of adult mortality are established at national and sub-national levels.

Distribution of adult deaths

In 2010, 54.3 per cent of adult deaths in age group 15-59 were male and 45.7 per cent were female at national level. In rural areas, 52.8 per cent and 47.2 per cent of adult deaths were those of males and females, respectively. The mean age at death was 34.6 years for all adult deaths; 35.2 years for males and 33.7 years for females. In rural areas, the mean age at death was 34.5 years for all adult deaths; 35.2 years and 33.6 years for males and females, respectively. In urban areas, the mean age at death was 35.3 years and 33.9 years for males and females, respectively. For all urban adult deaths, the mean age at death was 34.7 years. By the age of 32 years half of the female adults died and for males by the age of 35, irrespective of rural or urban residence. Table 1 below shows that adult mortality was higher among men than women in the age group 15-59 years. Mortality was highest in the age group 25-29 for women whereas for men it was in the age group 30-39 years.

Though unexpected when compared to other populations, adult mortality was higher in urban than rural areas. In both rural and urban areas, adult mortality was higher in the age group 25-39. In comparison, more female adult deaths occurred in rural areas than urban areas in total. In addition, the proportion of female adult deaths in the age group 25-29 was higher than for males in both rural and urban areas. Furthermore, the proportion of adult females who died from sickness and disease was also higher than for males in both rural and urban areas. Conversely, the percentage of adult male deaths attributed to accidents and injuries were twice as high as those of females. Similarly, the proportion of adult male deaths due to suicide and violence was higher than for females in both urban and rural areas. The 2010 census did not examine any associations with respect to determinants of adult mortality beyond the descriptives.

Table 4.2 Percentage distribution of adult deaths by age, sex, cause of death and rural-urban residence, Zambia 2010 Census

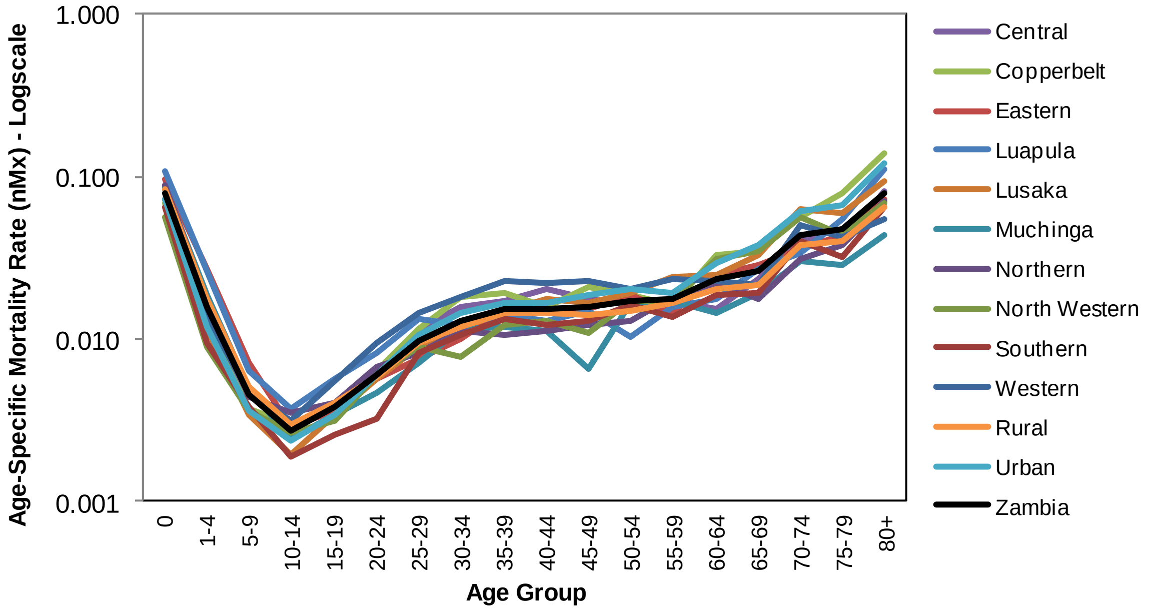
	Rural		Urban		Total	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Age group						
15-19	9.3	11.0	5.5	9.3	7.5	10.2
20-24	9.9	12.1	9.3	12.0	9.6	12.1
25-29	13.6	16.8	15.4	17.7	14.5	17.2
30-34	15.1	14.9	18.8	17.0	16.9	15.8
35-39	16.1	14.8	17.5	15.0	16.8	14.9
40-44	12.1	10.6	11.5	9.4	11.8	10.1
45-49	10.1	7.8	10.2	7.5	10.2	7.7
50-54	7.5	7.2	7.3	7.2	7.4	7.2
55-59	6.2	4.8	4.4	4.9	5.3	4.9
Cause of death						
Accidents and injuries	7.3	2.9	6.4	2.4	6.8	2.7
Suicide and violence	5.0	1.8	3.4	2.5	4.2	2.1
Sickness and disease	72.3	78.6	80.5	86.3	76.3	82.1
All other causes	15.4	16.7	9.8	8.8	12.7	13.1
Total	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	1862	1663	1770	1398	3632	3061

Source: Author computations from 2010 Zambia Census data files

Age Specific Mortality Rates

Figure 4.8 shows the age-specific mortality rates (ASMRs) for all ages for both males and females plotted on a log scale at national and sub-national levels. Generally, ASMRs curves for both males and females show the expected pattern of higher mortality at infant ages that rapidly falls to low levels in age group 10-14 and the gradually increase with age. There are fluctuations some age groups which may indicate age misreporting. Variations in ASMRs are evident across provinces. For Zambia, ASMRs for both males and females lie in the middle.

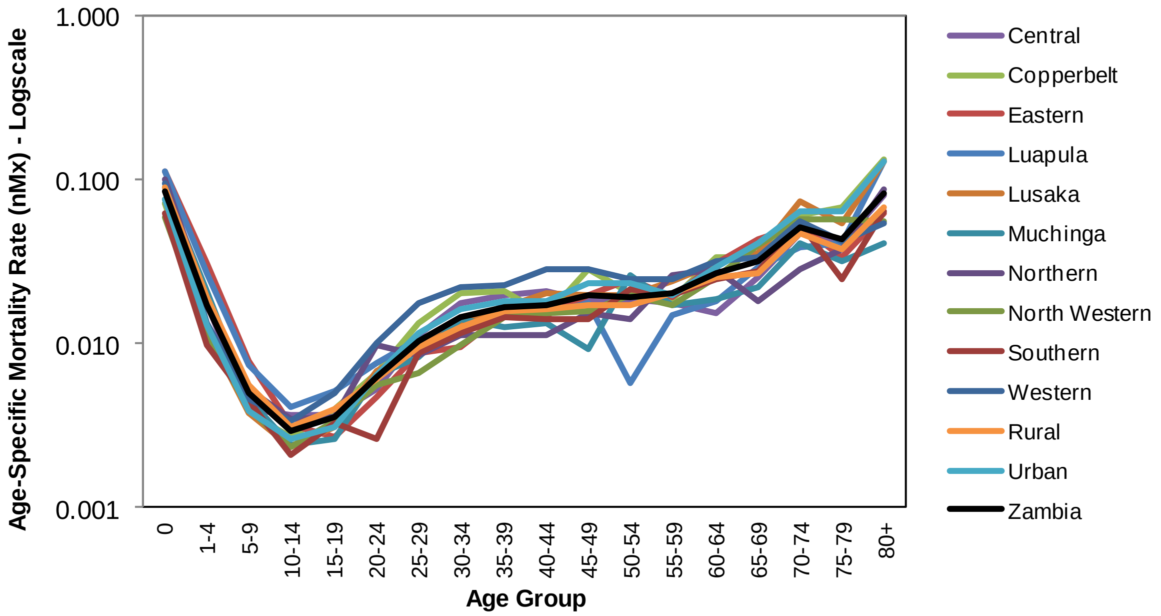
Figure 4.8 Age-specific mortality rates (log scale), Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Figure 4.9 shows the mortality pattern of males of all ages. The curves follow the expected pattern but with fluctuations for some provinces which may be attributed to age misreporting.

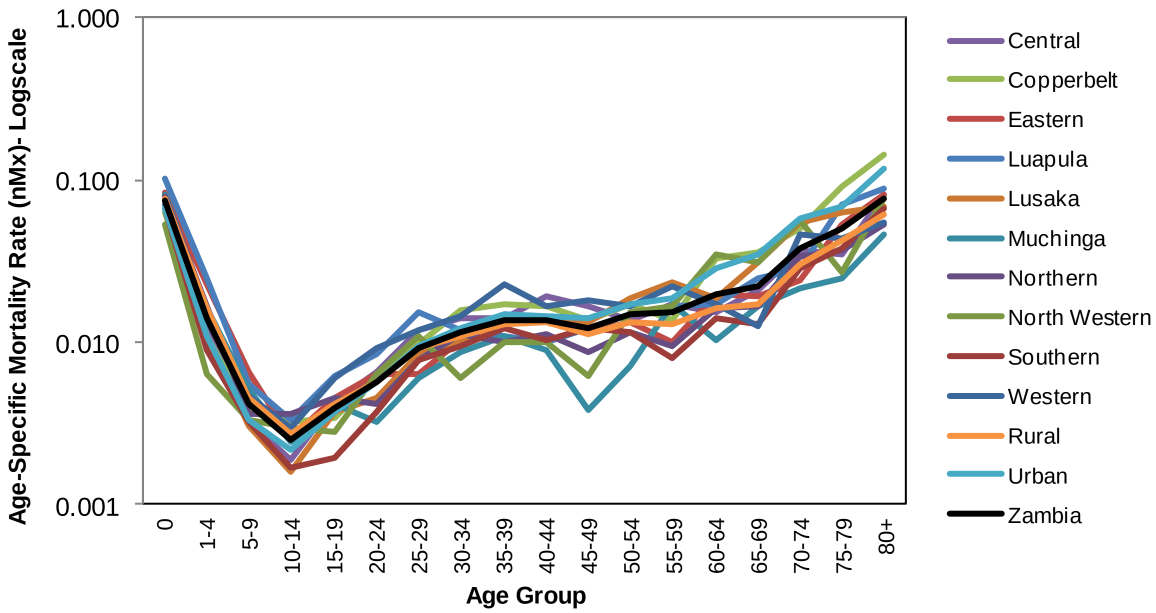
Figure 4.9 Age-specific mortality rates (log scale) for males, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Age specific mortality rates for females shown in Figure 4.10 also follow the expected pattern but with fluctuations at some ages which point to age misreporting.

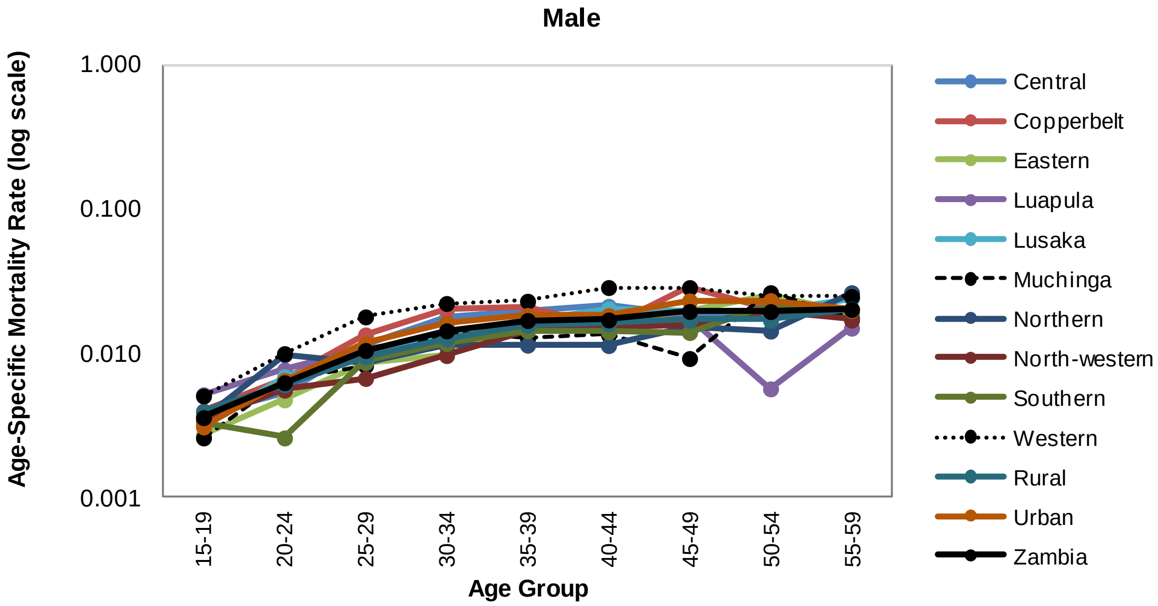
Figure 4.10 Age-specific mortality rates (log scale) for females, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

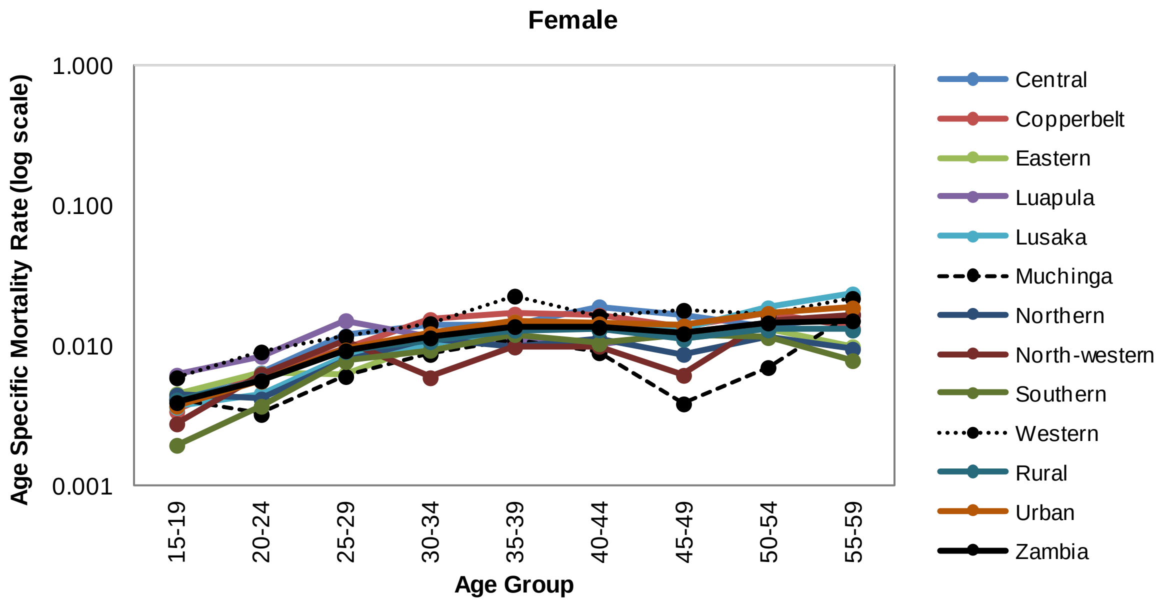
Figures 4.11 and 4.12 show the adult age-specific mortality rates (ASMRs) for males and females, respectively. Generally, ASMRs for both males and females progressively increase with age except in some age groups where there are fluctuations. Variations in ASMRs are evident across provinces. Western province experienced the highest ASMRs for both males and females. Muchinga and North-western provinces had generally lower ASMRs for females. Urban ASMRs are higher than rural ASMRs. For Zambia, ASMRs for both males and females lie in the middle.

Figure 4.11 Age-specific mortality rates for males in age group 15-59, Zambia 2010 Census



Source: Author computations from 2010 Zambia Census data files

Figure 4.12 Age-specific mortality rates for females in age group 15-59, Zambia 2010 Census

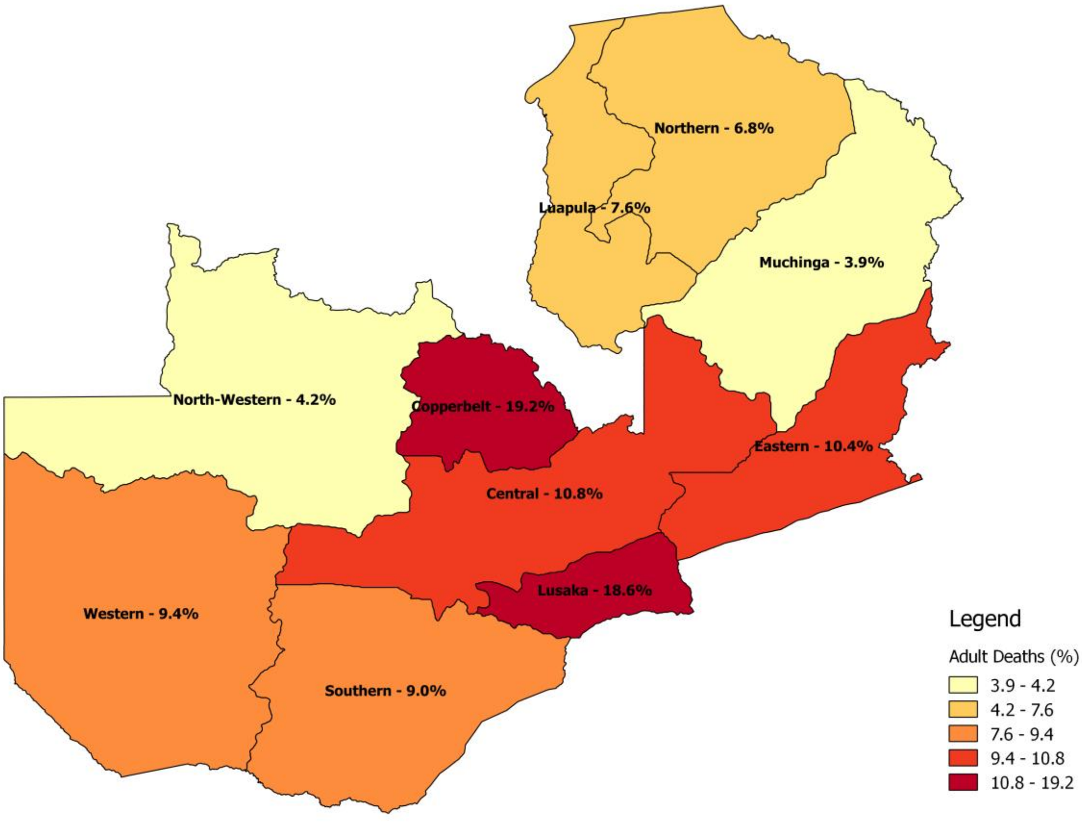


Source: Author computations from 2010 Zambia Census data files

Provincial (regional) variations in the distribution of adult deaths

Figure 4.13 below shows that Copperbelt province had the highest proportion (19.2 per cent) of adult deaths in the age group 15-59 out of the total deaths for all provinces in Zambia. Lusaka province had the second highest proportion of adult deaths. These two provinces are the most developed and urbanised in the country. Muchinga province had the lowest proportion of adult deaths (3.9 per cent), followed by North-Western province (4.2 per cent). Muchinga province is predominantly rural while North-Western province is a fast developing province due to heavy mining investment to exploit the large copper deposits found in the area.

Figure 4.13 Percentage distribution of adult deaths by province, Zambia 2010 Census



Source: Author generated from 2010 Zambia Census data files using QGIS

Table 4.3 Percentage distribution of adult deaths by age, sex, cause of death and province, Zambia 2010 Census

	Central		Copperbelt		Eastern		Luapula		Lusaka		Muchinga		Northern		North-western		Southern		Western		Total	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Age group																						
15-19	7.7	10.1	6.8	8.1	6.9	12.3	11.4	13.3	5.4	9.4	6.6	15.3	8.4	13.8	9.4	9.0	9.4	6.9	7.5	10.0	7.5	10.2
20-24	7.7	11.6	8.2	11.4	8.6	14.1	11.4	14.4	10.5	10.9	11.9	9.9	16.4	10.3	10.7	15.7	5.5	10.6	10.5	13.4	9.6	12.1
25-29	13.8	17.6	15.3	15.9	13.6	12.0	14.2	23.5	14.4	17.7	13.2	15.3	13.2	17.7	11.4	23.9	15.2	18.6	16.9	14.7	14.5	17.2
30-34	18.3	16.2	19.8	18.6	12.8	14.7	15.0	12.9	17.0	16.2	18.5	16.2	14.4	16.7	14.1	9.7	17.3	17.2	16.6	14.0	16.9	15.8
35-39	18.0	12.7	17.0	15.7	17.2	16.8	17.1	10.2	18.3	15.1	14.6	17.1	12.8	13.3	16.8	12.7	17.3	17.2	14.5	16.7	16.8	14.9
40-44	14.1	12.1	8.8	10.8	11.7	11.1	12.2	6.8	14.3	9.6	11.3	9.9	9.2	10.3	12.8	9.0	11.2	10.2	13.0	9.0	11.8	10.1
45-49	8.8	8.7	12.4	7.9	11.9	8.1	11.0	7.2	9.2	7.2	6.0	3.6	10.0	6.9	10.1	4.5	9.1	9.5	9.3	8.7	10.2	7.7
50-54	6.9	6.1	6.8	7.6	11.1	7.2	2.8	6.8	6.1	7.9	12.6	4.5	6.8	6.9	8.7	9.0	9.7	6.9	6.9	7.4	7.4	7.2
55-59	4.8	4.9	4.8	4.1	6.1	3.6	4.9	4.9	4.8	5.9	5.3	8.1	8.8	3.9	6.0	6.7	5.5	2.9	4.8	6.0	5.3	4.9
Cause of death																						
Accidents and injuries	5.6	4.0	5.2	2.2	4.4	2.4	9.3	1.1	6.8	3.3	7.9	1.8	9.2	4.9	8.7	2.2	10.6	2.9	5.7	1.3	6.8	2.7
Suicide and violence	6.1	3.2	3.0	2.7	7.5	0.6	1.6	1.5	4.1	1.8	2.0	0.0	3.2	2.5	11.4	3.7	2.4	2.6	3.6	2.0	4.2	2.1
Sickness and disease	79.0	82.4	82.4	87.0	76.9	82.0	69.5	80.3	77.9	84.7	68.2	81.1	74.8	72.4	58.4	73.9	73.3	79.9	76.5	82.3	76.3	82.1
All other causes	9.3	10.4	9.4	8.1	11.1	15.0	19.5	17.0	11.2	10.1	21.9	17.1	12.8	20.2	21.5	20.1	13.6	14.6	14.2	14.4	12.7	13.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	377	346	731	555	360	333	246	264	706	542	151	111	250	203	149	134	330	274	332	299	3632	3061

Source: Author computations from 2010 Zambia Census data files

A comparison across all the provinces as shown in Table 4.3 above, confirms that as noted earlier adult deaths for both males and females are higher in the age group 25-39 relative to the other age groups. The proportion of adult female deaths remained high in the age group 25-29, and it was higher in Luapula (23.5 per cent) and North-western (23.9 per cent) provinces.

By cause of death—which is later covered in more detail in Chapter 5 using SAVVY data—Luapula (9.3 per cent), Northern (9.2 per cent) and Southern (10.6 per cent) provinces reported high proportions of adult male deaths due to accidents and injuries. Additionally, the number of adult male deaths was higher than for females across all the 10 provinces. However, Copperbelt and Lusaka provinces had the biggest number of male and female adult deaths. On the other hand, Muchinga and North-western provinces had the smallest number of male and female adult deaths. Table 4.3 above also shows that the percentage of adult female deaths attributed to sickness and disease was higher than for males across all the provinces. As expected, adult male deaths due to accidents and injuries were higher than for females.

4.4 Estimated adult mortality rates ($_{45}q_{15}$)

In this section, adult mortality rates derived by direct and indirect demographic methods of estimation are presented.

4.4.1 Directly derived adult mortality rates

The direct adult mortality rates are derived from the life tables constructed from census and SAVVY data (See appendix for the life tables). Sibling history survival data collected by the 2013/2014 Zambia demographic and health survey were also used to derive direct estimates of adult mortality. Table 4.4 presents the directly estimated adult mortality rates. It is evident that adult mortality varied by sex, rural-urban residence and province. There are differences in the magnitude of the mortality estimates. Despite the differences, there are similarities in the pattern of the mortality estimates. At national level adult mortality rates range from 43.4 per cent to 51.2

per cent. For males, the probability of dying between ages 15 and 60 years ranges from 47.2 per cent to 55.3 per cent, whereas for females, it ranges from 39.4 per cent to 47 per cent. It is evident, therefore, that adult mortality is higher among males than females at national level. The table shows higher adult mortality in urban areas than in rural areas. The overall ${}_{45}q_{15}$ ranges from 41 per cent to 41.6 per cent. These are very close estimates derived from two different data sources. In urban areas, the ${}_{45}q_{15}$ ranges from 46.7 per cent to 52.3 per cent. For males, adult mortality is higher in urban areas than rural areas. Adult male mortality ranges from 50.5 per cent to 58.4 per cent in urban areas while in rural areas it ranges from 44.6 per cent to 47.9 per cent. A similar pattern is observed for females, higher mortality in urban areas ranging from 42.4 per cent to 46.7 per cent than in rural areas with mortality ranging from 35.5 per cent to 37.3 per cent.

Table 4.4 Direct Census, Sibling and SAVVY estimates of probability of dying between ages 15 and 60 years (${}_{45}q_{15}$), Zambia 2010-2014

	Direct Census 2010			*Direct Sibling 2013/2014*			*Direct SAVVY 2010-2012*		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Province									
Central	0.488	0.443	0.466	0.522	0.420	0.468	-	-	-
Copperbelt	0.522	0.430	0.478	0.573	0.477	0.522	-	-	-
Eastern	0.451	0.365	0.408	0.507	0.372	0.438	-	-	-
Luapula	0.414	0.412	0.414	0.516	0.389	0.459	-	-	-
Lusaka	0.485	0.422	0.456	0.633	0.468	0.548	-	-	-
Muchinga	0.424	0.295	0.362	0.396	0.387	0.390	-	-	-
Northern	0.428	0.325	0.378	0.391	0.331	0.358	-	-	-
North-western	0.416	0.342	0.380	0.293	0.307	0.301	-	-	-
Southern	0.424	0.319	0.371	0.526	0.348	0.438	-	-	-
Western	0.604	0.497	0.548	0.655	0.379	0.511	-	-	-
Residence									
Rural	0.446	0.373	0.410	0.479	0.355	0.416	-	-	-
Urban	0.505	0.424	0.467	0.584	0.467	0.523	-	-	-
Zambia	**0.472**	**0.394**	**0.434**	**0.523**	**0.403**	**0.461**	**0.551**	**0.470**	**0.512**

Source: Author computations from 2010 Zambia Census, 2013/2014 Zambia Demographic and Health Survey, 2010-2012 SAVVY data files

At regional level adult mortality rates varied. Generally, adult mortality at provincial level is higher for males than females. Western province had the highest adult male mortality rates ranging from 60.4 per cent to 65.5 per cent. Lusaka province has one mortality estimate of 63.3 per cent for adult males. Copperbelt province has consistent estimates of high adult mortality ranging from 52.2 per cent to 27.3 per cent. North-Western province appears to show lower male adult mortality ranging from 26.3 per cent to 41.6 per cent. However, there is an inconsistent estimate of higher female than male adult mortality. Female adult mortality appears to be consistently high in Copperbelt province ranging from 43 per cent to 47.7 per cent. Central province also has high adult female mortality rates ranging from 42 per cent to 44.3 per cent.

There is no clear pattern in the mortality estimates as to which province had the lowest female mortality. Urbanised provinces of Lusaka and Copperbelt had high adult mortality rates. In addition, provinces where international highways pass through like Central and Southern also appear to have high adult mortality. The SAVVY adult mortality estimates were higher than for the other data sources, perhaps because of the small sample size.

4.4.2 Indirectly derived adult mortality rates

The indirectly derived adult mortality estimates are presented in Table 4.5. The adult mortality estimates equally confirm the variations in mortality rates observed from the direct estimates. A comparison of adult mortality rates across the regions derived by the three indirect methods—BGB, GGB and SEG—; confirms that the chances of dying were higher for males than females as observed in the direct estimates. It is also evident that males in the Western province had the highest probability of dying ranging from 59.4 per cent to 68.8 per cent. Copperbelt (52.7 per cent to 56 per cent) and Lusaka (49.9 per cent to 58.6 per cent) provinces equally had higher probabilities of adult mortality. The probability of dying was higher for women in Copperbelt province ranging from 47.2 per to 47.9 per cent. Western (43.2 per cent to 52.6 per cent) and Luapula (44 per cent to 47.5 per cent) provinces also had high adult mortality.

In contrast, North-western province appears to have had the lowest probability of adult mortality for both males and females based on two methods, that is, the BGB and GGB. The SEG produced higher adult mortality estimates.

Despite differences in the magnitude of the mortality rates both direct and indirect mortality estimates show that the probability of adult mortality for males is highest in Western province. Copperbelt and Lusaka provinces follow closely. The probability of adult female mortality is higher in Copperbelt province going by the estimates of the BGB and GGB methods. The probability of dying was higher for males in urban (ranging from 0.540 to 0.588) than rural (ranging from 0.398 to 0.485) areas. This mortality pattern is in tandem with HIV prevalence rates in urban and rural areas. At national level, the estimated probabilities of dying for Zambia, male (ranging from 0.488 to 0.593) and female (ranging from 0.386 to 0.454), are within comparable limits to those of the United Nations Population Division (UNPD) (male, 0.458 and female, 0.450) for the period 2010-2015.

Table 4.5 Brass Growth Balance, Generalized Growth Balance, Synthetic Extinct Generations estimates of probability of dying between ages 15 and 60 years ($_{45}q_{15}$), Zambia 2010 Census

	Probability of dying between age 15 and 60 years ($_{45}q_{15}$)					
	Brass Growth Balance		*Generalised Growth Balance*		*Synthetic Extinct Generation*	
	Male	Female	Male	Female	Male	Female
Province						
Central	0.481	0.457	0.484	0.408	0.555	0.475
Copperbelt	0.560	0.479	0.525	0.471	0.527	0.472
Eastern	0.422	0.377	0.475	0.357	0.478	0.335
Luapula	0.475	0.470	0.475	0.441	0.497	0.452
Lusaka	0.548	0.439	0.499	0.424	0.586	0.458
Muchinga	0.421	0.396	0.441	0.387	0.450	0.429
Northern	0.420	0.376	0.425	0.346	0.574	0.412
North-western	0.367	0.348	0.413	0.345	0.597	0.422
Southern	0.470	0.368	0.481	0.433	0.561	0.431
Western	0.594	0.473	0.580	0.432	0.688	0.526
Residence						
Rural	0.398	0.365	0.485	0.376	0.487	0.396
Urban	0.567	0.431	0.588	0.398	0.540	0.401
Zambia	**0.488**	**0.454**	**0.577**	**0.386**	**0.593**	**0.415**
UNPD*	0.458	0.450				

Source: Author computations from 2010 Zambia Census data files
*UNPD: United Nations Population Division

Considering all the adult mortality estimates derived from the direct and indirect methods a consistent adult mortality pattern emerges despite the differences in the magnitude of the estimates. The estimates show that adult males experienced higher mortality than females at national and sub-national levels. In addition, the estimates show that urban areas had higher adult mortality than rural areas. Consistently from all the estimates, Western, Copperbelt and Lusaka provinces had higher adult mortality than the other provinces.

With respect to the differences in magnitudes of the mortality estimates, it should be noted that demographically indirect methods of mortality yield higher estimates than direct methods.

4.5 Summary of Chapter

The chapter findings show that for the assessment of single-year age population data there was a presence of age misreporting, age heaping, terminal age digit preference (0 and 5), and age exaggeration at older ages. Grouping and applying Arriaga light smoothing method minimized age misreporting errors in the population age data, thus, enabling the data to be of acceptable quality for use in estimating adult mortality.

Household reported deaths showed some irregularities as indicated by fluctuations when plotted by age and sex prior to smoothing and adjustment. Completeness of household death reporting as evaluated by applying the death distribution methods, that is, GGB, BGB and SEG varied by sex and residence but was within acceptable limits of 60 per cent and above completeness for use in estimating adult mortality. For females, the level of completeness of death reporting ranged from 64 per cent in Southern province to 109 per cent in North Western province. Whereas for males, the level of completeness of death reporting ranged from 61 per cent in Northern province to 135 per cent in North Western province. In rural areas, the level of completeness of death reporting ranged from 72 per cent to 116 per cent among males while for females, it ranged from 87 per cent to 109 per cent. At national level, the level of completeness of reporting of deaths ranged from 70 per cent to 99 per cent for males and 82 per cent to 96 per cent for females.

Direct estimates of adult mortality showed that the probability of dying between age 15 and 60 years ranged from 43.4 per cent to 51.2 per cent at national level. For males, it ranged from 47.2 per cent to 55.1 per cent whereas for females, it ranged from 39.4 per cent to 47 per cent. This indicates that adult males experienced higher mortality than females.

Adult mortality was higher in urban than rural areas. The probability of dying between age 15 and 60 years ranged from 46.7 per cent to 52.3 per cent in urban areas whereas in rural areas it ranged from 41 per cent to 41.6 per cent. By gender/sex, adult mortality was higher among males and females in urban areas than rural areas. Adult male mortality ranged from 50.5 per cent to 58.4 per cent and 42.4 per cent to 46.7 per cent among females in urban areas. In rural areas, adult mortality among males ranged from 44.6 per cent to 47.9 per cent whereas among females it ranged from 35.5 per cent to 37.3 per cent.

By province of residence, Western province had the highest levels of adult male mortality ranging from 60.4 per cent to 65.5 per cent whereas North Western province appeared to have lower adult mortality among males ranging from 26.3 per cent to 41.6 per cent. Among females, adult mortality was higher in Copperbelt province ranging from 43 per cent to 47.7 per cent. It is not evidently clear as to which province had lower female adult mortality. From the adult mortality estimates, it is evident that the urbanised provinces of Lusaka and Copperbelt had high probability of adult mortality, this also includes provinces with international highway routes to neighbouring countries, such as Central and Southern provinces.

Indirect estimates of adult mortality showed that at national level, among males the probability of dying between ages 15 and 60 years ranged from 48.8 per cent to 59.3 per cent whereas among females it ranged from 38.6 per cent to 45.4 per cent. Adult mortality was higher among males in urban areas (54 per cent to 58.8 per cent) than in rural areas (39.8 per cent to 48.5 per cent). At provincial level, Western province had higher adult mortality for males ranging from 59.4 per cent to 68.8 per cent. Female adult mortality was higher in Copperbelt province ranging from 47.2 per cent to 47.9 per cent. North Western province appeared to have had the lowest adult mortality rates for both males and females based on indirect estimates.

Despite the differences in the magnitude of the adult mortality rates derived by both the direct and indirect methods, the pattern of adult mortality appears consistent. Adult mortality is higher among males than females. It is higher among males in Western province and for females in Copperbelt province. Adult mortality is higher in urban areas than rural areas. At national level, adult mortality rates for males and females are comparable to those estimated by the United Nations Population Division. The chapter presents for the first-time adult mortality estimates at sub-national level that were previously not available in Zambia. There are differences in magnitude among the estimated adult mortality rates both from the direct and indirect methods. A consistent pattern emerges that shows that adult mortality is high in urban areas than rural areas which is demographically unusual compared to mortality experiences of other populations. As expected, adult mortality is higher among males than females. Regionally, adult mortality varies by region. Western, Copperbelt and Lusaka provinces generally experienced higher probabilities of adult mortality while North Western province experienced the lowest adult mortality rates. It can be noted that despite the differences in the estimation methods and data sources, there is consistency in the adult mortality rates derived with respect to level and pattern.

This chapter has reaffirmed what has been reviewed in the literature in Chapter 2 that adult mortality in Zambia is high and it varies by background characteristics.

CHAPTER 5: CAUSES OF DEATH AND DECOMPOSITION OF ADULT MORTALITY RATES IN ZAMBIA

5.1 Introduction

Chapter 4 highlighted broadly some of the causes of death among adults in the age group 15-59 using census data. However, these data are not detailed in terms of information on the causes of death. Chapter 5, therefore, explores in detail the causes of death in order to understand the causes that could be attributed to the high levels of adult mortality in Zambia. This is important for addressing major health concerns in the adult mortality age group which has remained largely ignored by health policies. The chapter also serves as a link of the Zambian adult mortality situation to changes in mortality patterns that have been observed in several developing countries with respect to the epidemiological transition. Therefore examining cause-specific mortality is relevant in understanding the epidemiological disease profile of adults in Zambia. The chapter addresses objectives two and three of the study using detailed causes of death data collected by the 2010-2012 SAVVY.

Despite adult mortality remaining high as indicated in the previous chapter, the causes of death in the adult mortality group (15-59) are not well documented in Zambia. This is largely as a result of lack of comprehensive, complete and accurate data from the civil and vital registration system which remains rudementally and partial in coverage and registration of births and deaths. Chapter 3 provides a detailed exposition on the SAVVY data that is used in this chapter to examine causes of death. Chapter 5, first provides the background characteristics of the deceased adults in Zambia and then explores causes of death by background characteritics. The chapter, then examines the causes of death in the context of the Global Burden of Disease major groupings of the causes. Age-cause-specific mortality patterns are analysed. The elimination of causes of deaths to determine the number of years of additional life gained as a result of getting rid of a particular disease is analysed as well as its effect on adult mortality. Then decomposition of age-sex and cause-specific deaths is performed to ascertain the contribution of adult mortality to the gap in life expectancy at birth between males and females. A summary of the chapter is provided at the end.

Decomposition analysis is a useful tool that provides relevant information needed for identifying health problems in the population as well as determining age- and cause-specific mortality changes that have more impact on overall changes in the life expectancy (Kitagawa 1955; Das Gupta 1978; Arriaga 1984; Pollard 1988; Auger, Feuillet, Martel *et al.* 2014). It also helps in uncovering and understanding inherent health inequalities in life expectancy (Khang, Yang, Cho *et al.* 2010; Hosseinpoor, Lee, Lynch *et al.* 2012).

Therefore, a decomposition of life expectancy would unmask information pertaining to inequalities in socioeconomic and health conditions that manifest themselves in widening gaps in life expectancy in the population (Preston, Heuveline and Guillot 2001; Khang, Yang, Cho *et al.* 2010; Yang, Khang, Chun *et al.* 2012). In the same vein, variations in life expectancy by region, and socioeconomic status reflect differences in access to public health, medical care, and nutrition in the population (Silber 1992; Seale 2000; Seifarth, McGowan and Milne 2012; Auger, Feuillet, Martel *et al.* 2014; Mondal and Shitan 2014; Sede and Ohemeng 2015). For this reason, a decomposition of age- and cause-specific mortality contributions to life expectancy can tell us which age groups and causes of death health policy programmes and interventions can focus on.

5.2 Demographic and socioeconomic background characteristics of the study population

This section describes the demographic and socioeconomic characteristics of the deceased adults in the age group 15-59. As reviewed in the literature in Chapter 2, background characteristics of individuals are associated with adult mortality. Table 5.1 presents the selected background variables of the deceased that have been found to be associated with adult mortality.

In the period 2010-2012 a total of 2,759 deaths of all ages, of these 1,078 deaths occurred among adults in the age group 15-59. More than half of the adult deaths were among males (54 per cent) than females (46 per cent). The mean age at death was 35.7 years for all adult deaths. It was 36.5 years for males and 34.8 years for females. By the age of 35, half of all adults the age group had died; 36 years for males and 34 years for females. It is evident from the table that by rural-urban residence, majority of the adult deaths occurred in rural areas (55.3 per cent) than urban areas (44. 7 per cent). Variations in the distribution of the proportion of adult deaths are notable by province. Lusaka province had the highest proportion of adult death (22.7 per cent) whereas North-western had the lowest (3.7 per cent). Adult deaths vary by age. It is notable that the proportion of adult deaths by age was higher in the age group 35-39 (18 per cent) and lowest in age group 55-59 (5.7 per cent). From age group 35-39 on wards the proportion of adult deaths decreases progressively with increase in age.

Considering educational attainment, nearly half (47.4 per cent) of the adult deaths occurred among those who had attained primary level of education. Those who had higher level of educational attainment had the lowest proportion of adult deaths. After primary level of education, the proportion of adult deaths appears to decrease with an increase in education level. The proportion of adult deaths varies with marital status of the decedents. More than half of the adult deaths (52.5 per cent) occurred among those who were either married or living with a partner. Adult deaths appear to be lower among the decedents who were separated. Adult deaths vary by type of occupation. About 40 per cent of the adult deaths occurred among the elementary operations type of occupation. They are followed by the skilled agricultural and fishery workers (30. 8 per cent). The decedents who were legislators, senior official and managers had the lowest proportion of adult deaths (1.8 per cent). With respect to family relationships, about one-fifth of the decedents were either a spouse (20.1 per cent) or other relative (20.4 per cent) to the respondent of the verbal autopsy interview.

Studies reviewed in chapter 2 have found association between risk factors, health conditions, health seeking behaviour, causes of death, place of death and adult mortality. Table 5.2 below presents the risk factors that some of the deceased adults may have engaged in prior to their death. The table also presents some of the reported health conditions that the deceased experienced before they died. The health seeking behaviour or health care utilisation of the deceased for the health conditions and where they sought health care are also presented. The causes of death of the deceased as certified by medical personnel as well as the place of death are examined. Studies have reviewed that excessive alcohol consumption is a risk factors of adult mortality. More than two-thirds (43.5 per cent) of the adult decedents were involved in drinking alcohol prior to their death. Smoking is another risk factor that is associated with diseases in adulthood. Slightly more than one-fifth (24. 2 per cent) of the decedents were involved in smoking before they died. With respected to the health conditions that the decedents experienced, about 22 per cent were reported to have suffered from tuberculosis; less than 5 per cent had cancer. About 34 per cent were reported to have had HIV/AIDS before they died.

Furthermore, 10.3 per cent suffered from injuries and accidents. Nearly 11 per cent had a high blood pressure health condition. About 3 per cent had diabetes while 4.2 per cent had asthma. Just about 4 per cent had epilepsy while 3.4 per cent suffered from malnutrition.

Pertaining to health seeking behaviour, about 80 per cent of all deceased adults sought and received treatment prior to their death. Slightly more than one-third (35. 3 per cent) received treatment at home whereas 16 per cent sought treatment from a traditional healer. Majority of the deceased adults sought treatment from a government health facility (74. 4 per cent) while 11 per cent received treatment from a private health facility. Almost one-fifth (18.7 per cent) sought treatment from a either a pharmacy or drug store. About 12 per cent of the decedents received treatment from ether a faith based organisation or hospice health facility before they died. In seeking health services, it is also possible that the decedents may have consulted more than one type of health provider or facility prior to their death.

As reviewed in the literature, adults in age group 15-59 die from a number and different types of causes. Based on the confirmed causes of death by medical providers, it is evident from Table 5.2 that the leading cause of death in this age group is HIV/AIDS (40.7 per cent), seconded by injuries and accidents (11.2 per cent) and tuberculosis (7.7 per cent) in third place. About 42 per cent of the adults died at home while 40.3 per cent died in a hospital and 10.3 per cent in other health facilities.

Table 5.1 Demographic and socioeconomic background characteristics of the deceased adults in age group 15-59 years, Zambia 2010-2012 SAVVY

	Weighted	
Variable	Number	Percent
Sex		
Male	582	54.0
Female	496	46.0
Residence		
Rural	596	55.3
Urban	482	44.7
Province		
Central	69	6.4
Copperbelt	67	6.2
Eastern	183	16.9
Luapula	153	14.2
Lusaka	245	22.7
Northern	70	6.5
North Western	40	3.7
Southern	126	11.7
Western	126	11.6
Age group		
15-19	67	6.2
20-24	107	10.0
25-29	163	15.1
30-34	168	15.6
35-39	195	18.0
40-44	118	11.0
45-49	103	9.6
50-54	94	8.7
55-59	62	5.7
Educational attainment		
None	96	8.9
Primary	511	47.4
Secondary	377	35.0
Higher	63	5.9
Marital Status		
Never married	253	23.5
Married/Living with a partner	566	52.5
Widowed	96	8.9
Divorced	115	10.7
Separated	43	4.0
Occupation		
Legislators/Senior Officials/Managers	20	1.8
Professionals	22	2.1
Technicians/Associate Professionals	23	2.1
Clerks	67	6.2
Service/Shop/Market sales workers	99	9.2
Skilled Agricultural/Fishery workers	332	30.8
Craft and related trade workers	30	2.8
Plant and Machine Operators/Assemblers	55	5.1
Elementary Occupations	430	39.9
Household composition Relationship		
Father	86	7.9
Mother	202	18.8
Spouse	216	20.1
Sibling	192	17.8
Child	149	13.8
Other relative	220	20.4
No relation	11	1.0
Total	**1078**	**100.0**

Source: Computations from 2010-2012 SAVVY data files

Table 5.2 Risk factors, Health conditions, Health service utilisation, Cause of Death and Place of Death among deceased adults age group 15-59, Zambia 2010-2012 SAVVY

Variable	Weighted Number	Weighted %
Risk factors		
Alcohol		
Yes	469	43.5
No	601	55.8
Smoking		
Yes	261	24.2
No	808	75.0
Health conditions		
Tuberculosis		
Yes	237	21.9
No	817	75.7
Cancer		
Yes	37	3.5
No	1,025	95.1
HIV/AIDS		
Yes	365	33.8
No	614	57.0
Injuries & Accidents		
Yes	111	10.3
No	963	89.3
High blood pressure		
Yes	114	10.6
No	672	62.4
Diabetes		
Yes	30	2.7
No	1,023	94.9
Asthma		
Yes	45	4.2
No	1,019	94.5
Epilepsy		
Yes	42	3.9
No	1,025	95.1
Malnutrition		
Yes	37	3.4
No	1,029	95.5
Health service utlisation		
Received treatment		
Yes	860	79.7
No	205	19.0
Home		
Yes	381	35.3
No	460	42.7
Traditional Healer		
Yes	172	16.0
No	672	62.4
Government health facility		
Yes	802	74.4
No	276	25.6
Private health facility		
Yes	118	10.9
No	960	89.1
Pharmacy/Drug seller/Drug store		
Yes	202	18.7
No	642	59.5
Faith Based Organisation/Hospice		
Yes	128	11.9
No	950	88.1
Cause of death		
Diarrhoeal diseases	15	1.4
HIV disease	439	40.7
Malaria	71	6.6
Neoplasms	34	3.1
Nutritional & other anemias	13	1.2
Diabetes mellitus	19	1.7
Malnutrition	6	0.5
Tuberculosis	86	7.9
Meningitis	17	1.6
Disease of the circulatory system	59	5.5
Pneumonia/ARI	25	2.3
Other disorders of the digestive system	14	1.3
Disorders of the kidney	7	0.6
Maternal causes	19	1.8
Injuries & Accidents	120	11.2
All other causes	83	7.7
Ill-defined & undetermined causes	52	4.8
Place of death		
Hospital	434	40.3
Other health facility	111	10.3
Home	447	41.5
Other	83	7.7
Total	**1,078**	**100.0**

Source: Computations from 2010-2012 SAVVY data files

Table 5.3 presents the 15 leading causes of deaths by selected background characteristics of the deaceased adults in age group 15-59. The table shows that the leading cause of death among males and females is HIV/AIDS. Female (44.1 per cent) decedents experienced more HIV/AIDS deaths than males (37.9 per cent). Adult males (15.3 per cent) died more from injuries and accidents than females (6.3 per cent). The association is statistically significant (p-value= 0.0000). Examining the causes of death by age, there are variations. It again emerges that HIV/AIDS deaths are common across all age groups, progressively increasing with age peaking in age group 35-44 where slightly more than 50 per cent of the deaths are due to HIV/AIDS. The proportion of HIV/AIDS deaths decreases after age group 45-49. Slightly above one-tenth of tuberculosis (TB) deaths occurred in age groups, 15-19 (10.9 per cent) and 45-49 (11 per cent). Malaria related deaths are higher in age groups 15-19 (8.3 per cent), 20-24 (9.5 per cent), and 25-29 (8 per cent). Deaths due to diseases of the circulatory system are notable in age groups 45-49 (11.3 per cent) and 55-59 (18.2 per cent). Injuries and accidents deaths are evident in age groups 15-19 (19.1 per cent), 20-24 (15 per cent), 25-29 (14.6 per cent), 35-39 (11.4 per cent) and 55-59 (13.4 per cent). The differences in variation in deaths are statistically significant (p-value=0.0072).

In both rural and urban areas HIV/AIDS deaths were leading, 40.8 per cent and 40.7 per cent, respectively. Injuries and accidents deaths were almost the same proportions, 11.7 per cent in rural areas and 10.5 per cent in urban areas. There is no statistical difference in the variation of deaths by causes of death between rural and urban areas (p-value=0.3088). At provincial level, HIV/AIDS deaths were common with the exception of Copperbelt, Luapula, Northern and North-Western provinces, the rest of the provinces had HIV/AIDS deaths above 40 per cent. Malaria deaths were higher in Copperbelt province (15.7 per cent) than the rest of the provinces. TB deaths were higher in Luapula (10.9 per cent), Northern (11.8 per cent) and North-western

(10.7 per cent) provinces than the other provinces. Deaths due to injuries and accidents were higher in Central (12.6 per cent), Luapula (11.5 per cent), Lusaka (12.5 per cent), Northern (12.3 per cent) and Southern (13.2 per cent) than the rest of the provinces. There is no statistical difference in deaths due to causes of deaths among the provinces (p-value=0.5347).

Across all educational attainment levels, HIV/AIDS deaths were leading. HIV/AIDS deaths were higher among decedents with primary level educational attainment (45.1 per cent) and lower among the deceased who had higher level of educational attainment (24.9 per cent). Deaths due to injuries and accidents were higher in decedents who had higher level of educational attainment (19.6 per cent) than those who had primary level of educational attainment (9.6 per cent). There is no statistical difference in variation of deaths by educational attainment levels. More than half (53.2 per cent) of HIV/AIDS deaths were among the widowed/divorced/separated marital status category. In other categories, more than one-third of the deaths were due to HIV/AIDS: married/living with partner (38.6 per cent) and never married (33.8 per cent). Injuries and accidents deaths were higher among the never married (16.9 per cent) and married (11.5 per cent) than the widowed/divorced/separated. There was no statistical difference (p-value=0.1375).

HIV/AIDS deaths were commmon across all occupation types. Higher HIV/AIDS deaths among the service/shop/market sales workers (46.5 per cent) and lower among the legislators/senior officials/managers (23.7 per cent). Malaria deaths were higher among clerks (11.6 per cent) and plant machine operators/assemblers (10.2 per cent) than the other occupations. Diabetes mellitus deaths were higher among decedents who were legislators/senior officials/manager (10.6 per cent) than the other occupations. The proportion of TB deaths was higher among legislators/senior officials/managers (10.1 per cent) and those who were professionals (17.8 per cent) than the other occupations. Meningitis deaths are notable among deceased adults who were craft and related trade workers (10. 1 per cent). Deaths due to injuries and accidents were higher among professionals (24 per cent) and lower among those were technicians/associate professionals (4.8 per cent). The variation in deaths was border line statistically (p-value=0.0523).

In terms of risk behaviour, more than 40 per cent of HIV/AIDS deaths occurred among adults who drunk alcohol. In addition, more injuries and accidents deaths happened among those who consumed alcohol (12.2 per cent). The statistical significance is borderline (p-value=0.0541). Furthermore, about 43 per cent HIV/AIDS deaths occurred among those who smoked tobacco as well as 12.6 per cent injuries and accidents deaths. The association is not statistically significant (p-value=0.2130).

With respect to family relationship, across all relationship types, HIV/AIDS deaths were common with a peak among siblings (50.4 per cent). The proportion of TB deaths was higher among siblings (10.4 per cent) than the other type of relationships. Injuries and accidents deaths were higher among the deceased who were fathers (22.5 per cent) and lower among those who were children to the respondent (7.6 per cent). The association was statistically significant (p-value=0.0000).

In terms of place of death, nearly half (45.1 per cent) HIV/AIDS deaths occurred in a hospital while 41 per cent took place at home. Almost half (49.1 per cent) injuries and accidents deaths occurred at other places. The differences are statistically significant (p-value=0.0000).

Table 5.3 Cause of death by demographic and socioeconomic background characteristics of the deceased adults in age group in 15-59 years, Zambia 2010-2012 SAVVY

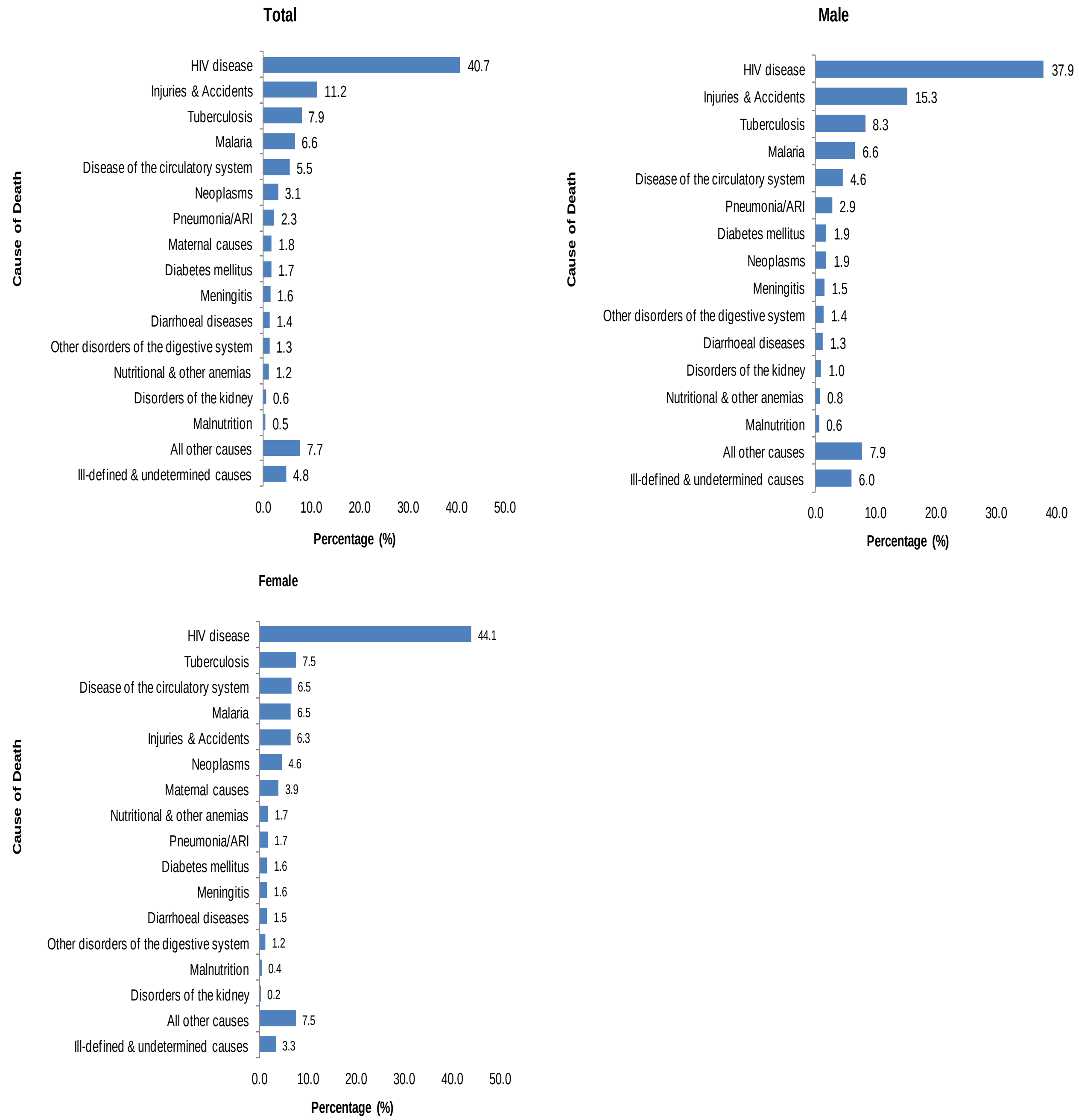
Variable	Diarrhoeal diseases	HIV disease	Malaria	Neoplasms	Nutritional & other anemias	Diabetes mellitus	Malnutrition	Tuberculosis	Meningitis	Disease of the circulatory system	Pneumonia/ ARI	Other disorders of the digestive system	Disorders of the kidney	Maternal causes	Injuries & Accidents	All other causes	Ill-defined & undetermined causes	Total (%)	Number (15-59)	P-value
Sex																				**0.0000**
Male	1.3	37.9	6.6	1.9	0.8	1.9	0.6	8.3	1.5	4.6	2.9	1.4	1.0	0.0	15.3	7.9	6.0	100.0	582	
Female	1.5	44.1	6.5	4.6	1.7	1.6	0.4	7.5	1.6	6.5	1.7	1.2	0.2	3.9	6.3	7.5	3.3	100.0	496	
Age group																				**0.0072**
15-19	4.1	23.6	8.3	1.4	4.2	0.0	1.3	10.9	2.7	2.7	1.4	0.0	0.0	5.3	19.1	9.4	5.7	100.0	67	
20-24	0.9	31.5	9.5	3.5	2.6	0.0	0.0	7.2	2.8	3.5	4.3	0.0	0.0	4.5	15.0	7.9	7.0	100.0	107	
25-29	1.7	37.5	8.0	1.3	0.6	1.9	0.0	8.3	1.4	4.3	1.1	2.5	0.0	2.9	14.6	8.4	5.4	100.0	163	
30-34	1.7	47.1	5.2	2.3	0.6	1.7	0.0	8.9	1.2	3.0	4.1	1.8	0.6	1.2	9.9	7.2	3.6	100.0	168	
35-39	0.9	54.4	6.5	3.4	0.4	1.5	0.0	4.0	1.9	1.9	3.0	1.0	0.0	2.1	11.4	3.4	4.3	100.0	195	
40-44	2.5	50.4	4.9	3.3	0.0	0.8	0.7	6.8	1.7	6.5	0.7	0.8	1.6	0.0	9.1	8.8	1.6	100.0	118	
45-49	0.9	38.6	5.7	3.8	0.9	1.8	0.0	11.0	1.9	11.3	0.9	0.9	1.9	0.0	2.7	12.1	5.5	100.0	103	
50-54	0.0	32.5	4.4	5.7	2.3	4.6	1.0	9.9	0.0	7.8	3.3	2.3	2.2	0.0	7.5	7.6	9.0	100.0	94	
55-59	0.0	21.4	7.6	5.1	2.7	4.6	5.0	9.3	0.0	18.2	0.0	1.9	0.0	0.0	13.4	8.9	1.9	100.0	62	
Residence																				**0.3068**
Rural	1.7	40.8	6.0	2.9	1.3	1.4	1.0	8.0	1.1	5.9	2.4	1.0	0.4	2.4	11.7	8.6	3.4	100.0	596	
Urban	1.0	40.7	7.3	3.4	1.1	2.1	0.0	7.9	2.1	5.0	2.2	1.7	1.0	1.0	10.5	6.5	6.5	100.0	482	
Province																				**0.5347**
Central	0.0	43.2	4.4	0.0	2.6	5.2	0.0	4.4	7.0	6.5	2.9	1.5	0.0	1.6	12.6	5.4	2.8	100.0	69	
Copperbelt	0.0	37.9	15.7	1.4	3.0	1.4	1.4	7.2	0.0	1.5	2.9	5.9	1.4	0.0	8.8	7.3	4.4	100.0	67	
Eastern	3.1	44.9	6.4	3.8	1.0	2.2	1.2	4.7	0.5	4.3	2.6	0.5	0.0	2.0	9.6	8.6	4.6	100.0	183	
Luapula	1.3	37.4	8.2	1.3	1.3	0.0	1.1	10.9	3.1	6.9	2.4	1.3	0.7	2.5	11.3	9.0	1.2	100.0	153	
Lusaka	1.2	40.4	5.3	4.1	1.6	0.5	0.0	7.4	0.9	5.4	2.1	1.8	1.2	0.8	12.5	6.9	8.1	100.0	245	
Northern	4.0	25.5	4.4	0.0	1.4	4.4	0.0	11.8	1.4	7.4	2.7	0.0	0.0	6.9	12.3	16.5	1.5	100.0	70	
North Western	2.1	37.8	2.6	4.4	0.0	2.8	0.0	10.7	2.5	15.8	4.4	0.0	0.0	0.0	7.3	7.0	2.5	100.0	40	
Southern	0.0	44.6	2.4	5.4	0.7	3.2	0.0	8.6	0.9	5.1	0.9	1.6	1.7	0.0	13.2	5.4	6.3	100.0	126	
Western	0.7	45.1	9.9	4.0	0.0	0.8	0.8	8.9	0.8	3.3	2.2	0.0	0.0	3.2	9.8	5.3	5.2	100.0	126	
Educational attainment																				**0.0818**
None	4.0	34.1	7.7	2.2	2.1	3.1	2.9	7.0	2.0	2.9	0.9	1.0	0.0	1.0	10.1	10.7	8.3	100.0	96	
Primary	1.1	45.1	5.1	2.5	1.1	0.7	0.4	8.3	1.0	7.1	2.8	0.8	0.6	2.1	9.6	7.7	3.9	100.0	511	
Secondary	1.2	39.6	8.7	3.9	1.5	2.4	0.0	7.6	1.8	3.6	2.0	2.1	0.3	1.8	12.3	6.1	5.2	100.0	377	
Higher	1.6	24.9	4.8	1.5	0.0	3.2	1.5	7.7	1.5	7.7	3.0	1.5	4.5	1.6	19.6	12.4	3.0	100.0	63	
Marital Status																				**0.1375**
Never Married	1.5	33.8	7.0	2.7	1.1	1.2	0.7	7.9	2.0	3.4	2.6	0.8	0.4	1.5	16.9	9.3	7.3	100.0	253	
Married/Living with a partner	1.7	38.6	6.8	3.3	1.2	2.3	0.5	7.8	1.6	6.4	2.1	1.6	0.9	2.6	11.5	7.1	4.2	100.0	566	
Widowed/Divorced/Separated	0.8	53.2	5.8	3.1	1.5	1.1	0.3	8.1	1.1	5.2	2.6	1.2	0.4	0.4	5.0	7.0	3.2	100.0	255	
Occupation																				**0.0523**
Legislators/Senior Officials/Managers	5.0	23.7	5.0	5.3	0.0	10.6	5.1	10.1	0.0	5.0	0.0	5.0	0.0	5.1	9.8	5.1	5.2	100.0	20	
Professionals	0.0	27.1	0.0	4.3	0.0	4.5	0.0	17.8	0.0	0.0	0.0	0.0	8.6	0.0	24.0	8.9	4.8	100.0	22	
Technicians/Associate Professionals	0.0	43.4	0.0	0.0	0.0	4.5	0.0	9.2	4.3	0.0	4.1	4.2	0.0	0.0	4.8	12.6	12.9	100.0	23	
Clerks	0.0	42.8	11.6	2.9	0.0	0.0	0.0	9.3	0.0	7.3	2.8	3.1	0.0	1.5	5.7	8.8	4.3	100.0	67	
Service/Shop/Market sales workers	0.0	46.5	5.8	5.4	1.1	3.5	0.0	8.0	1.0	6.1	0.0	2.1	0.0	1.1	10.4	7.0	2.0	100.0	99	
Skilled Agricultural/Fishery workers	1.9	39.6	6.9	2.9	0.9	1.5	0.6	7.9	0.9	5.2	3.2	1.2	1.0	2.3	13.5	6.7	3.8	100.0	332	
Craft and related trade workers	0.0	42.9	3.3	0.0	0.0	7.4	0.0	6.6	10.1	0.0	0.0	0.0	0.0	3.2	10.3	9.5	6.8	100.0	30	
Plant and Machine Operators/Assemblers	1.8	35.8	10.2	3.5	3.5	0.0	0.0	9.2	0.0	4.9	0.0	3.9	0.0	1.7	18.7	5.2	1.6	100.0	55	
Elementary Occupations	1.6	41.8	6.2	2.9	1.7	0.9	0.7	7.0	2.1	6.3	2.7	0.5	0.4	1.6	9.2	8.4	6.0	100.0	430	
Alcohol Consumption																				**0.0541**
Yes	1.0	44.2	6.4	2.4	0.4	1.0	0.8	8.7	0.8	4.5	2.3	1.1	0.6	0.0	12.2	8.6	4.9	100.0	469	
No	1.7	38.3	6.6	3.7	1.9	2.3	0.3	7.5	2.1	6.4	2.3	1.5	0.7	3.2	10.0	6.9	4.6	100.0	601	
Tobacco Smoking																				**0.2130**
Yes	0.7	42.6	5.5	2.5	1.0	0.4	1.1	11.0	1.1	3.8	2.6	0.8	0.4	0.4	12.6	9.5	4.1	100.0	261	
No	1.6	40.4	6.8	3.4	1.3	2.2	0.4	6.9	1.7	6.1	2.3	1.5	0.7	2.3	10.5	7.2	4.8	100.0	808	
Family Relationship																				**0.0000**
Father	1.0	32.2	5.4	2.4	0.0	3.4	0.0	5.7	1.2	6.1	2.1	1.3	1.1	5.6	22.5	6.6	3.4	100.0	86	
Mother	2.4	44.8	10.6	2.4	2.3	0.4	0.0	7.4	2.1	4.6	0.5	1.0	0.5	2.0	9.3	5.6	4.2	100.0	202	
Spouse	1.6	32.1	6.2	5.0	0.4	2.9	0.5	8.8	1.3	7.8	3.1	2.4	0.5	1.0	13.0	9.7	3.7	100.0	216	
Sibling	0.0	50.4	3.6	1.0	1.5	1.0	1.5	10.4	1.0	4.8	2.5	0.5	0.0	2.0	9.3	4.0	6.5	100.0	192	
Child	2.6	38.4	8.7	6.2	0.6	2.0	0.6	6.1	0.6	6.0	1.3	1.9	0.6	1.9	7.6	9.7	5.2	100.0	149	
Other relative	0.9	42.3	4.8	2.1	1.7	1.4	0.5	7.6	2.7	4.5	4.0	0.9	0.9	0.8	10.5	9.4	5.0	100.0	220	
No relation	0.0	45.9	0.0	0.0	0.0	0.0	0.0	9.3	0.0	0.0	0.0	0.0	0.0	0.0	18.1	18.0	8.7	100.0	11	
Place of Death																				**0.0000**
Hospital	0.9	45.1	6.7	5.1	1.5	2.5	0.0	7.9	2.1	5.0	2.2	1.6	0.9	2.4	6.5	7.3	2.2	100.0	434	
Other health facility	3.4	39.1	7.8	0.0	0.9	1.7	0.0	7.0	1.8	6.6	6.2	1.8	0.0	4.4	8.9	7.0	3.5	100.0	111	
Home	1.3	41.6	6.3	2.5	1.3	1.4	1.3	9.3	1.1	6.3	1.9	0.9	0.7	0.7	9.0	7.0	7.4	100.0	447	
Other	2.1	16.1	5.6	0.0	0.0	0.0	0.0	2.2	1.2	2.2	0.0	1.1	0.0	1.2	49.1	13.7	5.7	100.0	86	
Total	**1.4**	**40.7**	**6.6**	**3.1**	**1.2**	**1.7**	**0.5**	**7.9**	**1.6**	**5.5**	**2.3**	**1.3**	**0.6**	**1.8**	**11.2**	**7.7**	**4.8**	**100.0**	**1078**	

Source: Computations from 2010-2012 SAVVY data files

5.3 Leading causes of adult mortality in Zambia

In this section, the leading causes of death among adults aged 15-59 are examined. The top 15 leading causes are identified and analysed further in terms of mortality patterns. The analysis is later in the chapter restricted to the top 5 leading causes. It is evident from Figure 5.1 that after ranking the causes of death among adults in the age group under study HIV/AIDS emerges as the leading cause of death. About 41 per cent of deaths among all adult decedents were attributed to HIV/AIDS. The proportion of HIV/AIDS deaths is even higher among deceased adult females (44.1 per cent). About 38 per cent of adult males died of HIV/AIDS. From the figure, it is evident that more adult females are dying from HIV/AIDS than males. Population basd surveys conducted in Zambia with an HIV testing component have found higher HIV prevalence among females than males.

Figure 5.1 Top 15 leading cause of death among adults in age group 15-59, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

Figure 5.1 also shows that as Zambia experiences mortality changes in line with the epidemiologic transition, non-communicable diseases such as diseases of the circulatory system, neoplasms and diabetes mellitus may be slowly rising on the ranking of leading causes of death. Examining the causes of death by sex in the figure, it is notable that the second ranking causes of death differ for males and females in the age group 15-59. For males, injuries and accidents deaths (15.3 per cent) are the second leading cause of death while for females it is TB (7.5 per cent). TB is third ranked as a cause of death for males (8.3 per cent) whereas for females it is diseases of the circulatory system (6.5 per cent). Interestingly, injuries and accidents are 5th ranked for females while for males diseases of the circulatory system assume the same ranking. Both are ranked immediately below malaria which is ranked 4th as a leading cause of death for both males (6.6 per cent) and females (6.5 per cent).

Apart from HIV/AIDS which is the leading cause of death in both sexes, public health interventions must take cognisance of the gender differences in causes of death that are of priority to each particular sex. It is notable that while males were dying of pneumonia/ARI and diabetes mellitus in the 6th and 7th rankings respectively, females were dying of neoplasms and maternal causes in the same raking order. Furthermore, while disorders of the kidney (0.2 per cent) are least ranked as cause of death among females; a proportion of 1 per cent of male deaths were attributed to the same cause of death.

5.3.1 Cause of Death and Rural-Urban Residence

Table 5.4 further disaggregates the causes of death by rural-urban residence and sex to assess how they vary by these characteristics. It is notable from the table that in both rural and urban areas, the proportion of HIV/AIDS deaths is the highest for males and females. Females had a higher proportion of HIV/AIDS deaths than males irrespective of whether rural or urban area. The proportion of neoplasm deaths was higher among women in urban (5.5 per cent) than rural (3.9 per cent) areas. Diabetes mellitus deaths were higher among males in urban areas (2.6 per cent) than males in rural areas (1.3 per cent). A higher proportion of TB deaths among males than females in both rural and urban areas are evident. The proportion of deaths attributed to diseases of the circulatory system was higher among females than males in both rural and urban areas. In rural areas, a higher proportion (3.1 per cent) of pneumonia/ARI attributed deaths was experienced than in urban areas (2.6 per cent) among deceased adult males. Injuries and accidents attributed deaths were higher among males than females in both rural and urban areas. The proportion was even higher among rural males (16 per cent) than urban males (14.5 per cent).

Table 5.4 Causes of death among adults by rural-urban residence, Zambia 2010-2012 SAVVY

	Male			Female			Both		
Cause of Death	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Diarrhoeal diseases	1.8	0.7	1.3	1.6	1.4	1.5	1.7	1.0	1.4
HIV disease	37.9	38.0	37.9	44.0	44.2	44.1	40.8	40.7	40.7
Malaria	5.3	8.1	6.6	6.7	6.1	6.5	6.0	7.3	6.6
Neoplasms	1.9	1.8	1.9	3.9	5.5	4.6	2.9	3.4	3.1
Nutritional & other anemias	0.9	0.7	0.8	1.8	1.7	1.7	1.3	1.1	1.2
Diabetes mellitus	1.3	2.6	1.9	1.7	1.4	1.6	1.4	2.1	1.7
Malnutrition	1.2	0.0	0.6	0.7	0.0	0.4	1.0	0.0	0.5
Tuberculosis	8.5	8.1	8.3	7.4	7.7	7.5	8.0	7.9	7.9
Meningitis	1.3	1.9	1.5	1.0	2.3	1.6	1.1	2.1	1.6
Disease of the circulatory system	5.5	3.6	4.6	6.4	6.7	6.5	5.9	5.0	5.5
Pneumonia/ARI	3.1	2.6	2.9	1.6	1.8	1.7	2.4	2.2	2.3
Other disorders of the digestive system	1.3	1.6	1.4	0.7	1.9	1.2	1.0	1.7	1.3
Disorders of the kidney	0.7	1.4	1.0	0.0	0.5	0.2	0.4	1.0	0.6
Maternal causes	0.0	0.0	0.0	5.0	2.4	3.9	2.4	1.0	1.8
Injuries & Accidents	16.0	14.5	15.3	7.2	5.2	6.3	11.7	10.5	11.2
All other causes	9.4	6.1	7.9	7.8	7.1	7.5	8.6	6.5	7.7
Ill-defined & undetermined causes	4.0	8.4	6.0	2.7	4.1	3.3	3.4	6.5	4.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	309	274	582	288	208	496	596	482	1078

Source: Computations from 2010-2012 SAVVY data files

5.3.2 Cause of Death and Provincial Residence

It is evident that by provincial residence, HIV/AIDS deaths had the highest proportions among deceased males. Western (46.2 per cent) province had the highest proportion of HIV/AIDS deaths and Northern the lowest (24.6 per cent). A higher proportion of malaria deaths are notable among male decedents in Copperbelt province (16.3 per cent) than the rest of the provinces. Diabetes mellitus deaths were higher in Northern (6.2 per cent) province than other provinces. Proportions of deaths attributable to TB were higher in Luapula (13.6 per cent), Northern (15.8 per cent) and North-Western (17.2 per cent). Meningitis deaths were higher in Central (5.3 per cent) and Luapula (4.9 per cent). The proportions of deaths attributable to diseases of the circulatory system among males were higher in Central (6.9 per cent), Luapula

(6.0 per cent) and North-Western provinces (8.7 per cent). Injuries and accidents attributable deaths were high across all provinces but higher in Central (17.7 per cent), Lusaka (16.8 per cent), Northern (17.8 per cent) and Southern (16.2 per cent).

Table 5.5 Causes of death among male adults by provincial residence, Zambia 2010-2012 SAVVY

Cause of Death	Central	Copperbelt	Eastern	Luapula	Lusaka	Northern	North Western	Southern	Western	Total
Diarrhoeal diseases	0.0	0.0	2.7	1.3	1.3	5.6	0.0	0.0	0.0	1.3
HIV disease	41.5	39.2	37.1	34.4	36.2	24.6	33.1	44.0	46.2	37.9
Malaria	5.3	16.3	7.3	7.3	6.6	6.3	0.0	1.4	8.4	6.6
Neoplasms	0.0	0.0	3.7	0.0	3.4	0.0	0.0	2.6	0.0	1.9
Nutritional & other anemias	0.0	2.6	1.8	0.0	0.6	0.0	0.0	1.2	0.0	0.8
Diabetes mellitus	2.7	2.6	1.9	0.0	0.7	6.2	0.0	4.0	1.7	1.9
Malnutrition	0.0	2.6	1.0	1.1	0.0	0.0	0.0	0.0	1.8	0.6
Tuberculosis	2.7	5.5	5.6	13.6	8.6	15.8	17.2	5.2	8.6	8.3
Meningitis	5.3	0.0	0.0	4.9	0.7	3.1	0.0	1.4	0.0	1.5
Disease of the circulatory system	6.9	2.9	5.8	6.0	4.2	3.3	8.7	4.2	1.7	4.6
Pneumonia/ARI	5.2	2.9	2.9	3.6	2.6	5.7	0.0	1.4	1.6	2.9
Other disorders of the digestive system	2.7	0.0	0.0	1.3	2.8	0.0	0.0	2.6	0.0	1.4
Disorders of the kidney	0.0	2.6	0.0	1.3	1.2	0.0	0.0	2.8	0.0	1.0
Maternal causes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Injuries & Accidents	17.7	11.3	13.7	14.3	16.8	17.8	7.7	16.2	15.0	15.3
All other causes	7.4	5.8	10.0	8.6	5.8	11.7	24.6	6.3	6.8	7.9
Ill-defined & undetermined causes	2.7	5.7	6.4	2.4	8.5	0.0	8.7	6.7	8.3	6.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	38	36	99	78	155	32	11	77	56	582

Source: Computations from 2010-2012 SAVVY data files

Table 5.6 presents a similar pattern of HIV/AIDS attributable deaths among deceased female adults. Eastern province had the highest proportion of HIV/AIDS deaths (54 per cent) while Northern province had the lowest (26.2 per cent). Copperbelt and Western provinces had higher proportions of adult female deaths attributable to malaria, 15.1 per cent and 11.2 per cent, respectively. Neoplasms deaths were higher among women in Lusaka (5.5 per cent), North-Western (6.2 per cent) and Western (7.1 per cent) provinces. Deaths due to nutritional and other anaemia (5.8 per cent) as well as diabetes mellitus (8.3 per cent) were higher among females in Central province. A higher proportion of deaths attributable to TB is notable in Southern province (13.9 per cent). Meningitis deaths are higher among females in Central province (9.1 per cent) while deaths attributable to disorders of the digestive system are higher in Copperbelt province (12.4 per cent). A higher proportion of women died from maternal causes in Northern province (12.9 per cent) than other provinces. Injuries and accidents attributable deaths were higher in Luapula (8.2 per cent) and Southern (8.5 per cent).

Table 5.6 Causes of death among female adults by provincial residence, Zambia 2010-2012 SAVVY

Cause of Death	Central	Copperbelt	Eastern	Luapula	Lusaka	Northern	North Western	Southern	Western	Total
Diarrhoeal diseases	0.0	0.0	3.5	1.3	1.1	2.5	2.9	0.0	1.3	1.5
HIV disease	45.4	36.3	54.3	40.6	47.5	26.2	39.7	45.6	44.3	44.1
Malaria	3.4	15.1	5.5	9.0	3.2	2.7	3.7	4.1	11.2	6.5
Neoplasms	0.0	2.9	3.8	2.7	5.5	0.0	6.2	10.0	7.1	4.6
Nutritional & other anemias	5.8	3.4	0.0	2.6	3.2	2.5	0.0	0.0	0.0	1.7
Diabetes mellitus	8.3	0.0	2.5	0.0	0.0	2.8	3.9	2.0	0.0	1.6
Malnutrition	0.0	0.0	1.3	1.2	0.0	0.0	0.0	0.0	0.0	0.4
Tuberculosis	6.4	9.1	3.7	8.1	5.3	8.4	8.1	13.9	9.1	7.5
Meningitis	9.1	0.0	1.2	1.3	1.1	0.0	3.5	0.0	1.4	1.6
Disease of the circulatory system	6.0	0.0	2.5	7.8	7.5	10.9	18.7	6.5	4.6	6.5
Pneumonia/ARI	0.0	3.0	2.2	1.2	1.1	0.0	6.2	0.0	2.7	1.7
Other disorders of the digestive system	0.0	12.4	1.1	1.3	0.0	0.0	0.0	0.0	0.0	1.2
Disorders of the kidney	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.2
Maternal causes	3.5	0.0	4.4	5.2	2.1	12.9	0.0	0.0	5.7	3.9
Injuries & Accidents	6.3	5.9	4.6	8.2	5.2	7.5	7.2	8.5	5.7	6.3
All other causes	2.9	9.0	6.9	9.4	8.7	20.7	0.0	4.0	4.2	7.5
Ill-defined & undetermined causes	2.9	3.0	2.5	0.0	7.4	2.8	0.0	5.6	2.8	3.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	31	32	83	75	90	37	28	49	70	496

Source: Computations from 2010-2012 SAVVY data files

5.3.3 Cause of Death and Age group

Among adult male decedents, Table 5.7 shows that the proportion of HIV/AIDS deaths increases with age reaching a peak in age group 35-39 (50.5 per cent) and then decreases from age group 40-44 onwards. Malaria deaths were highest in age group 20-24 (11.9 per cent). A progressive increase in the proportion of neoplasm associated deaths with age is notable in age groups 45-59, 3.4 per cent to 3.6 per cent. Diabetes mellitus deaths were higher in age group 50-54 (5.3 per cent). The proportion of TB attributable deaths appears to increase progressively with age from age group 40-44 (8.4 per cent) among males and peaking in age group 55-59 (17.6

per cent). Deaths due to the diseases of the circulatory system were highest in age group 55-59 (22 per cent). The proportion of deaths related to injuries and accidents are highest among males in age group 15-19 (36 per cent) and decreases progressively with age until age group 45-49 (5.2 per cent) when deaths gradually increase to 12.3 per cent in age group 55-59.

Table 5.7 Causes of death among male adults by age group, Zambia 2010-2012 SAVVY

Cause of Death	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	Total
Diarrhoeal diseases	6.0	0.0	0.0	2.1	0.7	3.3	1.7	0.0	0.0	1.3
HIV disease	15.6	24.0	33.6	44.5	50.5	45.4	41.9	34.5	9.3	37.9
Malaria	9.3	11.9	7.4	6.4	7.1	6.3	5.5	0.0	8.2	6.6
Neoplasms	0.0	3.9	1.3	0.0	1.5	1.7	3.4	3.5	3.6	1.9
Nutritional & other anemias	6.2	2.0	0.0	0.0	0.7	0.0	1.7	0.0	0.0	0.8
Diabetes mellitus	0.0	0.0	2.5	2.1	1.5	1.7	0.0	5.3	3.1	1.9
Malnutrition	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.6	6.1	0.6
Tuberculosis	8.9	8.3	9.0	6.4	3.9	8.4	8.6	13.7	17.6	8.3
Meningitis	0.0	0.0	2.6	1.1	3.0	1.7	1.9	0.0	0.0	1.5
Disease of the circulatory system	2.9	1.9	3.5	3.4	0.8	8.1	5.5	5.2	22.0	4.6
Pneumonia/ARI	0.0	5.9	0.0	5.5	4.0	1.5	0.0	5.2	0.0	2.9
Other disorders of the digestive system	0.0	0.0	2.5	2.2	0.8	0.0	1.7	1.8	3.6	1.4
Disorders of the kidney	0.0	0.0	0.0	1.2	0.0	1.6	3.6	3.4	0.0	1.0
Injuries & Accidents	36.0	17.9	22.3	15.3	17.1	8.1	5.2	6.9	12.3	15.3
All other causes	8.7	10.2	7.1	7.6	4.5	7.9	12.2	8.5	10.7	7.9
Ill-defined & undetermined causes	6.4	14.1	8.1	2.3	3.8	3.1	7.0	10.5	3.6	6.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	31	46	85	91	124	59	54	59	33	582

Source: Computations from 2010-2012 SAVVY data files

Among females, HIV/AIDS is the leading cause of deaths across all age groups. HIV/AIDS deaths increase progressively with age from 30.2 per cent in age group 15-19 to peak at 61.3 per cent in age group 35-39 and then decrease gradually to 28.9 per cent in age group 50-54 as shown in Table 5.8. The age group 55-59 has unexpected increase in HIV/AIDS deaths (35 per cent). The proportion of malaria related deaths among females is highest in age group 50-54 (12 per cent). High proportions of deaths attributable to neoplasms are notable in age groups 35-39 (6.9 per cent), 50-54 (9.5 per cent) and 55-59 (6.9 per cents). The proportion of deaths attributable to nutritional anaemias–6.3 per cent in age group 50-54 and 5.7 per cent in age group 55-59–as well as deaths due to diabetes mellitus are notable in age group 55-59 (6.3 per cent). Proportions of TB deaths are higher in age groups 15-19 (12.6 per cent), 30-34 (11.9

per cent) and 45-49 (13.7 per cent). Deaths attributable to diseases of the circulatory system are higher in age groups 20-24 (12.7 per cent), 40-44 (10 per cent), and 55-59 (14.5 per cent).

Table 5.8 Causes of death among female adults by age group, Zambia 2010-2012 SAVVY

Cause of Death	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	Total
Diarrhoeal diseases	2.5	1.5	3.6	1.3	1.2	1.7	0.0	0.0	0.0	1.5
HIV disease	30.2	37.0	41.8	50.1	61.3	55.4	34.9	28.9	35.0	44.1
Malaria	7.4	7.7	8.7	3.7	5.4	3.4	6.0	12.0	6.9	6.5
Neoplasms	2.5	3.3	1.2	4.9	6.9	4.9	4.2	9.5	6.9	4.6
Nutritional & other anemias	2.4	3.1	1.3	1.3	0.0	0.0	0.0	6.3	5.7	1.7
Diabetes mellitus	0.0	0.0	1.2	1.2	1.5	0.0	3.7	3.4	6.3	1.6
Malnutrition	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.4
Tuberculosis	12.6	6.3	7.6	11.9	4.0	5.1	13.7	3.4	0.0	7.5
Meningitis	5.0	4.8	0.0	1.3	0.0	1.7	2.0	0.0	0.0	1.6
Disease of the circulatory system	2.4	4.7	5.2	2.6	3.7	4.9	17.7	12.4	14.0	6.5
Pneumonia/ARI	2.6	3.0	2.4	2.5	1.2	0.0	1.9	0.0	0.0	1.7
Other disorders of the digestive system	0.0	0.0	2.5	1.2	1.3	1.5	0.0	3.2	0.0	1.2
Disorders of the kidney	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.2
Maternal causes	9.8	8.0	6.2	2.7	5.7	0.0	0.0	0.0	0.0	3.9
Injuries & Accidents	5.1	12.7	6.1	3.6	1.3	10.0	0.0	8.7	14.5	6.3
All other causes	9.9	6.3	9.8	6.7	1.3	9.7	12.1	5.9	6.9	7.5
Ill-defined & undetermined causes	5.0	1.6	2.4	5.1	5.2	0.0	3.9	6.4	0.0	3.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	37	61	78	77	70	59	49	34	29	496

Source: Computations from 2010-2012 SAVVY data files

5.3.4 Causes of Death and Educational Attainment

Education is considered a promoter of beliefs in modern medicine, hygienic practices and better knowledge of nutrition. Table 5.9 shows causes of death in relation to educational attainment of the deceased adults. The table shows that from primary to higher level of educational attainment the proportion of HIV/AIDS deaths decrease progressively with an increase in level of educational attainment. For both males and females, deceased adults who attained primary level of education had the highest proportions of HIV/AIDS deaths, 43.5 per cent and 46.7 per cent respectively. Malaria related deaths were higher among those with no education for males (8.5 per cent) while for females it was among those with secondary level of education (11 per cent). Among females, neoplasm deaths were higher among those with secondary and higher educational attainment, 7.3 per cent and 5.2 per cent respectively. Diabetes mellitus deaths were higher among males with none (5.9 per cent) and higher (4.6 per cent) educational levels. Among females, the proportion of TB deaths appears to increase progressively with level of education to 10.2 per cent for deceased women who had higher education.

For males, the opposite is the case from primary level of education. The proportion of TB deaths decreases with level of education from 9.2 per cent among those who had primary education to 6.6 per cent with higher education. Deaths due to diseases of the circulatory system were higher among those with higher education level (8.8 per cent) for males while for females it was among those with primary level education (9.3 per cent). The proportion of deaths attributable to injuries and accidents was higher among those with higher educational attainment for males and females, 20.9 per cent and 16.4 per cent respectively.

Table 5.9 Causes of death among all adults by education level, Zambia 2010-2012 SAVVY

	Male					Female					Both				
Cause of Death	None	Primary	Secondary	Higher	Total	None	Primary	Secondary	Higher	Total	None	Primary	Secondary	Higher	Total
Diarrhoeal diseases	5.8	1.1	0.8	2.2	1.3	3.0	1.1	2.1	0.0	1.5	4.0	1.1	1.2	1.6	1.4
HIV disease	11.6	43.5	37.6	28.6	37.9	45.4	46.7	43.2	15.9	44.1	34.1	45.1	39.6	24.9	40.7
Malaria	8.5	5.9	7.5	4.5	6.6	7.4	4.4	11.0	5.3	6.5	7.7	5.1	8.7	4.8	6.6
Neoplasms	0.0	2.4	2.0	0.0	1.9	3.3	2.6	7.3	5.2	4.6	2.2	2.5	3.9	1.5	3.1
Nutritional & other anemias	2.9	0.4	1.1	0.0	0.8	1.6	1.8	2.2	0.0	1.7	2.1	1.1	1.5	0.0	1.2
Diabetes mellitus	5.9	0.4	2.0	4.6	1.9	1.7	1.0	3.0	0.0	1.6	3.1	0.7	2.4	3.2	1.7
Malnutrition	5.8	0.4	0.0	2.2	0.6	1.4	0.4	0.0	0.0	0.4	2.9	0.4	0.0	1.5	0.5
Tuberculosis	8.8	9.2	7.6	6.6	8.3	6.1	7.4	7.5	10.2	7.5	7.0	8.3	7.6	7.7	7.9
Meningitis	0.0	1.2	2.1	0.0	1.5	3.1	0.7	1.4	5.2	1.6	2.0	1.0	1.8	1.5	1.6
Disease of the circulatory system	5.7	4.7	3.9	8.8	4.6	1.4	9.3	3.1	5.0	6.5	2.9	7.1	3.6	7.7	5.5
Pneumonia/ARI	0.0	3.9	2.0	4.3	2.9	1.4	1.8	2.0	0.0	1.7	0.9	2.8	2.0	3.0	2.3
Other disorders of the digestive system	3.1	0.9	2.1	0.0	1.4	0.0	0.8	2.2	5.2	1.2	1.0	0.8	2.1	1.5	1.3
Disorders of the kidney	0.0	1.3	0.0	6.3	1.0	0.0	0.0	0.7	0.0	0.2	0.0	0.6	0.3	4.5	0.6
Maternal causes	0.0	0.0	0.0	0.0	0.0	1.4	4.1	5.1	5.5	3.9	1.0	2.1	1.8	1.6	1.8
Injuries & Accidents	14.9	11.8	17.8	20.9	15.3	7.7	7.5	2.1	16.4	6.3	10.1	9.6	12.3	19.6	11.2
All other causes	11.7	7.6	7.4	6.7	7.9	10.3	7.8	3.7	26.2	7.5	10.7	7.7	6.1	12.4	7.7
Ill-defined & undetermined causes	15.4	5.4	6.1	4.3	6.0	4.7	2.5	3.5	0.0	3.3	8.3	3.9	5.2	3.0	4.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	32	248	244	45	582	64	263	133	19	496	96	511	377	63	1078

Source: Computations from 2010-2012 SAVVY data files

5.3.5 Causes of Death and Marital Status

Mortality literature shows that marital status is associated with the risk of death, though with mixed evidence. Table 5.10 shows the association between cause of death and marital status. Again, HIV/AIDS takes centre stage as the leading cause of death. The proportion of HIV/AIDS deaths was higher among the deceased adults who were widowed, divorced, and separated for both males and females, 48.6 per cent and 55.8 per cent, respectively. Malaria related deaths were highest among the never married (7.7 per cent) for males and 8 per cent for females among the widowed, divorced and separated. The proportion of TB deaths was higher among the never married (10.2 per cent) for females and 12.7 per cent among the widowed, divorced and separated for males. Deaths due to diseases of the circulatory system were higher among the married/living with partner (9.7 per cent) for females and 8.1 per cent among the widowed, divorced and separated for males. The proportion of injuries and accidents deaths was highest among the never married (24 per cent) for males and 8.9 per cent for the married/living with partner for the females.

Table 5.10 Causes of death among all adults by marital status, Zambia 2010-2012 SAVVY

Cause of Death	Male: Never Married	Male: Married/Living with a partner	Male: Widowed/ Divorced/ Separated	Male: Total	Female: Never Married	Female: Married/Living with a partner	Female: Widowed/ Divorced/ Separated	Female: Total	Both: Never Married	Both: Married/Living with a partner	Both: Widowed/ Divorced/ Separated	Both: Total
Diarrhoeal diseases	1.7	1.5	0.0	1.3	1.1	1.9	1.2	1.5	1.5	1.7	0.8	1.4
HIV disease	28.5	39.8	48.6	37.9	44.0	36.9	55.8	44.1	33.8	38.6	53.2	40.7
Malaria	7.7	7.5	1.9	6.6	5.5	5.9	8.0	6.5	7.0	6.8	5.8	6.6
Neoplasms	1.7	1.8	2.3	1.9	4.5	5.3	3.6	4.6	2.7	3.3	3.1	3.1
Nutritional & other anemias	1.1	0.8	0.0	0.8	1.0	1.6	2.3	1.7	1.1	1.2	1.5	1.2
Diabetes mellitus	1.2	2.5	1.2	1.9	1.1	2.1	1.0	1.6	1.2	2.3	1.1	1.7
Malnutrition	0.6	0.6	0.9	0.6	1.0	0.4	0.0	0.4	0.7	0.5	0.3	0.5
Tuberculosis	6.7	7.9	12.7	8.3	10.2	7.6	5.5	7.5	7.9	7.8	8.1	7.9
Meningitis	1.3	1.8	1.0	1.5	3.3	1.2	1.2	1.6	2.0	1.6	1.1	1.6
Disease of the circulatory system	4.1	3.9	8.1	4.6	2.2	9.7	3.6	6.5	3.4	6.4	5.2	5.5
Pneumonia/ARI	1.8	3.0	4.2	2.9	4.4	0.8	1.7	1.7	2.6	2.1	2.6	2.3
Other disorders of the digestive system	0.0	2.2	1.2	1.4	2.3	0.8	1.3	1.2	0.8	1.6	1.2	1.3
Disorders of the kidney	0.6	1.2	1.0	1.0	0.0	0.4	0.0	0.2	0.4	0.9	0.4	0.6
Maternal causes	0.0	0.0	0.0	0.0	4.3	6.0	0.6	3.9	1.5	2.6	0.4	1.8
Injuries & Accidents	24.0	13.4	6.2	15.3	3.3	8.9	4.3	6.3	16.9	11.5	5.0	11.2
All other causes	9.1	7.4	7.4	7.9	9.6	6.8	6.8	7.5	9.3	7.1	7.0	7.7
Ill-defined & undetermined causes	9.9	4.5	3.3	6.0	2.3	3.8	3.1	3.3	7.3	4.2	3.2	4.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (15-59)	166	322	92	582	87	244	162	496	253	566	255	1078

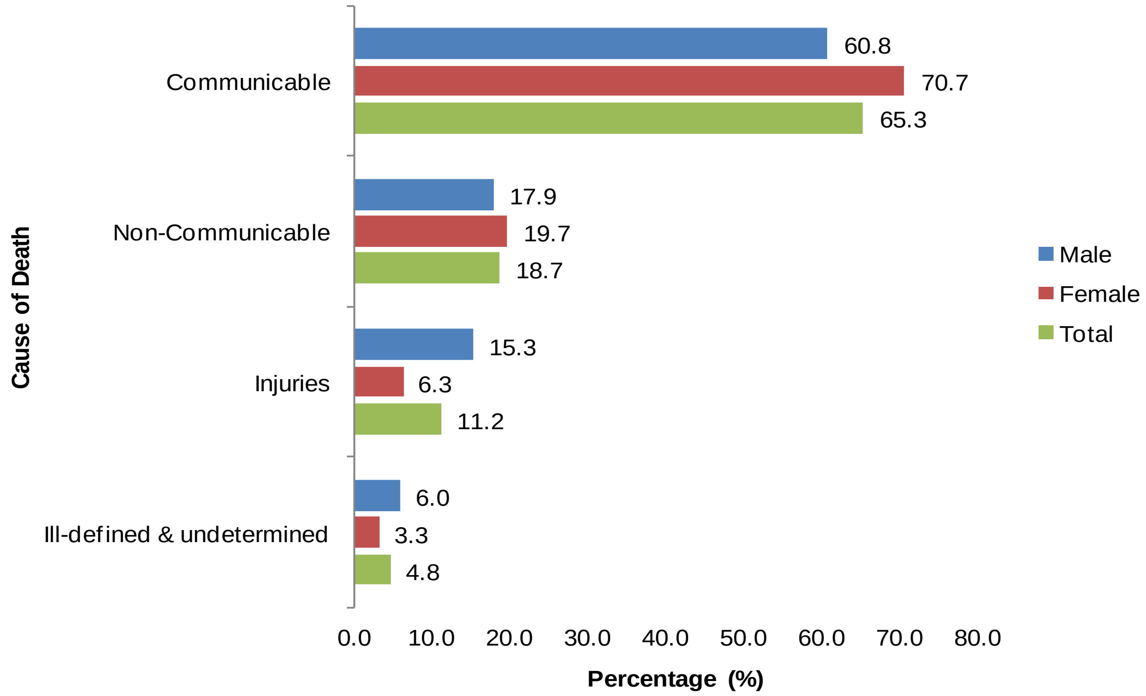
Source: Computations from 2010-2012 SAVVY data files

5.4 Global Burden of Diseases major groups of Cause of Death

In this section, the causes of death presented above are grouped into the Global Burden of Diseases classification system, only the commonly used broad groups. The Global Burden of Diseases classifies the causes of diseases into major groups using the international classification of diseases (ICD) system which is in its current 10th version (ICD-10). The main groups are: group I-communicable diseases, group II-non-communicable diseases (NCDs), and group III-external causes or injuries. Group I-communicable diseases include infectious and parasitic diseases caused by pathogens such as bacteria, viruses, fungi and they are spread directly or indirectly from one person to another. The group include diseases like HIV/AIDS, Tuberculosis (TB), malaria, diarrhoea, measles, rabies, and others. Maternal and perinatal (causes e.g. maternal haemorrhage, birth trauma) and nutritional deficiency conditions are also in group I. Group II-non-communicable diseases these are health conditions that are non-infectious and cannot be transmitted from one person to another. Non-communicable diseases include diabetes mellitus, neoplasms, cancer, malignant conditions, asthma, cardiovascular conditions, etc. Group III- external causes or injuries–cause mortality–and include accidents, suicide, homicide, and others.

The external causes are also referred to as unnatural causes, for example, road traffic accidents, committing suicide or death by gunshots. Figure 5.2 presents the main groupings of causes of death as per the Global Burden of Diseases. The figure shows that overall 65.3 per cent of the causes of death among adults aged 15-59 years are due to communicable diseases. The proportion of communicable causes of death is higher among females (70.7 per cent) than males (60.8 per cent).

Figure 5.2 Percentage of adult deaths according to Global Burden of Diseases major groups of causes of death by sex, Zambia 2010-2012 SAVVY

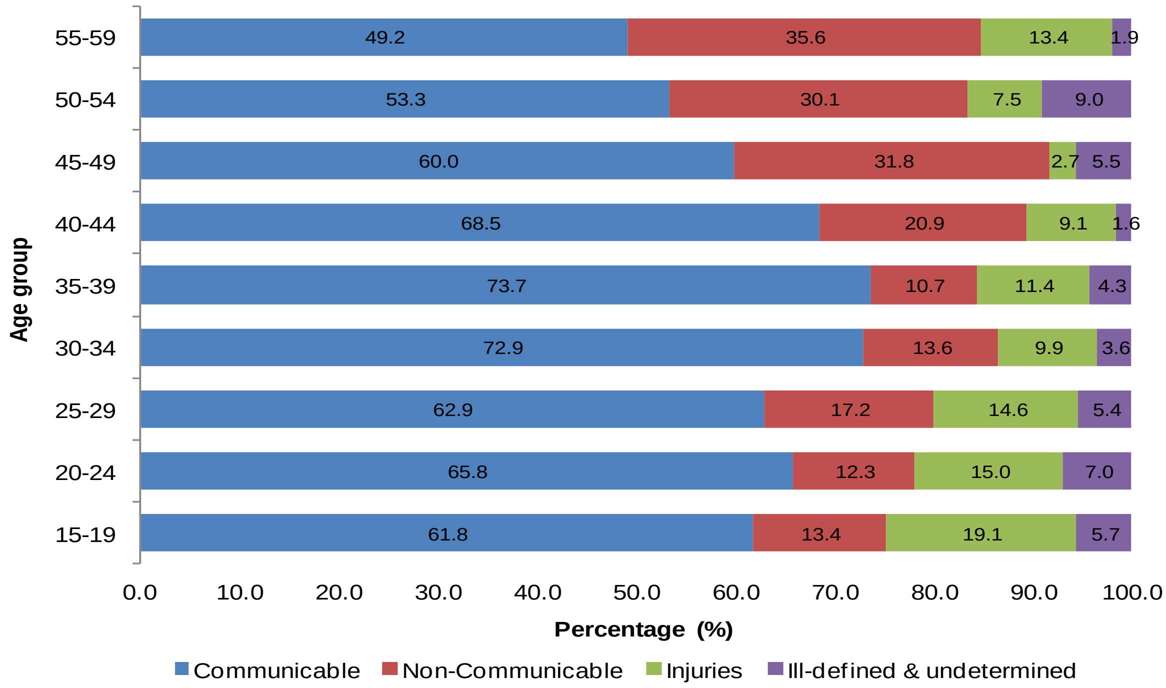


Source: Computations from 2010-2012 SAVVY data files

With respect to non-communicable diseases, Figure 5.2 shows that about one-fifth (19.7 per cent) of adult female deaths were attributable to non-communicable diseases while about 18 per cent of adult male deaths were due the same causes. The proportion of adult deaths due to external causes or injuries was higher among males (15.3 per cent) than females (6.3 per cent). From the figure, it is evident that the major contributor causes of adult mortality in Zambia are communicable diseases.

Figure 5.3 presents the GBD groupings of causes of death by age group 15-59. It is evident that the communicable diseases are the most prevalent causes of death across all ages, peaking in age group 35-39 (73.7 per cent) and lower in age group 55-59 (49.2 per cent). For NCDs causes of death, they increase from age group 40-44 to the highest proportion 35.6 per cent in age group 55-59. For external causes of death, injuries are more prevalent in age group 15-19 (19.1 per cent) and lowest in age group 45-49 (2.7 per cent). In the older age group 55-59 injuries increase again. It is also worth to note that there is an interesting pattern of changes to causes of deaths by age in line with the epidemiologic transition. The figure shows that from age group 35-39 to 55-59 the proportion of adult deaths due to communicable diseases decreases progressively with age. On the other hand, the opposite is the case for deaths attributable to non-communicable diseases.

Figure 5.3 Percentage of adult deaths according to Global Burden of Diseases major groups of causes of death by age group, Zambia 2010-2012 SAVVY

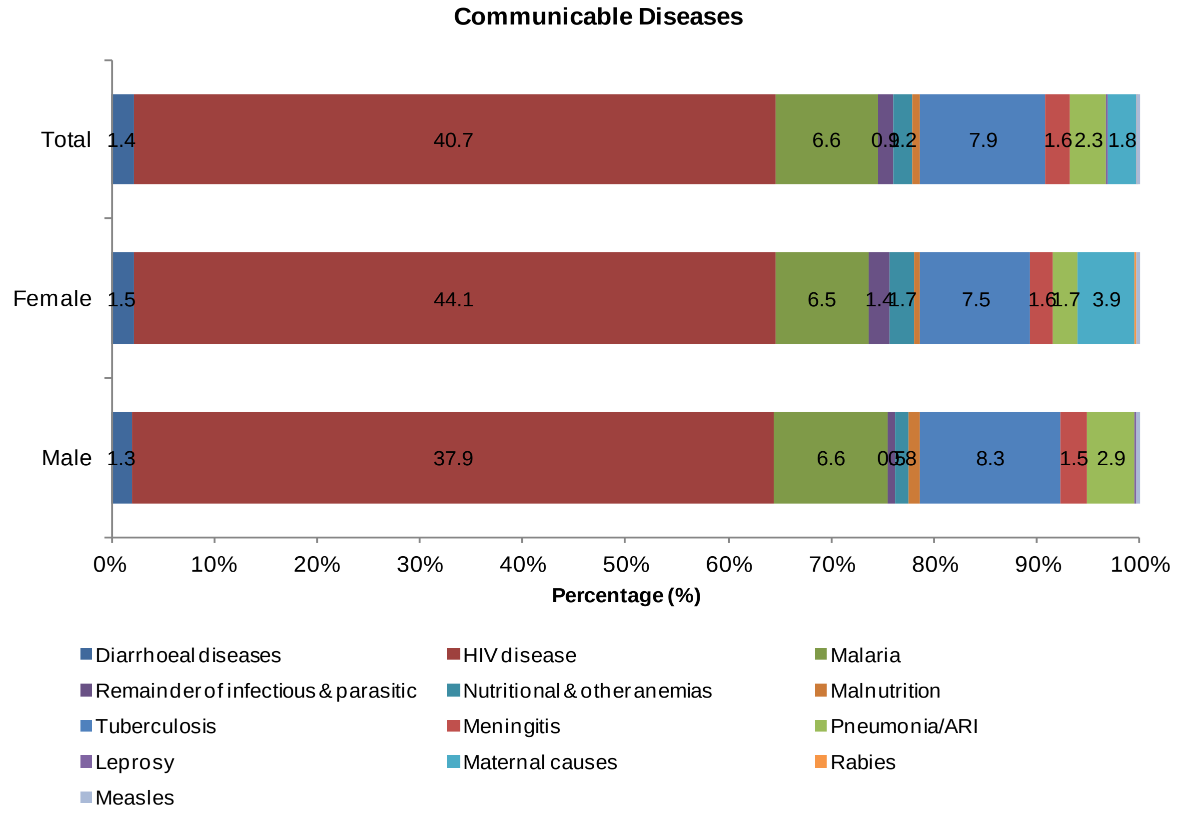


Source: Computations from 2010-2012 SAVVY data files

5.4.1 Communicable diseases causes of death

In this section, communicable diseases are examined. Figure 5.4 shows the grouping of infectious and parasitic causes of death among adults into the communicable diseases group. The figure shows that among the communicable diseases causes of death, HIV/AIDS remains the leading cause of death of adults in age group 15-59 (40.7 per cent) overall, and 44.1 per cent for females and 37.9 per cent for males. Tuberculosis is the second leading communicable cause of death, 7.9 per cent overall, and for females 7.5 per cent. Adult male decedents had the highest proportion of deaths attributable to TB, 8.3 per cent. Malaria is the third leading communicable cause of death for both males and females, 6.6 per cent and 6.5 per cent, respectively. Pneumonia/ARI is the fourth leading communicable disease among the deceased males (2.9 per cent) while among the female decedents it is maternal causes (3.9 per cent).

Figure 5.4 Percentage of adult deaths according to communicable causes of death by sex, Zambia 2010-2012 SAVVY

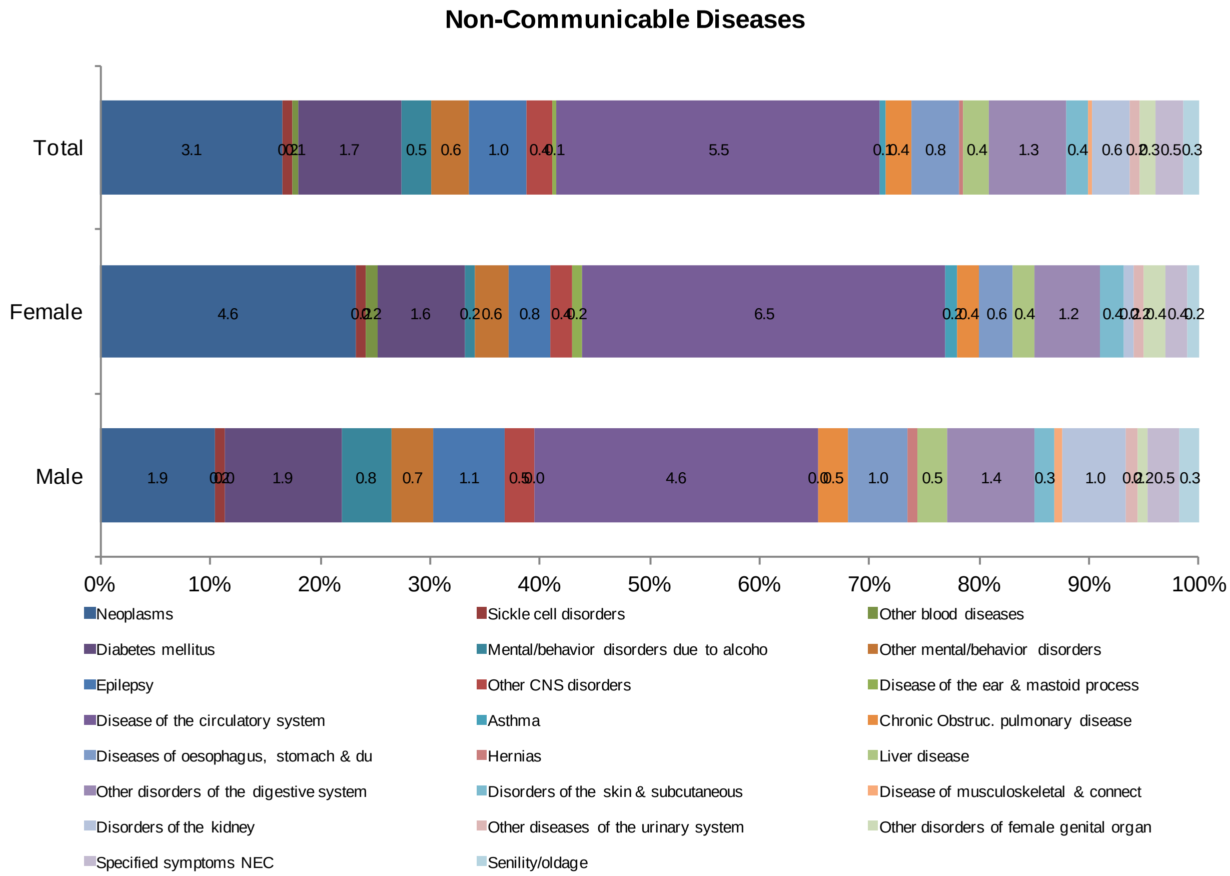


Source: Computations from 2010-2012 SAVVY data files

5.4.2 Non-communicable diseases causes of death

In this section, non-communicable causes of death are examined. Among the non-communicable causes of death, diseases of the circulatory system were the leading causes of death among adults, 5.5 per cent overall as shown in Figure 5.5. The proportion of deaths was higher among females (6.5 per cent) than among males (4.6 per cent). The second leading cause of death was neoplasms for females (4.6 per cent) while for males it was diabetes mellitus (1.9 per cent). Neoplasms was the third leading cause of death among deceased adult males (1.87 per cent) while for females it was diabetes mellitus (1.6 per cent).

Figure 5.5 Percentage of adult deaths according to non-communicable causes of death by sex, Zambia 2010-2012 SAVVY

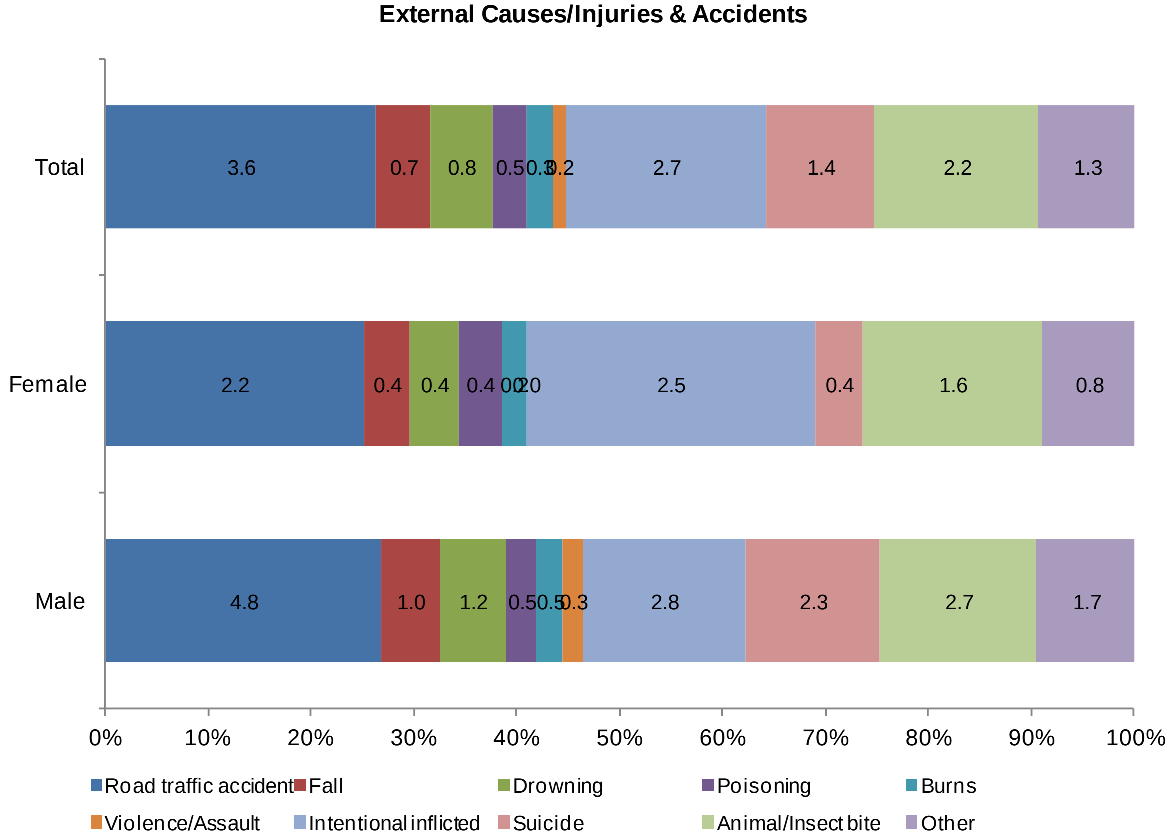


Source: Computations from 2010-2012 SAVVY data files

5.4.3 External causes of death

This section examines external causes of death. External causes or injuries and accidents were the second leading cause of death among adults out of all causes. A disaggregation of the injuries and accidents shows that road traffic accidents were the leading cause of death among external causes for males (4.8 per cent) while for females it was intentional inflicted injuries (2.5 per cents). The proportion of male road traffic accident deaths was twice higher that of female deaths. Intentional inflicted deaths were the second leading cause of death among males (2.8 per cent) while among females it was road traffic accidents (2.2 per cent). Animal/insect bite deaths were the third leading cause of death among both males (2.7 per cent) and females (1.6 per cent). Males had a higher proportion of the animal/insect bite deaths.

Figure 5.6 Percentage of adult deaths according to external causes of death by sex, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

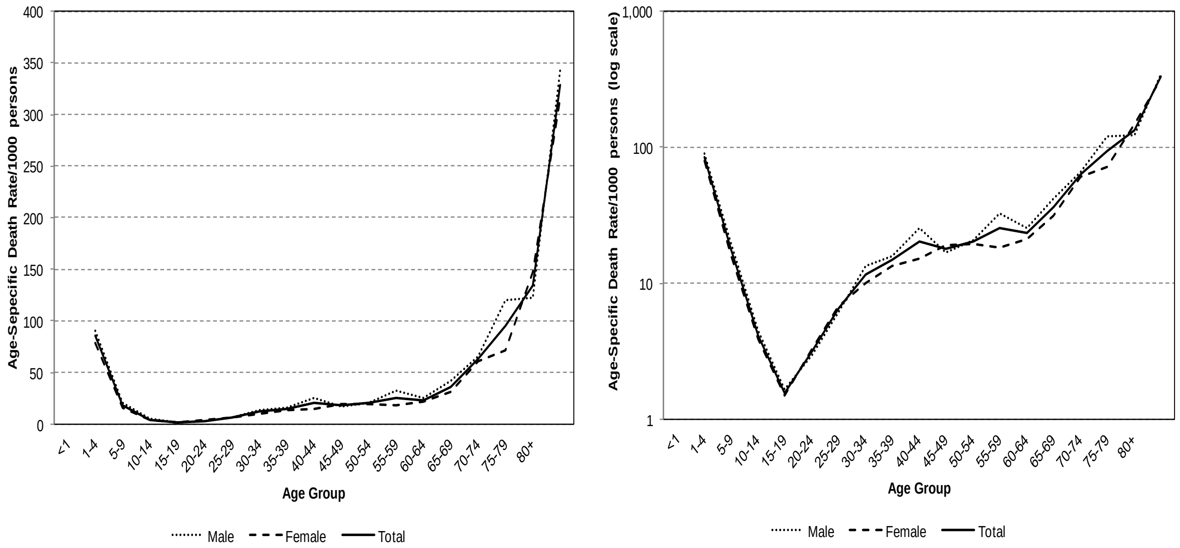
5.5 Age-Cause-Specific Mortality Patterns

In this section, age-cause-specific mortality patterns are analysed further by computing age-specific death rates, age-cause-specific death rates and age-cause-specific death ratios which are plotted in graphs. This is done to further understand the mortality patterns attributed to the causes of death among adults. The top 5 leading cause of death among adults in Zambia were selected to further explore the mortality patterns. The top 5 leading causes are HIV/AIDS, injuries and accidents, tuberculosis, malaria and diseases of the circulatory system.

5.5.1 All-Cause Age Mortality Pattern

Figure 5.7 shows the plot of computed age-specific death rates per 1,000 persons for all-cause mortality and all ages. The age mortality pattern shown in the figure is the expected "J" shape observed in most populations, that is, high mortality in infant ages which rapidly declines to low levels in the teen ages before gradually increasing progressively with age. Males experience higher mortality than females due several factors. A plot of the age-specific death rates on a log scale gives a clear picture of the pattern of mortality by age. It is notable that between ages 25-45 as well as 50-59, there is higher adult male mortality than for females. The humps in the curves in adult mortality ages could be reflective of HIV/AIDS mortality.

Figure 5.7 All-cause mortality pattern by age and sex, Zambia 2010-2012 SAVVY

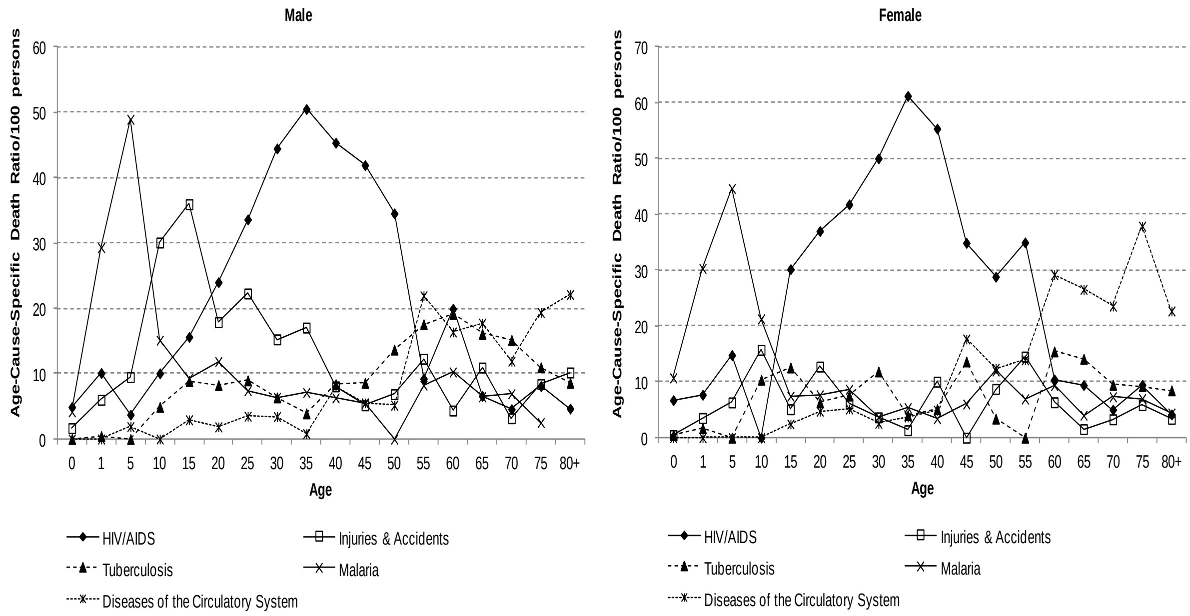


Source: Computations from 2010-2012 SAVVY data files

5.5.2 Age-Pattern of Specific Causes of Death

Figure 5.8 shows the age-cause-specific mortality pattern of the top 5 leading causes of death by sex. The age-cause-specific death ratios magnify the effect of each cause of death based on all deaths. For both males and females, the HIV/AIDS curves clearly show the concentration of deaths attributed to the cause of death between ages 15 and 55. HIV/AIDS deaths progressively increase with age, peaking in age group 35-39 and then decrease gradually for both males and females. Malaria deaths are more concentrated in younger ages between age 1 and 5. Injuries and accidents deaths are higher among males between ages 5 and 35. Tuberculosis deaths are higher for males than females between ages 45 and 60. Deaths attributable to diseases of the circulatory system are higher for females than males from the age of 45 and above.

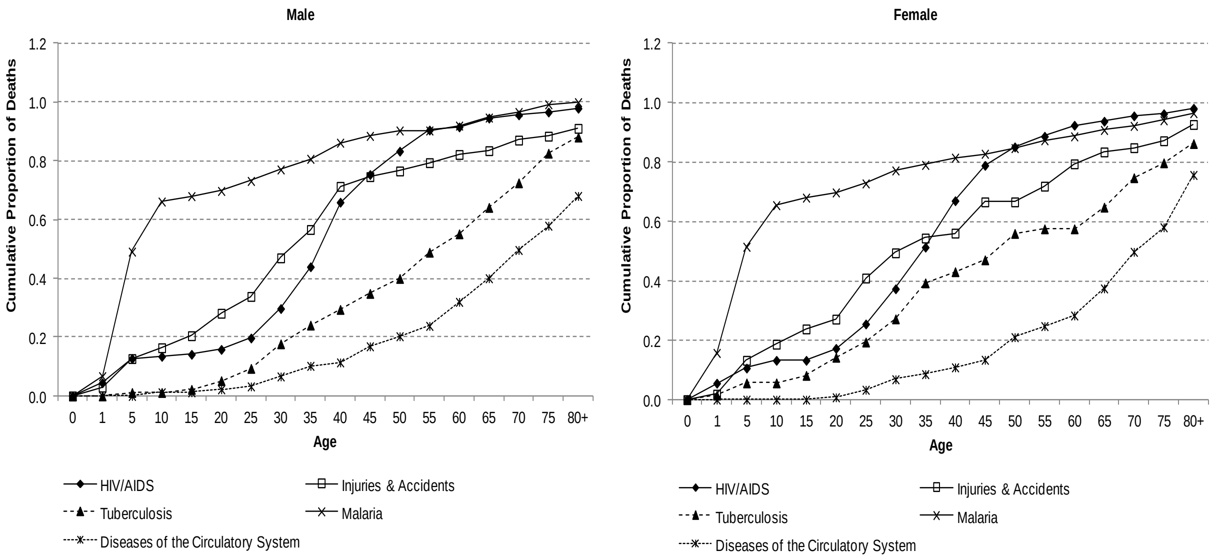
Figure 5.8 Male and female age-cause-specific mortality pattern, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

Figure 5.9 shows the cumulated proportions of deaths attributed to each of the five causes of death and it is evident that there were more deaths attributed to malaria across all ages for both males and females. HIV/AIDS deaths are cumulatively higher from ages 40+ for males and 35+ for females when compared to injuries and accidents deaths. Deaths attributed to diseases of the circulatory system are the lowest when compared to the other causes.

Figure 5.9 Age-Pattern of Specific Causes of Death, Zambia 2010-2012 SAVVY

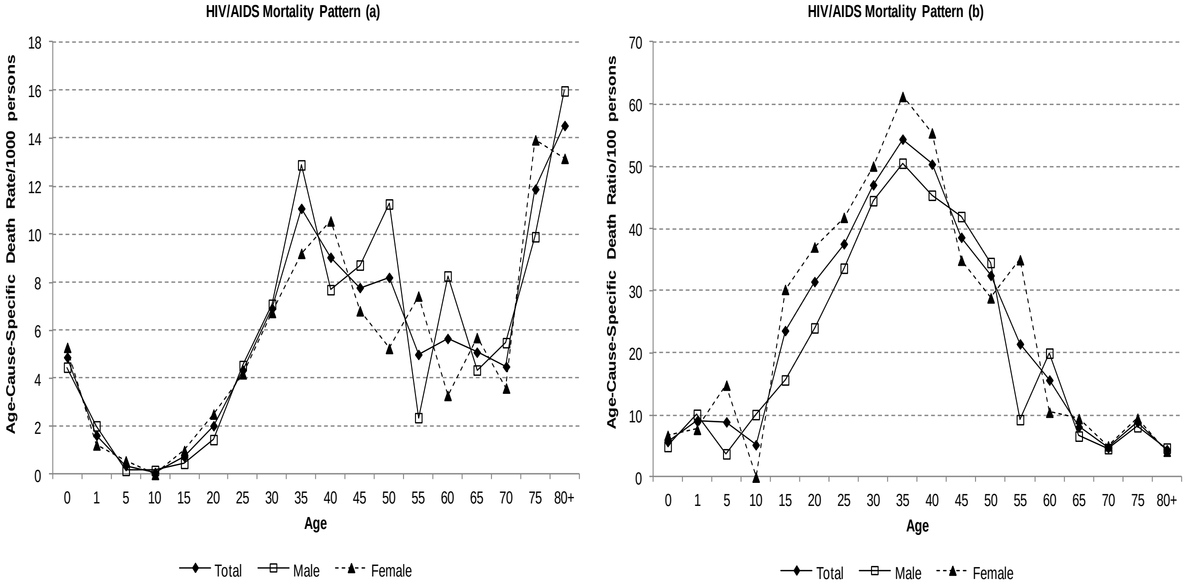


Source: Computations from 2010-2012 SAVVY data files

5.5.2.1 HIV/AIDS Mortality Pattern

Figure 5.10 shows the HIV/AIDS mortality pattern by age and sex. It is evident from the figure that age-cause-specific death ratios magnify the HIV/AIDS mortality pattern. The ratios show the significance of the cause of death in each age group. Age-cause-specific death rates measure more of the occurrence of deaths. Based on the ratios, adult females experienced higher HIV/AIDS deaths than males between ages 15 and 45. It is also clear that after reaching a peak in age group 35-39, HIV/AIDS deaths decrease gradually with an increase in age.

Figure 5.10 HIV/AIDS mortality pattern by age and sex, Zambia 2010-2012 SAVVY

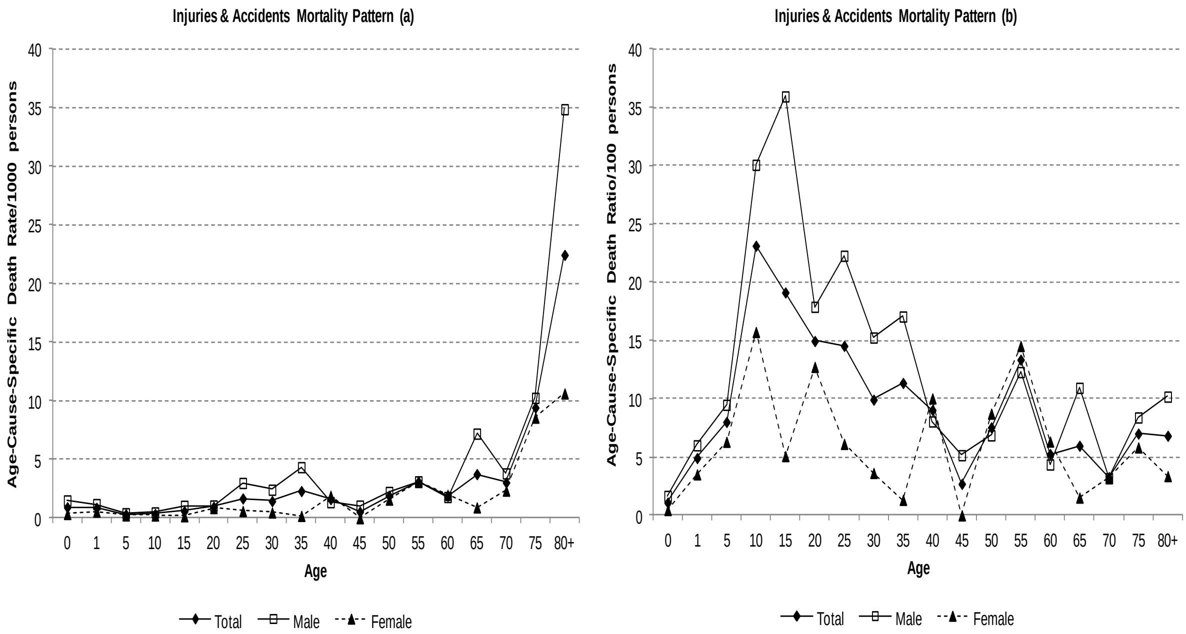


Source: Computations from 2010-2012 SAVVY data files

5.5.2.2 Injuries and Accidents Mortality Pattern

Deaths attributed to injuries and accidents are magnified by the plot age-cause-specific death ratios in Figure 5.11. The high concentration of injuries and accidents deaths was among males between ages 5 and 35 with the peak in age group 15-19. The age-cause-specific death rates show that deaths due to injuries and accidents increased progressively with age; higher between age 20 and 40 for males.

Figure 5.11 Injuries and accidents mortality pattern by age and sex, Zambia 2010-2012 SAVVY

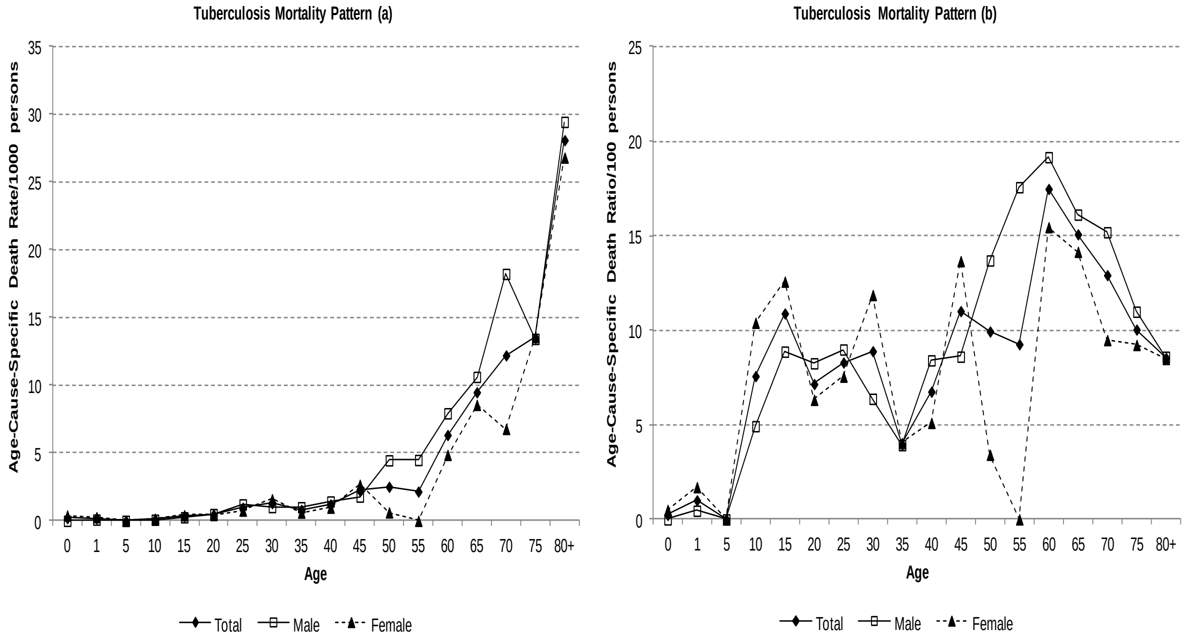


Source: Computations from 2010-2012 SAVVY data files

5.5.2.3 Tuberculosis Mortality Pattern

The age-cause-specific death rates show that TB deaths increased progressively with age and were higher among males than females between ages 45 and 75 as shown in Figure 5.12. A close examination of TB deaths by age-cause-specific death ratios shows that TB death varied by age. Female deaths attributed to TB were higher than for male in adult ages 25-35. TB deaths among males increased progressively with age from age 50 and above.

Figure 5.12 Tuberculosis mortality pattern by age and sex, Zambia 2010-2012 SAVVY

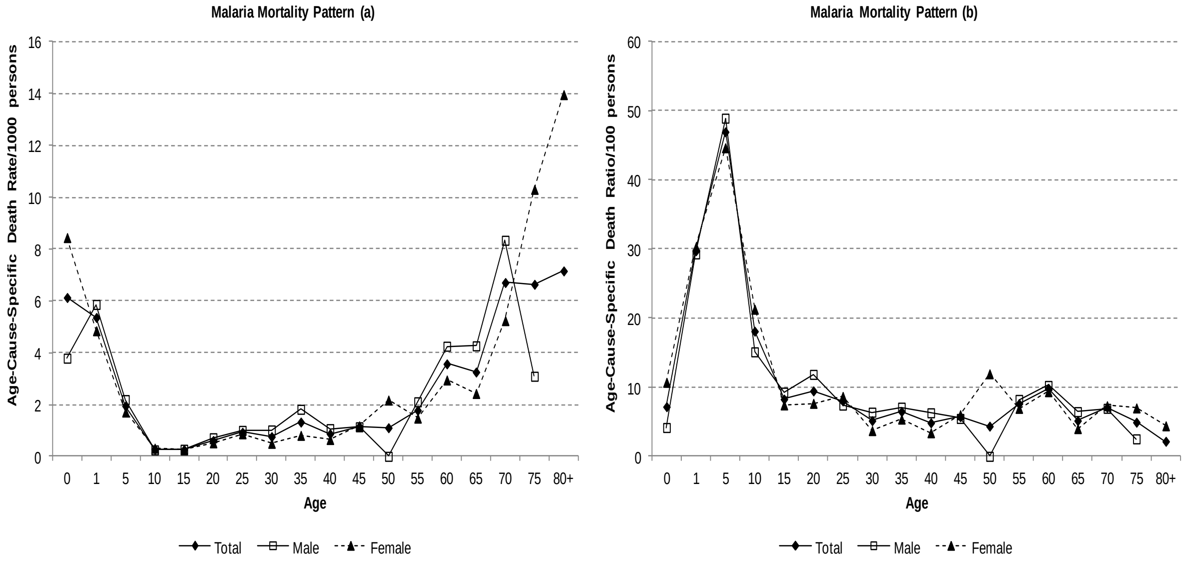


Source: Computations from 2010-2012 SAVVY data files

5.5.2.4 Malaria Mortality Pattern

Figure 5.13 shows the malaria age-sex mortality pattern. It is evident from the figure that malaria deaths are high in infant ages but rapidly decline to low deaths in age group 10-14 and thereafter gradually increases progressively with age according to the age-cause-specific death rates. The age-cause-specific death ratios show that the concentration of malaria deaths was between ages 1 and 10 with the peak in age group 5-9. In adult ages malaria deaths were higher for males between ages 15 and 45 while for females between ages 45 and 55.

Figure 5.13 Malaria mortality pattern by age and sex, Zambia 2010-2012 SAVVY

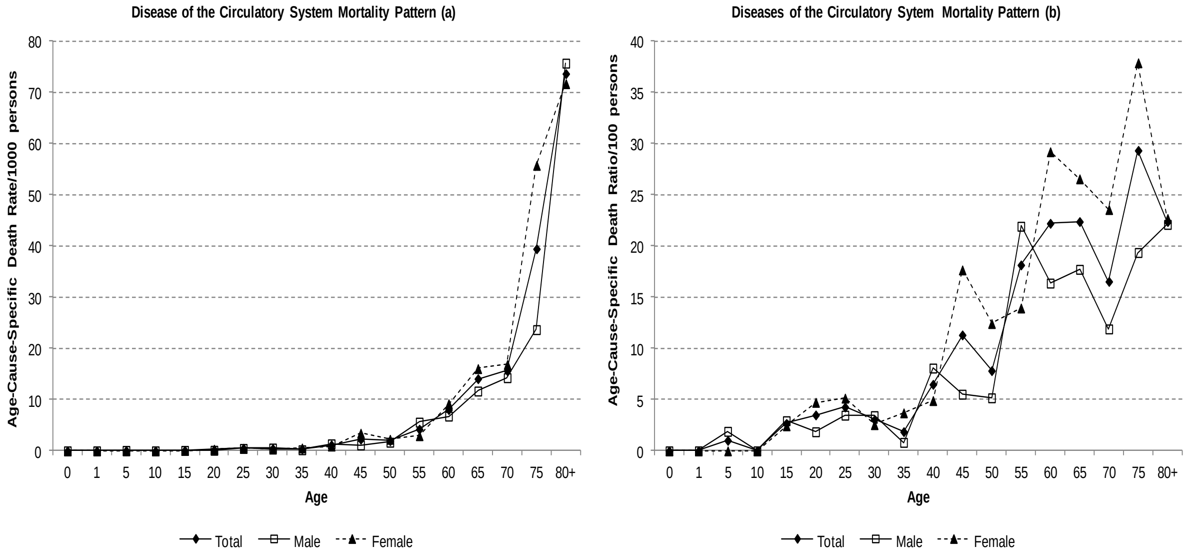


Source: Computations from 2010-2012 SAVVY data files

5.5.2.5 Diseases of the Circulatory System Mortality Pattern

The age-cause-specific death rates show that deaths attributable to diseases of the circulatory system increased with age from age 40 and above and were higher among females than males as shown in Figure 5.14. The age-cause-specific death ratios show that deaths related to diseases of the circulatory system also increased with age and higher among females. The ratios show a clearer picture of what is happening in each age group with respect to deaths attributed to diseases of the circulatory system. Deaths of the diseases of the circulatory system are concentrated in older ages for both males and females.

Figure 5.14 Diseases of the circulatory system mortality pattern by age and sex, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

5.6 Cause of Death Elimination

In this section, the study analyses the effect of eliminating a particular cause of death–that is, cause-deleted–this is of significance to public health for interventions specifically targeting a disease. Though in reality some causes of death are interrelated, therefore, it may not be possible to completely eliminate a disease and thus intended health benefits achieved. To estimate the number of years gained as a result of eliminating a particular cause of death the life expectancy at each age derived from the SAVVY life table was subtracted from that of the constructed cause-deleted life table. The percentage reduction in the probability of dying after eliminating the cause of death was also computed.

5.6.1 HIV/AIDS elimination

Table 5.11 shows the number of years gained in life expectancy at each age if HIV/AIDS were eliminated as a cause of death. In other words, this is the number of additional years of life that individuals at each particular age would expect to live if there was no HIV/AIDS as a cause of death. It is evident from the table that a significant number of additional years of life would be gained by eliminating HIV/AIDS as a cause of death for both males and females. The number of years gained are higher for females than males. For males, the highest number of years gained is 5.77 years in age group 15-19 while for females it is 6.40 years in the same age group. For both males and females, the gain in the number of years of additional life is higher in the adult mortality group which is mostly affected by HIV/AIDS. Females gained more years because they experience a higher prevalence of HIV/AIDs as well as deaths. The table also shows the percentage reduction in the probability of dying if HIV/AIDS were eliminated. The percentage reduction is small in younger ages for both males and females but increases with age. The highest percentage reduction in the probability of dying is among females in age group 35-39 which is 60.5 per cent. For males, it is 49 per cent in the same age group. The percentage reduction decreases after the peak age groups.

Table 5.11 Number of years gained by eliminating the risk of HIV/AIDS, Zambia 2010-2012 SAVVY

Age	Total				Male				Female			
	Life Expectancy at Birth (e_0)-HIV/AIDS eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-HIV/AIDS eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-HIV/AIDS eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying
<1	53.08	47.33	5.75	5.7	50.80	45.36	5.43	5.4	55.58	49.45	6.14	7.4
1-4	56.49	50.52	5.97	9.0	54.33	48.67	5.67	9.9	58.79	52.50	6.28	7.8
5-9	56.18	50.15	6.03	9.0	54.24	48.56	5.68	3.8	58.24	51.85	6.39	15.0
10-14	52.21	46.15	6.05	5.4	50.37	44.61	5.76	10.2	54.16	47.81	6.35	0.3
15-19	47.57	41.49	6.08	23.6	45.72	39.95	5.77	15.7	49.54	43.14	6.40	30.3
20-24	43.12	37.11	6.01	31.3	41.26	35.51	5.75	23.8	45.09	38.82	6.26	36.8
25-29	39.02	33.25	5.78	37.0	37.16	31.52	5.64	33.0	41.01	35.08	5.92	41.4
30-34	35.37	30.08	5.28	46.3	33.75	28.55	5.20	43.6	37.15	31.76	5.38	49.4
35-39	31.67	27.19	4.48	53.3	30.16	25.71	4.44	49.0	33.33	28.81	4.52	60.5
40-44	28.06	24.85	3.21	49.4	26.96	23.88	3.08	44.4	29.24	25.87	3.37	54.4
45-49	24.22	21.95	2.27	37.6	23.12	20.78	2.34	40.8	25.40	23.21	2.19	34.0
50-54	20.61	19.02	1.59	31.3	19.41	17.79	1.62	32.9	21.90	20.35	1.56	28.2
55-59	17.22	16.26	0.97	20.7	16.31	15.50	0.81	8.9	18.20	17.05	1.15	34.0
60-64	13.64	12.96	0.68	14.7	13.01	12.28	0.73	18.5	14.32	13.69	0.63	10.0
65-69	10.48	10.05	0.43	7.2	9.91	9.55	0.37	5.8	11.12	10.61	0.51	8.5
70-74	8.18	7.88	0.30	4.0	7.61	7.33	0.28	3.7	8.85	8.51	0.34	4.6
75-79	6.48	6.22	0.26	6.9	6.71	6.48	0.23	6.4	6.45	6.14	0.31	7.3
80+	5.00	5.00	0.00	0.0	5.00	5.00	0.00	0.0	5.40	5.40	0.00	0.0

Source: Computations from 2010-2012 SAVVY data files

5.6.2 Injuries and Accidents elimination

Table 5.12 shows the number of years of additional life that would be gained if injuries and accidents were eliminated. It is evident from the table that males from the age 0 to 39 would gain more years of additional life than females if injuries and accidents were eliminated. The concentration of gain in number of years is from age 0 to 24 for males while for females it from age 0 to 14. The highest number of years gained is 2.40 years for males and 1.14 years for females in age group 1-4. In the adult mortality age group, significant gains are in ages 15-39 for males. For females, the gain in number of years is less than 1 year. The highest percentage reduction in the probability of dying is 35.9 per cent among males in age group 15-19 while for females it is 16 per cent in age group 10-14.

Table 5.12 Number of years gained by eliminating the risk of Injuries and accidents, Zambia 2010-2012 SAVVY

	Total				Male				Female			
Age	Life Expectancy at Birth (e_0)- Injuries & Accidents eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)- Injuries & Accidents eliminated	Life Expectancy at Birth (e_0)- All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)- Injuries & Accidents eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying
<1	49.03	47.33	1.70	1.3	47.65	45.36	2.29	2.3	50.56	49.45	1.11	1.4
1-4	52.30	50.52	1.79	5.0	51.06	48.67	2.40	5.9	53.65	52.50	1.14	3.7
5-9	51.87	50.15	1.72	8.2	50.90	48.56	2.33	9.5	52.93	51.85	1.08	6.6
10-14	47.82	46.15	1.67	23.3	46.89	44.61	2.28	30.1	48.85	47.81	1.04	16.0
15-19	43.09	41.49	1.60	19.2	42.14	39.95	2.19	35.9	44.13	43.14	0.99	5.4
20-24	38.61	37.11	1.50	15.0	37.52	35.51	2.01	17.8	39.79	38.82	0.97	12.8
25-29	34.61	33.25	1.37	14.4	33.40	31.52	1.87	21.8	35.91	35.08	0.83	6.3
30-34	31.24	30.08	1.16	9.8	30.06	28.55	1.51	14.9	32.52	31.76	0.76	3.8
35-39	28.21	27.19	1.02	11.0	26.98	25.71	1.27	16.3	29.54	28.81	0.73	1.6
40-44	25.64	24.85	0.79	8.9	24.72	23.88	0.84	7.9	26.62	25.87	0.75	9.9
45-49	22.61	21.95	0.66	2.8	21.52	20.78	0.74	5.1	23.78	23.21	0.56	0.3
50-54	19.68	19.02	0.66	7.3	18.49	17.79	0.71	6.5	20.96	20.35	0.61	8.7
55-59	16.81	16.26	0.56	12.9	16.12	15.50	0.62	11.8	17.56	17.05	0.50	14.2
60-64	13.34	12.96	0.37	5.0	12.74	12.28	0.46	4.1	13.99	13.69	0.30	6.2
65-69	10.37	10.05	0.32	5.4	9.99	9.55	0.44	9.7	10.82	10.61	0.21	1.6
70-74	8.10	7.88	0.22	2.8	7.57	7.33	0.24	2.6	8.73	8.51	0.22	3.1
75-79	6.43	6.22	0.21	5.5	6.72	6.48	0.23	6.7	6.33	6.14	0.19	4.6
80+	5.00	5.00	0.00	0.0	5.00	5.00	0.00	0.0	5.40	5.40	0.00	0.0

Source: Computations from 2010-2012 SAVVY data files

5.6.3 Tuberculosis elimination

Table 5.13 shows the number of additional years of life that would be gained if tuberculosis were eliminated as a cause of death. Both males and females would gain additional years of life but males would gain more years. The highest number of additional years of life gained is 1.72 years for males in age group 10-14 and 1.46 years for females in the same age group if TB were eliminated as a cause of death. The highest percentage reduction in the probability of dying is 17.8 per cent in age group 60-64 for males and 14.8 per cent for females in the same age group.

Table 5.13 Number of years gained by eliminating the risk of Tuberculosis, Zambia 2010-2012 SAVVY

Age	Total				Male				Female			
	Life Expectancy at Birth (e_0)-Tuberculosis eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Tuberculosis eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Tuberculosis eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying
<1	48.73	47.33	1.40	0.4	46.83	45.36	1.47	0.8	50.81	49.45	1.37	1.4
1-4	52.02	50.52	1.51	1.2	50.24	48.67	1.58	0.6	53.92	52.50	1.42	2.0
5-9	51.72	50.15	1.57	0.3	50.25	48.56	1.68	0.1	53.29	51.85	1.44	0.3
10-14	47.75	46.15	1.60	7.8	46.33	44.61	1.72	5.0	49.27	47.81	1.46	10.7
15-19	43.08	41.49	1.59	11.0	41.67	39.95	1.71	8.9	44.58	43.14	1.44	12.8
20-24	38.65	37.11	1.54	7.3	37.20	35.51	1.69	8.3	40.19	38.82	1.37	6.5
25-29	34.75	33.25	1.50	8.3	33.17	31.52	1.65	8.8	36.41	35.08	1.33	7.7
30-34	31.50	30.08	1.42	8.8	30.11	28.55	1.56	6.3	33.02	31.76	1.26	11.8
35-39	28.51	27.19	1.32	4.0	27.25	25.71	1.54	3.8	29.88	28.81	1.08	4.2
40-44	26.19	24.85	1.34	6.7	25.48	23.88	1.60	8.2	26.93	25.87	1.06	5.2
45-49	23.26	21.95	1.31	10.8	22.34	20.78	1.56	8.3	24.25	23.21	1.03	13.4
50-54	20.21	19.02	1.19	9.6	19.32	17.79	1.53	12.9	21.16	20.35	0.81	3.6
55-59	17.34	16.26	1.09	9.0	16.87	15.50	1.36	16.8	17.87	17.05	0.82	0.3
60-64	14.00	12.96	1.04	16.4	13.46	12.28	1.18	17.8	14.60	13.69	0.91	14.8
65-69	10.86	10.05	0.81	13.5	10.47	9.55	0.92	14.3	11.32	10.61	0.71	12.8
70-74	8.44	7.88	0.56	10.9	8.02	7.33	0.69	12.2	8.95	8.51	0.44	8.4
75-79	6.52	6.22	0.30	7.9	6.79	6.48	0.31	8.7	6.44	6.14	0.30	7.1
80+	5.00	5.00	0.00	0.0	5.00	5.00	0.00	0.0	5.40	5.40	0.00	0.0

Source: Computations from 2010-2012 SAVVY data files

5.6.4 Malaria elimination

Table 5.14 shows the number of additional years of life that would be gained if malaria as a cause of death were eliminated. The highest number of additional years of life gained is 2.79 years among females in age 0 and 2.66 years among males in age group 1-4 if malaria were eliminated as a cause of death. It is notable from the table that the gain in the number of additional years of life decreases progressively with age from age group 1-4 for both males and females. This indicates that malaria is more of a public health concern in the ages below 10 years. The highest percentage reduction in the probability of dying is 48.8 per cent in age group 5-9 among males and 44.6 per cent among females in the same age group.

Table 5.14 Number of years gained by eliminating the risk of Malaria, Zambia 2010-2012 SAVVY

Age	Total				Male				Female			
	Life Expectancy at Birth (e_0)-Malaria eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Malaria eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Malaria eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying
<1	50.02	47.33	2.69	7.1	48.01	45.36	2.64	4.7	52.24	49.45	2.79	11.2
1-4	53.10	50.52	2.58	29.2	51.33	48.67	2.66	28.6	55.01	52.50	2.51	29.9
5-9	51.75	50.15	1.60	46.9	50.20	48.56	1.64	48.8	53.42	51.85	1.57	44.6
10-14	47.30	46.15	1.15	18.2	45.75	44.61	1.14	15.2	48.97	47.81	1.16	21.5
15-19	42.58	41.49	1.09	8.4	41.05	39.95	1.10	9.4	44.24	43.14	1.09	7.7
20-24	38.16	37.11	1.05	9.6	36.57	35.51	1.06	11.8	39.88	38.82	1.06	7.9
25-29	34.22	33.25	0.97	8.0	32.49	31.52	0.96	7.3	36.07	35.08	0.99	8.8
30-34	30.95	30.08	0.87	5.2	29.42	28.55	0.87	6.3	32.64	31.76	0.88	3.9
35-39	28.01	27.19	0.82	6.4	26.50	25.71	0.79	6.8	29.66	28.81	0.85	5.5
40-44	25.56	24.85	0.71	4.8	24.53	23.88	0.64	6.2	26.66	25.87	0.79	3.6
45-49	22.61	21.95	0.66	5.7	21.35	20.78	0.57	5.4	23.99	23.21	0.78	6.1
50-54	19.62	19.02	0.60	4.3	18.30	17.79	0.51	0.1	21.06	20.35	0.71	11.8
55-59	16.82	16.26	0.57	7.5	16.10	15.50	0.60	7.9	17.61	17.05	0.55	6.9
60-64	13.45	12.96	0.49	9.3	12.80	12.28	0.51	9.5	14.18	13.69	0.49	9.0
65-69	10.40	10.05	0.35	4.7	9.91	9.55	0.36	5.7	10.97	10.61	0.36	3.8
70-74	8.17	7.88	0.29	6.0	7.60	7.33	0.27	5.5	8.85	8.51	0.34	6.5
75-79	6.37	6.22	0.15	3.9	6.56	6.48	0.07	2.1	6.37	6.14	0.23	5.4
80+	5.00	5.00	0.00	0.0	5.00	5.00	0.00	0.0	5.40	5.40	0.00	0.0

Source: Computations from 2010-2012 SAVVY data files

5.6.5 Diseases of the Circulatory System elimination

Table 5.15 shows the number of additional life years that would be gained if diseases of the circulatory system were eliminated as a cause of death. It is evident from the table that females would gain more additional years of life than males. The number of additional years of life increases with age but decreases after reaching the peak years. The highest gain in number of additional years of life is 2.52 years among females in age group 45-49 while for males it is 1.39 years in age group 40-44 if diseases of the circulatory system were eliminated. The highest percentage reduction in the probability of dying is 27.9 per cent among females in age group 60-

64 and 21 per cent for males in age group 55-59. Unlike malaria which is concentrated in the younger ages, diseases of the circulatory system are more prevalent in older ages.

Table 5.15 Number of years gained by eliminating the risk of Diseases of the Circulatory System, Zambia 2010-2012 SAVVY

Age	Total				Male				Female			
	Life Expectancy at Birth (e_0)-Diseases of Circulatory System eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Diseases of Circulatory System eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying	Life Expectancy at Birth (e_0)-Diseases of Circulatory System eliminated	Life Expectancy at Birth (e_0)-All Causes	Number of years Gained	Percentage Reduction in Probability of Dying
<1	48.72	47.33	1.39	0.2	46.41	45.36	1.05	0.8	51.36	49.45	1.91	0.9
1-4	52.02	50.52	1.51	0.2	49.78	48.67	1.11	0.1	54.53	52.50	2.02	0.3
5-9	51.76	50.15	1.61	1.3	49.76	48.56	1.20	2.0	54.00	51.85	2.15	0.3
10-14	47.78	46.15	1.63	0.2	45.81	44.61	1.20	0.1	49.99	47.81	2.19	0.3
15-19	43.13	41.49	1.64	2.9	41.17	39.95	1.21	3.1	45.34	43.14	2.20	2.7
20-24	38.76	37.11	1.65	3.7	36.72	35.51	1.21	2.0	41.04	38.82	2.22	5.0
25-29	34.90	33.25	1.66	4.4	32.75	31.52	1.23	3.5	37.31	35.08	2.23	5.3
30-34	31.75	30.08	1.67	3.1	29.79	28.55	1.24	3.4	34.00	31.76	2.24	2.8
35-39	28.91	27.19	1.72	2.0	26.97	25.71	1.26	0.9	31.14	28.81	2.33	3.9
40-44	26.69	24.85	1.84	6.4	25.27	23.88	1.39	7.9	28.29	25.87	2.42	5.0
45-49	23.81	21.95	1.85	11.1	22.12	20.78	1.34	5.4	25.73	23.21	2.52	17.3
50-54	20.80	19.02	1.78	7.6	19.15	17.79	1.36	4.9	22.68	20.35	2.33	12.2
55-59	18.06	16.26	1.81	17.5	16.94	15.50	1.43	21.0	19.35	17.05	2.30	13.6
60-64	14.62	12.96	1.66	20.9	13.45	12.28	1.17	15.2	15.97	13.69	2.28	27.9
65-69	11.46	10.05	1.41	20.1	10.53	9.55	0.98	15.7	12.56	10.61	1.94	24.1
70-74	8.95	7.88	1.07	14.0	8.05	7.33	0.72	9.5	10.07	8.51	1.56	21.0
75-79	7.12	6.22	0.90	23.9	7.03	6.48	0.55	15.6	7.46	6.14	1.32	31.0
80+	5.00	5.00	0.00	0.0	5.00	5.00	0.00	0.0	5.40	5.40	0.00	0.0

Source: Computations from 2010-2012 SAVVY data files

5.6.6 Impact of eliminating causes of death on adult mortality

Table 5.16 shows the impact it would have on adult mortality if each particular cause of death were eliminated. The highest percentage reduction in the probability of dying between ages 15 and 60 years is 30.6 per cent overall and this is achieved by eliminating HIV/AIDS as a cause of death. Adult females would greatly benefit from eliminating HIV/AIDS as a cause of death as it would reduce their probability of dying between ages 15 and 60 years by 35 per cent. The impact of eliminating the other causes of death on improving adult survivorship is far less when compared to eliminating HIV/AIDS. Therefore, HIV/AIDS elimination should be priority for public health interventions.

Table 5.16 Effect of eliminating causes of death on adult mortality, Zambia 2010-2012 SAVVY

	Probability of dying between age 15 and 60 years										
	All Cause	HIV/AIDS eliminated	Percent Reduction	Injuries & Accidents eliminated	Percent Reduction	Tuberculosis eliminated	Percent Reduction	Malaria eliminated	Percent Reduction	Diseases of Circulatory System eliminated	Percent Reduction
Male	0.5512	0.4038	26.75	0.5039	8.58	0.5128	6.98	0.5297	3.91	0.5246	4.83
Female	0.4703	0.3055	35.04	0.4449	5.40	0.4473	4.89	0.4463	5.10	0.4379	6.89
Total	**0.5117**	**0.3554**	**30.55**	**0.4748**	**7.21**	**0.4806**	**6.07**	**0.4888**	**4.46**	**0.4824**	**5.73**

Source: Computations from 2010-2012 SAVVY data files

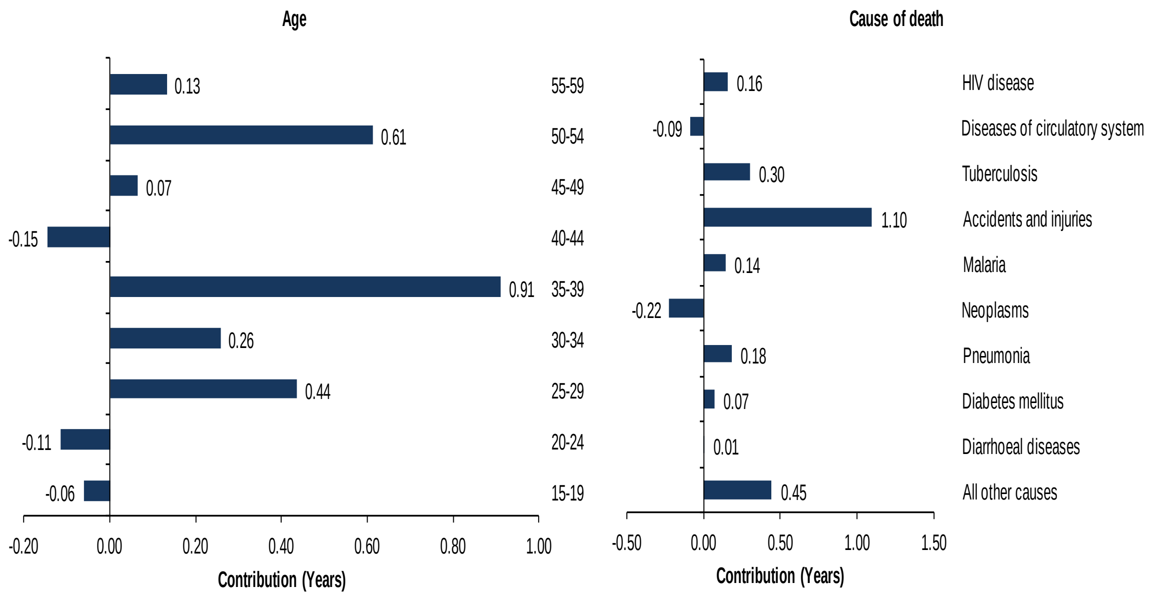
5.7 Decomposition of contributions of age- and cause-specific mortality rates

In this section, decomposition analysis is performed to assess the contributions of adult age- and cause-specific mortality rates to the change in the life expectancy gap at birth between males (45.4 years) and females (49.5 years). A gap of 4.1 years was observed in life expectancy at birth between males and females from the SAVYY life tables that were constructed. The contributions to changes in the life expectancy gap are represented by each bar whether for age group or cause of death. A positive value on the bar indicates a contribution to the widening of the gap in life expectancy whereas a negative value shows a narrowing of the gap.

A decomposition of adult age-and-cause-specific contributions to the changes in the life expectancy gap shows that age-specific mortality was higher among males in age groups 25-39 years and 45-59 years than female mortality as shown in Figure 5.15. Male mortality in the stated age groups contributed the largest to the widening gap in life expectancy. Female mortality in age groups 15-24 and 40-44 years, offset male mortality, and contributed to the narrowing of the gap. The major contributor to widening of the gap in life expectancy was age group 35-39 years (0.91 years, 22.4 per cent); followed by age group 50-54 contributing 0.61 years (15 per cent); and then age group 25-29 (0.44 years, 10.7per cent).

Figure 5.15 shows that not all causes of death contributed positively to the widening of the life expectancy gap between males and females. Neoplasms and diseases of the circulatory system contributed to narrowing whereas the remaining causes contributed to widening of the gap in life expectancy. Female mortality due to Neoplasms and diseases of the circulatory system offset male mortality. However, male mortality from the remaining types of causes contributed the most to widening the gap. The cause-specific decomposition analysis showed that accidents and injuries (1.10 years, 26.8 per cent) were major contributors to widening the gap in life expectancy. Tuberculosis contributed 0.30 years (7.4 per cent); pneumonia/ARI (0.18 years, 4.5 per cent); HIV disease (0.16 years, 3.9 per cent); malaria (0.14 years, 3.5 per cent); and all other causes (0.45 years, 10.9 per cent) to widening of the life expectancy gap. Neoplasms and diseases of the circulatory system contributed -0.22 years (-5.4 per cent) and -0.09 years (-2.1 per cent) to narrowing of the gap. It is notable that there is a rise in adult cause-specific mortality due to accidents and injuries in Zambia.

Figure 5.15 Number of years contributed by adult age and cause to the life expectancy gender gap, Zambia 2010-2012 SAVVY

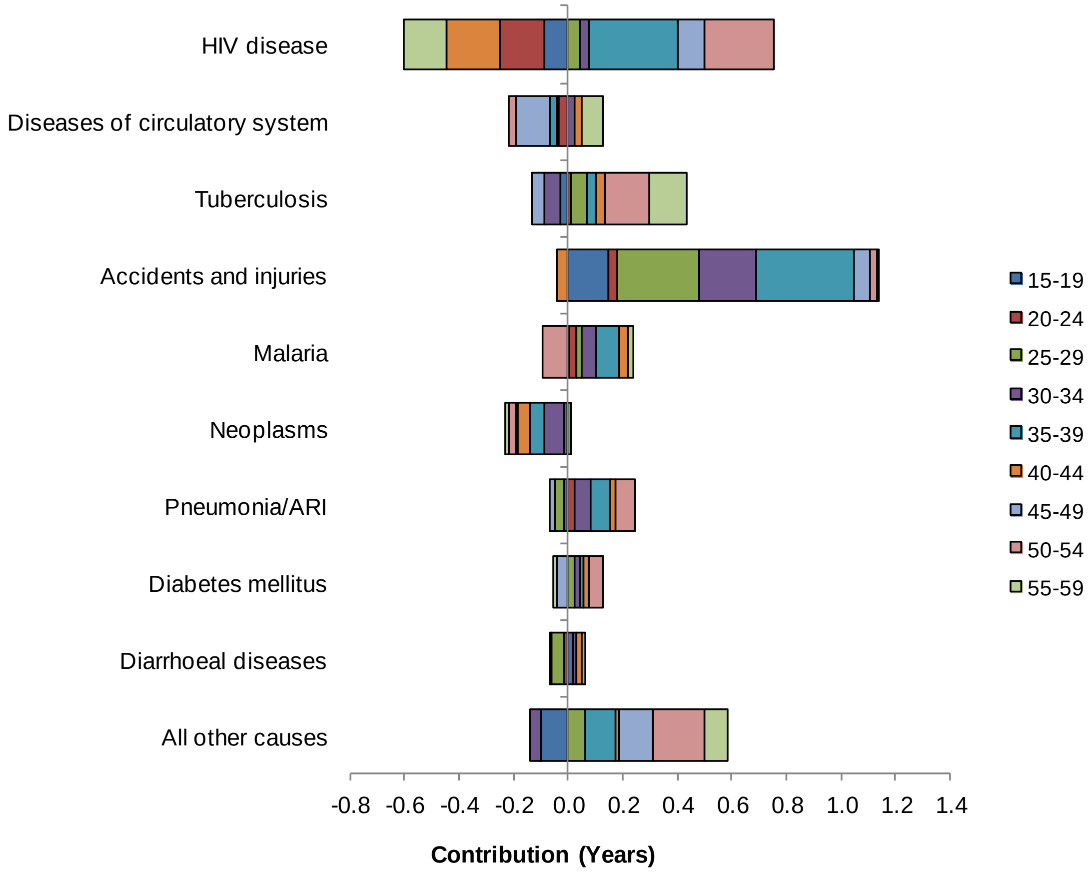


Source: Computations from 2010-2012 SAVVY data files

A decomposition analysis of the gap in life expectancy by combining both the age- and cause-specific mortality revealed that the major cause of death contributor, accidents and injuries were mostly at age group 35-39 (0.36 years; 8.9 per cent) (Figure 5.16). Closely followed by age group 25-29 (0.30 years; 7.4 per cent). HIV/AIDS disease had the most offsetting pattern in mortality between males and females. HIV/AIDS disease made large contributions to widening of the gap in age groups 35-39 (0.32 years; 7.9 per cent); 50-54 (0.26 years; 6.3 per cent); and 45-49 (0.10 years; 2.5 per cent). However, these contributions were offset by age groups 15-19 (-0.09 years; -2.2 per cent); 20-24 (-0.16 years; -3.9 per cent); 40-44 (-0.20 years; -4.8 per cent); and 55-59 (-0.16 years; -3.8 per cent). This resulted in HIV/AIDS disease, overall, contributing 0.16 years (3.9 per cent) to the widening of life expectancy. Tuberculosis made its larger contributions in age groups 50-54 (0.16 years; 4.0 per cent) and 55-59 (0.14 years; 3.4 per cent). Pneumonia/ARI made its larger contributions through age groups 35-39 and age group 50-54 (0.07 years; 1.8 per cent) in either case. Malaria contributions were larger in age groups 35-39 (0.09 years) and 30-34 (0.05 years; 1.3 per cent). Neoplasms made the larger contributions in narrowing the gap in life expectancy at age groups 30-34 (-0.07 years; -1.7 per cent); 35-39 (-0.06 years; -1.4 per cent) and 40-44 (-0.04 years; -1.1 per cent). Diseases of the circulatory system also had a large contribution to narrowing the gap at age group 45-49 (-0.12 years; -3.0 per cent).

The decomposition analysis shows that adult age-and cause-specific mortality positively contributed 50 per cent of the years to widening the gap in life expectancy between males and females.

Figure 5.16 Cause-specific mortality contributions to the life expectancy gap by age, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

Table 5.17 Cause-specific mortality contributions by age group, Zambia 2010-2012 SAVVY

Age	Total Effect		HIV disease		Diseases of circulatory system		Tuberculosis		Accidents and injuries		Malaria		Neoplasms		Pneumonia/ARI		Diabetes mellitus		Diarrhoeal diseases		All other causes	
	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%	Years	%
15-19	-0.06	-1.46	-0.09	-2.17	0.00	0.02	-0.03	-0.62	0.15	3.61	0.00	0.11	-0.01	-0.34	-0.01	-0.34	0.00	0.00	0.02	0.37	-0.10	-2.43
20-24	-0.11	-2.80	-0.16	-3.92	-0.03	-0.78	0.01	0.26	0.03	0.80	0.03	0.71	0.00	0.05	0.02	0.59	0.00	0.00	-0.02	-0.38	0.00	-0.08
25-29	0.44	10.70	0.04	1.07	-0.01	-0.16	0.06	1.41	0.30	7.41	0.02	0.39	0.01	0.18	-0.03	-0.74	0.03	0.68	-0.05	-1.13	0.07	1.60
30-34	0.26	6.32	0.04	0.89	0.02	0.52	-0.06	-1.51	0.21	5.04	0.05	1.33	-0.07	-1.72	0.06	1.44	0.02	0.44	0.02	0.42	-0.04	-0.90
35-39	0.91	22.35	0.32	7.86	-0.03	-0.75	0.03	0.84	0.36	8.86	0.09	2.13	-0.06	-1.38	0.07	1.80	0.01	0.34	0.00	0.00	0.11	2.68
40-44	-0.15	-3.57	-0.20	-4.79	0.03	0.72	0.03	0.76	-0.04	-0.91	0.03	0.69	-0.04	-1.08	0.02	0.42	0.02	0.48	0.02	0.39	0.01	0.33
45-49	0.07	1.61	0.10	2.48	-0.12	-3.03	-0.05	-1.14	0.06	1.40	0.00	-0.06	-0.01	-0.13	-0.02	-0.48	-0.04	-0.95	0.02	0.46	0.12	3.06
50-54	0.61	15.04	0.26	6.28	-0.03	-0.62	0.16	4.01	0.03	0.68	-0.09	-2.28	-0.02	-0.60	0.07	1.79	0.05	1.15	0.00	0.00	0.19	4.64
55-59	0.13	3.25	-0.16	-3.83	0.08	1.98	0.14	3.40	0.00	0.04	0.02	0.47	-0.02	-0.41	0.00	0.00	-0.02	-0.42	0.00	0.00	0.08	2.02
Total	**2.10**	**51.29**	**0.16**	**3.85**	**-0.09**	**-2.10**	**0.30**	**7.38**	**1.10**	**26.85**	**0.14**	**3.48**	**-0.22**	**-5.42**	**0.18**	**4.47**	**0.07**	**1.72**	**0.01**	**0.13**	**0.45**	**10.88**

Source: Computations from 2010-2012 SAVVY data files

5.8 Summary of Chapter

The study findings show that the top 5 leading causes of adult mortality in Zambia are HIV/AIDS, injuries and accidents, tuberculosis, malaria and diseases of the circulatory system. HIV/AIDS was the major leading cause of deaths across all demographic and socioeconomic background characteristics of the deceased adults. The proportions of deaths attributable to HIV/AIDS increased by age and peaked in age group 35-39 and then started to decrease. The pattern was the same for both male and female HIV/AIDS deaths. The proportion of HIV/AIDS deaths was higher among females than males. Injuries and accidents were the second leading cause of death among male deaths while among females it was tuberculosis. Diseases of the circulatory system were the third leading cause of death among female decedents while tuberculosis was the third cause of death among males. Malaria was the fourth leading cause of death for both males and females.

Communicable diseases remain the leading cause of adult mortality, however, non-communicable diseases as well as external causes are also on the increase. Adult deaths attributable to non-communicable diseases are more evident in older ages 45-59 while injuries and accidents are more prevalent in age group 15-35. Injuries and accidents deaths were higher among the deceased who had higher level of education for both males and females. The deaths were also higher among the never married.

The elimination of causes of death by constructing cause-deleted life tables showed that if HIV/AIDS were eliminated as a cause of death, it would contribute the most to the number of additional years of life gained compared to eliminating the other causes of death. Females in age group 15-19 would gain the highest number of years of 6.40 while for males in the same age group 5.77 years of additional life. The percentage reduction in the probability of dying would be highest among females, 60.5 per cent and 49 per cent among males in the age group 35-39. Eliminating HIV/AIDS as a cause of death would also have the most impact in reducing adult mortality in

Zambia. The percentage reduction in the probability of dying between ages 15 and 60 years would be 30 per cent overall and 35 per cent for females. The decomposition analysis showed that the age- and cause-specific mortality rates in the adult mortality age group 15-59 contribute 50 per cent of the years in widening the life expectancy gap between males and females in Zambia.

This chapter provides some explanations to the high adult mortality estimated in Chapter 4 for some regions in Zambia. In Chapter 4, the adult mortality estimates show high mortality in Western, Copperbelt and Lusaka provinces. In Chapter 5, it has been found that Western province had the highest proportion of HIV/AIDS deaths in addition to high injuries and accidents deaths. Copperbelt province had the highest proportion of malaria deaths among adults coupled with a high proportion of HIV/AIDS, TB and injuries and accident deaths. Lusaka province had a high proportion of HIV/AIDS, TB deaths as well as injuries and accidents.

CHAPTER 6: ECOLOGICAL DETERMINANTS OF ADULT MORTALITY VARIATIONS IN ZAMBIA

"Social research regularly involves problems that investigate the relationship between individuals and society. The general concept is that individuals interact with social contexts to which they belong, that individual persons are influenced by social groups or contexts to which they belong, and that those groups are in turn influenced by the individuals who make up that group" (Hox, Moerbeek and van de Schoot 2010: 1)

6.1 Introduction

Having established the causes of death among adults in Zambia in the previous chapter (5), in this chapter, the risk of dying of the adults between age 15 and 60 years by sociodemographic, health behaviour, health condition, socioeconomic, and ecological factors is investigated further through survival analysis by fitting Cox proportional hazards regression models as elaborated in the methodology chapter 3. The chapter also examines the extent to which ecological factors mediate on the individual outcome of adult mortality in response to objective 4 of the study by applying multilevel survival analysis as explicated in the methodology in chapter (3). The chapter accentuates the ecological argument that health outcomes like adult mortality cannot be understood in isolation since they are shaped and determined by the broader societal context within which they occur through the effects at individual, household or family, and community levels.

In chapter 5, the sociodemographic, socioeconomic, health behaviour and health conditions background characteristics of the deceased persons are elaborated. In this chapter, the study starts by examining the association between the background characteristics of the deceased adults and the risk of dying between age 15 and 60 years. This is done by applying bivariate analysis using Cox proportional hazards regression models of each covariate with the risk of dying between age 15 and 60 years. This is to establish how each of the explanatory variables independently influences the risk of dying of an adult. This stage also provides the unadjusted Hazard Ratios (uHRs). Kaplan-Maier survival curves are used to explore the survival experiences of deceased adults for categorical variables. The study then proceeds to apply multivariate Cox proportional hazards regression analysis to assess the net effect of each explanatory variable on the risk of dying between age 15 and 60 years while controlling for the other variables in the models. Measures of association are used to examine the fixed effects of the results to establish relationships with the risk of dying between age 15 and 60 years and the covariates.

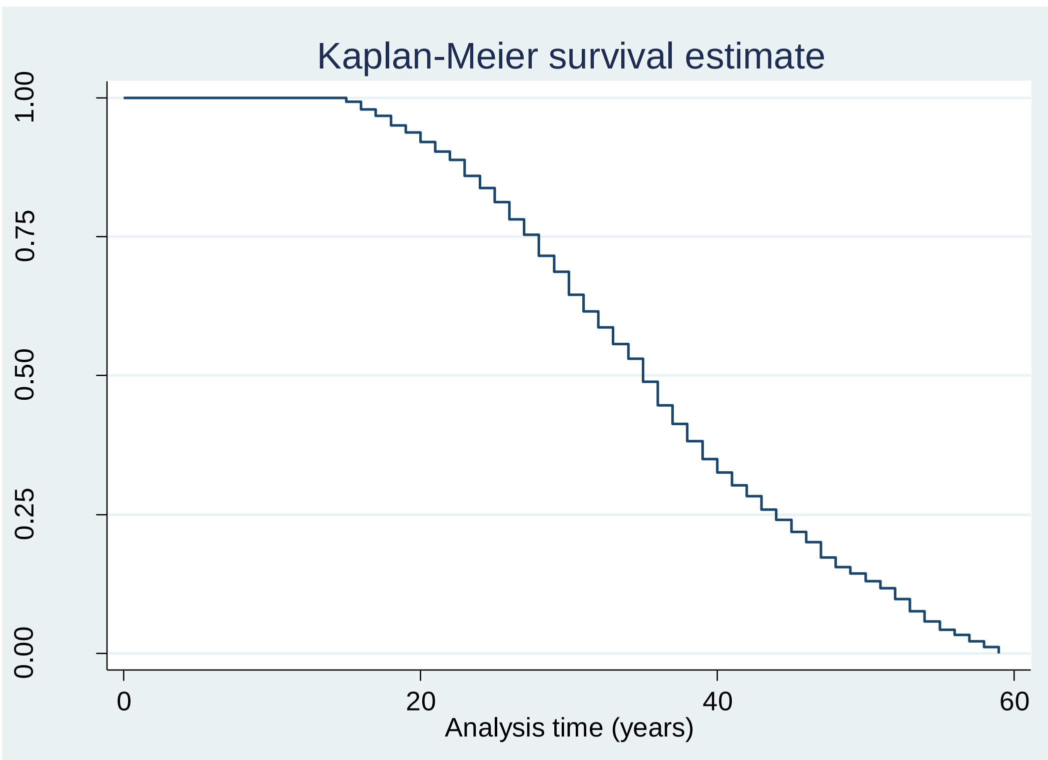
The study then proceeds to perform multivariate multilevel survival analysis by introducing random effects to determine the variations in the risk of adult mortality that is attributable to the influence of ecological or community-level factors by assessing the measures of variation. Multilevel survival analysis is applied as elaborated in chapter 3. Stata 14's multilevel survival analysis *mstreg* command module was used for multilevel survival analysis and with the Weibull distribution family. The Weibull parametric proportional hazard regression model and the Cox proportional hazards regression model share same assumptions. The two "models produce results that are directly comparable" (Cleves et al., 2010: 234). Previous studies on adult mortality also used the Weibull proportional hazard regression to examine factors associated with adult mortality (Sartorius, Kahn, Collinson *et al.* 2013; Sartorius and Sartorius 2013).

The chapter is organised in five sections. The first section presents the results on the survival time of the adult prior to their death; the second section, presents results of the bivariate Cox proportional hazards analysis; the third section, presents results of the multivariate Cox proportional hazards analysis; the fourth section, presents results of multivariate multilevel proportional hazards analysis; the fifth section, presents hypotheses testing; and the sixth section is the summary of the chapter.

6.2 Survival time of adults

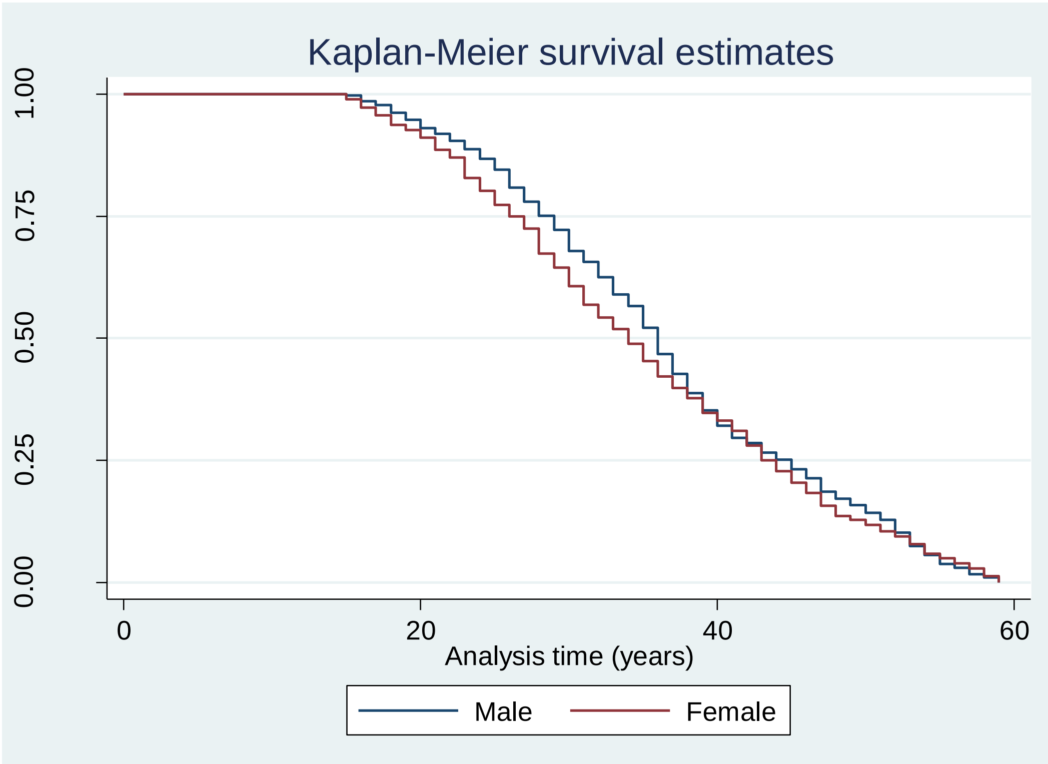
This section presents survival time of the deceased adults prior to their death. A total of 1,078 adult were observed from the time they were alive at age 15 up to age 59 when the last person died. This represents a 35-year period of observation. By the age of 35, half of the adults had died and by the age of 44 three-quarters of them had died. There was not much difference in survivorship between male and female decedents as shown in Figure 6.2. Although males appear to have survived a bit longer, by the age of 36 half of them had died whereas for females it was age 34. Three quarters of the males had died by the age of 45 whereas for females it was age 43.

Figure 6.1 Kaplan-Meier survival estimates for adults between age 15 and 60 years, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

Figure 6.2 Kaplan-Meier survival estimates for male and female adults between age 15 and 60 years, Zambia 2010-2012 SAVVY



Source: Computations from 2010-2012 SAVVY data files

Figure 6.1 presents the Kaplan-Meier survival curve and Figure 6.2 presents a Kaplan-Meier survival curve for males and females. For the other selected variables, the Kaplan-Meier plots are in the appendix (Chapter 6 Appendix).

6.3 Bivariate survival analysis

The bivariate Cox proportional hazards regression analysis (Cox PH) was performed to establish associations between explanatory variables and the risk of adult mortality. Table 6.1 presents unadjusted hazard ratios of the risk of experiencing adult mortality. The table shows that there is no significant difference in the risk of adult mortality between males and females. Sex is not significantly associated with the risk of adult mortality. Marital status is significantly associated with the risk of adult mortality. The deceased adults who were married/living with partner and those who were formerly married have lower hazards of experiencing adult mortality compared with the never married decedents. Education is negatively associated with the risk of adult mortality. The deceased adults with higher level of education have significantly lower hazards of mortality than the decedents with no education. The occupation status of the adult decedents appears to have a positive association with the risk of adult mortality. Adult decedents who were craft and trade related workers, plant and machine operators/assemblers, and elementary occupation workers have significantly higher risks of experiencing adult mortality than those who were legislators/senior officials/managers.

There is no significant difference in the risk of adult mortality between decedents who did not have tuberculosis, cancer and diabetes health conditions, and the deceased adults who had the health conditions. As expected, the risk of adult mortality is significantly lower for adult decedents who did not have HIV/AIDS compared with those who had. Injuries and accidents health condition shows no significant difference in the risk of mortality between the deceased persons who did not have the health condition and those who had.

Studies show that health behaviour has an influence on the risk of mortality. It is well documented in literature that positive health behaviour lowers the risk of mortality while negative health behaviour elevates the risks. Table 6.1 shows that there is no significant difference in the risk of adult mortality between decedents who were involved in alcohol consumption and smoking tobacco, and the deceased adults who did not engage in these risk health behaviours.

For the household level factor, family relationship is negatively associated with the risk of experiencing adult mortality. The types of family relationship appear to lower the risk of mortality. Decedents who had spouses have significantly lower risks of adult mortality than those who had a relationship with the father.

With respect to ecological factors, that is, rural-urban residence, province of residence, place of death, community education, community health service utilisation, and community illness treatment received. There is no significant difference in the risk of experiencing adult mortality between rural and urban residence. Table 6.1 shows that Copperbelt province has elevated risks of adult mortality while Southern province has lower hazards compared to the decedents in Central province. There is no significant difference in the risk of adult mortality between decedents who resided in a community with a high proportion of educated individuals and those who lived in a community with a low proportion.

A significant difference is not evident in the risk of adult mortality between decedents who lived in a community with a high proportion of individuals who received treatment for their health conditions prior to death and those in low proportion treatment received communities. The risk of adult mortality is also not significantly different between decedents who lived in a community with a high proportion of health service utilization and those who lived in communities with low proportions of health service utilization. Place of death is not significantly associated with the risk of adult mortality. The risk of dying at home and other places is not significantly different among decedents when compared to those who died at a health facility.

Table 6.1 Bivariate Cox proportional hazards regression analysis

Predictor	uHR	P-value	[95% CI]
Individual			
Sex			
Male (Ref.)	1.00		
Female	1.07	0.199	[0.964,1.186]
Marital Status			
Never married (Ref.)	1.00		
Married/Living with a partner	0.36***	0.000	[0.298,0.433]
Divorced/separated/widowed	0.36***	0.000	[0.296,0.438]
Education			
No education (Ref.)	1.00		
Primary	0.93	0.523	[0.745,1.163]
Secondary	0.95	0.624	[0.767,1.174]
Higher	0.70*	0.019	[0.524,0.942]
Occupation			
Legislators/Senior Officials/Managers (Ref.)	1.00		
Professionals	1.56	0.074	[0.957,2.535]
Technicians/Associate Professionals	1.13	0.633	[0.680,1.876]
Clerks	1.43	0.077	[0.961,2.119]
Service\Shop\Market sales workers	1.14	0.465	[0.800,1.620]
Skilled Agricultural/Fishery workers	1.28	0.157	[0.907,1.806]
Craft and related trade workers	1.89***	0.001	[1.314,2.719]
Plant and Machine Operators/Assemblers	1.59*	0.031	[1.044,2.419]
Elementary Occupations	1.82***	0.001	[1.288,2.563]
Proximate/Intervening			
Tuberculosis			
Yes (Ref.)	1.00		
No	0.99	0.851	[0.880,1.111]
Cancer			
Yes (Ref.)	1.00		
No	1.27	0.057	[0.992,1.627]
Diabetes			
Yes (Ref.)	1.00		
No	1.44	0.065	[0.097,1.935]
HIV/AIDS			
Yes (Ref.)	1.00		
No	0.87*	0.031	[0.774,0.987]
Accidents & injuries			
Yes (Ref.)	1.00		
No	0.87	0.148	[0.724,1.051]
Drink Alcohol			
Yes (Ref.)	1.00		
No	1.13	0.059	[0.995,1.280]
Smoke Tobacco			
Yes (Ref.)	1.00		
No	1.37	0.063	[0.981,1.576]
Household			
Family Relations			
Father (Ref.)	1.00		
Mother	0.83	0.222	[0.614,1.122]
Spouse	0.40***	0.000	[0.291,0.559]
Sibling	0.70*	0.027	[0.517,0.959]
Child	0.71	0.060	[0.494,1.016]
Other relatives	0.77	0.118	[0.554,1.071]
Community			
Residence			
Rural (Ref.)	1.00		
Urban	1.10	0.161	[0.964,1.244]
Province			
Central (Ref.)	1.00		
Copperbelt	1.31*	0.034	[1.022,1.673]
Eastern	0.96	0.699	[0.765,1.198]
Luapula	1.03	0.835	[0.795,1.327]
Lusaka	1.05	0.645	[0.841,1.320]
Northern	1.19	0.181	[0.919,1.548]
North Western	0.89	0.391	[0.678,1.166]
Southern	0.77**	0.008	[0.633,0.930]
Western	0.94	0.763	[0.639,1.390]
Community education			
Low (Ref.)	1.00		
High	0.99	0.941	[0.855,1.156]
Community treatment received			
Low (Ref.)	1.00		
High	1.10	0.189	[0.953,1.270]
Community health utilisation			
Low (Ref.)	1.00		
High	0.99	0.908	[0.856,1.148]
Place of death			
Health facility (Ref.)	1.00		
Home	0.94	0.405	[0.805,1.093]
Other	1.08	0.533	[0.839,1.400]

* p<0.05, ** p<0.01, *** p<0.001; uHR - Unadjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category

6.4 Multivariate survival analysis

In this section, further tests of the association are performed to determine whether the established relationships with respect to the risk of adult mortality still hold once the effect of other relevant independent variables are controlled for through multivariate analysis. In addition, bivariate associations could to some extent be attributable to the effect of confounding factors that are not considered at this level of analysis.

Model I in Table 6.2 controls for individual sociodemographic and socioeconomic background characteristics of the deceased persons. In model I, the hazards of dying significantly increase by 20 per cent [aHR=1.20; 95% CI: 1.051,1.363] for deceased females compared to males, after adjusting for marital status, education and occupation. The risk of dying for married/living with a partner [aHR=0.34; 95%, CI: 0.287,0.405] and formerly married [aHR=0.33; 95%, CI: 0.270,0.404] decedents is significantly different and lower for both categories when compared with the never married deceased persons.

The hazards of adult mortality remained negatively associated with education, and decrease with level of education attainment. Adult decedents with higher level of education have a significantly lower [aHR=0.71; 95%, CI: 0.530,0.946] risk of mortality when controlling for sex, marital status, and occupation. Adjusting for other variables in model I increase the hazards of dying for the deceased adults who had occupations as professionals [aHR= 1.75; 95%, CI: 1.133,2.712], crafts and trade related [aHR=2.20; 95%, CI: 1.481,3.260], plant and machine operators/assemblers [aHR=1.80; 95%, CI: 1.144,2.839], and elementary occupations [aHR=1.93; 95%, CI: 1.269,2.940].

Table 6.2 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality among both deceased males and females in Zambia, 2010-2012 SAVVY

	Model I[a]		Model II[b]		Model III[c]		Model IV[d]	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual								
Sex								
Male (Ref.)	1.00		1.00		1.00		1.00	
Female	1.20**	[1.051,1.363]	1.05	[0.889,1.232]	1.00	[0.829,1.201]	0.98	[0.818,1.171]
Marital Status								
Never married (Ref.)	1.00		1.00		1.00		1.00	
Married/Living with a partner	0.34***	[0.287,0.405]	0.32***	[0.263,0.389]	0.39***	[0.315,0.481]	0.39***	[0.315,0.485]
Divorced/separated/widowed	0.33***	[0.270,0.404]	0.32***	[0.256,0.411]	0.30***	[0.236,0.371]	0.28***	[0.228,0.346]
Education								
No education (Ref.)	1.00		1.00		1.00		1.00	
Primary	0.92	[0.696,1.227]	0.81	[0.610,1.080]	0.79	[0.589,1.064]	0.75	[0.554,1.021]
Secondary	0.90	[0.707,1.139]	0.78*	[0.617,0.989]	0.79	[0.604,1.031]	0.76*	[0.582,0.999]
Higher	0.71*	[0.530,0.946]	0.61***	[0.468,0.804]	0.59**	[0.415,0.834]	0.58**	[0.405,0.825]
Occupation								
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00		1.00	
Professionals	1.75*	[1.133,2.712]	1.61*	[1.079,2.414]	1.59	[0.897,2.812]	1.51	[0.896,2.540]
Technicians/Associate Professionals	1.25	[0.685,2.269]	1.21	[0.681,2.152]	1.15	[0.585,2.253]	1.08	[0.605,1.935]
Clerks	1.56	[0.931,2.627]	1.46	[0.887,2.385]	1.54	[0.870,2.724]	1.37	[0.809,2.312]
Service\Shop\Market sales workers	1.32	[0.848,2.058]	1.35	[0.884,2.055]	1.48	[0.887,2.472]	1.35	[0.828,2.190]
Skilled Agricultural/Fishery workers	1.35	[0.877,2.069]	1.32	[0.887,1.977]	1.48	[0.903,2.418]	1.36	[0.870,2.126]
Craft and related trade workers	2.20***	[1.481,3.260]	2.08***	[1.436,3.022]	2.33**	[1.383,3.921]	2.08**	[1.238,3.503]
Plant and Machine Operators/Assemblers	1.80*	[1.144,2.839]	1.66*	[1.091,2.512]	1.71	[0.997,2.936]	1.56	[0.935,2.611]
Elementary Occupations	1.93**	[1.269,2.940]	1.83**	[1.230,2.712]	2.04**	[1.250,3.329]	1.93**	[1.215,3.048]
Proximate/Intervening								
Tuberculosis								
Yes (Ref.)			1.00		1.00		1.00	
No			1.04	[0.923,1.168]	0.97	[0.849,1.101]	0.94	[0.816,1.076]
Cancer								
Yes (Ref.)			1.00		1.00		1.00	
No			1.24	[0.906,1.686]	1.06	[0.802,1.409]	1.08	[0.809,1.452]
Diabetes								
Yes (Ref.)			1.00		1.00		1.00	
No			1.40*	[1.023,1.923]	1.59*	[1.113,2.273]	1.45*	[1.008,2.090]
HIV/AIDS								
Yes (Ref.)			1.00		1.00		1.00	
No			0.84*	[0.707,1.000]	0.86	[0.704,1.045]	0.82*	[0.697,0.966]
Accidents & injuries								
Yes (Ref.)			1.00		1.00		1.00	
No			0.85	[0.650,1.105]	0.82	[0.621,1.088]	0.81	[0.610,1.073]
Drink Alcohol								
Yes (Ref.)			1.00		1.00		1.00	
No			1.00	[0.886,1.129]	1.02	[0.907,1.154]	1.01	[0.885,1.140]
Smoke Tobacco								
Yes (Ref.)			1.00		1.00		1.00	
No			1.51***	[1.274,1.791]	1.57***	[1.322,1.857]	1.62***	[1.378,1.903]
Household								
Family Relations								
Father (Ref.)					1.00		1.00	
Mother					0.85	[0.638,1.124]	0.92	[0.693,1.222]
Spouse					0.40***	[0.287,0.556]	0.40***	[0.287,0.555]
Sibling					0.68*	[0.487,0.950]	0.75	[0.532,1.060]
Child					0.80	[0.568,1.134]	0.83	[0.573,1.205]
Other relatives					0.78	[0.562,1.082]	0.81	[0.579,1.139]
Community								
Residence								
Rural (Ref.)							1.00	
Urban							1.03	[0.862,1.222]
Province								
Central (Ref.)							1.00	
Copperbelt							1.24	[0.901,1.714]
Eastern							1.15	[0.913,1.439]
Luapula							1.30*	[1.060,1.597]
Lusaka							1.11	[0.942,1.316]
Northern							1.63**	[1.171,2.274]
North Western							0.72	[0.472,1.105]
Southern							0.88	[0.702,1.103]
Western							0.99	[0.643,1.513]
Community education								
Low (Ref.)							1.00	
High							0.70**	[0.546,0.884]
Community treatment received								
Low (Ref.)							1.00	
High							1.12	[0.946,1.315]
Community health utilisation								
Low (Ref.)							1.00	
High							0.93	[0.762,1.127]
Place of death								
Health facility (Ref.)							1.00	
Home							0.93	[0.911,1.375]
Other							1.39*	[1.085,1.783]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category
[a]Model I: controlling for individual level variables
[b]Model II: controlling for Individual and health condition/behaviour proximate variables
[c]Model III: controlling for individual, health condition/behaviour proximate, and household variables
[d]Model IV: controlling for individual, health condition/behaviour proximate, household and community variables

Model II in Table 6.2 adjusts for individual sociodemographic and socioeconomic background characteristics and health conditions and behaviours. The health conditions are tuberculosis, cancer, diabetes, HIV/AIDS, and accidents and injuries. As shown in Chapter 5, these are some of the leading causes of death among adults in Zambia. The health behaviours are alcohol drinking and tobacco smoking. Previous studies have shown that health behaviours like smoking tobacco and alcohol consumption are risk factors of mortality. Model II shows that controlling for health conditions and behaviour results in some changes in the risk of adult mortality. The risk of adult mortality between male and female decedents is offset to the advantage of females. Female decedents have slightly non-significant reduced [aHR=1.05; 95%, CI: 0.889,1.232] hazards of dying relative to model I [aHR=1.20; 95% CI: 1.051,1.363]. The risk of dying for married/living with a partner (aHR=0.32; 95%, CI: 0.263,0.389] and formerly married [aHR=0.32; 95%, CI: 0.256,0.411] adult decedents is significantly lower when compared to the never married decedents, and reduced relative to model I. The addition of health conditions and behaviours to the model further reduced the risk of adult mortality with respect to education.

The hazards of adult mortality decrease by level of educational attainment and are significantly lower for decedents who attained secondary [aHR=0.78; 95%, CI: 0.617,0.989] and higher [aHR=0.59; 95%, CI: 0.468,0.804] levels of education. In model II, the risk of adult mortality remains statistically significant for occupations as professionals, craft and trade related, plant and machine operators/assemblers, and elementary occupations.

The inclusion of health conditions and behaviours in the model significantly reduces the risk of mortality for these occupations, professionals [aHR=1.61; 95%, CI: 1.079,2.414], craft and trade related [aHR=2.08; 95%, CI: 1.436,3.022], plant and machine operators/assemblers [aHR=1.66; 95%, CI: 1.091,2.512], and elementary occupations [aHR=1.83; 95%, CI: 1.230,2.712]. The risk of adult mortality is not statistically significantly different for deceased adults who had tuberculosis, cancer, and accidents and injuries as health conditions. For diabetes health condition, however, an unexpected result shows a significantly elevated risk of adult mortality for decedents who did not have diabetes [aHR=1.40; 95%, CI: 1.023,1.923] compared with those who had it. Whereas for HIV/AIDS, as expected the risk of adult mortality is significantly lower [aHR=0.84; 95%, CI: 0.707,1.000] for the deceased persons who did not have the health condition compared with those who had it.

For health behaviour, there is no statistically significant difference in the risk of adult mortality between adult decedents who consumed alcohol and those who did not. This is an unexpected result considering what previous studies have found. With respect to tobacco smoking, unexpectedly, the risk of adult mortality is significantly elevated for non-smokers [aHR=1.51; 95%, CI: 1.274,1.791] compared to the smokers.

Model III controls for individual sociodemographic and socioeconomic background characteristics, health conditions and behaviour, and household/family level factors. In particular, in model III, family relations is added to the model to ascertain its effect on the risk of adult mortality while controlling for the other variables. Studies have found evidence that social relations could either increase or decrease the hazards of mortality depending on the nature and type of the relationship. In most studies, however, a protective effect of social relations against mortality has been found. Social relations are a given form of social capital that individuals rely on in addressing some aspects of their health conditions.

In model III, the risk of adult mortality further marginally reduces to the advantage of female decedents though not statistically significant. The risk of adult mortality is significantly heightened for married/living with partner decedents [aHR=0.39; 95%, CI: 0.315,0.481] while that of formerly married decedents is further reduced [aHR=0.30; 95%, CI: 0.236,0.371]. The risk of adult mortality still decreased by level of education and is further significantly lowered for deceased persons with higher level of education [aHR=0.59; 95%, CI: 0.415,0.834].

The addition of family relations in the model changes the risk of adult mortality with respect to type of occupation, only craft and trade related and elementary occupations remain statistically significant. For craft and trade related, the risk of adult mortality is significantly elevated to 2.33 [aHR=2.33; 95%, CI: 1.383,3.921] while for elementary occupations, it increases to 2.04 [aHR=2.04; 95%, CI: 1.250,3.329].

There is no significant difference in the risk of dying among decedents who had tuberculosis, cancer, and accidents and injuries compared to those who did not have, after introducing family relations in the model while controlling for the other variables. Health conditions, diabetes and HIV/AIDS remained statistically significant with unexpectedly elevated risk of adult mortality for decedents who did not have diabetes [aHR=1.59; 95%, CI: 1.113,2.273] and conversely, a non-significant hazard ratio less than 1 for decedents who did not have HIV/AIDs.

With respect to health behaviour, there is still no significant difference in the risk of adult mortality between decedents who drank alcohol and those who did not. In addition, the unexpected result continued where the risk of dying for the decedents is significantly elevated for non-smokers [aHR=1.57; 95%, CI: 1.322,1.857] when compared with smokers. The risk of adult mortality is significantly lower by 60 per cent [aHR=0.40; 95%, CI: 0.287,0.556] for deceased persons who had a spouse as a family relation compared to those who had a father as a family relation. Adult decedents who had a sibling as a family relation also had a significantly reduced adult mortality risk [aHR=0.68; 95%, CI: 0.487,0.950].

Model IV controls for individual sociodemographic and socioeconomic background characteristics, health conditions and behaviour, household/family relations, and community or ecological level factors. Specifically, community or ecological factors are added to the original model.

Community level factors represent the ecological factors. Here, ecological factors sustain the argument in the literature that health outcomes like adult mortality should be understood in consideration of the effect of individual, household and community level factors where societal conditions shape and determine the environment within which the outcomes occur. Previous studies have revealed the effect of ecological factors on health outcomes. Ecological factors play a role in influencing health outcomes at individual level including mortality. Studies have shown how neighbourhood effects, in crime ridden, poverty stricken and resourced endowed societies, have influenced mortality outcomes.

In model IV, the addition of community level or ecological factors, rural-urban residence, province of residence, community education, community treatment received, community health utilisation, and place of death changes the risk of adult mortality. For female decedents, though not significant the hazard ratio is less than 1, an indication that the risk of mortality may be lower compared with that of males. The risk of adult mortality remains significantly lower for decedents who were married/living with a partner [aHR=0.39; 95%, CI: 0.315,0.485] whereas the mortality risk for the formerly married is significantly reduced [aHR=0.28; 95%, CI: 0.228,0.346].

The risk of adult mortality is further reduced by education attainment and is significantly lower for deceased persons who had secondary [aHR=0.76; 95%, CI: 0.582,0.999] and higher [aHR=0.58; 95%, CI: 0.405,0.825] levels of education. For decedents who were in craft and trade related [aHR=2.08; 95%, CI: 1.238,3.503], and elementary [aHR=1.93: 95%, CI: 1.215,3.048] occupations their mortality risk remained significantly high but slightly lower.

For health conditions, tuberculosis, cancer, and accidents and injuries, the mortality risk for decedents who did not have these health conditions is not statistically significantly different from those who had them, after adjusting for ecological and other factors in the model. The unusual results of elevated adult mortality risk for decedents who did not have diabetes [aHR=1.45; 95%, CI:

1.008,2.090], and those who did not smoke [aHR=1.62; 95%, CI: 1.378,1.903] continued. The risk of adult mortality continued to be significantly lower for deceased persons who did not have HIV/AIDS [aHR=0.82; 95%, CI: 0.697,0.966] compared to those who had the health condition. The hazards of adult mortality remained significantly the same [aHR=0.40; 95%, CI: 0.287,0.555] for decedents who had a spouse as a family relation compared to those who had a father.

With respect to ecological factors, there is no significant difference in the risk of adult mortality for decedents in urban areas when compared to those in rural areas. Across provinces, there are variations in the risk of adult mortality when compared to Central province. From the hazard ratios, Copperbelt, Eastern and Lusaka provinces appear to have higher adult mortality risks that are not statistically significant whereas North-western and Southern provinces appear to have slightly lower non-significant adult mortality when compared to Central province. However, statistically significant differences in adult mortality risk are observed at province of residence level for Luapula and Northern provinces. Both provinces exhibit significantly higher risk of adult mortality, Luapula [aHR=1.30; 95%, CI: 1.060,1.597] and Northern [aHR=1.63; 95%, CI: 1.171,2.274] when compared to Central province.

Adult decedents who lived in communities with a high proportion of educated persons have a 30 per cent [aHR=0.70; 95%, CI: 0.546,0.884] significantly lower risk of adult mortality compared to those who resided in communities with a low proportion of educated persons. The adult mortality risk of decedents living in a community with a high proportion of persons receiving treatment for their health conditions is not statistically significantly different from that of decedents residing in a community with a low proportion of persons receiving treatment for their health conditions. In addition, living in a community with a high proportion of health care utilisation from the hazard ratio that is less than 1, appears to lower the risk of adult mortality but not statistically significant when compared to living in a community with low health care utilisation. Other place of death is associated with a significantly higher risk of adult mortality [aHR=1.39; 95%, CI: 1.085,1.783].

Adult mortality risk of males

Previous studies show that adult mortality differs by sex between males and females as well as the factors influencing mortality may vary by sex (Heuveline and Clark 2011; Himes 2011; GBD 2015 Mortality and Causes of Death Collaborators 2016). Chapter 4 also found differences in the level of adult mortality rates between males and females. In this section, the study examines the risk of adult mortality by sex as well as the associated factors.

Table 6.3 presents the individual, household and ecological factors associated with the risk of adult mortality for males in Zambia. Model I adjusts for individual factors. The risk of adult mortality for married/living with partner male decedents is slightly significantly lower [aHR=0.38; 95%, CI: 0.310,0.476] than for the formerly married male deceased persons [aHR=0.40; 95%, CI: 0.294,0.552] when compared to the never married male decedents. There is no statistically significant difference in the risk of adult mortality by education of the male decedents. However, mortality risk appears to decrease by level of education going by the hazard ratios. Adult male decedents who were in occupations as professionals [aHR=2.01; 95%, CI: 1.210,3.334], craft and trade related [aHR=2.64; 95%, CI: 1.650,4.232], plant and machine operators/assemblers [aHR=1.86; 95%, CI: 1.065,3.249], and elementary occupations [aHR=2.08; 95%, CI: 1.211,3.573] have significantly elevated mortality risk when compared legislators/senior officials/managers decedents.

In model II, the risk of adult mortality of married/living with partner male decedents is slightly significantly reduced [aHR=0.34; 95%, CI: 0.271,0.436] whilst that of formerly married male decedents is slightly significantly attenuated [aHR=0.42; 95%, CI: 0.292,0.605]. The mortality risk of adult male deceased persons is further lowered by education in model II and is significantly lower for male adult decedents with higher level of education [aHR=0.59; 95%, CI: 0.381,0.909]. The risk of adult mortality of male decedents in occupations as professionals [aHR=1.90: 95%, CI: 1.212,2.979], crafts and trade related [aHR=2.57; 95%, CI: 1.619,4.091], plant and machine operators/assemblers [aHR=1.77; 95%, CI: 1.063,2.955], and elementary [aHR=1.95; 95%, CI: 1.205,3.161] is further lowered despite remaining significantly high when compared to legislators/senior officials/managers male decedents.

Inclusion of health conditions and behaviour factors in model II shows no significant difference in the risk of adult mortality between male decedents who did not have tuberculosis, cancer, diabetes, HIV/AIDS, and accidents and injuries when compared to those who had these health conditions. Furthermore, there is no significant difference in mortality risk between adult male decedents who consumed alcohol and those who did not drink alcohol. Unexpectedly, there is a significant difference in mortality risk between adult male decedents who smoked and those did not, with the latter exhibiting significantly higher mortality risk [aHR=1.43; 95%, CI: 1.180,1.733], this is an unusual, considering findings from other studies that show the contrary.

In model III, the addition of the family relations variable to the model elevated the risk of mortality for male deceased adults who were married/living with a partner [aHR=0.39; 95%, CI: 0.303,0.500] while the mortality risk of formerly married decedents is slightly significantly lowered [aHR=0.40; 95%, CI: 0.273,0.580]. The risk of adult mortality among deceased males reduced further with respect to education with male decedents with higher education having significantly lower mortality risk [aHR=0.51; 95%, CI: 0.340,0.769]. By occupation, the risk of adult mortality of male deceased persons in occupations as professionals [aHR=1.99; 95%, CI: 1.130,3.521], crafts and trade related [aHR=2.71; 95%, CI: 1.457,5.024], and elementary occupations [aHR=2.10; 95%, CI: 1.203,3.669] continued being statistically significantly elevated when compared to the legislators/senior officials/managers deceased males.

Adult mortality risk with respect to health conditions for deceased males, there is insignificant difference in the risk of mortality between decedent who did not have tuberculosis, cancer, diabetes, HIV/AIDS, and accidents and injuries, and the male decedents who had these health conditions. The same is the case for the morality risk of adult male decedents who did not drink alcohol and those who did. An unusually, significantly elevated mortality risk is observed for male decedent who did not smoke tobacco [aHR=1.53; 95%, CI: 1.284,1.829] compared to those who smoked. The risk of adult mortality is significantly lower [aHR=0.42; 95%, CI: 0.290,0.615] for male decedents who had a spouse as a family relation as well as for those who had a sibling [aHR=0.63; 95%, CI: 0.426,0.933] as a family relation.

In model IV, community level or ecological factors are added to the original model for males. The risk of adult mortality for male decedents who were married/living with a partner is significantly lowered [aHR=0.36; 95%, CI: 0.275,0.459]. The risk is further significantly reduced for the formerly married male deceased persons [aHR=0.34; 95%, CI: 0.243,0.477]. The risk of adult mortality continues to be lower by education for male decedents. However, it is slightly attenuated for the male deceased persons with higher level of education [aHR=0.56; 95%, CI: 0.348,0.890] relative to model III. The mortality risk by occupations continued to be significantly high for adult male decedents in occupations as professionals [aHR=2.05; 95%, CI: 1.084,3.868], crafts and trade related [aHR=2.85; 95%, CI: 1.515,5.371], and elementary occupations [aHR=2.25; 95%, CI: 1.285,3.940].

The risk of adult mortality remained statistically insignificant between male deceased persons who did not have tuberculosis, cancer, diabetes, HIV/AIDS, and accidents and injuries and those who had these health conditions. By health behaviour, the risk of adult mortality for male decedents who did not drink alcohol is not significantly different for that of those who consumed alcohol. However, as noted earlier, the risk of mortality for male non-smokers [aHR=1.51; 95%, CI:

1.261,1.813] remained significantly elevated when compared to the smokers, which is not expected. Adult male decedents who had spouses [aHR=0.36; 95%, CI: 0.247,0.531], sibling [aHR=0.60; 95%, CI: 0.405,0.899], and other relative [aHR=0.67; 95%, CI: 0.460,0.987] as family relations have significantly lower risk of mortality.

For ecological factors, that is, rural-urban residence, province of residence, place of death, community education, community health service utilisation, and community illness treatment received. The risk of male adult mortality is not significantly different between urban areas when compared to rural areas. The risk of adult mortality is significantly high for male decedents in Lusaka province [aHR=1.40; 95%, CI: 1.021,1.912] and higher in Northern province [aHR=2.17; 95%, CI: 1.431,3.290] when compared to male decedents in Central province.

Living in a community with a high proportion of educated persons is associated with a significantly lower risk of adult mortality of 56 per cent [aHR=0.44; 95%, CI: 0.340,0.571] compared to residing in a community with a low proportion of educated people, for the adult male decedents. There is no significant difference in mortality risk for male deceased persons between living in a community with a high proportion of persons receiving treatment for their health conditions and residing in a community with a low proportion of persons receiving treatment for their health conditions. There is no significant difference in mortality risk for adult male decedents by place of death.

Table 6.3 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality among deceased males in Zambia, 2010-2012 SAVVY

	Model I[a]		Model II[b]		Model III[c]		Model IV[d]	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual								
Marital Status								
Never married (Ref.)	1.00		1.00		1.00		1.00	
Married/Living with a partner	0.38***	[0.310,0.476]	0.34***	[0.271,0.436]	0.39***	[0.303,0.500]	0.36***	[0.275,0.459]
Divorced/separated/widowed	0.40***	[0.294,0.552]	0.42***	[0.292,0.605]	0.40***	[0.273,0.580]	0.34***	[0.243,0.477]
Education								
No education (Ref.)	1.00		1.00		1.00		1.00	
Primary	0.90	[0.577,1.402]	0.85	[0.535,1.337]	0.79	[0.524,1.196]	0.74	[0.487,1.117]
Secondary	0.90	[0.609,1.330]	0.80	[0.529,1.200]	0.78	[0.543,1.121]	0.76	[0.527,1.097]
Higher	0.69	[0.444,1.069]	0.59*	[0.381,0.909]	0.51**	[0.340,0.769]	0.56*	[0.348,0.890]
Occupation								
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00		1.00	
Professionals	2.01**	[1.210,3.334]	1.90**	[1.212,2.979]	1.99*	[1.130,3.521]	2.05*	[1.084,3.868]
Technicians/Associate Professionals	1.18	[0.606,2.306]	1.23	[0.648,2.326]	1.16	[0.572,2.341]	1.17	[0.582,2.370]
Clerks	1.60	[0.854,3.009]	1.53	[0.865,2.692]	1.60	[0.890,2.883]	1.74	[0.931,3.259]
Service\Shop\Market sales workers	1.25	[0.700,2.231]	1.32	[0.799,2.172]	1.39	[0.771,2.490]	1.41	[0.766,2.605]
Skilled Agricultural/Fishery workers	1.45	[0.859,2.457]	1.50	[0.911,2.480]	1.60	[0.907,2.823]	1.89	[0.981,3.655]
Craft and related trade workers	2.64***	[1.650,4.232]	2.57***	[1.619,4.091]	2.71**	[1.457,5.024]	2.85**	[1.515,5.371]
Plant and Machine Operators/Assemblers	1.86*	[1.065,3.249]	1.77*	[1.063,2.955]	1.62	[0.848,3.080]	1.65	[0.886,3.076]
Elementary Occupations	2.08**	[1.211,3.573]	1.95**	[1.205,3.161]	2.10**	[1.203,3.669]	2.25**	[1.285,3.940]
Proximate/Intervening								
Tuberculosis								
Yes (Ref.)			1.00		1.00		1.00	
No			1.09	[0.910,1.306]	1.05	[0.856,1.287]	1.02	[0.824,1.263]
Cancer								
Yes (Ref.)			1.00		1.00		1.00	
No			0.88	[0.580,1.332]	0.93	[0.570,1.523]	0.97	[0.585,1.608]
Diabetes								
Yes (Ref.)			1.00		1.00		1.00	
No			1.20	[0.723,1.980]	1.49	[0.747,2.951]	1.29	[0.648,2.573]
HIV/AIDS								
Yes (Ref.)			1.00		1.00		1.00	
No			0.83	[0.628,1.093]	0.88	[0.659,1.186]	0.86	[0.668,1.107]
Accidents & injuries								
Yes (Ref.)			1.00		1.00		1.00	
No			0.81	[0.591,1.108]	0.79	[0.581,1.075]	0.83	[0.620,1.108]
Drink Alcohol								
Yes (Ref.)			1.00		1.00		1.00	
No			1.07	[0.910,1.255]	1.09	[0.947,1.262]	1.15	[0.940,1.397]
Smoke Tobacco								
Yes (Ref.)			1.00		1.00		1.00	
No			1.43***	[1.180,1.733]	1.53***	[1.284,1.829]	1.51***	[1.261,1.813]
Household								
Family Relations								
Father (Ref.)					1.00		1.00	
Mother					1.29	[0.883,1.892]	1.15	[0.748,1.770]
Spouse					0.42***	[0.290,0.615]	0.36***	[0.247,0.531]
Sibling					0.63*	[0.426,0.933]	0.60*	[0.405,0.899]
Child					0.83	[0.529,1.298]	0.75	[0.471,1.201]
Other relatives					0.74	[0.491,1.102]	0.67*	[0.460,0.987]
Community								
Residence								
Rural (Ref.)							1.00	
Urban							0.95	[0.787,1.146]
Province								
Central (Ref.)							1.00	
Copperbelt							1.25	[0.784,2.004]
Eastern							1.25	[0.883,1.764]
Luapula							1.13	[0.770,1.655]
Lusaka							1.40*	[1.021,1.912]
Northern							2.17***	[1.431,3.290]
North Western							1.61	[0.864,2.999]
Southern							0.83	[0.573,1.200]
Western							0.90	[0.475,1.687]
Community education								
Low (Ref.)							1.00	
High							0.44***	[0.340,0.571]
Community treatment received								
Low (Ref.)							1.00	
High							1.11	[0.892,1.381]
Community health utilisation								
Low (Ref.)							1.00	
High							1.16	[0.901,1.504]
Place of death								
Health facility (Ref.)							1.00	
Home							0.90	[0.741,1.098]
Other							1.12	[0.788,1.598]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category
[a]Model I: controlling for individual level variables
[b]Model II: controlling for Individual and health condition/behaviour proximate variables
[c]Model III: controlling for individual, health condition/behaviour proximate, and household variables
[d]Model IV: controlling for individual, health condition/behaviour proximate, household and community variables

Adult mortality risk of females

Table 6.4 show the risk of adult mortality for female decedents controlling for individual sociodemographic and socioeconomic background characteristics, health conditions and behaviour, household/family, and community level or ecological factors. Relative to male risk of adult mortality in model I of the previous table (6.3), female mortality risk is significantly lower for married/living with a partner [aHR=0.26; 95%, CI: 0.192,0.339] and formerly married [aHR=0.24; 95%, CI: 0.186,0.317]. Among female adult decedents, the risk of mortality does not significantly vary by level of education despite the hazard ratios declining by level of education in model I. The risk of adult mortality does not significantly differ by type of occupation among the female deceased persons; though it appears that the risk is elevated as most of the hazard ratios are above 1 for several occupation types.

In model II, adjusting for health conditions and behaviour, the risk of mortality remains statistically significantly the same for married/living with a partner [aHR=0.26; 95%, CI: 0.197,0.347] and formerly married [aHR=0.24; 95%, CI: 0.184,0.317] female decedents when compared to the never married. The risk of adult mortality by level of education among the female deceased persons is slightly reduced and is significantly lower for female decedents with secondary [aHR=0.71; 95%, CI: 0.504,0.988] level of education. There is no significant difference in the risk of adult mortality for female deceased persons by type of occupation even when the hazard ratios are elevated above 1.

Furthermore, with respect to health conditions, the risk of adult mortality is insignificantly different for female decedents who did not have tuberculosis, cancer, HIV/AIDS, and accidents and injuries when compared to those who had the health conditions. Unexpectedly, however, the risk of mortality was significantly higher for female deceased persons who did not have diabetes [aHR=1.69; 95%, CI: 1.038,2.751] when compared to those who had diabetes. In terms of health behaviour, the risk of adult mortality between deceased females who did not drink alcohol and those who did is statistically insignificant. Conversely and unexpectedly, adult female decedents who did not smoke tobacco have a significantly elevated mortality risk [aHR=2.01; 95%, CI: 1.488,2.837] compared to those who smoked tobacco.

In model III, the addition of family relations to the original model changes the risk of adult mortality. The risk of adult mortality for married/living with a partner remained statistically significant lower but attenuated [aHR=0.33; 95%, CI: 0.247,0.440] as well as for the formerly married the risk significantly lowered [aHR=0.23; 95%, CI: 0.171,0.304] when compared to the never married female decedents.

By education, the risk of mortality of adult female decedents is significantly different and low between deceased persons with primary level of education [aHR=0.75; 95%, CI: 0.556,1.000] and even lower for female decedents with secondary level of education [aHR=0.67; 95%, CI: 0.481,0.926] when compared to those with no education. As in the other previous models in the table, the risk of adult mortality is insignificantly different by occupation type among female deceased persons, except for female decedents in elementary occupations whose mortality risk is significantly elevated [aHR=2.61; 95%, CI: 1.159,5.857].

It is now evident in model III with respect to health conditions that female decedents who did not have tuberculosis their risk of mortality is significantly lower by 17 per cent [aHR=0.83; 95%, CI: 0.693,0.984] when compared to the deceased females who had tuberculosis. For cancer, HIV/AIDS, and accidents and injuries, there is no significant difference in the risk of adult mortality between female decedents who did not have these health conditions and those who had. As in model I and II of this table, deceased female persons who did not have diabetes as a health condition have an unexpectedly significantly higher mortality risk [aHR=1.89; 95%, CI: 1.205,2.971] when compared to those who had diabetes.

In terms of health behaviour, a statistically insignificant difference in adult mortality risk exists between deceased adult females who did not drink alcohol and those who consumed alcohol. Furthermore, the unexpectedly elevated mortality risk of female decedents who did not smoke tobacco when compared to those who smoked tobacco continued in model III. Different from male decedents, deceased female persons who had mothers as family relations have significantly low mortality risk [aHR=0.58; 95%, CI: 0.383,0.870] and even lower for those who had a spouse as a family relation by 70 per cent [aHR=0.30; 95%, CI: 0.191,0.479].

Model IV adjusts for community level or ecological factors in the risk of adult mortality for female decedents. The inclusion of ecological factors changes the risk of adult mortality for female decedents in the model. The risk of adult mortality is significantly attenuated for married/living with a partner [aHR=0.36; 95%, CI: 0.258,0.488] for female decedents to the level of male adult mortality risk in table 6.3; whereas the risk of mortality for the formerly married adult female decedents remains significantly low at the same level [aHR=0.23; 95%, CI: 0.175,0.301].

With respect to education, there are significant differences in mortality risk by level of education. The risk of adult mortality significantly decreased across all levels of education relative to model III. Adult female decedents with higher level of education have significantly the lowest risk of mortality, reduced by 46 per cent [aHR=0.54; 95%, CI: 0.299,0.971] when compared to those with no education. By type of occupation, it is evident that despite the hazard ratios being above 1 for the risk of adult mortality, there is no significant difference in mortality risk by type of occupation among female deceased persons.

With respect to health conditions, model IV confirms that female decedents who did not have tuberculosis have significantly lower risk of adult mortality by 22 per cent [aHR=0.78; 95%, CI: 0.641,0.948] compared to those who had tuberculosis. Again, there is no significant difference in the risk of adult mortality between female decedents who did not have cancer, HIV/AIDS, and accidents and injuries as health condition and those who had them. The unexpectedly significant high mortality risk of female deceased persons who did not have diabetes [aHR=1.77; 95%, CI: 1.104,2.827] continued compared to those who had diabetes.

The inclusion of community level factors in model IV now shows that there is a significant difference in the risk of adult mortality between female decedents who did not drink alcohol and those who consumed alcohol. The deceased females who did not drink alcohol have a significantly lower mortality risk by 21 per cent [aHR=0.79; 95%, CI: 0.641,0.977] compared to those who consumed alcohol. As noted earlier, the unexpected significant high mortality risk of female decedents who did not smoke tobacco [aHR=2.24; 95%, CI: 1.623,3.092] when compared to those who smoked tobacco continued. The significant lower risk of adult mortality difference continued for female decedents who had mothers [aHR=0.65; 95%, CI: 0.427,0.987] and spouse [aHR=0.31; 95%, CI: 0.197,0.498] as family relations.

Ecologically in model IV, there is no significant difference in adult mortality risk of deceased female adults in urban areas compared to those in rural areas. The risk of adult mortality among female decedents remained significantly high in Luapula province by 45 per cent [aHR=1.45; 95%, CI: 1.006,2.095] and even higher in Northern province by 61 per cent [aHR=1.61; 95%, CI: 1.025,2.540]. On the contrary, the risk of adult mortality of female decedents is significantly lower by 50 per cent [aHR=0.50; 95%, CI: 0.281,0.876] in North-western province. This result corroborates with adult mortality estimates in Chapter 4 for North-western province.

Among female decedents, there is no statistically significant difference in the risk of adult mortality between living in a community with a high proportion of educated persons and living in a community with a low proportion of educated persons. The same is the case for the risk of adult mortality between living in a community with a high proportion of persons receiving treatment for their health conditions and living in a community with a low proportion of persons receiving treatment for their health conditions. On the other hand, living in a community with a high proportion of heath care utilisation is associated with a significantly lower risk of adult mortality by 21 per cent [aHR=0.79; 95%, CI: 0.638,0.988] compared to living in a community with a low proportion of health care utilisation among adult female deceased persons.

There is insignificant difference in adult mortality risk by place of death among adult female decedents. A statistically insignificant association is observed where home place of death has slightly low risk of adult mortality while other place of death has slightly elevated mortality risk when compared to health facility place of death.

Table 6.4 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality among deceased females in Zambia, 2010-2012 SAVVY

	Model I[a]		Model II[b]		Model III[c]		Model IV[d]	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual								
Marital Status								
Never married (Ref.)	1.00		1.00		1.00		1.00	
Married/Living with a partner	0.26***	[0.192,0.339]	0.26***	[0.197,0.347]	0.33***	[0.247,0.440]	0.36***	[0.258,0.488]
Divorced/separated/widowed	0.24***	[0.186,0.317]	0.24***	[0.184,0.317]	0.23***	[0.171,0.304]	0.23***	[0.175,0.301]
Education								
No education (Ref.)	1.00		1.00		1.00		1.00	
Primary	0.97	[0.714,1.309]	0.75	[0.548,1.012]	0.75*	[0.556,1.000]	0.69*	[0.515,0.920]
Secondary	0.86	[0.624,1.170]	0.71*	[0.504,0.988]	0.67*	[0.481,0.926]	0.63**	[0.447,0.882]
Higher	0.66	[0.381,1.139]	0.61	[0.367,1.011]	0.63	[0.355,1.103]	0.54*	[0.299,0.971]
Occupation								
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00		1.00	
Professionals	1.26	[0.530,2.979]	1.22	[0.583,2.572]	1.63	[0.606,4.387]	1.27	[0.493,3.255]
Technicians/Associate Professionals	1.90	[0.616,5.834]	1.92	[0.639,5.756]	2.07	[0.571,7.460]	1.13	[0.332,3.843]
Clerks	1.34	[0.670,2.693]	1.38	[0.686,2.777]	1.93	[0.753,4.961]	1.25	[0.497,3.129]
Service\Shop\Market sales workers	1.15	[0.554,2.386]	1.33	[0.663,2.653]	1.97	[0.819,4.735]	1.27	[0.513,3.160]
Skilled Agricultural/Fishery workers	1.05	[0.539,2.047]	1.17	[0.630,2.168]	1.66	[0.729,3.773]	1.08	[0.457,2.536]
Craft and related trade workers	1.10	[0.483,2.525]	1.30	[0.541,3.141]	1.82	[0.748,4.424]	1.05	[0.390,2.834]
Plant and Machine Operators/Assemblers	1.59	[0.656,3.852]	1.63	[0.679,3.927]	2.46	[0.851,7.116]	1.74	[0.513,5.905]
Elementary Occupations	1.56	[0.820,2.951]	1.74	[0.949,3.174]	2.61*	[1.159,5.857]	1.89	[0.792,4.530]
Proximate/Intervening								
Tuberculosis								
Yes (Ref.)			1.00		1.00		1.00	
No			0.93	[0.775,1.123]	0.83*	[0.693,0.984]	0.78*	[0.641,0.948]
Cancer								
Yes (Ref.)			1.00		1.00		1.00	
No			1.36	[0.965,1.925]	1.18	[0.854,1.624]	1.34	[0.926,1.924]
Diabetes								
Yes (Ref.)			1.00		1.00		1.00	
No			1.69*	[1.038,2.751]	1.89**	[1.205,2.971]	1.77*	[1.104,2.827]
HIV/AIDS								
Yes (Ref.)			1.00		1.00		1.00	
No			0.87	[0.725,1.052]	0.86	[0.717,1.037]	0.83	[0.675,1.011]
Accidents & injuries								
Yes (Ref.)			1.00		1.00		1.00	
No			0.76	[0.463,1.246]	0.66	[0.423,1.041]	0.64	[0.362,1.111]
Drink Alcohol								
Yes (Ref.)			1.00		1.00		1.00	
No			0.86	[0.688,1.083]	0.86	[0.691,1.081]	0.79*	[0.641,0.977]
Smoke Tobacco								
Yes (Ref.)			1.00		1.00		1.00	
No			2.06***	[1.488,2.837]	1.98***	[1.424,2.752]	2.24***	[1.623,3.092]
Household								
Family Relations								
Father (Ref.)					1.00		1.00	
Mother					0.58**	[0.383,0.870]	0.65*	[0.427,0.987]
Spouse					0.30***	[0.191,0.479]	0.31***	[0.197,0.498]
Sibling					0.67	[0.435,1.041]	0.78	[0.482,1.252]
Child					0.70	[0.455,1.066]	0.76	[0.478,1.221]
Other relatives					0.67	[0.430,1.039]	0.79	[0.495,1.270]
Community								
Residence								
Rural (Ref.)							1.00	
Urban							1.06	[0.813,1.369]
Province								
Central (Ref.)							1.00	
Copperbelt							1.40	[0.843,2.331]
Eastern							1.00	[0.675,1.482]
Luapula							1.45*	[1.006,2.095]
Lusaka							0.85	[0.565,1.264]
Northern							1.61*	[1.025,2.540]
North Western							0.50*	[0.281,0.876]
Southern							1.01	[0.668,1.513]
Western							1.05	[0.676,1.639]
Community education								
Low (Ref.)							1.00	
High							0.97	[0.657,1.439]
Community treatment received								
Low (Ref.)							1.00	
High							1.07	[0.852,1.345]
Community health utilisation								
Low (Ref.)							1.00	
High							0.79*	[0.638,0.988]
Place of death								
Health facility (Ref.)							1.00	
Home							0.96	[0.755,1.218]
Other							0.95	[0.518,1.746]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category
[a]Model I: controlling for individual level variables
[b]Model II: controlling for Individual and health condition/behaviour proximate variables
[c]Model III: controlling for individual, health condition/behaviour proximate, and household variables
[d]Model IV: controlling for individual, health condition/behaviour proximate, household and community variables

Adult mortality risk by age

Previous studies show that mortality risk and associated factors vary by age (Hosegood, Vanneste and Timaeus 2004; Dzekedzeke, Siziya and Fylkesnes 2008; Mberu, Wamukoya, Oti *et al.* 2015; Masquelier, Eaton, Gerland *et al.* 2017). In Chapter 5, the causes of deaths of adults in age group 15-59 varied by age group. In this section, the study examines the risk of adult mortality by age and the associated factors. Age is grouped in three categories: age group 15-34 to represent adolescents, youth and young adults' risk of mortality; age group 35-44 represents mortality of the middle-aged adults in the prime of socioeconomic productive and reproductive activities; and age group 45-59, represents mortality of older adults who are in the late stages of socioeconomic productive and reproductive activities. The risk factors considered are the usual ones used in the previous models, that is, individual sociodemographic and socioeconomic background characteristics, health conditions and behaviour, household/family, and community level or ecological factors.

Table 6.5 shows the hazard ratios of the risk of adult mortality and the risk factors by age group. It is evident from the table that the risk of adult mortality does not significantly differ by sex among the deceased persons in age group 15-34 as well as in age group 45-59. The risk of adult mortality is, however, significantly lower by 33 per cent [aHR=0.67; 95%, CI: 0.507,0.889] for female decedents when compared to male deceased persons in age group 35-44. The risk of adult mortality is significantly lower by marital status only among decedents in age group 15-34. The married/living with partner decedents' risk of mortality is low by 46 per cent [aHR=0.54; 95%, CI: 0.410,0.700] and even lower by 55 per cent [aHR=0.45; 95%, CI: 0.342,0.586] for the formerly married decedents when compared with the never married deceased persons in age group 15-34.

It is interesting to note that the risk of adult mortality by education is statistically insignificant given the fact that education is one of the strong predictors of mortality. For all the three age groups, it is evident that education is negatively associated with the risk of adult mortality which generally decreases with the level of education when compared to the decedents with no education.

By occupation type, in age group 15-34, the risk of adult mortality is significantly higher for decedents in occupations as professionals [aHR=2.10; 95%, CI: 1.172,3.756], service\shop\market sales [aHR=2.35; 95%, CI: 1.567,3.512], skilled agricultural\fishery [aHR=1.50; 95%, CI: 1.026,2.186], plant and machine operators\assemblers [aHR=1.76; 95%, CI: 1.101,2.814], and elementary occupations [aHR=2.06; 95%, CI: 1.366,3.10]. In age group 35-44, the risk of adult mortality is significantly lower by 59 per cent [aHR=0.41: 95%, CI: 0.190,0.891] for technicians\associate professionals. For other types of occupation in age group 35-44, though the hazard ratios are less than 1 indicating lower mortality risk but they are not statistically significant. In age group 45-59, the mortality risk is significantly higher [aHR=3.69; 95%, CI: 1.308,10.40] for decedents who are professionals, also for those who are plant and machine operators\assemblers [aHR=2.41; 95%, CI: 1.029,5.643] and those in elementary occupations [aHR=2.28; 95%, CI: 1.056,4.939].

With respect to health conditions and behaviour, the risk of mortality attributable to tuberculosis was not statistically significant across all the three age groups between decedents who did not have tuberculosis and those who had the health condition. However, for age group 15-34, the risk of adult mortality for decedents who did not have cancer is significantly lower by 49 per cent [aHR=0.51; 95%, CI: 0.324,0.792] compared to those who had cancer. For the other two age groups, 35-44 and 45-59, the hazard ratios are less than 1 indicating a possibility of reduced mortality risk for those who did not have cancer but the ratios are not statistically significant. There is no significant difference in the risk of adult mortality between decedents who did not have diabetes and those who had diabetes across all the three age groups.

There is a statistically significant difference in mortality risk between decedents who did not have HIV/AIDS as a health condition and those who had HIV/AIDS for age groups 15-34 and 45-59. For age group 15-34, unexpectedly decedents who did not have HIV/AIDS have a significantly higher mortality risk by 18 per cent [aHR=1.18; 95%, CI: 1.003,1.381] compared to decedents who had HIV/AIDS. On the contrary, for age group 45-59, as expected decedents who did not have HIV/AIDS have a significantly lower risk of adult mortality by 46 per cent [aHR=0.54; 95%, CI: 0.360,0.795] compared to those who had HIV/AIDS. Only in age group 35-44 is the risk of mortality from accidents and injuries significantly lower by 44 per cent [aHR=0.56; 95%, CI: 0.392,0.793].

The risk of mortality for decedents who did not drink alcohol is unexpectedly significantly higher in age group 15-34 [aHR=1.33; 95%, CI: 1.041,1.698] compared to decedents who consumed alcohol. Again, the risk of adult mortality is unusually significantly elevated for decedents who did not smoke tobacco [aHR=1.50; 95%, CI: 1.079,2.083] compared to those who smoked tobacco in age group 45-59.

The risk of adult mortality associated with family relations is unexpectedly significantly high for age group 35-44 for decedents who had the mother as family relation [aHR=1.46; 95%, CI: 1.000,2.124], conversely, for age group 45-59, the risk of adult is significantly lower [aHR=0.58; 95%, CI: 0.377,0.895] for decedents who had a spouse as a family relation.

Across all the three age groups, the risk of adult mortality is not significantly different by the ecological factor urban-rural residence. However, by province of residence, Copperbelt province has significantly higher adult mortality risk [aHR=1.82; 95%, CI: 1.070,3.101] for decedents in age group 45-59. Eastern province has significantly higher risk of mortality for decadents in age group 15-34 [aHR=1.36; 95%, CI: 1.009,1.840] and age group 45-59 [aHR=1.79; 95%, CI: 1.019,3.147]. Significantly higher adult mortality risk is evident in Luapula province for decedents in age group 15-34 [aHR=1.61; 95%, CI: 1.075,2.397]. In Northern province, significantly high mortality risk is observed for decedents in age group 15-34 [aHR=1.80; 95%, CI: 1.273,2.540] and even higher mortality risk in age group 45-59 [aHR=3.23; 95%, CI: 1.735,6.013].

There is no significant difference in the risk of adult mortality between decedents living a community with a high proportion of educated persons and those living in a community with a low proportion of educated persons across all the three age groups. However, the hazard ratios for the three age groups are less than 1 an indication probably of lower adult mortality risk but not statistically significant. Across all the three age groups, there is no significant difference in the risk of adult mortality for decedents living in a community with a high proportion of persons receiving treatment for their health conditions compared to those living in a community with a low proportion of persons receiving treatment for their health conditions. There is also an insignificant difference in adult mortality risk between decedents living in a community with a high proportion of health care utilisation and those living in a community with a low proportion of health care utilisation. Only in age group 45-59 is the risk of adult mortality significantly higher for other place of death [aHR=2.05; 95%, CI: 1.141,3.686] compared to health facility place of death.

Table 6.5 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality by age group among both deceased males and females, in Zambia, 2010-2012 SAVVY

	Model I[a] (15-34)		Model II[b] (35-44)		Model III[c] (45-59)	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual						
Sex						
Male (Ref.)	1.00		1.00		1.00	
Female	1.06	[0.808,1.391]	0.67**	[0.507,0.889]	0.84	[0.600,1.186]
Marital Status						
Never married (Ref.)	1.00		1.00		1.00	
Married/Living with a partner	0.54***	[0.410,0.700]	1.07	[0.771,1.479]	0.96	[0.500,1.855]
Divorced/separated/widowed	0.45***	[0.342,0.586]	1.14	[0.833,1.551]	0.62	[0.330,1.179]
Education						
No education (Ref.)	1.00		1.00		1.00	
Primary	1.03	[0.675,1.562]	1.36	[0.883,2.104]	1.25	[0.795,1.978]
Secondary	1.05	[0.701,1.562]	1.24	[0.699,2.188]	0.99	[0.638,1.527]
Higher	0.91	[0.533,1.542]	0.96	[0.441,2.091]	0.71	[0.347,1.465]
Occupation						
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00	
Professionals	1.09	[0.668,1.780]	0.86	[0.344,2.128]	3.69*	[1.308,10.40]
Technicians/Associate Professionals	2.10*	[1.172,3.756]	0.41*	[0.190,0.891]	1.56	[0.586,4.177]
Clerks	1.40	[0.917,2.133]	0.82	[0.402,1.691]	2.07	[0.809,5.307]
Service\Shop\Market sales workers	2.35***	[1.567,3.512]	0.76	[0.312,1.849]	2.07	[0.849,5.045]
Skilled Agricultural/Fishery workers	1.50*	[1.026,2.186]	0.65	[0.328,1.284]	1.51	[0.665,3.422]
Craft and related trade workers	1.63	[0.829,3.210]	0.66	[0.275,1.602]	3.11	[0.911,10.59]
Plant and Machine Operators/Assemblers	1.76*	[1.101,2.814]	0.89	[0.446,1.755]	2.41*	[1.029,5.643]
Elementary Occupations	2.06***	[1.366,3.101]	0.70	[0.373,1.327]	2.28*	[1.056,4.939]
Proximate/Intervening						
Tuberculosis						
Yes (Ref.)	1.00		1.00		1.00	
No	1.01	[0.834,1.234]	0.88	[0.649,1.197]	0.84	[0.624,1.118]
Cancer						
Yes (Ref.)	1.00		1.00		1.00	
No	0.51**	[0.324,0.792]	0.51	[0.249,1.056]	0.81	[0.446,1.472]
Diabetes						
Yes (Ref.)	1.00		1.00		1.00	
No	1.43	[0.755,2.722]	0.588	[0.307,1.127]	0.726	[0.435,1.210]
HIV/AIDS						
Yes (Ref.)	1.00		1.00		1.00	
No	1.18*	[1.003,1.381]	1.00	[0.692,1.433]	0.54**	[0.360,0.795]
Accidents & injuries						
Yes (Ref.)	1.00		1.00		1.00	
No	0.89	[0.652,1.201]	0.56**	[0.392,0.793]	1.52	[0.964,2.384]
Drink Alcohol						
Yes (Ref.)	1.00		1.00		1.00	
No	1.33*	[1.041,1.698]	1.14	[0.889,1.466]	0.81	[0.548,1.190]
Smoke Tobacco						
Yes (Ref.)	1.00		1.00		1.00	
No	1.24	[0.950,1.604]	0.76	[0.571,1.013]	1.50*	[1.079,2.083]
Household						
Family Relations						
Father (Ref.)	1.00		1.00		1.00	
Mother	1.00	[0.681,1.454]	1.46*	[1.000,2.124]	1.15	[0.695,1.913]
Spouse	0.91	[0.669,1.242]	0.71	[0.477,1.053]	0.58*	[0.377,0.895]
Sibling	0.99	[0.690,1.413]	1.24	[0.853,1.795]	1.38	[0.773,2.476]
Child	0.89	[0.579,1.353]	0.91	[0.596,1.372]	1.25	[0.687,2.285]
Other relatives	1.14	[0.808,1.604]	1.15	[0.768,1.729]	1.38	[0.682,2.806]
Community						
Residence						
Rural (Ref.)	1.00		1.00		1.00	
Urban	0.85	[0.678,1.052]	1.18	[0.934,1.491]	0.91	[0.601,1.376]
Province						
Central (Ref.)	1.00		1.00		1.00	
Copperbelt	1.02	[0.679,1.529]	1.07	[0.613,1.859]	1.82*	[1.070,3.101]
Eastern	1.36*	[1.009,1.840]	0.74	[0.446,1.236]	1.79*	[1.019,3.147]
Luapula	1.61*	[1.075,2.397]	0.89	[0.510,1.538]	1.21	[0.704,2.068]
Lusaka	1.18	[0.887,1.574]	0.96	[0.584,1.589]	1.10	[0.708,1.703]
Northern	1.80**	[1.273,2.540]	1.21	[0.660,2.219]	3.23***	[1.735,6.013]
North Western	1.96	[0.816,4.705]	0.81	[0.490,1.326]	0.89	[0.382,2.052]
Southern	1.18	[0.856,1.631]	1.02	[0.597,1.727]	1.12	[0.676,1.847]
Western	1.19	[0.901,1.562]	1.03	[0.600,1.767]	0.87	[0.489,1.534]
Community education						
Low (Ref.)	1.00		1.00		1.00	
High	0.84	[0.656,1.061]	0.97	[0.645,1.468]	0.79	[0.515,1.202]
Community treatment received						
Low (Ref.)	1.00		1.00		1.00	
High	1.19	[0.974,1.448]	0.99	[0.768,1.266]	0.95	[0.678,1.343]
Community health utilisation						
Low (Ref.)	1.00		1.00		1.00	
High	1.01	[0.832,1.213]	0.81	[0.566,1.170]	0.73	[0.503,1.068]
Place of death						
Health facility (Ref.)	1.00		1.00		1.00	
Home	0.91	[0.759,1.091]	0.92	[0.709,1.182]	1.14	[0.837,1.559]
Other	1.30	[0.820,2.053]	0.87	[0.556,1.373]	2.05*	[1.141,3.686]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category
[a]Model I: Age group 15-34 controlling for individual, health condition/behaviour proximate, household and community variables
[b]Model II: Age group 35-44 controlling for individual, health condition/behaviour proximate, household and community variables
[c]Model III: Age group 45-59 controlling for individual, health condition/behaviour proximate, household and community variables

Adult mortality risk by age and sex-Males

As noted earlier the risk of adult mortality varied by sex, in this section, the study assess how mortality risk differs by age and sex using the age groups disaggregated above (age groups: 15-34, 35-44, and 45-59). Table 6.6 shows the hazard ratios of the risk of adult mortality and the risk factors disaggregated by age group for males. Only for male decedents in the age 15-34 is the risk of adult mortality significantly lower for married/living with a partner by 51 per cent [aHR=0.49; 95%, CI: 0.320,0.735] and formerly married, lower by 65% [aHR=0.35; 95%, CI: 0.217,0.558] compared to never married deceased persons in the same age group. Among the male decedents, despite the risk of adult mortality not being statistically significantly associated with education, the hazard ratios show that the risk decreases with the level of education across all age groups.

The risk of adult mortality for males is significantly higher for occupation types as technicians/associate professionals [aHR=2.28; 95%, CI: 1.065,4.867], service/shop/markets sales [aHR=1.94; 95%, CI: 1.085,3.470], and elementary occupations [aHR=2.05; 95%, CI: 1.127,3.727] for age group 15-34 whereas for age group 45-59, it is occupations as craft and trade related [aHR=4.93; 95%, CI: 1.195,20.38] and plant and machine operators/assemblers [aHR=3.33; 95%, CI: 1.067,10.40].

By health conditions, there is no significant difference in the risk of adult mortality for male decedents between those who did not have tuberculosis and those who had tuberculosis as a health condition across all the three age groups. Among male decedents in age groups 15-34 and 3544, the risk of adult mortality for those who did not have cancer as a health condition is significantly lower by 58 per cent [aHR=0.42; 95%, CI: 0.235,0.761] for age group 15-34 whereas for age group 35-44, the risk is even significantly lower by 80 per cent [aHR=0.20; 95%, CI: 0.110,0.345] compared to the deceased males who had cancer.

The risk of adult mortality is significantly lower by 69 per cent [aHR=0.31; 95%, CI: 0.194,0.506] for male deceased persons who did not have HIV/AIDS compared to those who had HIV/AIDS as a health condition in age group 45-59. Adult male decedents who did not have accidents and injuries have a significantly lower risk of adult mortality [aHR=0.48; 95%, CI: 0.310,0.755] compared to those who had the health condition in age group 35-44.

With respect to health behaviour, male adult decedents who did not drink alcohol in age group 15-34, unexpectedly have a significantly higher risk of mortality [aHR=1.80; 95%, CI: 1.331,2.444] compared to those who consumed alcohol. On the contrary, decedent male adults in age group 45-59 who did not drink alcohol have a significantly lower risk of mortality by 48 per cent [aHR=0.52; 95%, CI: 0.319,0.851] compared to those who consumed alcohol. The risk of adult mortality is significantly lower by 46 per cent [aHR=0.54; 95%, CI: 0.381,0.752] for adult male decedents who did not smoke tobacco compared to those who smoked tobacco in age group 35-44. Conversely, the risk of mortality is unexpectedly significantly higher for male adult decedents in age group 45-59 who did not smoke tobacco [aHR=1.76; 95%, CI: 1.237,2.494] compared to those who smoked tobacco.

Among adult male decedents, only in age group 35-44 is the risk of adult mortality significantly lower by 61 per cent [aHR=0.39; 95%, CI: 0.220,0.694] for those who had a spouse as a family relation.

The risk of adult mortality is significantly higher by 65 per cent [aHR=1.65; 95%, CI: 1.244,2.186] for male decedents in age group 35-44 who lived in urban areas compared to those who resided in rural areas. By province of residence, ecologically, Copperbelt province has significantly higher adult mortality risk [aHR=3.27; 95%, CI: 1.140,9.405] among male decedents in age group

45-59 years. Eastern province has significantly higher mortality risk for adult male deceased persons in age group 15-34 [aHR=1.73; 95%, CI: 1.115,2.671] and age group 45-59 [aHR=3.52; 95%, CI: 1.381,8.951]. Lusaka province also has significantly higher risk of adult mortality by 50 per cent [aHR=1.50: 95%, CI: 1.010,2.229] for male decedents in age group 15-34. Northern province equally has significant higher mortality for males in age group 15-34 [aHR=2.07; 95%, CI: 1.288,3.310] and age group 45-59 [aHR=3.96; 95%, CI: 1.191,13.15]. For North-western province, the risk of adult mortality is significantly higher for male decedents in age group 15-34 [aHR=3.64; 95%, CI: 1.573,8.411].

Despite not being statistically significant the risk of adult mortality as indicated by the hazard ratios that are less than 1 may be lower for adult male decedents in age group 15-34 and 45-59 who lived in communities with a high proportion of educated persons compared to those who resided in communities with a low proportion of educated persons. For male decedents in age group 15-34, the risk of adult mortality is significantly elevated [aHR=1.75; 95%, CI: 1.411,2.175] for those who lived in communities with a high proportion of persons who received treatment for their health conditions compared to those who lived in communities with a low proportion of persons receiving treatment for their health conditions. For adult male decedents, living in a community with a high proportion of health care utilisation appeared to lower the risk of adult mortality for male deceased persons in age groups 35-44 and 45-59 going by the hazard ratios that are less than 1, though statistically insignificant. Other place of death for male decedents significantly elevated the risk of adult mortality for those in age group 15-34 [aHR=1.74; 95%, CI: 1.090,2.780] and age group 45-59 [aHR=2.94; 95%, CI: 1.394,6.200].

Table 6.6 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality by age group among deceased males in Zambia, 2010-2012 SAVVY

	Model I[a] (15-34)		Model II[b] (35-44)		Model III[c] (45-59)	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual						
Marital Status						
Never married (Ref.)	1.00		1.00		1.00	
Married/Living with a partner	0.49***	[0.320,0.735]	1.23	[0.737,2.059]	0.83	[0.374,1.840]
Divorced/separated/widowed	0.35***	[0.217,0.558]	1.06	[0.582,1.917]	0.48	[0.220,1.040]
Education						
No education (Ref.)	1.00		1.00		1.00	
Primary	1.56	[0.782,3.110]	1.52	[0.528,4.346]	0.92	[0.424,1.973]
Secondary	1.32	[0.642,2.691]	1.30	[0.456,3.695]	0.70	[0.346,1.427]
Higher	0.97	[0.437,2.162]	0.97	[0.324,2.896]	0.70	[0.245,2.002]
Occupation						
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00	
Professionals	1.36	[0.675,2.728]	0.73	[0.244,2.201]	2.16	[0.324,14.39]
Technicians/Associate Professionals	2.28*	[1.065,4.867]	0.37	[0.127,1.050]	1.53	[0.511,4.561]
Clerks	1.94	[0.962,3.890]	1.06	[0.445,2.518]	2.82	[0.804,9.861]
Service\Shop\Market sales workers	1.94*	[1.085,3.470]	0.65	[0.157,2.705]	1.33	[0.564,3.120]
Skilled Agricultural/Fishery workers	1.47	[0.786,2.737]	0.67	[0.258,1.744]	2.16	[0.970,4.791]
Craft and related trade workers	1.75	[0.661,4.619]	0.70	[0.270,1.825]	4.93*	[1.195,20.38]
Plant and Machine Operators/Assemblers	2.16	[0.944,4.933]	0.76	[0.327,1.773]	3.33*	[1.067,10.40]
Elementary Occupations	2.05*	[1.127,3.727]	0.54	[0.238,1.239]	1.94	[0.823,4.585]
Proximate/Intervening						
Tuberculosis						
Yes (Ref.)	1.00		1.00		1.00	
No	1.28	[0.866,1.888]	0.75	[0.492,1.156]	1.03	[0.677,1.557]
Cancer						
Yes (Ref.)	1.00		1.00		1.00	
No	0.42**	[0.235,0.761]	0.20***	[0.110,0.345]	0.49	[0.175,1.364]
Diabetes						
Yes (Ref.)	1.00		1.00		1.00	
No	1.28	[0.502,3.250]	0.49	[0.104,2.303]	0.61	[0.229,1.600]
HIV/AIDS						
Yes (Ref.)	1.00		1.00		1.00	
No	1.19	[0.837,1.691]	1.24	[0.807,1.915]	0.31***	[0.194,0.506]
Accidents & injuries						
Yes (Ref.)	1.00		1.00		1.00	
No	1.05	[0.749,1.483]	0.48**	[0.310,0.755]	1.09	[0.636,1.874]
Drink Alcohol						
Yes (Ref.)	1.00		1.00		1.00	
No	1.80***	[1.331,2.444]	1.33	[0.896,1.959]	0.52*	[0.319,0.851]
Smoke Tobacco						
Yes (Ref.)	1.00		1.00		1.00	
No	1.20	[0.838,1.728]	0.54***	[0.381,0.752]	1.76**	[1.237,2.494]
Household						
Family Relations						
Father (Ref.)	1.00		1.00		1.00	
Mother	1.28	[0.830,1.961]	1.03	[0.511,2.074]	1.48	[0.693,3.156]
Spouse	0.86	[0.516,1.423]	0.39**	[0.220,0.694]	0.66	[0.381,1.155]
Sibling	1.00	[0.599,1.677]	0.84	[0.456,1.542]	1.52	[0.589,3.941]
Child	0.91	[0.461,1.811]	0.70	[0.326,1.480]	1.02	[0.359,2.882]
Other relatives	1.22	[0.744,1.998]	0.85	[0.470,1.526]	1.05	[0.375,2.952]
Community						
Residence						
Rural (Ref.)	1.00		1.00		1.00	
Urban	0.85	[0.644,1.121]	1.65***	[1.244,2.186]	0.97	[0.524,1.805]
Province						
Central (Ref.)	1.00		1.00		1.00	
Copperbelt	1.32	[0.634,2.732]	1.08	[0.593,1.980]	3.27*	[1.140,9.405]
Eastern	1.73*	[1.115,2.671]	0.84	[0.544,1.310]	3.52**	[1.381,8.951]
Luapula	1.45	[0.825,2.556]	0.95	[0.565,1.595]	1.89	[0.702,5.108]
Lusaka	1.50*	[1.010,2.229]	0.92	[0.602,1.404]	2.22	[0.912,5.416]
Northern	2.07**	[1.288,3.310]	1.46	[0.693,3.077]	3.96*	[1.191,13.15]
North Western	3.64**	[1.573,8.411]	1.83	[0.582,5.744]	0.27	[0.057,1.308]
Southern	1.11	[0.668,1.852]	1.11	[0.637,1.933]	1.94	[0.767,4.919]
Western	1.54	[0.869,2.731]	0.80	[0.448,1.431]	1.10	[0.327,3.697]
Community education						
Low (Ref.)	1.00		1.00		1.00	
High	0.73	[0.515,1.032]	1.12	[0.627,2.002]	0.52	[0.177,1.523]
Community treatment received						
Low (Ref.)	1.00		1.00		1.00	
High	1.75***	[1.411,2.175]	1.00	[0.680,1.460]	1.43	[0.779,2.626]
Community health utilisation						
Low (Ref.)	1.00		1.00		1.00	
High	1.11	[0.849,1.443]	0.71	[0.481,1.039]	0.84	[0.423,1.673]
Place of death						
Health facility (Ref.)	1.00		1.00		1.00	
Home	0.95	[0.766,1.177]	1.23	[0.884,1.707]	0.84	[0.497,1.400]
Other	1.74*	[1.090,2.780]	0.61	[0.349,1.060]	2.94**	[1.394,6.200]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category

[a]Model I: Age group 15-34 controlling for individual, health condition/behaviour proximate, household and community variables

[b]Model II: Age group 35-44 controlling for individual, health condition/behaviour proximate, household and community variables

[c]Model III: Age group 45-59 controlling for individual, health condition/behaviour proximate, household and community variables

Adult mortality risk by age and sex-Females

For female decedents, the risk of adult mortality is significantly lower for the married/living with a partner [aHR=0.47; 95%, CI: 0.312,0.696] in age group 15-34 and [aHR=0.53; 95%, CI: 0.295,0.948] in age group 35-44 as shown in table 6.7. The risk of mortality is even significantly lower for the formerly married [aHR=0.38; 95%, CI: 0.240,0.609] female adult deceased persons in age group 15-34. The risk of adult mortality is not statistically significantly different with education among female decedents. The pattern of the risk of mortality variation by level of education is mixed for female decedents in age groups 15-34 and 35-44. It is only in age group 45-59 does the risk of adult mortality decrease with the level of education among female deceased persons.

Among female decedents, the risk of adult mortality is significantly lower for occupation types as technicians\associate professionals [aHR=0.03; 95%, CI: 0.00543,0.154] in age group 35-44. The risk of adult mortality is also significantly lower for female decedents who are clerks [aHR=0.34; 95%, CI: 0.125,0.918] in age group 35-44 and age group 45-49 [aHR=0.14; 95%, CI: 0.0299,0.656]. Furthermore, female adult mortality risk is significantly lower in age group 45-59 for occupations as skilled agricultural/fishery workers [aHR=0.07; 95%, CI: 0.0128,0.363], craft and trade related [aHR=0.10; 95%, CI: 0.0134,0.775], plant and machine operators/assemblers [aHR=0.06; 95%, CI: 0.00357,0.884] and elementary occupations [aHR=0.14; 95%, CI: 0.0282,0.683]. However, female adult mortality risk is higher in age group 15-34 for occupations as service\shop\market sales work [aHR=3.17; 95%, CI: 1.085,9.242] and elementary occupations [aHR=3.20; 95%, CI: 1.192,8.581]. Female adult mortality risk is also significantly high in age group 35-44 for craft and trade related occupation type [aHR=12.23; 95%, CI: 3.664,40.80].

With respect to health conditions, there is no significant difference in adult mortality risk among female decedents across all the three age groups attributable to tuberculosis, cancer and diabetes for deceased persons who did not have the conditions compared to those who had them.

The risk of adult mortality is significantly lower by 58 per cent [aHR=0.42; 95%, CI: 0.183,0.971] among female decedents who did not have HIV/AIDS compared to those who had the health condition in age group 45-59. Female deceased persons in age group 35-44 who did not have accidents and injuries as a health condition have significantly lower adult mortality risk [aHR=0.34; 95%, CI: 0.144,0.784]. On the contrary, female decedents in age group 45-59 have significantly higher mortality risk [aHR=7.54; 95%, CI: 2.228,25.51] compared to females who had accidents and injuries as a health condition.

In terms of health behaviour, there is no significant difference in mortality risk across all three age groups for female decedents who did not drink alcohol and those who consumed alcohol. However, unexpectedly, female decedents in age group 35-44 who did not smoke tobacco have significantly higher adult mortality risk [aHR=3.23; 95%, CI: 1.209,8.609] compared to those who smoked tobacco.

Interestingly, for female decedents in age group 35-44 the risk of adult mortality is significantly higher for all types of family relations. On the contrary, the risk of adult mortality is significantly lower for female deceased persons who had a spouse [aHR=0.18; 95%, CI: 0.0353,0.874] as a family relation in age group 45-59.

For female decedents across all three age groups, the risk of adult mortality is not statistically significantly different between urban and rural areas. At provincial level, however, the risk of adult mortality is significantly higher for female deceased persons in age group 15-34 in Luapula province [aHR=2.56; 95%, CI: 1.164,5.619] and Northern province [aHR=2.28; 95%, CI: 1.049,4.973], and for age group 45-59, it is Northern province [aHR=4.41; 95%, CI: 1.092,17.80].

Among female deceased persons, across all age groups there is no significant difference in adult mortality risk by living in a community with a high proportion of educated persons compared with living in a community with a low proportion of educated persons. Furthermore, there is a significant difference in mortality risk among female decedents that lived in communities with a high proportion of persons receiving treatment for their health conditions compared to those who resided in communities with a low proportion of persons receiving treatment for their health conditions in age group 15-34. The mortality risk significantly lower by 30 per cent [aHR=0.70; 95%, CI: 0.500,0.974] for female decedents who lived in communities with a high proportion of persons receiving treatment for their health conditions. For female deceased persons in age group 45-59, there is a significantly lower adult mortality risk of 74 per cent [aHR=0.26; 95%, CI: 0.107,0.632] for those who lived in communities with a high proportion of health care utilisation compared to decedents who resided in communities with a low proportion of health care utilisation.

Home place of death and other place of death have significantly higher adult mortality risk for female decedents in age group 45-59, aHR=3.18; 95%, CI: 1.641,6.149, and aHR=7.20; 95%, CI: 1.824,28.37, respectively. Other place of death has a significantly higher risk of adult mortality for female deceased persons in age group 35-44 [aHR=2.93; 95%, CI: 1.173,7.326] compared with health facility place of death.

Table 6.7 Multivariate Cox proportional hazards regression analysis showing hazard ratios of adult mortality by age group among deceased females in Zambia, 2010-2012 SAVVY

	Model I[a] (15-34)		Model II[b] (35-44)		Model III[c] (45-59)	
Predictor	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual						
Marital Status						
Never married (Ref.)	1.00		1.00		1.00	
Married/Living with a partner	0.47***	[0.312,0.696]	0.53*	[0.295,0.948]	1.77	[0.375,8.374]
Divorced/separated/widowed	0.38***	[0.240,0.609]	0.96	[0.572,1.613]	1.62	[0.598,4.402]
Education						
No education (Ref.)	1.00		1.00		1.00	
Primary	0.83	[0.546,1.255]	1.02	[0.563,1.857]	1.26	[0.500,3.149]
Secondary	0.96	[0.597,1.547]	1.11	[0.571,2.173]	1.21	[0.509,2.860]
Higher	2.00	[0.870,4.578]	2.28	[0.442,11.74]	0.56	[0.157,1.982]
Occupation						
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00	
Professionals					0.67	[0.134,3.375]
Technicians/Associate Professionals	3.32	[0.922,11.96]	0.03***	[0.005,0.154]		
Clerks	1.64	[0.581,4.612]	0.34*	[0.125,0.918]	0.14*	[0.030,0.656]
Service\Shop\Market sales workers	3.17*	[1.085,9.242]	0.34	[0.100,1.130]	0.22	[0.033,1.452]
Skilled Agricultural/Fishery workers	2.02	[0.775,5.247]	0.45	[0.179,1.105]	0.07**	[0.013,0.363]
Craft and related trade workers	2.16	[0.622,7.504]	12.23***	[3.664,40.80]	0.10*	[0.013,0.775]
Plant and Machine Operators/Assemblers	2.01	[0.548,7.357]	0.74	[0.145,3.740]	0.06*	[0.004,0.884]
Elementary Occupations	3.20*	[1.192,8.581]	0.46	[0.151,1.428]	0.14*	[0.028,0.683]
Proximate/Intervening						
Tuberculosis						
Yes (Ref.)	1.00		1.00		1.00	
No	0.76	[0.511,1.136]	1.28	[0.531,3.077]	0.66	[0.301,1.467]
Cancer						
Yes (Ref.)	1.00		1.00		1.00	
No	1.63	[0.476,5.578]	0.89	[0.447,1.754]	1.89	[0.471,7.593]
Diabetes						
Yes (Ref.)	1.00		1.00		1.00	
No	2.14	[0.974,4.707]	0.67	[0.151,2.919]	0.68	[0.238,1.937]
HIV/AIDS						
Yes (Ref.)	1.00		1.00		1.00	
No	1.21	[0.950,1.534]	0.86	[0.514,1.428]	0.42*	[0.183,0.971]
Accidents & injuries						
Yes (Ref.)	1.00		1.00		1.00	
No	0.71	[0.433,1.169]	0.34*	[0.144,0.784]	7.54**	[2.228,25.51]
Drink Alcohol						
Yes (Ref.)	1.00		1.00		1.00	
No	0.84	[0.584,1.210]	0.83	[0.541,1.260]	0.92	[0.442,1.908]
Smoke Tobacco						
Yes (Ref.)	1.00		1.00		1.00	
No	2.59	[0.924,7.283]	3.23*	[1.209,8.609]	1.28	[0.664,2.463]
Household						
Family Relations						
Father (Ref.)	1.00		1.00		1.00	
Mother	0.80	[0.487,1.311]	6.42***	[2.228,18.52]	0.28	[0.036,2.096]
Spouse	1.11	[0.639,1.938]	4.47**	[1.675,11.90]	0.18*	[0.035,0.874]
Sibling	1.30	[0.733,2.293]	5.01**	[1.635,15.38]	0.36	[0.044,2.908]
Child	0.87	[0.536,1.395]	2.60*	[1.072,6.295]	0.37	[0.049,2.714]
Other relatives	1.29	[0.710,2.342]	4.36**	[1.458,13.02]	1.00	[0.128,7.787]
Community						
Residence						
Rural (Ref.)	1.00		1.00		1.00	
Urban	0.77	[0.581,1.010]	1.14	[0.653,1.991]	0.98	[0.346,2.761]
Province						
Central (Ref.)	1.00		1.00		1.00	
Copperbelt	0.64	[0.298,1.360]	2.01	[0.231,17.55]	1.14	[0.390,3.352]
Eastern	1.15	[0.585,2.272]	0.56	[0.256,1.220]	0.76	[0.166,3.471]
Luapula	2.56*	[1.164,5.619]	1.15	[0.392,3.351]	0.64	[0.171,2.396]
Lusaka	0.98	[0.478,2.003]	1.27	[0.523,3.057]	0.45	[0.198,1.006]
Northern	2.28*	[1.049,4.973]	1.55	[0.485,4.950]	4.41*	[1.092,17.80]
North Western	1.43	[0.445,4.593]	0.49	[0.220,1.085]	0.38	[0.131,1.101]
Southern	1.44	[0.718,2.907]	1.44	[0.571,3.645]	0.51	[0.116,2.285]
Western	0.88	[0.498,1.559]	2.87	[0.961,8.543]	0.75	[0.269,2.064]
Community education						
Low (Ref.)	1.00		1.00		1.00	
High	0.77	[0.510,1.153]	1.17	[0.583,2.343]	1.35	[0.720,2.544]
Community treatment received						
Low (Ref.)	1.00		1.00		1.00	
High	0.70*	[0.500,0.974]	2.00	[0.930,4.297]	0.75	[0.339,1.648]
Community health utilisation						
Low (Ref.)	1.00		1.00		1.00	
High	0.94	[0.613,1.430]	0.64	[0.349,1.161]	0.26**	[0.107,0.632]
Place of death						
Health facility (Ref.)	1.00		1.00		1.00	
Home	0.78	[0.569,1.068]	0.57	[0.306,1.047]	3.18***	[1.641,6.149]
Other	0.99	[0.455,2.144]	2.93*	[1.173,7.326]	7.20**	[1.824,28.37]

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category
[a]Model I: Age group 15-34 controlling for individual, health condition/behaviour proximate, household and community variables
[b]Model II: Age group 35-44 controlling for individual, health condition/behaviour proximate, household and community variables
[c]Model III: Age group 45-59 controlling for individual, health condition/behaviour proximate, household and community variables

6.5 Multivariate multilevel survival analysis

Multilevel analysis was performed to sustain the ecological argument that health outcomes cannot be understood in isolation but by considering societal context within which they occur through the influences of individual, household, and community level factors. Multilevel analysis, therefore, facilitates the examination and determination of the contribution of community level or ecological factors in influencing health outcomes like adult mortality by partitioning of the total variation of individual and community through measures of variation. The contribution of ecological factors is determined by estimating the intra-cluster correlation coefficient (ICC).

Table 6.8 presents results of the multilevel analysis. For the fixed effects part, the risk of adult in the individual model is significantly higher for female deceased persons [HR=1.28; 95%, CI: 1.117,1.474] compared male decedents. However, after adjusting for all factors in the combined model the risk of adult mortality for female decedents is slightly lower compared to that of male deceased persons but it is statistically insignificant. By marital status, the risk of adult mortality is significantly lower for the married/living with a partner [HR=0.24; 95%, CI: 0.177,0.332] and formerly married [HR=0.23; 95%, CI: 0.162,0.320] decedents compared to the never married deceased persons. After controlling for all factors in the combined model, the risk of adult mortality remains significantly lower for married/living with a partner and formerly married decedents compared to the never married deceased persons. For the married/living with a partner decedents the risk of mortality slightly increased [HR=0.28; 95%, CI: 0.182,0.445] whereas for the formerly married the risk of mortality slightly decreased [HR=0.20; 95%, CI: 0.120,0.318].

Education is negatively associated with the risk of adult mortality. The risk of mortality decreases with the level of education. Deceased persons with higher level of education have a significantly lower risk of mortality [HR=0.62; 95%, CI: 0.443,0.858] compared to decedents with no education. After controlling for all factors in the combined model, the risk of adult mortality decreases further by level of education and it is significantly lower for decedents with secondary [HR=0.67; 95%, CI: 0.492,0.907] and higher [HR=0.50; 95%, CI: 0.382,0.659] levels of education.

By occupation type, the risk of adult mortality is significantly higher for decedents in occupations as professionals [HR=1.98; 95%, CI: 1.144,3.432], clerks [HR=1.84; 95%, CI: 1.174,2.880], skilled agricultural/fishery [HR=1.47; 95%, CI: 1.075,2.021], craft and trade related [HR=2.49; 95%, CI: 1.942,3.201], plant and machine operators/assemblers [HR=2.32; 95%, CI: 1.449,3.707], and elementary occupation types [HR=2.46; 95%, CI: 1.803,3.361]. Controlling for all variables in the adjusted model, the risk of adult mortality remains significantly high for occupations as clerks [HR=1.51; 95%, CI: 1.051,2.160], craft and trade related [HR=2.28; 95%, CI: 1.542,3.372], plant and machine operators/assemblers [HR=1.90; 95%, CI: 1.204,3.011], and elementary occupations [HR=2.36; 95%, CI: 1.647,3.376].

For the health conditions and behaviour model, there is no significant difference in the risk of adult mortality between deceased persons who did not have tuberculosis and those who had tuberculosis. After controlling for all factors in the combined model, the risk of mortality appears to be lower for decedents who did not have tuberculosis compared to those who had the health condition, though not statistically significant. The risk of adult mortality for decedents who did not have cancer is unexpectedly significantly higher [HR=1.27; 95%, CI: 1.013,1.584] compared to those who had cancer. However, after controlling for all the variables in the combined model, the risk of mortality is no longer statistically significantly higher but the hazard ratio remained above 1. The same is the case of the risk of adult mortality for decedents who did not have diabetes compared to those who had diabetes.

The risk of adult mortality for decedents who did not have HIV/AIDS is significantly lower [HR=0.85; 95%, CI: 0.722,0.996] in the health condition and behaviour model but the risk is no longer significantly lower after controlling for all factors in the combined model. The same situation is observed for the risk of mortality for decedents who did not have accidents and injuries compared to those who had them as a health condition.

With respect to health behaviour, there is no significant difference in the risk of adult mortality for deceased persons who did not drink alcohol compared with those who consumed alcohol in both the health conditions and behaviour model and the combined model adjusting for all factors. Unexpectedly, decedents who did not smoke tobacco have a significantly higher risk of adult mortality [HR=1.40; 95%, CI: 1.242,1.572] compared with those who smoked tobacco, even after controlling for all factors in the combined model, the association remained significant [HR=1.82; 95%, CI: 1.510,2.190].

The risk of adult mortality in the household/family model is significantly lower for decedents who had a mother [HR=0.79; 95%, CI: 0.637,0.981], spouse [HR=0.33; 95%, CI: 0.223,0.476], sibling [HR=0.63; 95%, CI: 0.448,0.888], child [HR=0.64; 95%, CI: 0.485,0.841], and other relatives [HR=0.70; 95%, CI: 0.550,0.879] as family relations. After controlling for all other variables in the combined model, the risk of mortality remained significantly lower for deceased adults who had a spouse [HR=0.29; 95%, CI: 0.214,0.378], sibling [HR=0.67; 95%, CI: 0.474,0.959], child [HR=0.72; 95%, CI: 0.530,0.986], and other relatives [HR=0.71; 95%, CI: 0.546,0.910] as family relations.

There is no significant difference in the risk of adult mortality in the community or ecological model between decedents who lived in urban areas and those who resided in rural areas. In the combined model, after controlling for all factors, there is still no significant difference in the risk of adult mortality between urban and rural areas. By province of residence, in the ecological model, the risk of adult mortality is significantly high in Copperbelt province [HR=1.44; 95%, CI: 1.112,1.855] and significantly lower in Southern province [HR=0.77; 95%, CI: 0.614,0.967]. After adjusting for all factors in the combined model, the risk of mortality is significantly higher in

Luapula province [HR=1.44; 95%, CI: 1.058,1.957], and Northern province [HR=1.92; 95%, CI: 1.081,3.420] compared to decedents in Central province.

In the ecological model, the risk of adult mortality is significantly lower by 33 per cent [HR=0.67: 95%, CI: 0.577,0.781] for decedents who lived in communities with a high proportion of educated persons compared with those who lived in communities with a low proportion of educated persons. Even after controlling for all factors in the combined model, the risk of adult mortality remained significantly lower [HR=0.59; 95%, CI: 0.491,0.718] for deceased persons who lived in communities with a high proportion of educated persons. Unexpectedly, decedents who lived in communities with a high proportion of persons receiving treatment for their health conditions have a significantly higher risk of adult mortality, even after controlling for all other factors in the combined model. There is no significant difference in mortality risk in both the ecological model and in the combined model for decedents who lived in communities with a high proportion of health care utilisation compared with those who lived in communities with a low proportion of health care utilisation.

The risk of adult mortality is significantly higher for home place of death [HR=1.28; 95%, CI: 1.100,1.484] and other place of death [HR=1.42; 95%, CI: 1.149,1.750] compared to health facility place of death. However, after controlling for all variables in the combined model only other place of death remained with a significantly higher risk of adult mortality [HR=1.47; 95%, CI: 1.218,1.767].

The random effects show that about 2.3 per cent of the total variation in mortality is due to intra-community compositional differences. Individual differences between clusters accounted for 0.43 per cent of the variation in mortality; whereas health conditions/behaviour factors accounted for 0.08 per cent of the variation in mortality. Family relations at household level accounted for 0.37 per cent of the mortality variation. The ecological or community factors accounted for 0.07 per cent.

Adjusting for all factors in the model reduces the intra-community correlation to 0.04 per cent meaning that the community level factors have an effect on the risk of adult mortality.

Table 6.8 Multivariate multilevel proportional hazards regression analysis showing hazard ratios of adult mortality among both deceased males and female in Zambia, 2010-2012 SAVVY

Predictors/Fixed effects	Null model	Individual factors HR	Individual factors [95% CI]	Health condition/behaviour proximate factors HR	Health condition/behaviour proximate factors [95% CI]	Household/family factors HR	Household/family factors [95% CI]	Community factors HR	Community factors [95% CI]	All combined factors HR	All combined factors [95% CI]
Sex											
Male (Ref.)		1.00								1.00	
Female		1.28***	[1.117,1.474]							0.97	[0.812,1.149]
Marital Status											
Never married (Ref.)		1.00								1.00	
Married/Living with a partner		0.24***	[0.177,0.332]							0.28***	[0.182,0.445]
Divorced/separated/widowed		0.23***	[0.162,0.320]							0.20***	[0.120,0.318]
Education											
No education (Ref.)		1.00								1.00	
Primary		0.89	[0.621,1.260]							0.70	[0.474,1.036]
Secondary		0.84	[0.630,1.129]							0.67*	[0.492,0.907]
Higher		0.62**	[0.443,0.858]							0.50***	[0.382,0.659]
Occupation											
Legislators/Senior Officials/Managers (Ref.)		1.00								1.00	
Professionals		1.98*	[1.144,3.432]							1.62	[0.870,3.002]
Technicians/Associate Professionals		1.30	[0.730,2.304]							1.09	[0.561,2.131]
Clerks		1.84**	[1.174,2.880]							1.51*	[1.051,2.160]
Service\Shop\Market sales workers		1.43	[0.951,2.134]							1.48	[0.832,2.636]
Skilled Agricultural/Fishery workers		1.47*	[1.075,2.021]							1.45	[0.966,2.185]
Craft and related trade workers		2.49***	[1.942,3.201]							2.28***	[1.542,3.372]
Plant and Machine Operators/Assemblers		2.32***	[1.449,3.707]							1.90**	[1.204,3.011]
Elementary Occupations		2.46***	[1.803,3.361]							2.36***	[1.647,3.376]
Smoke Tobacco											
Yes (Ref.)				1.00						1.00	
No				1.40***	[1.242,1.572]					1.82***	[1.510,2.190]
Family Relations											
Father (Ref.)						1.00				1.00	
Mother						0.79*	[0.637,0.981]			0.85	[0.699,1.024]
Spouse						0.33***	[0.223,0.476]			0.29***	[0.214,0.378]
Sibling						0.63**	[0.448,0.888]			0.67*	[0.474,0.959]
Child						0.64**	[0.485,0.841]			0.72*	[0.530,0.986]
Other relatives						0.70**	[0.550,0.879]			0.71**	[0.546,0.910]
Province											
Central (Ref.)								1.00		1.00	
Copperbelt								1.44**	[1.112,1.855]	1.45	[0.874,2.420]
Eastern								1.01	[0.800,1.284]	1.25	[0.810,1.920]
Luapula								1.03	[0.762,1.388]	1.44*	[1.058,1.957]
Lusaka								1.10	[0.800,1.525]	1.28	[0.929,1.752]
Northern								1.18	[0.815,1.722]	1.92*	[1.081,3.420]
North Western								0.94	[0.654,1.343]	0.69	[0.344,1.367]
Southern								0.77*	[0.614,0.967]	0.90	[0.649,1.245]
Western								1.06	[0.715,1.582]	1.05	[0.721,1.519]
Community education											
Low (Ref.)								1.00		1.00	
High								0.67***	[0.577,0.781]	0.59***	[0.491,0.718]
Community treatment received											
Low (Ref.)								1.00		1.00	
High								1.14*	[1.008,1.293]	1.20*	[1.039,1.393]
Place of death											
Health facility (Ref.)								1.00		1.00	
Home								1.28**	[1.100,1.484]	1.20	[0.997,1.449]
Other								1.42**	[1.149,1.750]	1.47***	[1.218,1.767]
Random effects											
Variance (SE)	0.0075*** (0.0012)	0.0159*** (0.0145)		0.0026*** (0.0009)		0.0128***(0.0020)		0.0024 (0.0012)		0.0015 (0.0008)	
VPC/ICC	**2.26**	**0.43**		**0.08**		**0.37**		**0.07**		**0.04**	
AIC	623.4	368.5		579.3		535.6		618.3		236.7	
BIC	643.4	458.1		634.1		580.6		713.3		459.6	

* p<0.05, ** p<0.01, *** p<0.001; HR - Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category; SE - Standard Error
Variables not statistically significant included in the model: Cancer, Diabetes, HIV/AIDS, Tuberculosis, Accidents & Injuries, Drink alcohol, Residence, Community health utilisation

Multilevel analysis-Male adult mortality risk

A further multilevel analysis of the risk of adult mortality by sex is presented in subsequent sections for males and females. Table 6.9 shows that the risk of adult mortality for married/living with a partner is significantly lower [HR=0.22; 95%, CI: 0.155,0.298] for male decedents and so is the mortality risk of the formerly married [HR=0.25; 95%, CI: 0.187,0.325] compared to never married male deceased persons. In the combined model, after controlling for all factors, the risk of adult mortality remains significantly lower for both married/living with a partner [HR=0.20; 95%, CI: 0.131,0.339] and formerly married [HR=0.23; 95%, CI: 0.148,0.346] decedents. The risk of mortality is further significantly reduced for the ever-married male decedents compared with the never married deceased persons. For male adult decedents, the risk of mortality decreases by level of education in both the individual model and the combined model, however, this is statistically insignificant.

The risk of adult mortality among male decedents by occupation type is significantly high for occupations as craft and trade related [HR=3.26; 95%, CI: 2.414,4.396], plant and machine operators/assemblers [HR=2.42; 95%, CI: 1.557,3.766], and elementary occupations [HR=2.71; 95%, CI: 1.654,4.428]. After controlling for all factors in the combined model, the risk of mortality remained significantly high for occupations: craft and trade related [HR=3.48; 95%, CI: 2.004,6.038], plant and machine operators/assemblers [HR=1.94; 95%, CI: 1.060,3.544], and elementary occupations [HR=2.60; 95%, CI: 1.370,4.942].

For deceased adult males, with respect to health conditions, there is no significant difference in the risk of mortality between those who did not have tuberculosis, cancer, diabetes, and HIV/AIDS, and those who had these health conditions even after controlling for all the factors in the combined model. Adult male decedents who did not have accidents and injuries as a health condition have significantly lower risk of mortality [HR=0.69; 95%, CI: 0.498,0.954], however, after controlling for all the factors in the combined model the association is no longer statistically significant.

The risk of adult mortality is unexpectedly significantly high [HR=1.39; 95%, CI: 1.017,1.909] for deceased males who did not drink alcohol compared with those who drank alcohol after controlling for all other factors in the combined model. Unexpectedly also, the risk of adult mortality is high for adult male decedents who did not smoke tobacco compared with those who smoked, this is statistically significant before [HR=1.35; 95%, CI: 1.113,1.639] and after [HR=1.68; 95%, CI: 1.286,2.200] adjusting for all variables in the combined model.

The risk of adult mortality for deceased males is significantly lower for those who had a spouse [HR=0.30; 95%, CI: 0.181,0.489] and other relative [HR=0.64; 95%, CI: 0.432,0.937] as a family relation. After controlling for all other variables in the model, the risk of mortality is even significantly lower, for spouse [HR=0.26; 95%, CI: 0.179,0.363], sibling [HR=0.52; 95%, CI: 0.352,0.775], and other relative [HR=0.56; 95%, CI: 0.412,0.765].

There is a significant difference in the risk of adult mortality for deceased males by urban-rural residence. The risk of adult mortality is significantly lower [HR=0.89; 95%, CI: 0.803,0.984] in urban areas than rural areas after controlling for all factors in the combined model for deceased males. By provincial residence, the risk of adult mortality is significantly lower for male decedents in Southern province [HR=0.64; 95%, CI: 0.415,0.984], however, this association is no longer significant after controlling for all factors in the model. The risk of adult mortality remained significantly high for male decedents in Northern province [HR=2.68; 95%, CI: 1.557,4.610] after controlling for all factors in the combined model.

The risk of adult mortality is significantly lower [HR=0.44; 95%, CI: 0.362,0.529] for male deceased persons who lived in communities with a high proportion of educated persons compared to those who resided in communities with a low proportion of educated persons. The mortality risk is further reduced [HR=0.32; 95%, CI: 0.256,0.396] after controlling for all factors in the combined model. Unexpectedly, the risk of adult mortality is significantly higher [HR=1.32; 95%, CI: 1.053,1.664] for male decedents who lived in communities with a high proportion of persons receiving treatment for their health conditions compared to those who resided in communities with a low proportion of persons receiving treatment for their health conditions, after controlling for all factors in the model. The same situation is observed for the mortality risk of adult male decedents who lived in communities with a high proportion of health care utilisation compared with deceased person who lived in communities with a low proportion of health care utilisation.

Other place of death is associated with significantly high risk of adult mortality [HR=1.52; 95%, CI: 1.201,1.924], however, in the adjusted model controlling for all factors, the risk of adult mortality for deceased males is no longer statistically significant for place of death.

The random effects show that, for males, individual differences between communities accounted for 1.14 per cent of the variation in mortality. Health conditions/behaviour factors accounted for 0.86 per cent of the variation in mortality. Family relations at household level accounted for 1.03 per cent of the mortality variation. Community factors accounted for 0.17 per cent. Adjusting for all factors in the model reduces the intra-community correlation to 0.10 per cent implying that community level factors influence the risk of adult mortality for males.

Table 6.9 Multivariate multilevel proportional hazards regression analysis showing hazard ratios of adult mortality among deceased males in Zambia, 2010-2012 SAVVY

Predictors/Fixed effects	Null model	Individual factors HR	Individual factors [95% CI]	Health condition/behaviour proximate factors HR	Health condition/behaviour proximate factors [95% CI]	Household/family factors HR	Household/family factors [95% CI]	Community factors HR	Community factors [95% CI]	All combined factors HR	All combined factors [95% CI]
Marital Status											
Never married (Ref.)		1.00								1.00	
Married/Living with a partner		0.22***	[0.155,0.298]							0.20***	[0.131,0.339]
Divorced/separated/widowed		0.25***	[0.187,0.325]							0.23***	[0.148,0.346]
Occupation											
Legislators/Senior Officials/Managers (Ref.)		1.00								1.00	
Professionals		2.08	[0.989,4.384]							2.27	[0.801,6.426]
Technicians/Associate Professionals		1.09	[0.412,2.897]							1.08	[0.334,3.478]
Clerks		1.74	[0.901,3.368]							1.72	[0.889,3.321]
Service\Shop\Market sales workers		1.28	[0.790,2.084]							1.53	[0.793,2.959]
Skilled Agricultural/Fishery workers		1.51	[0.833,2.745]							1.96	[0.949,4.066]
Craft and related trade workers		3.26***	[2.414,4.396]							3.48***	[2.004,6.038]
Plant and Machine Operators/Assemblers		2.42***	[1.557,3.766]							1.94*	[1.060,3.544]
Elementary Occupations		2.71***	[1.654,4.428]							2.60**	[1.370,4.942]
Accidents & injuries											
Yes (Ref.)				1.00						1.00	
No				0.69*	[0.498,0.954]					0.82	[0.519,1.296]
Drink Alcohol											
Yes (Ref.)				1.00						1.00	
No				1.12	[0.909,1.377]					1.39*	[1.017,1.909]
Smoke Tobacco											
Yes (Ref.)				1.00						1.00	
No				1.35**	[1.113,1.639]					1.68***	[1.286,2.200]
Family Relations											
Father (Ref.)						1.00				1.00	
Mother						1.17	[0.641,2.118]			1.20	[0.732,1.966]
Spouse						0.30***	[0.181,0.489]			0.26***	[0.179,0.363]
Sibling						0.61	[0.356,1.045]			0.52**	[0.352,0.775]
Child						0.70	[0.377,1.307]			0.64	[0.390,1.049]
Other relatives						0.64*	[0.432,0.937]			0.56***	[0.412,0.765]
Residence											
Rural (Ref.)								1.00		1.00	
Urban								0.97	[0.784,1.209]	0.89*	[0.803,0.984]
Province											
Central (Ref.)								1.00		1.00	
Copperbelt								1.21	[0.716,2.042]	1.30	[0.713,2.379]
Eastern								0.92	[0.582,1.468]	1.21	[0.726,2.006]
Luapula								0.76	[0.463,1.258]	1.12	[0.639,1.973]
Lusaka								1.21	[0.711,2.064]	1.56	[0.969,2.510]
Northern								1.28	[0.660,2.479]	2.68***	[1.557,4.610]
North Western								1.66	[0.719,3.843]	2.16	[0.984,4.729]
Southern								0.64*	[0.415,0.984]	0.74	[0.468,1.176]
Western								1.07	[0.527,2.165]	1.04	[0.426,2.527]
Community education											
Low (Ref.)								1.00		1.00	
High								0.44***	[0.362,0.529]	0.32***	[0.256,0.396]
Community treatment received											
Low (Ref.)								1.00		1.00	
High								1.26	[0.997,1.579]	1.32*	[1.053,1.664]
Community health utilisation											
Low (Ref.)								1.00		1.00	
High								1.04	[0.875,1.242]	1.32*	[1.049,1.658]
Place of death											
Health facility (Ref.)								1.00		1.00	
Home								1.04	[0.874,1.230]	0.87	[0.688,1.107]
Other								1.52***	[1.201,1.924]	1.00	[0.631,1.587]
Random effects											
Variance (SE)	0.0075*** (0.0012)	0.0456***(0.0061)		0.0308***(0.0058)		0.0379 (0.0046)		0.0058 (0.0001)		0.0040 (0.0002)	
VPC/ICC	**2.26**	**1.14**		**0.86**		**1.03**		**0.17**		**0.10**	
AIC	623.4	365.5		576.3		531.6		614.3		336.7	
BIC	643.4	459.1		632.1		583.6		711.3		559.6	

* p<0.05, ** p<0.01, *** p<0.001; HR - Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category; SE - Standard Error
Variables not statistically significant but included in the model: Education, Tuberculosis, Cancer, Diabetes, HIV/AIDS

Multilevel analysis-Female adult mortality risk

An analysis of the risk of adult mortality for female decedents in Table 6.10 shows that the risk of mortality remains significantly lower before and after controlling for all variables in the combined model; for married/living with a partner [HR=0.15; 95%, CI: 0.0556,0.401] and formerly married [HR=0.13; 95%, CI: 0.0470,0.367]. Controlling for other variables in the model, the mortality risk of married/living with a partner is slightly attenuated [HR=0.20; 95%, CI: 0.0738,0.549] whereas the risk of mortality for the formerly married it is further significantly lowered [HR=0.11; 95%, CI: 0.0337,0.350] compared with the never married male decedents.

By education, the risk of adult mortality for female decedents it is not statistically significant, however, the risk of mortality varies by level of education after controlling for all factors in the combined model as the hazard ratios decreased in magnitude and decline with level of education. For female adult decedents, the risk of adult mortality is not statistically significantly different by type of occupation either before or after controlling for all variables in the combined model.

After controlling for all factors in the combined model, the risk of adult mortality is significantly lower for female decedents who did not have tuberculosis [HR=0.69; 95%, CI: 0.499,0.961] compared to those who had tuberculosis. There is no significant difference in the risk of adult mortality for adult female decedents between those who did not have cancer and those who had cancer as a health condition. Unexpectedly, even after controlling for other factors, the risk of adult mortality remained significantly high for female decedents who did not have diabetes [HR=2.28; 95%, CI: 1.133,4.568] compared with those who had diabetes as a health condition.

As expected, the risk of adult mortality is significantly lower [HR=0.85; 95%, CI: 0.735,0.976] for female deceased persons who did not have HIV/AIDS compared with those who had HIV/AIDS as a health condition after controlling for all factors in the model. Adult female decedents who did not have accidents and injuries as a health condition have a significantly lower risk of mortality [HR=0.54; 95%, CI: 0.305,0.954] compared with those who had, after controlling for all other factors in the combined model.

In terms of health behaviour, there is no significant difference in mortality risk between adult female deceased persons who did not drink alcohol and those who drank alcohol, even after controlling for all factors in the combined model. Female decedents who did not smoke tobacco, unexpectedly have a significantly higher risk of adult mortality [HR=3.29; 95%, CI: 2.001,5.400] compared to those who smoked tobacco after controlling for other variables in the combined model.

The risk of adult mortality is significantly lower for female deceased persons who had a mother [HR=0.54; 95%, CI: 0.334,0.875], spouse [HR=0.24; 95%, CI: 0.128,0.455], sibling [HR=0.54; 95%, CI: 0.329,0.892] and child [HR=0.47; 95%, CI: 0.342,0.635] as a family relation, however, after controlling for all factors in the combined model only, female decedents with a mother [HR=0.60; 95%, CI: 0.371,0.968] and spouse [HR=0.19; 95%, CI: 0.0777,0.461] remained with significantly lower risk of adult mortality.

For female decedents, there is no significant difference in the risk of adult mortality between urban and rural areas, even after adjusting for all factors in the combined model. By province of residence, Copperbelt province has a significantly higher risk of adult mortality [HR=1.98; 95%, CI: 1.039,3.783] for female decedents, however, after controlling for other factors in the combined model the association is insignificant. North-western province has significantly lower risk of adult mortality [HR=0.36; 95%, CI: 0.134,0.945] for female decedents after adjusting for all factors in the combined model.

There is no significant difference in the risk of mortality for female decedents who lived in communities with a high proportion of educated persons compared with those who resided in communities with a low proportion of educated persons, even after controlling for other factors in the combined model. The same observation applies to the risk of adult mortality for female decedents who lived in communities with a high proportion of persons receiving treatment for their health conditions compared with those who resided in communities with a low proportion of persons receiving treatment for their health conditions. On the other hand, there is a significantly lower risk of adult mortality [HR=0.76; 95%, CI: 0.592,0.974] for female decedents who lived in communities with a high proportion of health care utilisation compared to those who resided in communities with a low proportion of health care utilisation, after controlling for all variables in the combined model. Place of death is not statistically significantly associated with the risk of adult mortality among female decedents, before and after controlling for other variables in the model.

For females, the random effects show that individual differences between communities accounted for 0.4 per cent of the variation in mortality. Health conditions/behaviour factors accounted for 0.3 per cent of the variation in mortality. Family relations at household level accounted for 0.13 per cent of the mortality variation. Community factors accounted for 0.05 per cent. Adjusting for all factors in the model reduces the intra-community correlation to 0.02 per cent implying a marginal effect of community level factors on the risk of adult mortality for females.

Table 6.10 Multivariate multilevel proportional hazards regression analysis showing hazard ratios of adult mortality among deceased females in Zambia, 2010-2012 SAVVY

Predictors/Fixed effects	Null model	Individual factors HR	Individual factors [95% CI]	Health condition/behaviour proximate factors HR	Health condition/behaviour proximate factors [95% CI]	Household/family factors HR	Household/family factors [95% CI]	Community factors HR	Community factors [95% CI]	All combined factors HR	All combined factors [95% CI]
Marital Status											
Never married (Ref.)		1.00								1.00	
Married/Living with a partner		0.15***	[0.056,0.401]							0.20**	[0.074,0.549]
Divorced/separated/widowed		0.13***	[0.047,0.367]							0.11***	[0.034,0.350]
Tuberculosis											
Yes (Ref.)				1.00						1.00	
No				0.92	[0.746,1.134]					0.69*	[0.499,0.961]
Diabetes											
Yes (Ref.)				1.00						1.00	
No				2.26*	[1.091,4.666]					2.28*	[1.133,4.568]
HIV/AIDS											
Yes (Ref.)				1.00						1.00	
No				0.84	[0.679,1.026]					0.85*	[0.735,0.976]
Accidents & injuries											
Yes (Ref.)				1.00						1.00	
No				0.85	[0.475,1.510]					0.54*	[0.305,0.954]
Smoke Tobacco											
Yes (Ref.)				1.00						1.00	
No				1.94***	[1.412,2.661]					3.29***	[2.001,5.400]
Family Relations											
Father (Ref.)						1.00				1.00	
Mother						0.54*	[0.334,0.875]			0.60*	[0.371,0.968]
Spouse						0.24***	[0.128,0.455]			0.19***	[0.078,0.461]
Sibling						0.54*	[0.329,0.892]			0.71	[0.322,1.545]
Child						0.47***	[0.342,0.635]			0.62	[0.344,1.119]
Other relatives						0.66	[0.388,1.111]			0.65	[0.353,1.189]
Province											
Central (Ref.)								1.00		1.00	
Copperbelt								1.98*	[1.039,3.783]	1.79	[0.772,4.132]
Eastern								1.12	[0.751,1.654]	1.14	[0.583,2.220]
Luapula								1.52	[0.897,2.565]	1.60	[0.821,3.107]
Lusaka								1.03	[0.685,1.544]	0.87	[0.532,1.432]
Northern								1.32	[0.835,2.098]	1.69	[0.829,3.441]
North Western								0.73	[0.439,1.200]	0.36*	[0.134,0.945]
Southern								0.98	[0.564,1.698]	1.06	[0.615,1.820]
Western								1.10	[0.732,1.645]	1.15	[0.788,1.663]
Community health utilisation											
Low (Ref.)								1.00		1.00	
High								0.84*	[0.738,0.961]	0.76*	[0.592,0.974]
Random effects											
Variance (SE)	0.0075*** (0.0012)	0.0158***(0.0035)		0.0011***(0.0005)		0.0048***(0.0002)		0.00195 (0.0001)		0.00081 (0.0004)	
VPC/ICC	**2.26**	**0.40**		**0.30**		**0.13**		**0.05**		**0.02**	
AIC	623.4	363.5		570.3		529.6		612.3		334.7	
BIC	643.4	455.1		631.1		582.6		710.3		557.6	

* p<0.05, ** p<0.01, *** p<0.001; HR - Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category; SE - Standard Error
Variables not statistically significant but included in the model: Education, Occupation, Cancer, Drink alcohol, Residence, Community education, Community treatment received, Place of death

Multilevel analysis- adult mortality risk by age

The study further performed multilevel analysis by the three age groups (15-34, 35-44 and 45-59) utilised and presented earlier in the other models, in order to assess the contribution of the factors to the risk of adult mortality by age. Table 6.11 shows that only in age group 35-44 is the risk of adult mortality significantly lower for female decedents [HR=0.58; 95%, CI: 0.463,0.735] compared to male deceased persons. The risk of adult mortality is also significantly lower only in age group 15-34 by marital status, for the married/living with partner [HR=0.47; 95%, CI: 0.324,0.694] and formerly married [HR=0.41; 95%, CI: 0.281,0.589] decedents.

By education, there is no statistically significant difference in the risk of adult mortality across all the three age groups; what is evident, however, is that the hazard ratios decrease with increase in the level of education.

By occupation type, the risk of adult mortality is significantly higher for professionals [HR=5.24; 95%, CI: 1.675,16.38] and clerks [HR=2.47; 95%, CI: 1.086,5.631] decedents in age group 45-59. A significantly lower risk of adult mortality [HR=0.33; 95%, CI: 0.138,0.767] is evident for decedents in occupation as technicians/associate professionals in age group 35-44. Significantly higher risk of adult mortality is observed for decedents in occupations as service/shop/market sales in age group 15-34 [HR=2.49; 95%, CI: 1.696,3.667] and age group 45-59 [HR=2.29; 95%, CI: 1.198,4.381]. Decedents is skilled agricultural/fishery occupations also have a significantly high risk of adult mortality in age group 15-34 [HR=1.52; 95%, CI: 1.074,2.154], on the contrary, in age group 35-44 the mortality risk is significantly lower [HR=0.57; 95%, CI: 0.336,0.979]. The risk of adult mortality is significantly high for craft and trade related occupation [HR=4.17; 95%, CI: 1.816,9.588] in age group 45-59. Adult mortality risk is also significantly high for plant and machine operators/assemblers decedents in age group 15-34 [HR=2.04; 95%, CI: 1.280,3.244] and age group

45-59 [HR=2.77; 95%, CI: 1.271,6.038]. Decedents in elementary occupations also have significantly high risk of adult mortality in age group 15-34 [HR=2.18; 95%, CI: 1.616,2.943] and age group 45-59 [HR=2.66; 95%, CI: 1.294,5.471].

There is no significant difference in the risk of adult mortality across all the three age groups between decedents who did not have tuberculosis and those who had tuberculosis as a health condition. Decedents who did not have cancer as a health condition have a significantly lower risk of adult mortality in age group 15-34 [HR=0.47; 95%, CI: 0.288,0.759] and age group 35-44 [HR=0.41; 95%, CI: 0.290,0.578] compared to those who had cancer. Unexpectedly, decedents in age group 15-34 have a significantly high mortality risk for those who did not have diabetes [HR=1.64; 95%, CI: 1.038,2.607] compared with those who had diabetes as a health condition.

Mixed results are observed for the HIV/AIDS health condition. Decedents in age group 15-34 who did not HIV/AIDS have a significantly high risk of adult mortality [HR=1.23; 95%, CI: 1.007,1.511] whereas those in age group 45-59 have a significantly lower mortality risk [HR=0.45; 95%, CI: 0.322,0.625] compared with those who had HIV/AIDS. Only in age group 35-44 is the risk of adult mortality significantly lower for decedents who did not have accidents and injuries [HR=0.45; 95%, CI: 0.336,0.591] compared with those who had the health condition.

The risk of adult mortality is unexpectedly significantly higher among decedents in age group 15-34 who did not drink alcohol [HR=1.48; 95%, CI: 1.146,1.908] compared to those who drank alcohol. Decedents who did not smoke tobacco in age group 45-59 also have unexpectedly a significantly higher risk of adult mortality [HR=1.59; 95%, CI: 1.127,2.252] compared with those who smoked tobacco.

The risk of adult mortality is unexpectedly significantly high for decedents in age group 34-44 who had a mother [HR=1.62; 95%, CI: 1.023,2.556] as a family relation; whereas on the contrary, for age group 45-59, the risk of adult mortality is significantly lower for decedents who had a spouse [HR=0.53; 95%, CI: 0.296,0.963] as a family relation.

There is no significant difference in the risk of adult mortality for decedents across all age groups between urban and rural areas. By province of residence, Eastern province has a significantly high mortality risk for decedents in age group 45-59 [HR=2.15; 95%, CI: 1.530,3.033]. Luapula province has a significantly high adult mortality risk for age group 15-34 [HR=1.68; 95%, CI: 1.074,2.640]. Northern province has a significantly high mortality risk for age group 15-34 [HR=1.86; 95%, CI: 1.167,2.967] and age group 45-59 [HR=4.30; 95%, CI: 2.568,7.189].

There is insignificant difference in adult mortality risk for decedents across all three age groups who lived in communities with a high proportion of educated persons compared with those who resided in communities with a low proportion of educated persons. Furthermore, there is also no significant difference in the risk of adult mortality between deceased persons who lived in communities with a high proportion of persons receiving treatment for their health conditions and those who resided in communities with a low proportion of persons receiving treatment for their health conditions. The hazard ratios are less than 1 across all the three age groups for decedents who lived in communities with a high proportion of health care utilisation, however, the mortality risk is not statistically different from that of deceased person who resided in communities with a low proportion of health care utilisation. The risk of adult mortality is significantly high for other place of death in age group 45-59 [HR=2.41; 95%, CI: 1.227,4.724] compared with health facility place of death.

Stratified by age, the random effects show that for age group 15-34 adjusting for all factors in the model the intra-community correlation was 0.22 per cent implying community level factors have an effect on the variation of risk of adult mortality. For age group 35-44, the intra-community correlation is 0.04 per cent while for age group 45-59 it is 0.02 per cent, implying a marginal effect of community level factors for the two age groups, however, they are not statistically significant.

Table 6.11 Multivariate multilevel proportional hazards regression analysis showing hazard ratios of adult mortality by age group among both deceased males and females in Zambia, 2010-2012 SAVVY

	Model I[a] (15-34)		Model II[b] (35-44)		Model III[c] (45-59)	
Predictors/Fixed Effects	aHR	[95% CI]	aHR	[95% CI]	aHR	[95% CI]
Individual						
Sex						
Male (Ref.)	1.00		1.00		1.00	
Female	1.07	[0.787,1.463]	0.58***	[0.463,0.735]	0.80	[0.553,1.151]
Marital Status						
Never married (Ref.)	1.00		1.00		1.00	
Married/Living with a partner	0.47***	[0.324,0.694]	1.13	[0.682,1.879]	0.98	[0.532,1.796]
Divorced/separated/widowed	0.41***	[0.281,0.589]	1.19	[0.692,2.040]	0.58	[0.251,1.314]
Occupation						
Legislators/Senior Officials/Managers (Ref.)	1.00		1.00		1.00	
Professionals	1.02	[0.648,1.610]	0.70	[0.278,1.750]	5.24**	[1.675,16.38]
Technicians/Associate Professionals	1.92	[0.890,4.138]	0.33*	[0.138,0.767]	1.78	[0.649,4.864]
Clerks	1.43	[0.915,2.237]	0.85	[0.408,1.753]	2.47*	[1.086,5.631]
Service\Shop\Market sales workers	2.49***	[1.696,3.667]	0.69	[0.262,1.842]	2.29*	[1.198,4.381]
Skilled Agricultural/Fishery workers	1.52*	[1.074,2.154]	0.57*	[0.336,0.979]	1.57	[0.629,3.896]
Craft and related trade workers	1.66	[0.713,3.882]	0.57	[0.155,2.060]	4.17**	[1.816,9.588]
Plant and Machine Operators/Assemblers	2.04**	[1.280,3.244]	0.91	[0.326,2.555]	2.77*	[1.271,6.038]
Elementary Occupations	2.18***	[1.616,2.943]	0.63	[0.302,1.334]	2.66**	[1.294,5.471]
Proximate/Intervening						
Cancer						
Yes (Ref.)	1.00		1.00		1.00	
No	0.47**	[0.288,0.759]	0.41***	[0.290,0.578]	0.77	[0.403,1.456]
Diabetes						
Yes (Ref.)	1.00		1.00		1.00	
No	1.64*	[1.038,2.607]	0.50	[0.246,1.006]	0.66	[0.324,1.334]
HIV/AIDS						
Yes (Ref.)	1.00		1.00		1.00	
No	1.23*	[1.007,1.511]	0.99	[0.609,1.624]	0.45***	[0.322,0.625]
Accidents & injuries						
Yes (Ref.)	1.00		1.00		1.00	
No	0.84	[0.647,1.095]	0.45***	[0.336,0.591]	1.64	[0.936,2.883]
Drink Alcohol						
Yes (Ref.)	1.00		1.00		1.00	
No	1.48**	[1.146,1.908]	1.17	[0.805,1.703]	0.81	[0.549,1.196]
Smoke Tobacco						
Yes (Ref.)	1.00		1.00		1.00	
No	1.25	[0.917,1.699]	0.70	[0.489,1.011]	1.59**	[1.127,2.252]
Household						
Family Relations						
Father (Ref.)	1.00		1.00		1.00	
Mother	0.94	[0.688,1.291]	1.62*	[1.023,2.556]	1.22	[0.753,1.973]
Spouse	0.80	[0.593,1.077]	0.64	[0.395,1.023]	0.53*	[0.296,0.963]
Sibling	0.92	[0.614,1.386]	1.33	[0.891,1.996]	1.60	[0.793,3.218]
Child	0.84	[0.495,1.411]	0.94	[0.496,1.768]	1.32	[0.730,2.375]
Other relatives	1.04	[0.674,1.598]	1.19	[0.677,2.073]	1.44	[0.749,2.766]
Community						
Province						
Central (Ref.)	1.00		1.00		1.00	
Copperbelt	1.00	[0.666,1.513]	1.01	[0.477,2.115]	2.18	[0.993,4.791]
Eastern	1.39	[0.990,1.957]	0.71	[0.347,1.430]	2.15***	[1.530,3.033]
Luapula	1.68*	[1.074,2.640]	0.87	[0.514,1.467]	1.25	[0.752,2.067]
Lusaka	1.16	[0.854,1.581]	0.95	[0.517,1.729]	1.22	[0.813,1.822]
Northern	1.86**	[1.167,2.967]	1.30	[0.614,2.757]	4.30***	[2.568,7.189]
North Western	2.06	[0.674,6.265]	0.71	[0.374,1.332]	0.78	[0.293,2.078]
Southern	1.16	[0.809,1.655]	1.06	[0.542,2.075]	1.27	[0.796,2.035]
Western	1.20	[0.875,1.638]	0.98	[0.587,1.631]	0.85	[0.429,1.699]
Place of death						
Health facility (Ref.)	1.00		1.00		1.00	
Home	0.90	[0.759,1.070]	0.89	[0.635,1.258]	1.21	[0.923,1.581]
Other	1.41	[0.889,2.241]	0.81	[0.517,1.269]	2.41*	[1.227,4.724]
Random effects						
Variance (SE)	0.00731 (0.00269)		0.00134 (0.000175)		0.00811 (0.00097)	
VPC/ICC	**0.22**		**0.04**		**0.02**	
AIC	532.6		234.7		231.7	
BIC	578.6		457.6		453.6	

* p<0.05, ** p<0.01, *** p<0.001; aHR - Adjusted Hazard Ratios; CI - Confidence Intervals; Ref. - Reference Category; SE - Standard Error
[a]Model I: Age group 15-34 controlling for individual, health condition/behaviour proximate, household and community variables
[b]Model II: Age group 35-44 controlling for individual, health condition/behaviour proximate, household and community variables
[c]Model III: Age group 45-59 controlling for individual, health condition/behaviour proximate, household and community variables
Variables not statistically significant but included in the model: Education, Tuberculosis, Residence, Community education, Community health utilisation, Community treatment received

6.6 Hypotheses testing

In this section, the hypotheses of the study presented in Chapter 2, Section 2.6 are examined based on the findings. The first hypothesis (H_A1) is that 'high adult mortality risk is associated with residence in communities with low proportion of deaths taking place at health facility.' The hypothesis was based on the assumption that place of death is a proxy indicator of health care access and service utilisation. A high proportion of adult deaths occurring at home or other place rather than at a health facility in a resource limited setting may indicate inequalities in access and utilisation of health services (McNamara and Rosenwax 2007; Goodridge, Lawson, Rennie *et al.* 2010). In Zambia, there are inequalities in the distribution of health facilties with rural areas at a disadvantage compared to urban areas. The location and distance of the health facilities in rural areas poses a challenge to access and utilisation for rural populations (Ministry of Health [Zambia] 2011, 2012). The study found an association between place of death and the risk of adult mortality. Significantly high adult mortality risk was associated with residence in communities with a low proportion of deaths taking place at a health facility ($p<0.001$). The null hypothesis (H_01) with no association is rejected. The results of the study confirm the posited hypothesis.

The second hypothesis (H_A2) postulated that 'lower adult mortality risk is associated with residence in communities with high proportion of health service utilisation.' This was based on the assumption that the proportion of health service utilisation is an indicator of availability, access and affordability of health services (Powles 1978; Reniers, Araya, Schaap *et al.* 2005; Dlodlo, Fujiwara, Hwalima *et al.* 2011; Lavergne, Lethbridge, Johnston *et al.* 2015). Therefore, a community with a high proportion of health service utilisation is likely to experience lower adult mortality. Whereas, on the other hand, a low proportion of health service utilisation portrays challenges among community members in accessing health care which eventually translates into poor health status of the population and ultimately high adult mortality. The study findings were mixed when disaggregated by gender. For males ($p<0.05$), residence in a community with a high proportion of health care utilisation was associated with an elevated risk of adult mortality whereas for females, the risk of adult mortality was significantly lower ($p<0.05$). This disparity in the findings may be attributed to gender differences in health seeking behaviour as well as socio-cultural socialisation with respect to health matters. The study did not expect these mixed results. Overall, the results were not significantly different but by gender. Therefore, the second hypothesis is only confirmed by disaggregating the analysis by gender. For the overall, we do not reject the null ($H_0 2$) hypothesis with no association as $p>0.05$.

The third hypothesis ($H_A 3$) posited that 'high adult mortality risk is associated with type of residence with low proportion who received treatment for illness.' In the context of a resource limited setting such as Zambia, community illness treatment received prior to death is a proxy indicator of the availability of medicines in health facilities. Overall, the findings of the study on this hypothesis were not significantly different statistically, however, a further disaggregated analysis by age and gender revealed significantly mixed results. For males, in age group 15-34, residence in a community with low proportion of persons who received treatment for illness was associated with high adult mortality risk, whereas for females, this was associated with lower risk of adult mortality. This hypothesis could only be confirmed by disaggregating the analysis by age and gender. For the overall, we do not reject the null ($H_0 3$) hypothesis with no association as $p>0.05$.

6.7 Summary of the chapter

This chapter has shown that the risk of adult mortality varies by sociodemographic, socioeconomic, health behaviour and heath conditions, and ecological background characteristics of the deceased persons. An insignificant association was found between sex and the risk of adult mortality. Marital status was significantly associated with the risk of adult mortality. The married/living with partner decedents had a significantly lower mortality risk compared with the never married decedents.

Education was negatively associated and a strong predictor of the risk of adult mortality. The risk of adult mortality decreased significant with an increase in the level of educational attainment. Type of occupation was significantly associated with the risk of adult mortality. Decedents who were in low status occupations (craft and trade related, and elementary occupations) had a significantly elevated risk of adult mortality compared with those in high status occupation type (legislators, senior officials and managers).

Health conditions, tuberculosis and cancer were insignificantly associated with the risk of adult mortality. However, HIV/AIDS was associated with the risk of adult mortality. Unexpectedly, decedents who did not have diabetes had a significantly elevated risk of adult mortality compared with those who had.

Only for female decedents, the risk of adult mortality was significantly lower for non-alcohol drinkers compared with those who drank alcohol. Smoking tobacco was significantly associated with the risk of adult mortality in an unusual way. Unexpectedly, decedents who were non-smokers had an elevated risk of adult mortality compared with the tobacco smokers.

Throughout the analysis, family relation was significantly associated with the risk of adult mortality. Decedents who had a spouse, mother, and sibling had a significantly lower risk of adult mortality. Therefore, family relation is a strong predictor of adult mortality risk.

For ecological factors, there was no significant difference in the risk of adult mortality between adult decedents who resided in urban and rural areas. Residence at province level was associated with the risk of adult mortality. Consistently, Luapula and Northern provinces had a significantly higher risk of adult mortality compared with Central province. North-western has the lowest significant adult mortality risk.

Residence in a community with a high proportion of educated individuals was associated with a significantly lower adult mortality risk. Only for female decedents, residence in a community with a high proportion of individuals receiving treatment for their health conditions was significantly associated with lower risk of adult mortality whereas for males residence in the stated communities was associated with an elevated adult mortality risk. Similarly, females who resided in communities with a high proportion of health care utilisation had significantly lower risk of adult mortality. On the contrary, for male decedents they had a significantly increased risk of adult mortality.

Place of death was associated with the risk of adult mortality. Other place of death was associated with significantly elevated adult mortality risk compared with health facility place of death.

Multilevel survival analysis confirms the evidence for an ecological effect on the risk of adult mortality besides the individual effect. The chapter has reaffirmed the current debate in existing literature on the ecological argument that health behaviours and cannot be understood in isolation but within the broader social context that shapes and determines the outcomes as influenced by individual, household/family and community level factors. The chapter has shown the contribution of the ecological factors to adult mortality variations in Zambia.

Furthermore, analysis of the determinants of adult mortality using the ecological model ensured that health behaviours and outcomes influenced by individual, household, and community characteristics are examined to the benefit of public health policy and in the design of health programmes and interventions that not only target individual but the broader community context as well.

CHAPTER 7: DISCUSSION

7.1 Introduction

The aim of this chapter is to discuss the findings of the study in relation to the existing literature. The chapter is organised into the following sections: the first section discusses the findings of the levels of adult mortality in Zambia; second section, discusses the findings of the causes of death of adult mortality in Zambia; third section, discusses the findings on the age- and cause-specific mortality contributions and differentials in adult mortality; the fourth section, discusses findings on the individual-, household-, and community-level factors which influence the risk of adult mortality as well as the extent to which ecological factors contribute to variations in adult mortality in Zambia; and the fifth section, draws attention to the strengths and limitations of the study.

7.2 Levels of adult mortality in Zambia

The study found that adult mortality remained high and varied by age, sex, rural-urban residence, and provincial or regional residence in Zambia. At national level, the study estimated high adult mortality rates for both males and females. Male adult mortality rates were higher than for females. Despite being high, the adult mortality rates indicate a decline from the mortality rates of the late 1990s and early 2000s. The derived mortality estimates were comparable to those of the United Nations Population Division (United Nations 2013a) which gives confidence in the estimates. The adult mortality advantage in favour for females compared to males is expected as this is the case in most populations of the world (Potter and Volpp 1993; Turra and Goldman 2007; United Nations 2013b). The mortality advantage for the females has been attributed to several factors in the literature, for example, biological, behavioural, and socioeconomic (Preston and Wang 2006; Rogers, Everett, Saint Onge *et al.* 2010). The biological and behavioural factors are in favour of the females while males are at a disadvantage (Lantz, House, Lepkowski *et al.* 1998; Himes 2011). This finding is consistent with results obtained by other studies.

By age, adult mortality was higher in age group 25-29 years for females, by the age of 32 half of them had died. In fact, a high proportion of adult female deaths in the same age group were observed by rural-urban residence and across all the provinces or regions. This is a cause of concern and further investigation is required. It may be possible that most of these deaths could be attributable to maternal causes or HIV/AIDS. For males, adult mortality was high in age group 30-39 years. The concentration of both male and female deaths in age group 25-39 is characteristic of AIDS mortality-that is, the "HIV/AIDS hump"-when compared to low HIV prevalence populations by age structure. The finding is consistent with a previous study by Banda (Banda 2015) who found high maternal deaths in Luapula and Northern provinces. Also in agreement is another study that examined pregnancy-related deaths in Zambia by Banda *et al*., (2015) who found high adult female mortality in age group 25-29 with higher mortality in urban than rural areas. Dzekedzeke *et al.,* (2008) in a cohort study conducted in selected communities of Zambia also found high young adult female mortality of which 74 per cent was attributed to HIV/AIDS. In another, multi-year population level study conducted in Lusaka urban district from 2004-2011 by Rathod et al., (Rathod, Timæus, Banda *et al.* 2016) found high mortality among younger adult females in age group 20-40 years.

Other scholars have attributed concentration of adult female deaths in the reproductive age group to socioeconomic and sociocultural factors that limit women's access to modern maternal health services plus gender inequalities linked to societal influence as to who receives health care services, especially in poor societies, ultimately impact on female mortality (Banda, Odimegwu, Ntoimo *et al.* 2016). In addition, the pattern of the age gap observed in adult deaths between males and females may possibly be attributed to inter-generational sex whereby younger females are in sexual relationships with older males and get infected at younger ages; a sexual behaviour pattern observed in high HIV prevalence populations (Leclerc-Madlala 2003; Kimuna and Djamba 2005; Dzekedzeke, Siziya and Fylkesnes 2008; Leclerc-Madlala 2008).

At sub-national level and at this level of analysis, the study found a consistent pattern of high adult mortality in urban areas than rural areas, which is unusual when compared to mortality experiences of other populations. It is expected that in urban areas, with urbanisation which is associated with modernisation, socioeconomic groups with higher incomes, better infrastructure, and access to health and social services, adult mortality rates would be lower than in rural areas.

Interestingly, even the life expectancy at birth in 2010 was lower in urban areas (50.8 years) than in rural areas (51.7 years) in Zambia (Central Statistical Office [Zambia] 2012) . The last three demographic and health surveys, 2001/2002; 2007 and 2013/2014 ZDHS, conducted in Zambia and tested for HIV/AIDS consistently reported HIV prevalence rates in urban areas that were twice as high as those in rural areas (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). Another nation-wide HIV-testing study conducted by the Ministry of Health found that HIV prevalence was higher among urban adults than rural adults (Chanda-Kapata, Kapata, Klinkenberg *et al.* 2016).

At provincial or regional level, the probability of dying between ages 15 and 60 years varied across provinces. The pattern of adult mortality variation by region is closely linked to HIV/AIDS prevalence. Western province had the highest adult mortality rate for males and HIV prevalence is high. The high mortality among males could be attributed to the large fishing community and the risks that this type of industry poses. Studies have found higher HIV prevalence in the fishing communities than in the general population (Kissling, Allison, Seeley *et al.* 2005; Seeley and Allison 2005; Béné and Merten 2008). Copperbelt province is highly urbanised and compact in land area, had the highest probability of dying for adult females and high HIV prevalence rate. On the other hand, North-western province had the lowest adult mortality rates for both males and females. North-western province is still predominantly rural but urbanising rapidly because of increased multinational corporation investment in mining activities in the area. Central province is a transit point of two major international highway trucking routes-one to Congo DRC and the other to Tanzania-as well as railway line. Therefore, the relatively high HIV prevalence rates in this province may explain the high adult mortality rates among females. Luapula province has fishing communities as noted earlier HIV prevalence may be contributing to the high adult mortality rates among females. The estimated adult mortality rates for Lusaka province derived from sibling survival information are comparable to those of Rathod et al., (2016) for Lusaka urban.

From the adult mortality estimates, it may be deduced that despite the antiretroviral, tuberculosis and malaria programmes implemented in Zambia, adult mortality remains high and a public health burden even at regional level.

The regional adult mortality rates also show that there are regions in Zambia that experience higher adult mortality rates that are above the national average mortality rates. These regions, therefore, require special attention. The regional variations in adult mortality rates are indicative of the differences in government and health systems' capability to adequately address health needs at sub-national level. Therefore, government health interventions should not be implemented in a homogeneous manner across the provinces but be responsive to the respective unique environment of each province, this will enable them to be more appropriate and effective.

7.3 Causes of death of adult mortality in Zambia

The second objective of the study was to examine the causes of adult mortality in Zambia. An examination of the causes of death among adults in the age group 15-59 years using 2010 census data shows that majority of the deceased persons died from sickness and disease as evident in chapter 4 of the study.

Census data on causes of death were not collected in a detailed manner and therefore there is no standard classification of diseases per the ICD-10. The high mortality in age group 25-39 for both males and females was also mainly due to sickness and disease. A higher proportion of females than males died from sickness and disease across all provinces and by rural-urban residence. Though the census questionnaire did not specify a category for "HIV/AIDS" as a cause of death; however, the Institute of Health Metrics and Evaluation, through the global burden of disease study of 2013 reported that HIV/AIDS, malaria and lower respiratory infections were the leading causes of death in Zambia (GBD 2015 Mortality and Causes of Death Collaborators 2016; Wang and al. 2016). In chapter 5, using 2010-2012 SAVVY data, the study found that the top 5 leading causes of adult mortality in Zambia were HIV/AIDS, injuries and accidents, tuberculosis, malaria, and diseases of the circulatory system ranked in that order. This finding is also in agreement with a study by Mudenda *et al.,* (2011) who also found that HIV/AIDS and malaria were the leading cause of death among adults. Also, Rathod *et al.,* (2016) found that the top three most common causes of death among adults in Lusaka urban district were tuberculosis, HIV/AIDS and malaria in that order.

HIV/AIDS was the major leading cause of deaths across all demographic and socioeconomic background characteristics of the deceased adults. The proportions of deaths attributable to HIV/AIDS increased by age and peaked in age group 35-39 and then started to decrease. The pattern was the same by sex for both male and female HIV/AIDS deaths. This finding is consistent with results in a study by Masquelier *et al.*, (2017) on age patterns and sex ratios of adult mortality in countries with high HIV prevalence. Consistent with previous studies, the study found a higher proportion of HIV/AIDS deaths among females than males (Rao, Lopez and Hemed 2006; Kanjala, Michael, Todd *et al.* 2014; Melaku, Sahle, Tesfaye *et al.* 2014; Mberu, Wamukoya, Oti *et al.* 2015). This may be attributed to the higher HIV prevalence in females than males as revealed by surveys conducted in Zambia (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014; Chanda-Kapata, Kapata, Klinkenberg *et al.* 2016).

Irrespective of either rural or urban residence the proportion of HIV/AIDS deaths was higher among females than males. Some studies have tried to link this as a consequence of transactional sexual behaviour among young women as they try to meet their consumerism needs (Leclerc-Madlala 2003; Uchudi, Magadi and Mostazir 2012). Western province had the highest proportion of HIV/AIDS deaths for males while North-western province had the lowest. . Western province is one of the provinces with high poverty levels and hosts a fishing industry (Central Statistical Office [Zambia] 2012). Previous studies have associated fish trade with high HIV prevalence (Seeley and Allison 2005; Béné and Merten 2008). Whereas Eastern province had the highest proportion of HIV/AIDS deaths for females while North-western province had the lowest. It is not clear why Eastern province has the highest proportion of HIV/AIDS deaths. This requires further investigation.

The proportion of HIV/AIDS deaths decreased with level of educational attainment. This finding is consistent with a study in Ethiopia that found a high proportion of adult deaths among the illiterate deceased persons (Melaku, Sahle, Tesfaye *et al.* 2014). Consistent with studies in Angola (Rosario, Costa, Timoteo *et al.* 2016) and Ethiopia (Melaku, Sahle, Tesfaye *et al.* 2014; Ashenafi, Eshetu, Assefa *et al.* 2017), the study found that HIV/AIDS deaths were higher among the formerly married for both males and females. The background demographic and socioeconomic factors were important in determining the distribution of proportions of HIV/AIDS as a leading cause of death among adults.

Northern, North Western and Luapula provinces had higher proportions of Tuberculosis deaths compared to the other provinces. This could be probably due to inadequate health infrastructure considering that these provinces are predominantly rural and the populations are sparsely distributed to effectively provide health services. The government DOTS strategy on TB has helped in reducing the deaths attributed to TB. However, it is also well-known that tuberculosis is closely associated with HIV/AIDS (Naidoo, Grobler, Deghaye *et al.* 2015; Samandari, Agizew, Nyirenda *et al.* 2015) and this could be contributing to ineffectiveness of the DOTS strategy.

Unexpectedly, malaria attributed adult deaths were higher in Copperbelt province. This is not easy to explain since the province is one of the urbanised in the country. However, the province has one of the highest HIV prevalence rates and inconclusive studies have linked malaria to HIV/AIDS (Abu-Raddad, Patnaik and Kublin 2006; Mermin, Ekwaru, Liechty *et al.* 2006; Mandisodza 2010).

Adult male deaths attributed to accidents and injuries were twice as high as those of females. Here both the 2010 census and 2010-2012 SAVVY results converge. Consistent with previous studies, the study found a high proportion of deaths attributed to injuries and accidents among young people in age group 15-25 (Melaku, Sahle, Tesfaye *et al.* 2014; Streatfield, Khan, Bhuiya *et al.* 2014; Ashenafi, Eshetu, Assefa *et al.* 2017). Some studies claim that young people are more adventurous and end up in hazardous life-threatening situations compare to older adults who are usually careful (Waldon, McCloskey and Earle 2005; Rao, Lopez and Hemed 2006; Streatfield, Khan, Bhuiya *et al.* 2014). Injuries and accidents were the second leading cause of death among males while among females it was tuberculosis. The study found higher proportions of injuries and accidents deaths among male and female decedents who had higher level of educational attainment. This was also the case for the never married decedents. This finding is consistent with a studies conducted in Ethiopia (Melaku, Sahle, Tesfaye *et al.* 2014; Ashenafi, Eshetu, Assefa *et al.* 2017). Deaths due to injuries and accidents were higher in Central, Lusaka, Northern and Southern provinces than the rest of the provinces. The possible reason could be the major highways that pass through these provinces as they carry a lot for traffic, and accidents are a daily occurrence.

What is of concern, however, is the high mortality of the highly educated males and females from injuries and accidents. The highly educated persons contribute significantly to the country's economy and socioeconomic development. Injuries and accidents in Zambia have increased and it is projected that deaths from these causes are likely to exceed those attributed to HIV/AIDS (Schatz 2008; World Health Organization 2013b; Lusakatimes.com 2014, 2015).

Furthermore, deaths attributed to suicide and violence were also higher among males than females. Among females, intentional inflicted injury deaths were higher than for males. Poverty levels are high in Zambia, as noted earlier, about 61 per cent of the population live on less than a dollar per day. The economic performance of the country has been sluggish. This has put a lot of people under economic pressure in terms of their livelihoods. Other studies conducted in South Africa (Naidoo and Schlebusch 2014; Matzopoulosa, Prinslooa, Pillay-van Wyka *et al.* 2015; Pillay-van Wyk, Msemburi, Laubscher *et al.* 2016), Japan (Trovato and Heyen 2006; World Health Organization 2013a), Canada (Trovato and Heyen 2006; World Health Organization 2013a), South Korea (Yang, Khang, Chun *et al.* 2012) and Europe (Trovato and Heyen 2006; Bernal, Haro, Bernert *et al.* 2007; Stuckler, Basu, Suhrcke *et al.* 2009) also had similar findings with deaths due to suicide and violence being high among males because of economic pressure, alcohol and drug abuse, and poverty.

Diseases of the circulatory system were the third leading cause of death among female decedents while tuberculosis was the third cause of death among males. Malaria was the fourth leading cause of death for both males and females. It evident that communicable diseases remain the leading causes of death among adults. While government interventions have been directed at combating the communicable disease burden, a new epidemic of non-communicable diseases is on the rise. This study found that the epidemiological transition (Omran 1971) is underway in Zambia. Adult deaths attributable to non-communicable diseases progressed with age and are more evident in older ages 45-59 while injuries and accidents were more prevalent in age group 15-35. This finding is consistent with studies that have revealed evidence of the rising of the epidemic of NCDs in low- and middle-income countries (Kim Streatfield, Khan, Bhuiya *et al.*; Murray and Feachem 1990; Holmes, Dalal, Volmink *et al.* 2010; Dalal, Beunza, Volmink *et al.* 2011; Ezeh, Bongaarts and Mberu 2012; GBD 2015 Mortality and Causes of Death Collaborators 2016; GBD 2015 Risk Factors Collaborators 2016; Allen, Williams, Townsend *et al.* 2017). There is growing concern that the burden of NCDs will be heavier than the HIV/AIDS burden in the long term and that the impact will be more on the poor populations of the low- and middle-income countries (United Nations 2015).

Apart from HIV/AIDS being the leading cause of death for both males and females, public health interventions must take cognisance of the gender differences in causes of death that are of priority to each particular sex. For example, while males were dying of pneumonia/ARI and diabetes mellitus in the 6th and 7th rankings respectively, females were dying of neoplasms and maternal causes in the same ranking order.

The study examined the impact of eliminating the leading causes of death on adult mortality by constructing cause-deleted life tables from a health policy and programmatic perspective. The study found that if HIV/AIDS were eliminated it would contribute the most number of additional years of life gained compared to eliminating the other causes of death. Eliminating HIV/AIDS as a cause of death would have the most impact in reducing adult mortality in Zambia. The percentage reduction in the probability of dying between ages 15 and 60 years would be 30 per cent overall and 35 per cent for females. In addition, females in age group 15-19 would gain the highest number of years of additional life, 6.40, while for males in the same age group would gain 5.77 years. The percentage reduction in the probability of dying would be highest among females, 60.5 per cent and 49 per cent among males in age group 35-39. This finding provides evidence that should reaffirm HIV/AIDS programmes, that is, antiretroviral therapy interventions to further strengthen their efforts in ensuring that coverage and access of the drugs reaches those who need them. Studies have also proved that ART programmes have helped in reducing adult mortality (Reniers, Masquelier and Gerland 2011; Bendavid, Holmes, Bhattacharya *et al.* 2012; Murray, Ortblad, Guinovart *et al.* 2014). HIV/AIDS prevention programmes targeting adolescents should be strengthened so that additional years of life could be added to the youth.

7.4 Age- and cause-specific mortality contributions

The third objective of the study was to explore the age- and cause-specific mortality contributions and differentials in adult mortality. The decomposition analysis showed that the age-and cause-specific mortality rates in the adult mortality age group 15-59 contributed 50 per cent of the years in widening the life expectancy gap between males and females in Zambia.

Injuries and accidents were the major contributors to widening the gap in life expectancy, contributing 1.10 years (26.8 per cent). The accident and injuries were concentrated in age group 25-39 years, and the largest contributor was age group 35-39 years (0.36 years) and was higher among males than females. This finding is consistent with studies conducted in Japan and South Korea (Trovato and Heyen 2006). It is estimated that 3 out of 4 road deaths are among males (World Health Organization (WHO) 2013). Waldon et al (2005) attribute the high incidence of accident-related mortality among males than females to differences in biological and cultural or social factors that influence behavioural expectations by society of either sex.

As noted earlier, injuries and accidents are emerging as one of the leading causes of deaths in Zambia due to the increased number of motor vehicles and accidents. The number of registered motor vehicles in Zambia was estimated at 337,513 and the number of road traffic accident fatalities was estimated at 1,388 per annum in 2010 (World Health Organization 2013b) . The road-related fatality rate was estimated at 32.2 cases per 100,000 persons(World Health Organization 2013b). A study by the Ministry of Health (Zambia), on road traffic accidents found that the number of accidents increased by 45 per cent from 19,727 in 2008 to 29,118 in 2013 (Lusakatimes.com 2015).

Several interventions have been devised by the government through the Road Safety Agency, such as the public education campaign "Save lives Road Safety Awareness Campaign", the seat belt campaign "Arrive Alive", mounting of road blocks at check points, annual inspection of motor vehicle fitness.

However, despite all these interventions road traffic accidents have continued to claim lives in Zambia. In 2013, for example, 53 people were killed in what was termed one of the worst road traffic accidents in Zambia, involving a passenger bus and a heavy duty truck (Lusakatimes.com 2014). Some of the causes of road traffic accidents are over-speeding, misjudging of distance, cutting in (lanes), alcohol intake while driving, not observing traffic rules, overloading, poor state of vehicles and road infrastructure.

Suicide and violence positively contributed 0.30 years (6.8 per cent) to widening the gap in life expectancy. Males in age group 25-49 contributed the most to widening the gap. The larger contributor was age group 25-29, positively contributing 0.07 years (1.5 per cent). Mortality due suicide and violence was more common among males than females. The positive contribution of suicide and violence is consistent with findings from Japan, Canada, South Korea and United States where suicide and violence positively contributed to widening of the gap in life expectancy (Trovato and Heyen 2006; Denney, Rogers, Krueger *et al.* 2009; Auger, Harper, Barry *et al.* 2012; Yang, Khang, Chun *et al.* 2012).

Suicide and violence has been attributed to a number of factors such as economic crisis, abuse of alcohol and drugs, violent environment, abuse, and poverty among others. Individuals, especially males resort to suicide and violence as a response to these problems. The suicide death rate in Zambia was estimated at 18.9 deaths per 100,000 in 2011. There were 1,526 suicide deaths(World Health Organization 2014). The study by Waldon (1983) postulates that sex hormones and cultural influences contribute to differences in mortality between males and females. Male hormones contribute to higher violence-related deaths while female hormones are protective to the risk of ischematic heart disease. Societal cultural influences on men lead to hazardous behaviours such as alcohol consumption, cigarette smoking, drug abuse, and use of dangerous weapons which eventually result in higher mortality most among men (Waldon 1983).

HIV/AIDS disease positively contributed to the widening of the gap in life expectancy. It contributed 0.16 years (3.9 per cent). Male mortality was offset by female mortality. Male mortality was slightly higher than female mortality. Age groups 35-39, 45-49 and 50-54 contributed to widening the gap. In contrast, female HIV/AIDS mortality in age groups 15-19, 20-24, 40-44, and 55-59 negatively contributed to narrowing the gap. However, the age group 35-39 positively contributed the most to widening the gap, (0.32 years, 7.9 per cent). The gap in HIV deaths between males and females was small resulting in a marginal positive contribution to widening the gap in life expectancy. HIV/AIDS prevalence in Zambia is higher among females (15.1 per cent) than males (11.3 per cent) (Central Statistical Office [Zambia], Ministry of Health [Zambia] and ICF International 2014). Risky sexual behaviours are engaged into by both males and females. However, females have higher rates of infection because of their vulnerability due to the low socioeconomic status of women in Zambia.

Government health interventions on HIV/AIDS have over the years yielded positive results in reducing mortality following the introduction of antiretroviral therapy as well as behaviour change campaigns (Bendavid, Holmes, Bhattacharya *et al.* 2012). For instance, by mid-2013, 503, 420 adults were on Antiretroviral Therapy (ART) representing 92 per cent of those that need ART. Furthermore, 81 per cent of those who initiated ART were still surviving 12 months after commencing the treatment (National AIDS Council 2014). The marginal positive contribution to widening of the gap in life expectancy by HIV/AIDS disease could be attributed to the impact of antiretroviral therapy. With a reduction in mortality there is a possibility of having negative contributions that narrow the gap in life expectancy. In South Africa, an increase in life expectancy was observed following the introduction of antiretroviral therapy (Muhwava, Herbst and Newell 2013).

Tuberculosis positively contributed 0.30 years (7.4 per cent) to widening the gap in life expectancy. The contributing age-specific mortality age groups were 50-59 with age group 50-54 being the major contributor. Male mortality due to tuberculosis, after decomposition, was higher than in females. For females, tuberculosis mortality was higher in age groups 15-19, 30-34, and 45-49 years. Tuberculosis prevalence rate was 347 cases per 100,000 persons in 2012. Government interventions such as the integrated disease surveillance and response strategy maintained the tuberculosis cure rate at 83 per cent in 2012 (Ministry of Health [Zambia] 2014).

Neoplasms negatively contributed, -0.22 years (-5.4 per cent) to narrowing of the gap in life expectancy. Neoplasms mortality was higher among females and concentrated in age groups 30-44 with age group 30-34 contributing, -0.07 years (-1.7 per cent) being the largest.

Overall, the decomposition analysis of age- and cause-specific mortality rates in age group 15-59 contributed 2.1 years of the total gap of 4.1 years in life expectancy between males and females. The major cause-specific mortality positive contributors to widening the gap in life expectancy at birth between males and females are infectious and parasitic diseases as well as accidents and injuries in the adult mortality age group 15-59. The age-specific mortality positive contributions to widening the gap are larger in the age groups 20-49 and are concentrated in males.

Furthermore, the decomposition analysis showed that health policy interventions should target the emerging increase in accidents and injuries as well as targeting HIV/AIDS, Tuberculosis, Pneumonia, Neoplasms among females, suicide and violence. The interventions should target age groups 20-49 for both males and females.

7.5 Individual-, household-, and community-level factors influencing the risk of adult mortality

The fourth objective of the study was to determine the extent to which individual-, household-, and community-level factors influence adult mortality variations in Zambia. The Kaplan-Meier survival estimates show that for male majority survived up to age 36 and died thereafter whereas for females they survived up to age 34 and died afterwards. By the age of 45 for males and 43 for females, three-quarters of them had died. The Kaplan-Meier estimates provide evidence that the risk of adult mortality in Zambia is high as majority of the adults are dying prematurely in the prime of their most productive and reproductive time of life.

Consistent with other studies the risk of adult mortality was significantly lower for females compared with males but only after stratifying by age for age group 35-44. In the other models, the hazards were lower but not statistically significant after controlling for other variables. A study by the United Nations (2015) noted that there was a relatively small female advantage in mortality in Africa in 2010-2015 mainly as a result of the differential impact of the HIV/AIDS epidemic on mortality levels by sex, with HIV prevalence estimated to be higher among women than men. Sex differentials in adult mortality are mostly in favour of females than males. Studies on adult mortality have mostly found a higher risk of mortality for males than females (Brass and Li 1989; Kelly, Feldman, Ndubani *et al.* 1998; Gjonca, Tomassini and Vaupel 1999; Hummer, Rogers, Amir *et al.*

2000; Hill 2003; Dorrington, Timaeus, Moultrie *et al.* 2004; Hosegood, Vanneste and Timaeus 2004; Timaeus and Jasseh 2004; Bradshaw and Timaeus 2006; Preston and Wang 2006; Sankoh, Ngom, Clark *et al.* 2006; Nyirenda, Hosegood, Barnighausen *et al.* 2007; Obermeyer, Rajaratnam, Park *et al.* 2010; Rogers, Everett, Saint Onge *et al.* 2010; Saikia and Ram 2010; Heuveline and Clark 2011; Palloni and Pinto-Aguirre 2011; Reniers, Masquelier and Gerland 2011; Saikia, Jasilionis, Ram *et al.* 2011; Masquelier 2013; Udjo 2014; United Nations 2015; Rathod, Timæus, Banda *et al.* 2016; Chisumpa and De Wet 2017; Stringhini, Carmeli, Jokela *et al.* 2017). As noted earlier, the sex differentials in mortality risk between males and females have mainly been attributed to biological, behavioural, socioeconomic, sociocultural, and occupational among other reasons (Preston and Wang 2006; Rogers, Everett, Saint Onge *et al.* 2010; Lantz, Golberstein, House *et al.* 2010).

Marital status was significantly associated with the risk of adult mortality throughout the regression modelling process even after stratifying by age and sex. Adult decedents who were married/living with a partner had significantly lower risks of dying compared with the never married. This agrees with previous studies have found that marriage has a protective effect of reducing the hazards of adult mortality (Lillard and Waite 1995; Rogers 1995; Waite 1995; Lillard and Panis 1996; Rogers, Hummer and Nam 2000; Ikeda, Iso, Toyoshima *et al.* 2007; Dupre, Beck and Meadows 2009; Liu 2009; Ueyama and Yamauchi 2009; Umberson, Crosnoe and Reczek 2010). The spousal relationship is influential to the health and well-being of a husband/wife. The spousal relationship may provide increased social support ("social capital"), positive social control, positive health behaviour, and prevention of diseases. Other studies have also noted that the protective effect of marriage is only more effective if the marriage is legal not cohabitation; spouses are living together rather than separately; and that it is a first marriage and not a remarriage (Lillard and Waite 1995; Rogers, Hummer and Nam 2000).

On the contrary, it is not always that marriage will provide this protective effect, "toxic" marriages may increase the hazards of adult mortality. In this study, it has been established that marriage provides a protective effect by significantly lowering the risk of adult mortality. This, therefore, reinforces existing explanations for the marital advantage in longevity with respect to adult mortality despite the challenges that the marriage institution is facing in recent times as postulated by the second demographic transition which espouses the weakening of marriage as an institution and the emerging of new forms of families (Van de Kaa 1994; Lesthaeghe 1995, 1998; Van de Kaa 2002, 2004; Lesthaeghe 2010; Zheng and Thomas 2013).

In line with previous studies, educational attainment was negatively associated with the risk of adult mortality. The risk of adult mortality significantly decreased with an increase in the level of educational attainment. Adult deceased decedents who had higher levels of educational attainment experienced significantly lower hazards of adult mortality compared with the deceased persons with no education. Several studies have confirmed the existence of this inverse relationship between education attainment and adult mortality (Christenson and Johnson 1995; Elo and Preston 1996; Lleras-Muney 2005; Madsen, Andersen, Christensen *et al.* 2010; Hummer and Lariscy 2011; Masters, Hummer and Powers 2012; Montez, Hummer and Hayward 2012; Naess, Hoff, Lawlor *et al.* 2012; Hummer and Hernandez 2013; Rogers, Hummer and Everett 2013; Manzelli 2014; De Grande, Vandenheede and Deboosere 2015; Masquelier and Garbero 2016; Rogers, Everett, Zajacova *et al.* 2010). It is argued that educational attainment affects mortality through change in better health behaviour by adapting positive lifestyles and prevention of diseases; knowledge about health care access and utilisation, adherence to medical treatment guidelines; skills for employment, occupation type, and income level. Individuals who are highly educated are more likely to adapt positive health behaviours and prevent disease. Educational attainment influences employment status, type of occupation and level of income which in turn affects the risk of mortality. This study reaffirms that educational attainment is negatively associated with the risk of adult mortality and that higher level of educational attainment significantly lowers the risk of adult mortality. Stratifying by sex, however, education was no longer statistically significant perhaps due to small numbers in the sample as evident from the wide confidence intervals.

Occupation type was significantly associated with the risk of adult mortality. After adjusting for all the factors, adult decedents who were in occupation type as craft and related trade workers as well as those who were in elementary occupations had significantly higher risk of adult mortality compared with legislators/senior officials/managers. This finding is consistent with previous studies that found that professionals and managers experience lower risk of mortality than service workers, labourers and household domestic workers (Moore and Hayward 1990; Rogers, Hummer and Nam 2000). It is argued that compared to high status occupation types, lower status occupation types are associated with risky behaviours, low income, require less education, exposure to hazardous work environment, and emotionally draining work conditions which increase the risk of adult mortality. On the other hand, individuals in high status occupations engage in positive health behaviours, exercise personal control, have higher education and work in good environments (House, Strecher, Metzner *et al.* 1986 ; Sorlie and Rogot 1990; Rogers, Hummer and Nam 2000; Krueger and Burgard 2011). The study finding confirms that lower status occupation types are associated with elevated adult mortality risks.

The study examined health conditions of the deceased persons prior to their death and found mixed results. In some instances, the results were expected while in others they were unexpected. The study found a significantly lower risk of mortality between adult decedents who did not have tuberculosis and those who had, only for female deceased persons. This is consistent with previous studies that found an elevated risk of mortality for those who had tuberculosis (Kourbatova, Borodulin, Borodulina *et al.* 2006; Koyanagi and Shibuya 2010; Samandari, Agizew, Nyirenda *et al.* 2015; Rajaratnam, Markus, Rector *et al.* 2010; Murray, Ortblad, Guinovart *et al.* 2014). There was an insignificant difference in the risk of mortality between deceased persons who did not have cancer and those who had. The expectation was that decedents who had the health condition would experience a significantly higher risk of adult mortality as previous studies have found (Mayosi, Flisher, Lalloo *et al.* 2009; Mberu, Wamukoya, Oti *et al.* 2015; GBD 2015 Mortality and Causes of Death Collaborators 2016). There is a possibility of the small numbers factor here. Unexpectedly, adult decedents who did not have diabetes mellitus had an elevated risk of adult mortality compared with those who had. Here also the same small cell numbers may be a factor.

As expected, adult decedents who did not have HIV/AIDS experienced significantly lower risk of mortality. This result is consistent with most studies as HIV/AIDS compromises the immunity of a person and increases the chances of suffering from opportunistic infections (Stover 1994; Timaeus and Nunn 1997; Timaeus 1998; Feeney 2001; Doctor and Weinreb 2003; Blacker 2004; Hosegood, Vanneste and Timaeus 2004; Le Coeur, Halembokaka, Khlat *et al.* 2005; Nyirenda, Hosegood, Barnighausen *et al.* 2007; Muhwava, Herbst and Newell 2013; Oti, Mutua, Mgomella *et al.* 2013; Kharsany and Karim 2014; Mberu, Wamukoya, Oti *et al.* 2015; Wang and al. 2016; Masquelier, Eaton, Gerland *et al.* 2017). The study found no significant difference in mortality risk between decedents who did not experience accidents and injuries as a health condition and those who had. The hazard ratios were less than 1 but not statistically significant.

Health behaviours of the deceased persons were also examined prior to their death by the study; unexpected results were obtained for the association between the risk of adult mortality and drinking alcohol. There was no significant difference in the risk of adult mortality between decedents who did not drink alcohol and those who consumed alcohol. However, after modelling by sex, adult female decedents who did not drink alcohol had a significantly lower risk of mortality compared to those who drank alcohol. This result is expected as alcohol consumption among females in Zambia is lower than among males. It is well-documented by studies that alcohol consumption, especially excessive drinking of alcohol elevates the risk of mortality by compromising the health of a person in terms of being susceptible to diseases as well as being involved in interpersonal violence, road traffic accidents (Waldon, McCloskey and Earle 2005; Rogers, Everett, Saint Onge *et al.* 2010; Bora and Saikia 2015; Evans-Polce, Staff and Maggs 2016). Studies have found that heavy alcohol drinkers had substantially higher odds of mortality than never or light alcohol drinkers (Parrish, Dufour, Stinson *et al.* 1993; Liao, McGee, Cao *et al.* 2000; Rogers, Hummer and Nam 2000; Kawachi 2001; John and Hanke 2002; Klatsky and Udaltsova 2007; O'Brien, Lu, Ali *et al.* 2007; Zaridze, Brennan, Boreham *et al.* 2009). The study, therefore, reaffirms the findings that alcohol consumption is associated with elevated risk of adult mortality.

Unexpectedly, the study found a significantly elevated risk of adult mortality for decedents who did not smoke tobacco compared with the smokers. This result is unusual as it is contrary to existing evidence in the literature which supports that tobacco smoking increases the risk of adult mortality (Gajalakshmi, Peto, Kanaka *et al.* 2003; Frosch, Dierker, Rose *et al.* 2009; GBD 2015 Risk Factors Collaborators 2016). Smoking tobacco is harmful to one's health; it leads to multiple diseases or co-morbidities which increase the risk of dying over time (Pampel 2005). As in the case of alcohol drinking, heavy smokers have the highest risk of mortality than the never or light smokers. Smoking tobacco has also been linked as a contributor to the sex differentials in adult mortality (Rogers, Hummer and Nam 2000).

Family relations were significantly associated with the risk of adult mortality. Previous studies have associated family relations to adult health outcomes (Pensola and Martikainen 2003; Antonucci, Birditt and Webster 2010; Holt-Lunstad, Smith and Layton 2010). It is argued that family relations influence adult health outcomes through a protective effect role by encouraging positive health behaviours, providing emotional and other social support ("social capital"), and economic resources which may result in reduced risk of mortality. The study found that decedents who had a spouse as a family relation had significantly lower adult mortality risk. By sex, for males family relationships that significantly lowered the risk of adult mortality were spouse and sibling whereas for female decedents it was a mother and spouse. The spouse relationship appeared to be the most influential to the health and well-being of the deceased persons (Birditt and Antonucci 2007). This study reaffirms that type of family relationships influence the risk of adult mortality. Therefore, type of family relationship should be considered just like other risk factors of adult mortality.

The ecological factors, that is, rural-urban residence, province of residence, place of death, community education, community health service utilisation, and community illness treatment received sustain the argument in the literature that health outcomes like adult mortality should be understood in consideration of the effect of individual, household and community level factors where societal conditions shape and determine the environment within which the outcomes occur. Ecologically, the demographic analysis performed in chapter 4 found higher mortality in urban areas than rural areas, however, the indirectly and directly derived adult mortality estimates were not subject to statistical tests to determine if there was a significant difference in mortality between urban and rural areas. In chapter 5, the statistical test indicated that there was no significant difference in adult mortality between urban and rural areas. Results of the multivariate Cox proportional hazards regression analysis are also consistent in that there was no significant difference in the risk of adult mortality between urban and rural areas. However, most of the hazard ratios in the models were less than 1, but not significant, an indication that the risk of adult mortality may be lower in urban areas than rural areas. Previous studies have found higher risk of mortality in rural areas than in urban areas (Lulu, Berhane and Tesfaye 2002; Saikia and Ram 2010; Saikia, Jasilionis, Ram *et al.* 2011; Saikia, Singh, Jasilionis *et al.* 2013; Weldearegawi, Spigt and Berhane 2014).

The study found significantly elevated mortality risk in Luapula and Northern provinces, and significantly lower mortality risk for females only in North-western province. The Cox proportional hazards regression results confirm those obtained in Chapter 4. Again as noted earlier, this finding is consistent with previous studies conducted in Zambia (Banda 2015; Chisumpa and De Wet 2017). Luapula and Northern provinces are predominantly rural with limited health infrastructure and host fishing communities. Previous studies have associated fish trade with HIV/AIDS (Kissling, Allison, Seeley *et al.* 2005; Seeley and Allison 2005; Béné and Merten 2008). Luapula and Northern provinces emerge as regions in Zambia experiencing high adult mortality that require further investigation to understand the factors leading to this level of mortality. Regional differentials in mortality may reflect inherent inequalities in livelihoods, access to healthcare, lack of social amenities, and poverty in the population (Khosravi, Taylor, Naghavi *et al.* 2007; Saikia, Jasilionis, Ram *et al.* 2011). The cases of Luapula and Northern provinces may reflect these disparities in socioeconomic development in the regions of Zambia and the effect on health outcomes.

Consistent with other previous studies on mortality (Kibele 2014; Adedini, Odimegwu, Imasiku *et al.* 2015; Adedini and Odimegwu 2017), the study found a significant association between community education and the risk of adult mortality. Adult decedents who lived in communities with a high proportion of educated persons had significantly lower risk of mortality. This finding confirms the strong influence of educational attainment on adult mortality at both individual and community level.

The multivariate multilevel survival analysis found mixed results for the association between the risk of adult mortality and community treatment received. For male deceased persons who lived in communities with a high proportion of persons receiving treatment for their health conditions, the risk of adult mortality was significantly high. Whereas for female decedents in age group 15-34 who lived in communities with a high proportion of persons receiving treatment for their health conditions, the risk of adult mortality was significantly lower. This finding possibly point to differences in health seeking behaviour in communities between males and females whereby a higher proportion of females tend to seek health care early while males delay until the health condition has progressed by then it may be too late (Bertakis, Azari, Helms *et al.* 2000; Moss 2002; Galdas, Cheater and Marshall 2005).

The study found also that male decedents who lived in communities with a high proportion of health care utilisation had an elevated risk of adult mortality whereas female decedents who resided in the same communities had significantly lower risk of adult mortality. This finding leads to the point raised above on differences in health seeking behaviour between males and females. Sociocultural socialisation of males "masculine socialisation" in Zambian society encourages men to portray themselves as strong individuals who do not easily get sick. As a result, males tend to delay seeking health care services whenever they have a health condition, and when they do so in most cases the ailment would have reached an advanced stage (Moss 2002; Galdas, Cheater and Marshall 2005). Females have a comparative advantage when it comes to adapting preventive health behaviours, that is, routine health checks. Conversely, males engage in risky behaviours such as excessive smoking and drinking, violence, and illegal drug use. The male perception of symptoms and response to an illness is influenced by social and cultural factors as they tend to adopt the "wait and see attitude" (Moss 2002). Therefore, this finding point to the need for addressing sociocultural issues from a gender perspective that influence adult health seeking behaviour and health outcomes. The finding also reaffirms the socioecological theory guiding the study.

For males, ecological factors accounted for 0.17 per cent of the variation in adult mortality whereas individual differences between communities accounted for 1.14 per cent. The household level factor accounted for 1.03 per cent in adult mortality variation. The intra-community correlation after controlling for all factors in the model it was 0.10 per cent, indicating that community level factors have an effect on the risk of adult mortality for males.

Community factors accounted for 0.05 per cent of the variation in mortality whereas individual differences between communities accounted for 0.4 per cent of the variation in mortality for females. After adjusting for all factors in the model, the intra-community correlation is 0.02 per cent which indicates that community level factors have an influence on the risk of adult mortality for females.

The study found an association between place of death and the risk of adult mortality. Decedents who died at other place of death had a significantly high risk of adult mortality compared with those who died at a health facility. Place of death has been used as a proxy for access to and health care utilisation. The study finding is consistent with what previous studies found (Grande, McKerral, Addington-Hall *et al.* 2003; Grunier, Mor, Weitzen *et al.* 2007; McNamara and Rosenwax 2007; Houttekier, Cohen, Bilsen *et al.* 2009; Goodridge, Lawson, Rennie *et al.* 2010; Kinoshita, Maeda, Morita *et al.* 2014; Chisumpa, Odimegwu and De Wet 2017). An examination of the place of death of adults is useful for health policy and interventions as it would help in averting unnecessary adult deaths. Therefore, place of death should be considered just like other risk factors of adult mortality.

These finding supports the study's first hypothesis that high adult mortality risk was associated with residence in communities where deaths take place elsewhere other than the health facility. For the second hypothesis, that lower adult mortality risk was associated with residence in communities with a high proportion of health service utilisation. The study found mixed results; there was an elevated adult mortality risk for the male decedents, whereas for female deceased persons, the risk of adult mortality was significantly lower. For the third hypothesis, that high adult mortality risk was associated with residence in communities with a low proportion of persons who received treatment for illness. The study found mixed results for this hypothesis as well, adult mortality risk for male decedents was high whereas for female deceased persons in age group 15-34 the risk of mortality was significantly lower.

Overall, the findings of this study present better evidence for the policy makers and stakeholders, which in turn, may facilitate the design and implementation of appropriate interventions at different levels, especially at community level to reduce adult mortality and improve adult health in line with sustainable development goal number 3 "ensure healthy lives and promote well-being for all at all ages." Ecological factors play a role in influencing adult mortality and therefore, there is need for a better understanding of these factors in line with the World Health Organization's social determinants of health framework as well as the socioecological model.

7.6 Strengths and limitations of the study

The study has a number of strengths. First, this is the first study in Zambia to attempt to derive adult mortality rates at sub-national level, that is, at provincial or regional level. In deriving the adult mortality rates the study used different types of direct and indirect demographic methods of estimation for validation. The study also utilised different types of data sources, that is, 2010 census and 2010-2012 SAVVY data and for validation 2013/2014 Zambia demographic and health survey sibling survival data. In addition, the study was able to account for migration at sub-national level.

Second, it is the first comprehensive study to have used a nationally representative sample dataset, the 2010-2012 SAVVY, to examine ecological determinants at individual, household and community level that influence adult mortality in Zambia.

Third, the study used appropriate and relevant methods of performing survival analysis, that is, Cox proportional hazards regression as well as multivariate multilevel proportional hazards regression analysis. These methods adequately account for censored and uncensored survival data that other methods cannot be able to effectively handle.

Fourth, the study has reaffirmed the socioecological theory that ecological or community level factors equally matter in influencing adult mortality just like individual and household level factors in sub-Saharan Africa as in developed countries shown by previous studies.

The study has also limitations. First, the derived regional adult mortality rates should be interpreted in light of the typical errors that are inherent in demographic data. However, an effort was made to minimise the data errors in age misreporting and age exaggeration.

Second, for decomposition analysis, other studies have revealed that the Arriaga method may underestimate the contributions of cause-specific mortality at old ages (Beltran-Sanchez, Preston and Canudas-Romo 2008; Auger, Harper, Barry *et al.* 2012; Yang, Khang, Chun *et al.* 2012). This may arise because of the assumption that contributions of each cause of death to the gap in life expectancy within an age group is proportional to the deaths from each cause (Arriaga 1989). However, the impact of this should have been minimal since the study focused on age group 15-59.

Third, the study did not examine sociocultural norms, values and practices since no information was collected on this. Cultural norms, values and practices specific to ethnic groups play an important role in determining health behaviours which in turn affect adult mortality as well as other health outcomes. The ethnic differences in cultural norms and practices to some extent influence adult mortality as previous studies have shown. The study did not also examine the influence of religion on adult mortality as this information was not collected. Previous studies have found an association between religion and mortality.

Fourth, compositional community variables were constructed by aggregating individual level characteristics, this may bias the results at community level since primary sampling units were used as proxy for the community may lead to a selection bias effect as well as a possibility of collinearity (Pickett and Pearl 2001). However, this was checked and there was no collinearity between variables.

Fifth, the study is based on adult mortality and generally the death of an adult is considered a rare event. To be able to drive plausible adult mortality estimates you require large sample sizes of the population. As noted earlier in sub-Saharan Africa, collection of information on deaths is an emotive issue and considered taboo in some African cultures, this affects the quality of mortality data. However, this is not to doubt the quality of the data that was used by the study. The deaths from census data were captured country wide and this gave us confidence to use them. As for the data from the 2010-2012 SAVVY, this was a highly specialised and technical undertaking of data collection; the quality of the mortality data is acceptable (Mudenda et al., 2011; Curtis et al., 2015).

Sixth, the use of cross-sectional data makes it not possible to decipher the direction of causation in cases where reverse causation is to be established. Cross-sectional data gives a snapshot of the deaths and context measured at one time; the limitation of such data is that it is not easy to establish temporality and causality.

Seventh, the use of multilevel analysis does not come without limitations. misclassification of respondents into communities with wrong administrative boundaries biases estimates. Multilevel analysis estimates are also affected by selection bias whereby individuals of the same characteristics choose to live in one particular community, this affects the amount of variability between groups. That is, while the communities are geographically defined by CSAs there is also an aspect of the communities being defined along social interaction patterns. In addition, since the contribution of contextual effects on individual outcomes is usually smaller and weaker than individual effects, the lack of enough variability between groups may be a problem. Furthermore, a reasonably large sample size is required for level 2 and above units to get plausible estimates in multilevel analysis.

Eighth, the absence of qualitative data is another limitation this entails that the study is unable to answer some of the "why" questions with respect to the factors associated with adult mortality. The availability of such data would have helped to provide further insight into the "why" questions on gender differences in health seeking behaviour and socio-cultural socialisation with respect to health matters. A combination of both qualitative and quantitative data would have provided a holistic explanation of the influence of ecological factors on adult mortality.

Despite the limitations, the study findings reinforce the socioecological model and the proximate determinants framework for adult mortality. The study shows the importance of ecological or community level factors that should be addressed by policies and programmes beyond the individual in order to reduce adult mortality. The study's findings have enhanced the understanding of adult mortality in Zambia as well as in sub-Saharan Africa.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The aim of this study was to examine the effects of individual and community-level factors on adult mortality in Zambia through the lens of an ecological model by applying multilevel modeling utilizing 2010-2012 SAVVY data in order to answer the main research question "What individual, household and community level factors influence adult mortality in Zambia?" The study hypothesized that place of death, community health service utilisation, and community illness treatment received were associated with the risk of adult mortality.

The chapter is organised in the following sections: the first section, presents a summary of findings and conclusions of the study; the second section, highlights the policy implications of the study findings; the third section, presents the recommendations of the study; the fourth section, illuminates the contributions to knowledge of the study; and the fifth section, presents areas for future research.

8.2 Summary of findings and conclusions

The study found that the risk of adult mortality was significantly lower for females compared with males but only after stratifying by age for age group 35-44. The relatively small female advantage in mortality was mainly because of the differential impact of the HIV/AIDS epidemic on mortality levels by sex. Marital status was significantly associated with the risk of adult mortality. Adult decedents who were married/living with a partner and the formerly married had significantly lower risks of dying compared with the never married. Marriage has a protective effect of reducing the hazards of adult mortality.

Educational attainment was found to be negatively associated with the risk of adult mortality. The risk of adult mortality significantly decreased with increase in the level of educational attainment. Higher level of educational attainment significantly lowers the risk of adult mortality.

Occupation type was significantly associated with the risk of adult mortality. The study found that professionals and managers experienced lower risk of mortality than service workers, labourers and household domestic workers. The study finding confirms that lower status occupation types are associated with elevated adult mortality risks.

With respect to health conditions examined the study found an elevated risk of mortality for those who had tuberculosis. Adult decedents who did not have HIV/AIDS experienced significantly lower risk of mortality. Unexpectedly, adult decedents who did not have diabetes mellitus had an elevated risk of adult mortality compared with those who had.

In terms of health behaviour, adult female decedents who did not drink alcohol had a significantly lower risk of mortality as expected. The study, therefore, reaffirms that alcohol consumption is associated with an increased risk of adult mortality. On the contrary, the study found a significantly elevated risk of adult mortality for decedents who did not smoke tobacco compared with the smokers. This is unexpected when compared to findings of previous studies. However, smoking tobacco is harmful to one's health; it leads to multiple diseases or co-morbidities which increase the risk of dying over time.

Family relations were significantly associated with the risk of adult mortality. The study found that decedents who had a spouse as a family relation had significantly lower adult mortality risk. By sex, for males family relationships that significantly lowered the risk of adult mortality were spouse, sibling, and other relative, whereas for female decedents it was mother and spouse. The study reaffirms that type of family relationships influence the risk of adult mortality.

Ecologically, the study found an association between province or region of residence and the risk of adult mortality. Luapula and Northern provinces had significantly elevated mortality risk while North-western province had significantly lower mortality risk for female decedents only. Luapula and Northern provinces emerge as regions in Zambia with high adult mortality this reflects the disparities in socioeconomic development in the regions of Zambia and the effect on health outcomes.

The study found a significant association between community education and the risk of adult mortality. Adult decedents who lived in communities with a high proportion of educated persons had significantly lower risk of mortality. Educational attainment has a strong influence on adult mortality at both individual and community level.

An association was found between community treatment received and the risk of adult mortality but with mixed results. Male deceased persons who lived in communities with a high proportion of persons receiving treatment for their health conditions the risk of adult mortality was significantly high. Whereas for female decedents in age group 15-34 the risk of adult mortality was significantly lower. Similar results were obtained for community health utilisation. Differences in health seeking behaviour as well as sociocultural socialisation in communities between males and females may be contributing to these disparities. An association between place of death and the risk of adult mortality was found.

Decedents who died at other place of death had a significantly high risk of adult mortality. An examination of the place of death of adults is useful for health policy and interventions as it would help in averting unnecessary adult deaths.

Ecological factors play a role in influencing adult mortality and therefore, there is need for a better understanding of these factors in line with the social determinants of health framework of the World Health Organisation as well as the socioecological model in order to design interventions that target not only individuals but communities as well if meaningful reduction in adult mortality is to be achieved. For example, Zambia's national health policy and national health strategic plan to effectively and efficiently design health programmes and interventions aimed at reducing adult mortality in the wake of HIV/AIDS and NCDs epidemics amidst limited national resources at all levels.

The study used the adult mortality proximate determinants framework and the social ecological theory to develop a conceptual framework based on reviewed theoretical and empirical literature. The proximate determinants framework and social ecological theory facilitated in organising the variables used in the study for analysis at individual, household and community levels as presented in the conceptual framework (Figure 2.2). The findings of the study show that ecological factors have an influence on adult mortality in Zambia. This, therefore, confirms the relevance of the theoretical frameworks used in the study in explaining the influence of ecological factors on adult mortality.

8.3 Policy implications

The findings of this study have policy implications:

First, adult mortality rates derived by the study show that the level of adult mortality remains high in Zambia despite HIV/AIDS programmes that are implemented to reduced adult mortality. Of course, the levels of adult mortality are not comparable to those of the late 1990s and early 2000s when they were at their peak. The decline in adult mortality rates has been slow. There is need therefore for health programmes and interventions to accelerate their efforts to reduce the loss of adults who are still in their productive and reproductive stages of their lives otherwise the trend will continue.

Second, the variations in adult mortality rates by region indicate the socioeconomic inequalities in development. Western, Luapula and Northern provinces had high adult mortality levels. These regions are predominantly rural and have inadequate health infrastructure and where available they are sparsely located with long distances. There is need for investing in the health infrastructure for these provinces to reduce the general disease burden and ultimately adult mortality. If this is not done these areas will continue experiencing heavy disease burdens and high adult mortality.

Third, the study has established that the epidemiological transition is underway in Zambia. In addition, to the HIV/AIDS epidemic another epidemic of NCDs is emerging for which the country is not adequately prepared for. NCDs are a health and economic burden associated with a large impact on workforce productivity, health expenditure, absenteeism, presenteeism (present at work but unable to work due to ailment), loss of critical skills and deaths. It is anticipated that the NCD burden will outstrip that of HIV/AIDS, malaria and tuberculosis. About 60 per cent of Zambia's population is poverty stricken; this implies that since NCDs are costly to treat and manage, the poor are more likely to die as they cannot afford the resources to manage the health conditions. The Ministry of Health has attempted to develop an NCD strategic plan but it does not comprehensively address all the major NCDs in Zambia (Mukanu, Zulu, Mweemba *et al.* 2017). The epidemic of NCDs will continue to pose as a challenge to meeting the sustainable development goals if government does not respond effectively to this burden.

Fourth, the study established a very strong negative association between education and adult mortality at both individual and community level. This proves that education lowers the risk of mortality. A good education policy can also be viewed as a "health policy" in some way. However, the Government of Zambia's allocation of resources to the education sector has been on the decline in the past years. This threatens the gains that have been made in the education sector. Investment in education is a long-term solution to health problems as an educated population has lower morbidity and mortality. There is need therefore for government to promote and invest in the education sector as this will contribute to reducing adult mortality in the country. If the trend of reducing financial resources to the education sector continues then the country's population health will also be declining leading to high morbidity and mortality burden.

Fifth, injuries and accidents are one of the leading causes of death among adults as the study has found. Productive adult lives are lost in significant numbers nearly each year through injuries and accidents. Of particular concern is that the study shows that a high proportion of these injuries and accidents occur among the highly educated persons who contribute the most to the country's economy and socioeconomic development. There is need for government and its agencies responsible for road safety to devise interventions that will curb the needless loss of adult lives through injuries and accidents. Failure to address this, the country will continue losing its most productive human resource.

Sixth, the study found that family relationships lower the risk of adult mortality as they provide a protective effect. However, the family and marriage as institutions are facing challenges as the second demographic transition takes effect in African countries like Zambia. The alternative forms of living arrangements to family and marriage have been associated with a high risk of adult mortality. There is need for deliberate government policies and programmes that support family welfare in order to strengthen and sustain relations that promote good health, prolong longevity and ultimately reduce adult mortality. However, if family relations are neglected and allowed to weaken further this will lead to more health problems and eventually high adult mortality.

Seventh, periodic estimation of regional adult mortality rates is useful in monitoring and evaluating the impact of health programmes and interventions at sub-national level, for example the implementation of ART programmes aimed at reducing HIV/AIDS adult mortality. However, the current data systems do not encourage the undertaking of this activity. There is need therefore for concerted effort in mobilising investment in improving the data collection systems in the country especially the civil and vital registration system. Failure to improve data collection systems mean that health policy, programmes and intervention will continue to rely on modelled estimates rate than true accurate statistical estimates.

Eighth, the study established that the risk of adult mortality was higher in communities with a low proportion of health care utilisation, there is need to expand health care access through infrastructure development, minimising the distances to health facilities within the recommended radius of 5 km especially in rural areas. However, if this is not addressed these communities will continue experiencing poor health which results in morbidity and mortality.

8.4 Recommendations

The following are the recommendations based on the findings of the study:

(i) Adult mortality should be recognised by government as a health burden and feature the problem in development agendas only then will health policies and programmes devise strategies and interventions aimed reducing the mortality levels as well as at addressing variations in adult mortality at regional level.

(ii) Government should address the socioeconomic disparities in development at regional level. The variations in adult mortality rates indicate the need to design and tailor health interventions that are unique to each region's ecological social environment. Deliberate investment in health and social infrastructure should be implemented in the regions experiencing high mortality, for example, Luapula and Northern provinces.

(iii) The impact of the NCD epidemic is anticipated to be huge and costly financially. To minimise the impact of the burden of NCDs, government should revise the current NCD strategic plan so that it comprehensively covers all major NCDs. The NCD strategic plan should be adequately funded and implemented effectively. Health promotion programmes through behavioural change and communication should be developed to raise awareness of NCDs in the general population and how they should live healthy and active lifestyles.

(iv) Sustained investment in education will ensure that individuals and the country continue to reap the benefits of education in form of lower risk of mortality. Government should allocate more resources to the education sector to ensure a healthy population in the long term and ultimately low adult mortality risk. Also, expand access to education at all levels especially at higher level. Deliberate efforts should be made to develop funding models that will ensure that higher education is accessible to many qualified persons as possible.

(v) Agencies responsible for road safety should develop sustainable and effective interventions that will minimise the needless loss of adult lives in road traffic accidents. There is also need for these agencies to be adequately equipped and funded for them to operate effectively. An investigation is needed to uncover the reason for the high proportion of educated adults dying from injuries and accidents. Public educational promotion campaigns on road safety for pedesterians and motorists, roadworthiness of vehicles, good driving behaviour (no drinking and driving), and use of seat belts should be intensified.

(vi) Strategies and interventions should be developed and implemented that will promote and improve family welfare so that the family continues to provide the protect effect against mortality risks. For example, re-introduce tax relief incentives for families to help in improving their welfare.

(vii) Reliable adult mortality estimates for monitoring the implementation and effectiveness of health programmes will only be available when there is investment in data collection systems that are accurate and efficient. There is need for government to deliberately allocate resources to improve the current rudimentary data collection systems in the country. For instance, investing in improving and modernising the civil registration and vital statistics system in order to expand coverage from the lowest administrative level to the national level could increase the availability of adult mortality data. There is renewed interest in improving the civil registration and vital statistics systems in sub-Saharan African countries among United Nations agencies and bilateral donors, therefore funds could be mobilised for this purpose through development assistance.

(viii) To minimise the risk of adult mortality at community level, there is need for health infrastructure that is accessible at community level; community health promotion programmes should be intensified creating awareness around the top 5 leading causes of adult mortality. Community health initiatives should be strengthened and adequately supported to effectively function. For example, the community health neighbourhood committees require continued support by the Ministry of Health for them to function effectively in improving the health status of the population at community level.

8.5 Contribution to knowledge of the study

This research study is unique in that no other research has carried out a study of such depth in Zambia using 2010-2012 Sample Vital Registration with Verbal Autopsy data on adult mortality, examining ecological determinants at individual, household and community level. Also, no study has applied the socioecological theory and the proximate determinants framework of adult mortality in Zambia to investigate factors associated with adult mortality variations in Zambia. The research gap in ecological determinants of adult mortality in Zambia was identified through a comprehensive review of literature.

In addition, no study in Zambia has estimated adult mortality rates at provincial or regional level using 2010 census, 2010-2012 SAVVY and 2013/2014 ZDHS data by applying both direct and indirect methods of adult mortality estimation. The estimated adult mortality rates bring to light the regional variations in adult mortality which is in tandem with the HIV prevalence rates in the provinces. The estimates of adult mortality at regional level are useful as mortality indicators in monitoring and evaluating the effectiveness of health programmes and interventions aimed at reducing adult mortality especially antiretroviral programmes being implemented in the provinces. The findings of the study on adult mortality are a valuable resource for health policy, programmes and interventions.

The findings on causes of death shed more light on the emerging epidemic of NCDs that is concentrated in the adult mortality age group 15-59 years. The study findings on the NCD epidemic confirm that the epidemiologic transition in Zambia is underway and in motion, and government health policy, programmes and interventions must devise strategies, develop infrastructures and specialised human resources to combat the epidemic. This is in addition to the already overstretched resources used in fighting infectious diseases like malaria, tuberculosis, lower respiratory infection and above all the HIV/AIDS epidemic.

Furthermore, the findings of the study help in understanding issues related to adult mortality in Zambia from an ecological perspective and factors that drive the variations that have been observed. The study, therefore, lays a foundation for future studies that will investigate further or seek in-depth understanding of adult mortality in Zambia from an ecological perspective by exploring additional factors that this study has not been able to examine, such as sociocultural, religious, wealth status, and other factors due to lack of information.

This study has been a worthwhile research undertaking with several points of learning on adult mortality in Zambia resulting in a significant contribution to knowledge. To date, previous research on adult mortality in Zambia concentrated on estimating adult mortality rates as well as maternal mortality at national level without examining the determinants of adult mortality. This research, on the other hand, differs in the following respects, it has been able to derive adult mortality rates at both national and regional levels; it has examined the causes of death of adult mortality by sociodemographic and socioeconomic factors; examined the impact of eliminating the leading causes of death on adult mortality in terms of added years of life in Zambia; it has examined through decomposition analysis of adult mortality age-sex and cause-specific mortality rates the contribution to the gap in life expectancy; it has investigated the ecological determinants of adult mortality by applying multivariate multilevel analysis.

The importance of this study compared to what has been produced hitherto, lies in examining the ecological factors that influence adult mortality in Zambia. Several studies, population conferences have highlighted that adult mortality remains an under researched area more especially in sub-Saharan Africa. This study, by adopting to estimate adult mortality rates at national and regional levels, examining the causes of death of adult mortality, and ecological factors influencing adult mortality variations enhanced the understanding of adult mortality in Zambia as well as in sub-Saharan Africa. The knowledge, therefore, generated by this study has made an important and unique contribution to the understanding of adult mortality in sub-Saharan Africa.

Furthermore, research publications produced as a result of this research have contributed to the field of adult mortality in that the opportunity to publish and discuss adult mortality issues with fellow peers has not only stimulated productive and intellectual debate but also allowed other researchers to have access to the research deemed by peer-reviewed academic journal editors and scientific conference committees as making a contribution to the adult mortality academic community. The publications and conferences attended are listed below:

Peer reviewed publications:

1. Chisumpa, VH, Odimegwu, CO, and De Wet, N. 2017. "Adult mortality in sub-Saharan Africa, Zambia: Where do adults die?", *Social Science and Medicine -Population Health* **3**:227-235. http://dx.doi.org/10.1016/j.ssmph.2017.02.001

2. Chisumpa, VH and De Wet, N. 2017. "Estimating regional variations in adult mortality in Zambia", *African Population Studies Journal* **31**(1): 3144-3165. http://dx.doi.org/10.11564/31-1-950

3. Chisumpa, VH and Odimegwu, CO. Forthcoming (2018). "Decomposition of age- and cause-specific adult mortality contributions from census and survey data in Zambia", *Social Science and Medicine -Population Health*

Papers presented at conferences attended:

1. 2017 April 27th - 29th "Adult mortality in sub-Saharan Africa using 2001-2009 census data: Does estimation method matter?" Population Association of America Annual Meeting, Hilton Chicago Hotel, Chicago, Illinois, USA. Oral paper presentation

2. 2016 Aug 31st - Sept 2nd "Family relations and adult mortality in Zambia: Does type of relationship matter?" 11th Population Association of Southern Africa Conference, University of the Witwatersrand, Johannesburg, South Africa. Oral paper presentation

3. 2015 Nov 30th - Dec 4th "Adult mortality in sub-Saharan Africa using 2001-2009 census data: Application of different methods" 7th African Population Conference, St. George Hotel, Pretoria, South Africa. Oral paper presentation

4. 2015 Nov 30th - Dec 4th "Regional variations in adult mortality in Zambia: Do they matter?" 7th African Population Conference, St. George Hotel, Pretoria, South Africa. Poster presentation

5. 2015 Nov 30th - Dec 4th "Adult mortality in Zambia: Where do Adults die?" 7th African Population Conference, St. George Hotel, Pretoria, South Africa. Poster presentation

6. 2015 Aug 25 "Adult mortality in Zambia: Where do Adults die?" Wits School of Public Health Research Day: Healthography, 2015. Poster presentation

7. 2015 July 8th - 10th "Adult mortality variations in Zambia" 10th Population Association of Southern Africa Conference, University of KwaZulu-Natal, Durban, South Africa. Oral paper presentation

8.6 Future research

Adult mortality remains an under researched area thus it does not feature prominently on the development agenda of Zambia, even in development plans, health policy, national health strategic plan, there is no clear mention of programmes to address adult mortality in the country. The past Millennium Development Goals mainly focused on addressing maternal and child mortality while adult mortality was not in the picture. The new development agenda under the Sustainable Development Goals, has also taken the same approach except that SDG number 3 addresses some aspects of adult mortality, Targets 3.3 "End the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, waterborne diseases and other communicable diseases" and 3.4 "Reduce by a third, premature mortality from non-communicable diseases (NCDs) through prevention and treatment, and promote mental health and well-being."

This study has established a baseline for future studies on adult mortality in Zambia to investigate further the influence of ecological factors.

Future studies could explore using the life course approach to investigate the causal mechanisms in the relationship between ecological factors and adult mortality as a health outcome in Zambia. Furthermore, future studies should examine the role of sociocultural/ethnic factors in influencing the outcome of adult mortality, not investigated in this study due to lack information on the factors.

Additionally, future studies should also examine the role of religion in influencing adult mortality in Zambia. Information on religion was not collected by the 2010-2012 SAVVY.

In addition, in-depth studies on adult mortality at regional level are needed to further understand why some regions experience high mortality and others low mortality in Zambia.

Further analysis of the data from the next round of the SAVVY in needed for a deeper understanding of adult mortality in Zambia.

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CHAPTER 4: APPENDIX

Zambia Life Tables

Table A4.1 Abridged Life Table for both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	3,535	44,792	0.5	0.07892	0.07592	100,000	7,592	96,204	5,191,121	51.9
1-4	4	2,854	182,864	2.0	0.01561	0.06054	92,408	5,594	358,442	5,094,917	55.1
5-9	5	871	192,182	2.5	0.00453	0.02241	86,813	1,945	429,203	4,736,476	54.6
10-14	5	484	178,450	2.5	0.00271	0.01347	84,868	1,143	421,482	4,307,272	50.8
15-19	5	584	154,787	2.5	0.00377	0.01869	83,725	1,565	414,713	3,885,790	46.4
20-24	5	719	121,086	2.5	0.00594	0.02926	82,160	2,404	404,792	3,471,077	42.2
25-29	5	1,053	107,009	2.5	0.00984	0.04802	79,757	3,830	389,208	3,066,285	38.4
30-34	5	1,098	85,032	2.5	0.01291	0.06254	75,927	4,749	367,761	2,677,077	35.3
35-39	5	1,065	69,021	2.5	0.01543	0.07428	71,178	5,287	342,671	2,309,316	32.4
40-44	5	737	47,732	2.5	0.01544	0.07433	65,890	4,898	317,208	1,966,645	29.8
45-49	5	604	38,004	2.5	0.01589	0.07643	60,993	4,662	293,309	1,649,437	27.0
50-54	5	490	28,850	2.5	0.01698	0.08146	56,331	4,589	270,183	1,356,128	24.1
55-59	5	343	19,422	2.5	0.01766	0.08457	51,742	4,376	247,771	1,085,945	21.0
60-64	5	395	17,073	2.5	0.02314	0.10935	47,366	5,180	223,883	838,174	17.7
65-69	5	330	12,499	2.5	0.02640	0.12384	42,187	5,224	197,873	614,291	14.6
70-74	5	423	9,635	2.5	0.04390	0.19780	36,962	7,311	166,534	416,419	11.3
75-79	5	311	6,639	2.5	0.04684	0.20967	29,651	6,217	132,714	249,885	8.4
80+	0	549	6,896	5.0	0.07961	1.00000	23,434	23,434	117,171	117,171	5.0

Table A4.2 Abridged Life Table for Males, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	1886	22,333	0.5	0.08445	0.08103	100,000	8,103	95,949	4,980,501	49.8
1-4	4	1549	91,035	2.0	0.01702	0.06582	91,897	6,049	355,491	4,884,552	53.2
5-9	5	473	95,675	2.5	0.00494	0.02442	85,848	2,096	424,002	4,529,061	52.8
10-14	5	258	88,362	2.5	0.00292	0.01449	83,752	1,214	415,726	4,105,059	49.0
15-19	5	271	75,571	2.5	0.00359	0.01777	82,538	1,467	409,025	3,689,333	44.7
20-24	5	350	55,917	2.5	0.00626	0.03081	81,072	2,498	399,113	3,280,308	40.5
25-29	5	526	50,208	2.5	0.01048	0.05105	78,573	4,011	382,840	2,881,195	36.7
30-34	5	614	42,848	2.5	0.01433	0.06917	74,563	5,158	359,919	2,498,355	33.5
35-39	5	609	36,020	2.5	0.01691	0.08111	69,405	5,629	332,952	2,138,436	30.8
40-44	5	429	25,148	2.5	0.01706	0.08181	63,776	5,217	305,836	1,805,484	28.3
45-49	5	369	18,889	2.5	0.01954	0.09313	58,559	5,453	279,159	1,499,648	25.6
50-54	5	270	13,859	2.5	0.01948	0.09289	53,105	4,933	253,194	1,220,489	23.0
55-59	5	194	9,617	2.5	0.02017	0.09602	48,172	4,626	229,298	967,295	20.1
60-64	5	212	7,845	2.5	0.02702	0.12657	43,547	5,512	203,955	737,997	16.9
65-69	5	181	5,752	2.5	0.03147	0.14586	38,035	5,548	176,307	534,042	14.0
70-74	5	232	4,505	2.5	0.05150	0.22812	32,487	7,411	143,909	357,735	11.0
75-79	5	145	3,329	2.5	0.04356	0.19640	25,076	4,925	113,069	213,826	8.5
80+	0	268	3,276	5.0	0.08181	1.00000	20,151	20,151	100,757	100,757	5.0

Table A4.3 Abridged Life Table for Females, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	1,649	22,459	0.5	0.07342	0.07082	100,000	7,082	96,459	5,424,493	54.2
1-4	4	1,305	91,829	2.0	0.01421	0.05527	92,918	5,136	361,399	5,328,034	57.3
5-9	5	398	96,507	2.5	0.00412	0.02041	87,782	1,792	434,430	4,966,635	56.6
10-14	5	226	90,088	2.5	0.00251	0.01247	85,990	1,072	427,271	4,532,205	52.7
15-19	5	313	79,216	2.5	0.00395	0.01956	84,918	1,661	420,439	4,104,933	48.3
20-24	5	369	65,169	2.5	0.00566	0.02792	83,257	2,324	410,475	3,684,495	44.3
25-29	5	527	56,801	2.5	0.00928	0.04534	80,933	3,669	395,491	3,274,020	40.5
30-34	5	484	42,184	2.5	0.01147	0.05577	77,264	4,309	375,546	2,878,529	37.3
35-39	5	456	33,001	2.5	0.01382	0.06678	72,955	4,872	352,593	2,502,983	34.3
40-44	5	308	22,584	2.5	0.01364	0.06594	68,083	4,489	329,189	2,150,390	31.6
45-49	5	235	19,115	2.5	0.01229	0.05964	63,593	3,793	308,484	1,821,201	28.6
50-54	5	220	14,991	2.5	0.01468	0.07078	59,801	4,233	288,421	1,512,716	25.3
55-59	5	149	9,805	2.5	0.01520	0.07320	55,568	4,068	267,671	1,224,295	22.0
60-64	5	183	9,228	2.5	0.01983	0.09447	51,500	4,865	245,338	956,624	18.6
65-69	5	149	6,747	2.5	0.02208	0.10464	46,635	4,880	220,975	711,286	15.3
70-74	5	191	5,130	2.5	0.03723	0.17031	41,755	7,111	190,997	490,311	11.7
75-79	5	166	3,310	2.5	0.05015	0.22282	34,644	7,719	153,921	299,313	8.6
80+	0	281	3,620	5.4	0.07762	1.00000	26,925	26,925	145,392	145,392	5.4

Table A4.4 Abridged Life Table for Rural both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	2462	29763	0.5	0.08272	0.07943	100,000	7,943	96,028	5,230,862	52.3
1-4	4	2113	120295	2.0	0.01757	0.06788	92,057	6,248	355,729	5,134,834	55.8
5-9	5	635	126387	2.5	0.00502	0.02481	85,808	2,129	423,718	4,779,105	55.7
10-14	5	323	110743	2.5	0.00292	0.01448	83,679	1,211	415,367	4,355,386	52.0
15-19	5	357	88470	2.5	0.00404	0.01997	82,468	1,647	408,220	3,940,019	47.8
20-24	5	386	65802	2.5	0.00587	0.02891	80,820	2,336	398,262	3,531,799	43.7
25-29	5	532	57186	2.5	0.00930	0.04546	78,484	3,568	383,502	3,133,537	39.9
30-34	5	529	45270	2.5	0.01169	0.05677	74,917	4,253	363,950	2,750,035	36.7
35-39	5	545	38027	2.5	0.01433	0.06918	70,664	4,889	341,097	2,386,085	33.8
40-44	5	402	27531	2.5	0.01460	0.07044	65,775	4,633	317,293	2,044,988	31.1
45-49	5	318	22654	2.5	0.01404	0.06781	61,142	4,146	295,345	1,727,696	28.3
50-54	5	260	17430	2.5	0.01492	0.07190	56,996	4,098	274,735	1,432,350	25.1
55-59	5	196	11847	2.5	0.01654	0.07944	52,898	4,202	253,985	1,157,615	21.9
60-64	5	229	11343	2.5	0.02019	0.09609	48,696	4,679	231,782	903,630	18.6
65-69	5	188	8777	2.5	0.02142	0.10165	44,017	4,474	208,897	671,848	15.3
70-74	5	267	7048	2.5	0.03788	0.17303	39,542	6,842	180,606	462,951	11.7
75-79	5	198	4942	2.5	0.04006	0.18209	32,700	5,954	148,616	282,345	8.6
80+		336	5144	5.0	0.06532	1.00000	26,746	26,746	133,730	133,730	5.0

Table A4.5 Abridged Life Table for Rural male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	1312	14,773	0.5	0.08881	0.08503	100,000	8,503	95,748	5,013,009	50.1
1-4	4	1151	59,977	2.0	0.01919	0.07393	91,497	6,764	352,458	4,917,261	53.7
5-9	5	349	63,286	2.5	0.00551	0.02720	84,733	2,305	417,902	4,564,803	53.9
10-14	5	173	56,113	2.5	0.00308	0.01530	82,428	1,261	408,988	4,146,901	50.3
15-19	5	174	44,190	2.5	0.00394	0.01950	81,167	1,582	401,879	3,737,913	46.1
20-24	5	185	30,548	2.5	0.00606	0.02983	79,585	2,374	391,989	3,336,034	41.9
25-29	5	253	26,753	2.5	0.00946	0.04619	77,211	3,567	377,138	2,944,045	38.1
30-34	5	282	22,362	2.5	0.01261	0.06113	73,644	4,502	356,967	2,566,908	34.9
35-39	5	299	19,121	2.5	0.01564	0.07524	69,143	5,203	332,707	2,209,940	32.0
40-44	5	225	13,993	2.5	0.01608	0.07729	63,940	4,942	307,345	1,877,234	29.4
45-49	5	188	11,060	2.5	0.01700	0.08153	58,998	4,810	282,966	1,569,889	26.6
50-54	5	140	8,262	2.5	0.01695	0.08128	54,188	4,405	259,930	1,286,923	23.7
55-59	5	116	5,716	2.5	0.02029	0.09657	49,784	4,808	236,899	1,026,993	20.6
60-64	5	126	4,946	2.5	0.02548	0.11975	44,976	5,386	211,416	790,094	17.6
65-69	5	106	3,945	2.5	0.02687	0.12589	39,590	4,984	185,491	578,679	14.6
70-74	5	154	3,285	2.5	0.04688	0.20981	34,606	7,261	154,879	393,188	11.4
75-79	5	96	2,561	2.5	0.03749	0.17137	27,345	4,686	125,012	238,309	8.7
80+		176	2,556	5.0	0.06886	1.00000	22,659	22,659	113,297	113,297	5.0

Table A4.6 Abridged Life Table for Rural female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	1150	14,990	0.5	0.07672	0.07388	100,000	7,388	96,306	5,465,951	54.7
1-4	4	962	60,318	2.0	0.01595	0.06182	92,612	5,726	358,995	5,369,646	58.0
5-9	5	286	63,101	2.5	0.00453	0.02241	86,886	1,947	429,563	5,010,650	57.7
10-14	5	150	54,630	2.5	0.00275	0.01364	84,939	1,158	421,800	4,581,087	53.9
15-19	5	183	44,280	2.5	0.00413	0.02045	83,781	1,714	414,621	4,159,287	49.6
20-24	5	201	35,254	2.5	0.00570	0.02811	82,067	2,307	404,570	3,744,666	45.6
25-29	5	279	30,433	2.5	0.00917	0.04481	79,761	3,574	389,868	3,340,095	41.9
30-34	5	247	22,908	2.5	0.01078	0.05250	76,187	4,000	370,934	2,950,227	38.7
35-39	5	246	18,906	2.5	0.01301	0.06301	72,187	4,548	349,564	2,579,293	35.7
40-44	5	177	13,538	2.5	0.01307	0.06330	67,639	4,282	327,489	2,229,729	33.0
45-49	5	130	11,594	2.5	0.01121	0.05453	63,357	3,455	308,147	1,902,240	30.0
50-54	5	120	9,168	2.5	0.01309	0.06337	59,902	3,796	290,019	1,594,093	26.6
55-59	5	80	6,131	2.5	0.01305	0.06318	56,106	3,545	271,667	1,304,074	23.2
60-64	5	103	6,397	2.5	0.01610	0.07739	52,561	4,068	252,635	1,032,407	19.6
65-69	5	82	4,832	2.5	0.01697	0.08140	48,493	3,947	232,598	779,772	16.1
70-74	5	113	3,763	2.5	0.03003	0.13966	44,546	6,221	207,176	547,175	12.3
75-79	5	102	2,381	2.5	0.04284	0.19347	38,325	7,415	173,086	339,998	8.9
80+		160	2,588	5.4	0.06182	1.00000	30,910	30,910	166,913	166,913	5.4

Table A4.7 Abridged Life Table for Urban both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	1073	15029	0.5	0.07140	0.06893	100,000	6,893	96,553	5,155,159	51.6
1-4	4	741	62569	2.0	0.01184	0.04628	93,107	4,309	363,809	5,058,606	54.3
5-9	5	236	65795	2.5	0.00359	0.01778	88,798	1,578	440,044	4,694,797	52.9
10-14	5	161	67707	2.5	0.00238	0.01182	87,220	1,031	433,521	4,254,753	48.8
15-19	5	227	66317	2.5	0.00342	0.01697	86,189	1,463	427,287	3,821,232	44.3
20-24	5	333	55284	2.5	0.00602	0.02967	84,726	2,514	417,346	3,393,945	40.1
25-29	5	521	49823	2.5	0.01046	0.05095	82,212	4,189	400,589	2,976,599	36.2
30-34	5	569	39762	2.5	0.01431	0.06908	78,023	5,390	376,642	2,576,010	33.0
35-39	5	520	30994	2.5	0.01678	0.08051	72,634	5,848	348,548	2,199,367	30.3
40-44	5	335	20201	2.5	0.01658	0.07962	66,786	5,317	320,636	1,850,819	27.7
45-49	5	286	15350	2.5	0.01863	0.08901	61,469	5,472	293,664	1,530,183	24.9
50-54	5	230	11420	2.5	0.02014	0.09587	55,997	5,369	266,564	1,236,519	22.1
55-59	5	147	7575	2.5	0.01941	0.09254	50,628	4,685	241,429	969,956	19.2
60-64	5	166	5730	2.5	0.02897	0.13507	45,943	6,206	214,202	728,527	15.9
65-69	5	142	3722	2.5	0.03815	0.17415	39,738	6,920	181,388	514,324	12.9
70-74	5	156	2587	2.5	0.06030	0.26201	32,818	8,598	142,591	332,936	10.1
75-79	5	113	1697	2.5	0.06659	0.28543	24,219	6,913	103,813	190,345	7.9
80+		213	1752	5.0	0.12158	1.00000	17,306	17,306	86,531	86,531	5.0

Table A4.8 Abridged Life Table for Urban male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	574	7,560	0.5	0.07593	0.07315	100,000	7,315	96,343	4,975,389	49.8
1-4	4	398	31,058	2.0	0.01281	0.04998	92,685	4,632	361,476	4,879,047	52.6
5-9	5	124	32,389	2.5	0.00383	0.01896	88,053	1,670	436,091	4,517,571	51.3
10-14	5	85	32,249	2.5	0.00264	0.01309	86,383	1,131	429,089	4,081,480	47.2
15-19	5	97	31,381	2.5	0.00309	0.01534	85,252	1,307	422,993	3,652,391	42.8
20-24	5	165	25,369	2.5	0.00650	0.03200	83,945	2,686	413,009	3,229,398	38.5
25-29	5	273	23,455	2.5	0.01164	0.05655	81,259	4,595	394,805	2,816,389	34.7
30-34	5	332	20,486	2.5	0.01621	0.07788	76,663	5,970	368,391	2,421,584	31.6
35-39	5	310	16,899	2.5	0.01834	0.08770	70,693	6,200	337,967	2,053,192	29.0
40-44	5	204	11,155	2.5	0.01829	0.08744	64,493	5,639	308,369	1,715,226	26.6
45-49	5	181	7,829	2.5	0.02312	0.10928	58,854	6,432	278,191	1,406,857	23.9
50-54	5	130	5,597	2.5	0.02323	0.10976	52,422	5,754	247,728	1,128,666	21.5
55-59	5	78	3,901	2.5	0.01999	0.09521	46,669	4,444	222,234	880,938	18.9
60-64	5	86	2,899	2.5	0.02967	0.13809	42,225	5,831	196,549	658,704	15.6
65-69	5	75	1,807	2.5	0.04151	0.18802	36,394	6,843	164,865	462,155	12.7
70-74	5	78	1,220	2.5	0.06393	0.27562	29,552	8,145	127,396	297,290	10.1
75-79	5	49	768	2.5	0.06380	0.27513	21,407	5,890	92,309	169,895	7.9
80+		92	720	5.0	0.12778	1.00000	15,517	15,517	77,586	77,586	5.0

Table A4.9 Abridged Life Table for Urban female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	499	7,469	0.5	0.06681	0.06465	100,000	6,465	96,768	5,361,053	53.6
1-4	4	343	31,511	2.0	0.01089	0.04261	93,535	3,986	366,169	5,264,285	56.3
5-9	5	112	33,406	2.5	0.00335	0.01662	89,549	1,489	444,024	4,898,117	54.7
10-14	5	76	35,458	2.5	0.00214	0.01066	88,061	939	437,956	4,454,092	50.6
15-19	5	130	34,936	2.5	0.00372	0.01843	87,122	1,606	431,594	4,016,136	46.1
20-24	5	168	29,915	2.5	0.00562	0.02769	85,516	2,368	421,659	3,584,542	41.9
25-29	5	248	26,368	2.5	0.00941	0.04595	83,148	3,820	406,188	3,162,883	38.0
30-34	5	237	19,276	2.5	0.01230	0.05964	79,328	4,731	384,809	2,756,694	34.8
35-39	5	210	14,095	2.5	0.01490	0.07182	74,596	5,357	359,588	2,371,885	31.8
40-44	5	131	9,046	2.5	0.01448	0.06988	69,239	4,838	334,098	2,012,297	29.1
45-49	5	105	7,521	2.5	0.01396	0.06745	64,401	4,344	311,143	1,678,199	26.1
50-54	5	100	5,823	2.5	0.01717	0.08233	60,057	4,945	287,922	1,367,056	22.8
55-59	5	69	3,674	2.5	0.01878	0.08969	55,112	4,943	263,203	1,079,134	19.6
60-64	5	80	2,831	2.5	0.02826	0.13197	50,169	6,621	234,293	815,931	16.3
65-69	5	67	1,915	2.5	0.03499	0.16086	43,548	7,005	200,228	581,638	13.4
70-74	5	78	1,367	2.5	0.05706	0.24968	36,543	9,124	159,904	381,410	10.4
75-79	5	64	929	2.5	0.06889	0.29385	27,419	8,057	116,952	221,506	8.1
80+		121	1,032	5.4	0.11725	1.00000	19,362	19,362	104,554	104,554	5.4

Table A4.10 Abridged Life Table for Central both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	333	4551	0.5	0.07317	0.07059	100,000	7,059	96,471	5,171,846	51.7
1-4	4	278	18487	2.0	0.01504	0.05839	92,941	5,427	360,910	5,075,375	54.6
5-9	5	71	19601	2.5	0.00362	0.01795	87,514	1,571	433,643	4,714,465	53.9
10-14	5	52	18624	2.5	0.00279	0.01386	85,943	1,191	426,737	4,280,822	49.8
15-19	5	64	15984	2.5	0.00400	0.01982	84,752	1,680	419,559	3,854,085	45.5
20-24	5	69	11743	2.5	0.00588	0.02895	83,072	2,405	409,346	3,434,526	41.3
25-29	5	113	9770	2.5	0.01157	0.05620	80,667	4,534	391,998	3,025,181	37.5
30-34	5	125	7930	2.5	0.01576	0.07583	76,133	5,773	366,231	2,633,183	34.6
35-39	5	112	6553	2.5	0.01709	0.08196	70,360	5,766	337,383	2,266,952	32.2
40-44	5	95	4696	2.5	0.02023	0.09628	64,593	6,219	307,419	1,929,568	29.9
45-49	5	63	3625	2.5	0.01738	0.08328	58,374	4,861	279,718	1,622,149	27.8
50-54	5	47	2912	2.5	0.01614	0.07757	53,513	4,151	257,188	1,342,430	25.1
55-59	5	35	2022	2.5	0.01731	0.08296	49,362	4,095	236,573	1,085,243	22.0
60-64	5	27	1770	2.5	0.01525	0.07347	45,267	3,326	218,021	848,670	18.7
65-69	5	28	1215	2.5	0.02305	0.10895	41,941	4,569	198,283	630,649	15.0
70-74	5	40	957	2.5	0.04180	0.18921	37,372	7,071	169,181	432,367	11.6
75-79	5	28	729	2.5	0.03841	0.17522	30,301	5,309	138,229	263,186	8.7
80+		57	705	5.0	0.08085	1.00000	24,991	24,991	124,956	124,956	5.0

Table A4.11 Abridged Life Table for Central male, Zambia 2010

Age	n	${}_nD_x$	${}_nPY_x$	${}_na_x$	${}_nM_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
0	1	162	2,224	0.5	0.07284	0.07028	100,000	7,028	96,486	5,018,037	50.2
1-4	4	159	9,029	2.0	0.01761	0.06804	92,972	6,326	359,235	4,921,551	52.9
5-9	5	39	9,744	2.5	0.00400	0.01981	86,646	1,717	428,936	4,562,316	52.7
10-14	5	34	9,178	2.5	0.00370	0.01835	84,929	1,559	420,748	4,133,379	48.7
15-19	5	29	7,885	2.5	0.00368	0.01822	83,370	1,519	413,053	3,712,631	44.5
20-24	5	29	5,535	2.5	0.00524	0.02586	81,851	2,117	403,964	3,299,578	40.3
25-29	5	52	4,626	2.5	0.01124	0.05467	79,735	4,359	387,775	2,895,614	36.3
30-34	5	69	3,912	2.5	0.01764	0.08447	75,376	6,367	360,962	2,507,838	33.3
35-39	5	68	3,428	2.5	0.01984	0.09450	69,009	6,521	328,742	2,146,877	31.1
40-44	5	53	2,502	2.5	0.02118	0.10059	62,488	6,286	296,725	1,818,135	29.1
45-49	5	33	1,808	2.5	0.01825	0.08728	56,202	4,905	268,748	1,521,409	27.1
50-54	5	26	1,385	2.5	0.01877	0.08966	51,297	4,599	244,988	1,252,661	24.4
55-59	5	18	1,013	2.5	0.01777	0.08507	46,698	3,972	223,559	1,007,673	21.6
60-64	5	13	847	2.5	0.01535	0.07391	42,726	3,158	205,734	784,114	18.4
65-69	5	15	583	2.5	0.02573	0.12087	39,568	4,783	185,883	578,381	14.6
70-74	5	22	473	2.5	0.04651	0.20833	34,785	7,247	155,809	392,498	11.3
75-79	5	16	387	2.5	0.04134	0.18735	27,538	5,159	124,793	236,688	8.6
80+		30	375	5.0	0.08000	1.00000	22,379	22,379	111,895	111,895	5.0

Table A4.12 Abridged Life Table for Central female, Zambia 2010

Age	n	${}_nD_x$	${}_nPY_x$	${}_na_x$	${}_nM_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
0	1	171	2,327	0.5	0.07349	0.07088	100,000	7,088	96,456	5,345,794	53.5
1-4	4	119	9,458	2.0	0.01258	0.04909	92,912	4,561	362,525	5,249,338	56.5
5-9	5	32	9,857	2.5	0.00325	0.01610	88,351	1,423	438,197	4,886,813	55.3
10-14	5	18	9,446	2.5	0.00191	0.00948	86,928	824	432,580	4,448,616	51.2
15-19	5	35	8,099	2.5	0.00432	0.02138	86,104	1,841	425,917	4,016,036	46.6
20-24	5	40	6,208	2.5	0.00644	0.03171	84,263	2,672	414,637	3,590,119	42.6
25-29	5	61	5,144	2.5	0.01186	0.05759	81,592	4,698	396,211	3,175,482	38.9
30-34	5	56	4,018	2.5	0.01394	0.06734	76,893	5,178	371,520	2,779,271	36.1
35-39	5	44	3,125	2.5	0.01408	0.06801	71,715	4,877	346,383	2,407,751	33.6
40-44	5	42	2,194	2.5	0.01914	0.09134	66,838	6,105	318,927	2,061,368	30.8
45-49	5	30	1,817	2.5	0.01651	0.07928	60,733	4,815	291,626	1,742,441	28.7
50-54	5	21	1,527	2.5	0.01375	0.06648	55,918	3,717	270,296	1,450,815	25.9
55-59	5	17	1,009	2.5	0.01685	0.08084	52,201	4,220	250,453	1,180,519	22.6
60-64	5	14	923	2.5	0.01517	0.07307	47,981	3,506	231,139	930,065	19.4
65-69	5	13	632	2.5	0.02057	0.09782	44,475	4,350	211,498	698,926	15.7
70-74	5	18	484	2.5	0.03719	0.17013	40,124	6,826	183,556	487,427	12.1
75-79	5	12	342	2.5	0.03509	0.16129	33,298	5,371	153,063	303,871	9.1
80+		27	330	5.4	0.08182	1.00000	27,927	27,927	150,808	150,808	5.4

Table A4.13 Abridged Life Table for Copperbelt both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	375	5548	0.5	0.06759	0.06538	100,000	6,538	96,731	5,080,185	50.8
1-4	4	278	23822	2.0	0.01167	0.04561	93,462	4,263	365,321	4,983,454	53.3
5-9	5	94	25305	2.5	0.00371	0.01840	89,199	1,641	441,889	4,618,134	51.8
10-14	5	78	26439	2.5	0.00295	0.01464	87,557	1,282	434,580	4,176,245	47.7
15-19	5	95	25704	2.5	0.00370	0.01831	86,275	1,580	427,425	3,741,665	43.4
20-24	5	123	19406	2.5	0.00634	0.03120	84,695	2,642	416,871	3,314,239	39.1
25-29	5	200	17442	2.5	0.01147	0.05574	82,053	4,573	398,832	2,897,369	35.3
30-34	5	248	13841	2.5	0.01792	0.08575	77,480	6,644	370,789	2,498,537	32.2
35-39	5	211	11059	2.5	0.01908	0.09105	70,836	6,450	338,055	2,127,747	30.0
40-44	5	124	7849	2.5	0.01580	0.07599	64,386	4,893	309,699	1,789,692	27.8
45-49	5	135	6454	2.5	0.02092	0.09939	59,493	5,913	282,685	1,479,993	24.9
50-54	5	92	4947	2.5	0.01860	0.08885	53,580	4,761	256,000	1,197,308	22.3
55-59	5	58	3566	2.5	0.01626	0.07815	48,820	3,815	234,560	941,308	19.3
60-64	5	91	2745	2.5	0.03315	0.15307	45,005	6,889	207,801	706,748	15.7
65-69	5	64	1846	2.5	0.03467	0.15952	38,116	6,080	175,378	498,947	13.1
70-74	5	72	1300	2.5	0.05538	0.24324	32,035	7,792	140,696	323,570	10.1
75-79	5	68	868	2.5	0.07834	0.32755	24,243	7,941	101,363	182,874	7.5
80+		110	795	5.0	0.13836	1.00000	16,302	16,302	81,511	81,511	5.0

Table A4.14 Abridged Life Table for Copperbelt male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	199	2,779	0.5	0.07161	0.06913	100,000	6,913	96,543	4,917,197	49.2
1-4	4	147	11,921	2.0	0.01233	0.04814	93,087	4,481	363,385	4,820,653	51.8
5-9	5	47	12,569	2.5	0.00374	0.01852	88,606	1,641	438,925	4,457,269	50.3
10-14	5	35	12,999	2.5	0.00269	0.01337	86,964	1,163	431,915	4,018,343	46.2
15-19	5	50	12,534	2.5	0.00399	0.01975	85,801	1,694	424,771	3,586,429	41.8
20-24	5	60	9,157	2.5	0.00655	0.03223	84,107	2,711	413,757	3,161,657	37.6
25-29	5	112	8,342	2.5	0.01343	0.06495	81,396	5,287	393,763	2,747,900	33.8
30-34	5	145	7,203	2.5	0.02013	0.09583	76,109	7,294	362,312	2,354,137	30.9
35-39	5	124	5,928	2.5	0.02092	0.09939	68,816	6,840	326,979	1,991,825	28.9
40-44	5	64	4,253	2.5	0.01505	0.07251	61,976	4,494	298,645	1,664,845	26.9
45-49	5	91	3,223	2.5	0.02823	0.13186	57,482	7,580	268,460	1,366,200	23.8
50-54	5	50	2,478	2.5	0.02018	0.09604	49,902	4,793	237,529	1,097,740	22.0
55-59	5	35	1,858	2.5	0.01884	0.08995	45,109	4,058	215,403	860,211	19.1
60-64	5	49	1,460	2.5	0.03356	0.15482	41,052	6,356	189,370	644,809	15.7
65-69	5	32	937	2.5	0.03415	0.15733	34,696	5,459	159,834	455,439	13.1
70-74	5	39	648	2.5	0.06019	0.26157	29,238	7,648	127,069	295,604	10.1
75-79	5	32	467	2.5	0.06852	0.29250	21,590	6,315	92,162	168,536	7.8
80+		49	367	5.0	0.13351	1.00000	15,275	15,275	76,374	76,374	5.0

Table A4.15 Abridged Life Table for Copperbelt female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	176	2,769	0.5	0.06356	0.06160	100,000	6,160	96,920	5,262,473	52.6
1-4	4	131	11,901	2.0	0.01101	0.04308	93,840	4,043	367,273	5,165,553	55.0
5-9	5	47	12,736	2.5	0.00369	0.01828	89,797	1,642	444,880	4,798,280	53.4
10-14	5	43	13,440	2.5	0.00320	0.01587	88,155	1,399	437,278	4,353,400	49.4
15-19	5	45	13,170	2.5	0.00342	0.01694	86,756	1,470	430,107	3,916,121	45.1
20-24	5	63	10,249	2.5	0.00615	0.03027	85,287	2,582	419,979	3,486,015	40.9
25-29	5	88	9,100	2.5	0.00967	0.04721	82,705	3,905	403,763	3,066,036	37.1
30-34	5	103	6,638	2.5	0.01552	0.07469	78,800	5,885	379,289	2,662,273	33.8
35-39	5	87	5,131	2.5	0.01696	0.08133	72,915	5,930	349,750	2,282,984	31.3
40-44	5	60	3,596	2.5	0.01669	0.08009	66,985	5,365	321,513	1,933,234	28.9
45-49	5	44	3,231	2.5	0.01362	0.06585	61,620	4,058	297,958	1,611,721	26.2
50-54	5	42	2,469	2.5	0.01701	0.08159	57,563	4,696	276,073	1,313,763	22.8
55-59	5	23	1,708	2.5	0.01347	0.06514	52,866	3,444	255,723	1,037,690	19.6
60-64	5	42	1,285	2.5	0.03268	0.15108	49,423	7,467	228,447	781,967	15.8
65-69	5	32	909	2.5	0.03520	0.16178	41,956	6,788	192,811	553,519	13.2
70-74	5	33	652	2.5	0.05061	0.22464	35,168	7,900	156,092	360,708	10.3
75-79	5	36	401	2.5	0.08978	0.36660	27,268	9,996	111,350	204,617	7.5
80+		61	428	5.4	0.14252	1.00000	17,272	17,272	93,267	93,267	5.4

Table A4.16 Abridged Life Table for Eastern both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	556	5717	0.5	0.09725	0.09274	100,000	9,274	95,363	4,928,839	49.3
1-4	4	616	23023	2.0	0.02676	0.10159	90,726	9,217	344,469	4,833,476	53.3
5-9	5	177	24778	2.5	0.00714	0.03509	81,509	2,860	400,395	4,489,007	55.1
10-14	5	63	21979	2.5	0.00287	0.01423	78,649	1,119	390,446	4,088,612	52.0
15-19	5	66	18152	2.5	0.00364	0.01802	77,530	1,397	384,156	3,698,166	47.7
20-24	5	78	13906	2.5	0.00561	0.02766	76,133	2,106	375,400	3,314,009	43.5
25-29	5	89	11976	2.5	0.00743	0.03648	74,027	2,701	363,385	2,938,609	39.7
30-34	5	95	9489	2.5	0.01001	0.04884	71,327	3,483	347,925	2,575,224	36.1
35-39	5	118	7800	2.5	0.01513	0.07288	67,843	4,945	326,855	2,227,298	32.8
40-44	5	79	5474	2.5	0.01443	0.06965	62,899	4,381	303,542	1,900,443	30.2
45-49	5	70	4567	2.5	0.01533	0.07381	58,518	4,319	281,792	1,596,901	27.3
50-54	5	64	3418	2.5	0.01872	0.08944	54,199	4,847	258,876	1,315,109	24.3
55-59	5	34	2356	2.5	0.01443	0.06964	49,352	3,437	238,165	1,056,232	21.4
60-64	5	56	2299	2.5	0.02436	0.11480	45,915	5,271	216,395	818,067	17.8
65-69	5	51	1774	2.5	0.02875	0.13410	40,644	5,450	189,591	601,672	14.8
70-74	5	53	1483	2.5	0.03574	0.16404	35,193	5,773	161,533	412,080	11.7
75-79	5	44	1002	2.5	0.04391	0.19784	29,420	5,821	132,549	250,547	8.5
80+		81	1116	5.0	0.07258	1.00000	23,600	23,600	117,998	117,998	5.0

Table A4.17 Abridged Life Table for Eastern male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	311	2,794	0.5	0.11131	0.10544	100,000	10,544	94,728	4,625,758	46.3
1-4	4	351	11,342	2.0	0.03095	0.11657	89,456	10,428	336,967	4,531,030	50.7
5-9	5	95	12,248	2.5	0.00776	0.03804	79,028	3,007	387,622	4,194,063	53.1
10-14	5	35	11,099	2.5	0.00315	0.01564	76,021	1,189	377,133	3,806,440	50.1
15-19	5	25	9,174	2.5	0.00273	0.01353	74,832	1,013	371,628	3,429,308	45.8
20-24	5	31	6,509	2.5	0.00476	0.02353	73,819	1,737	364,753	3,057,680	41.4
25-29	5	49	5,662	2.5	0.00865	0.04235	72,082	3,053	352,778	2,692,927	37.4
30-34	5	46	4,776	2.5	0.00963	0.04703	69,029	3,246	337,030	2,340,149	33.9
35-39	5	62	4,042	2.5	0.01534	0.07386	65,783	4,859	316,767	2,003,119	30.5
40-44	5	42	2,793	2.5	0.01504	0.07246	60,924	4,415	293,583	1,686,352	27.7
45-49	5	43	2,195	2.5	0.01959	0.09338	56,509	5,277	269,355	1,392,768	24.6
50-54	5	40	1,608	2.5	0.02488	0.11710	51,233	5,999	241,165	1,123,414	21.9
55-59	5	22	1,146	2.5	0.01920	0.09159	45,233	4,143	215,810	882,249	19.5
60-64	5	29	932	2.5	0.03112	0.14435	41,091	5,931	190,624	666,439	16.2
65-69	5	31	717	2.5	0.04324	0.19509	35,159	6,859	158,647	475,814	13.5
70-74	5	32	613	2.5	0.05220	0.23088	28,300	6,534	125,165	317,167	11.2
75-79	5	16	469	2.5	0.03412	0.15717	21,766	3,421	100,277	192,002	8.8
80+		30	479	5.0	0.06263	1.00000	18,345	18,345	91,725	91,725	5.0

Table A4.18 Abridged Life Table for Eastern female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	245	2,923	0.5	0.08382	0.08045	100,000	8,045	95,978	5,241,276	52.4
1-4	4	265	11,681	2.0	0.02269	0.08681	91,955	7,982	351,857	5,145,298	56.0
5-9	5	82	12,530	2.5	0.00654	0.03219	83,973	2,703	413,106	4,793,442	57.1
10-14	5	28	10,880	2.5	0.00257	0.01279	81,269	1,039	403,750	4,380,335	53.9
15-19	5	41	8,978	2.5	0.00457	0.02258	80,230	1,811	396,624	3,976,586	49.6
20-24	5	47	7,397	2.5	0.00635	0.03127	78,419	2,452	385,965	3,579,962	45.7
25-29	5	40	6,314	2.5	0.00634	0.03118	75,967	2,369	373,912	3,193,997	42.0
30-34	5	49	4,713	2.5	0.01040	0.05067	73,598	3,729	358,667	2,820,085	38.3
35-39	5	56	3,758	2.5	0.01490	0.07183	69,869	5,019	336,798	2,461,418	35.2
40-44	5	37	2,681	2.5	0.01380	0.06670	64,850	4,326	313,437	2,124,620	32.8
45-49	5	27	2,372	2.5	0.01138	0.05534	60,525	3,349	294,249	1,811,183	29.9
50-54	5	24	1,810	2.5	0.01326	0.06417	57,175	3,669	276,703	1,516,934	26.5
55-59	5	12	1,210	2.5	0.00992	0.04839	53,506	2,589	261,058	1,240,231	23.2
60-64	5	27	1,367	2.5	0.01975	0.09411	50,917	4,792	242,606	979,172	19.2
65-69	5	20	1,057	2.5	0.01892	0.09033	46,125	4,167	220,210	736,566	16.0
70-74	5	21	870	2.5	0.02414	0.11382	41,959	4,776	197,854	516,356	12.3
75-79	5	28	533	2.5	0.05253	0.23217	37,183	8,633	164,332	318,502	8.6
80+		51	637	5.4	0.08006	1.00000	28,550	28,550	154,170	154,170	5.4

Table A4.19 Abridged Life Table for Luapula both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	386	3589	0.5	0.10755	0.10206	100,000	10,206	94,897	4,812,645	48.1
1-4	4	380	14699	2.0	0.02585	0.09832	89,794	8,829	341,517	4,717,748	52.5
5-9	5	99	15445	2.5	0.00641	0.03154	80,965	2,554	398,439	4,376,231	54.1
10-14	5	52	13919	2.5	0.00374	0.01851	78,411	1,451	388,427	3,977,792	50.7
15-19	5	63	11056	2.5	0.00570	0.02809	76,960	2,162	379,394	3,589,365	46.6
20-24	5	66	8133	2.5	0.00812	0.03977	74,798	2,975	366,553	3,209,971	42.9
25-29	5	97	7325	2.5	0.01324	0.06409	71,823	4,603	347,609	2,843,418	39.6
30-34	5	71	5803	2.5	0.01224	0.05936	67,220	3,990	326,125	2,495,810	37.1
35-39	5	69	4949	2.5	0.01394	0.06736	63,230	4,259	305,501	2,169,685	34.3
40-44	5	48	3756	2.5	0.01278	0.06192	58,971	3,651	285,724	1,864,183	31.6
45-49	5	46	3080	2.5	0.01494	0.07199	55,319	3,982	266,640	1,578,459	28.5
50-54	5	25	2455	2.5	0.01018	0.04965	51,337	2,549	250,312	1,311,818	25.6
55-59	5	25	1585	2.5	0.01577	0.07587	48,788	3,702	234,685	1,061,507	21.8
60-64	5	25	1424	2.5	0.01756	0.08409	45,086	3,791	215,953	826,821	18.3
65-69	5	29	1083	2.5	0.02678	0.12549	41,295	5,182	193,520	610,868	14.8
70-74	5	26	776	2.5	0.03351	0.15458	36,113	5,582	166,609	417,349	11.6
75-79	5	27	499	2.5	0.05411	0.23831	30,531	7,276	134,464	250,740	8.2
80+		42	380	5.0	0.11053	1.00000	23,255	23,255	116,275	116,275	5.0

Table A4.20 Abridged Life Table for Luapula male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	204	1,788	0.5	0.11409	0.10794	100,000	10,794	94,603	4,734,199	47.3
1-4	4	196	7,303	2.0	0.02684	0.10188	89,206	9,089	338,648	4,639,596	52.0
5-9	5	57	7,759	2.5	0.00735	0.03607	80,118	2,890	393,364	4,300,948	53.7
10-14	5	29	7,061	2.5	0.00411	0.02033	77,228	1,570	382,215	3,907,584	50.6
15-19	5	28	5,417	2.5	0.00517	0.02551	75,658	1,930	373,464	3,525,369	46.6
20-24	5	28	3,647	2.5	0.00768	0.03766	73,728	2,777	361,696	3,151,905	42.8
25-29	5	35	3,257	2.5	0.01075	0.05232	70,951	3,712	345,472	2,790,209	39.3
30-34	5	37	2,920	2.5	0.01267	0.06141	67,238	4,129	325,868	2,444,737	36.4
35-39	5	42	2,471	2.5	0.01700	0.08152	63,109	5,145	302,684	2,118,868	33.6
40-44	5	30	1,973	2.5	0.01521	0.07324	57,964	4,245	279,208	1,816,185	31.3
45-49	5	27	1,526	2.5	0.01769	0.08472	53,719	4,551	257,217	1,536,977	28.6
50-54	5	7	1,233	2.5	0.00568	0.02799	49,168	1,376	242,399	1,279,760	26.0
55-59	5	12	802	2.5	0.01496	0.07212	47,792	3,447	230,342	1,037,361	21.7
60-64	5	12	657	2.5	0.01826	0.08734	44,345	3,873	212,044	807,018	18.2
65-69	5	14	473	2.5	0.02960	0.13780	40,472	5,577	188,419	594,975	14.7
70-74	5	15	388	2.5	0.03866	0.17626	34,895	6,151	159,100	406,556	11.7
75-79	5	11	269	2.5	0.04089	0.18550	28,745	5,332	130,393	247,456	8.6
80+		26	199	5.0	0.13065	1.00000	23,413	23,413	117,063	117,063	5.0

Table A4.21 Abridged Life Table for Luapula female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	182	1,801	0.5	0.10105	0.09619	100,000	9,619	95,190	4,908,093	49.1
1-4	4	184	7,396	2.0	0.02488	0.09480	90,381	8,568	344,387	4,812,903	53.3
5-9	5	42	7,686	2.5	0.00546	0.02695	81,813	2,205	403,551	4,468,516	54.6
10-14	5	23	6,858	2.5	0.00335	0.01663	79,608	1,324	394,728	4,064,965	51.1
15-19	5	35	5,639	2.5	0.00621	0.03056	78,284	2,392	385,438	3,670,237	46.9
20-24	5	38	4,486	2.5	0.00847	0.04148	75,891	3,148	371,588	3,284,799	43.3
25-29	5	62	4,068	2.5	0.01524	0.07341	72,744	5,340	350,369	2,913,210	40.0
30-34	5	34	2,883	2.5	0.01179	0.05728	67,404	3,861	327,367	2,562,841	38.0
35-39	5	27	2,478	2.5	0.01090	0.05303	63,543	3,370	309,291	2,235,474	35.2
40-44	5	18	1,783	2.5	0.01010	0.04923	60,173	2,963	293,459	1,926,183	32.0
45-49	5	19	1,554	2.5	0.01223	0.05932	57,211	3,394	277,569	1,632,724	28.5
50-54	5	18	1,222	2.5	0.01473	0.07103	53,817	3,823	259,527	1,355,155	25.2
55-59	5	13	783	2.5	0.01660	0.07971	49,994	3,985	240,008	1,095,628	21.9
60-64	5	13	767	2.5	0.01695	0.08130	46,009	3,741	220,695	855,620	18.6
65-69	5	15	610	2.5	0.02459	0.11583	42,269	4,896	199,103	634,925	15.0
70-74	5	11	388	2.5	0.02835	0.13237	37,373	4,947	174,496	435,822	11.7
75-79	5	16	230	2.5	0.06957	0.29630	32,426	9,608	138,109	261,326	8.1
80+		16	181	5.4	0.08840	1.00000	22,818	22,818	123,217	123,217	5.4

Table A4.22 Abridged Life Table for Lusaka both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	461	6463	0.5	0.07133	0.06887	100,000	6,887	96,556	5,273,000	52.7
1-4	4	306	26805	2.0	0.01142	0.04464	93,113	4,157	364,137	5,176,444	55.6
5-9	5	95	27860	2.5	0.00341	0.01691	88,956	1,504	441,019	4,812,307	54.1
10-14	5	54	27686	2.5	0.00195	0.00970	87,452	849	435,138	4,371,287	50.0
15-19	5	89	26104	2.5	0.00341	0.01690	86,603	1,464	429,357	3,936,149	45.5
20-24	5	133	23663	2.5	0.00562	0.02771	85,139	2,360	419,798	3,506,793	41.2
25-29	5	198	22117	2.5	0.00895	0.04378	82,780	3,624	404,839	3,086,995	37.3
30-34	5	208	18004	2.5	0.01155	0.05614	79,156	4,444	384,668	2,682,156	33.9
35-39	5	211	14077	2.5	0.01499	0.07224	74,712	5,397	360,065	2,297,488	30.8
40-44	5	153	8678	2.5	0.01763	0.08443	69,315	5,852	331,942	1,937,423	28.0
45-49	5	104	6272	2.5	0.01658	0.07961	63,462	5,052	304,680	1,605,481	25.3
50-54	5	86	4465	2.5	0.01926	0.09188	58,410	5,367	278,633	1,300,801	22.3
55-59	5	66	2771	2.5	0.02382	0.11240	53,043	5,962	250,312	1,022,167	19.3
60-64	5	55	2212	2.5	0.02486	0.11705	47,081	5,511	221,630	771,856	16.4
65-69	5	47	1415	2.5	0.03322	0.15334	41,571	6,375	191,917	550,225	13.2
70-74	5	63	995	2.5	0.06332	0.27332	35,196	9,620	151,931	358,309	10.2
75-79	5	38	643	2.5	0.05910	0.25745	25,576	6,585	111,420	206,378	8.1
80+		69	733	5.0	0.09413	1.00000	18,992	18,992	94,958	94,958	5.0

Table A4.23 Abridged Life Table for Lusaka male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	244	3,237	0.5	0.07538	0.07264	100,000	7,264	96,368	5,091,025	50.9
1-4	4	157	13,277	2.0	0.01182	0.04621	92,736	4,285	362,374	4,994,657	53.9
5-9	5	52	13,632	2.5	0.00381	0.01889	88,451	1,671	438,077	4,632,284	52.4
10-14	5	31	13,163	2.5	0.00236	0.01171	86,780	1,016	431,359	4,194,207	48.3
15-19	5	38	12,163	2.5	0.00312	0.01550	85,764	1,329	425,496	3,762,848	43.9
20-24	5	74	10,747	2.5	0.00689	0.03385	84,435	2,858	415,029	3,337,351	39.5
25-29	5	102	10,630	2.5	0.00960	0.04685	81,577	3,822	398,329	2,922,323	35.8
30-34	5	120	9,304	2.5	0.01290	0.06247	77,755	4,858	376,629	2,523,994	32.5
35-39	5	129	7,811	2.5	0.01652	0.07930	72,897	5,781	350,033	2,147,365	29.5
40-44	5	101	4,974	2.5	0.02031	0.09662	67,116	6,485	319,368	1,797,332	26.8
45-49	5	65	3,334	2.5	0.01950	0.09295	60,631	5,636	289,067	1,477,963	24.4
50-54	5	43	2,181	2.5	0.01972	0.09395	54,996	5,167	262,061	1,188,896	21.6
55-59	5	34	1,418	2.5	0.02398	0.11311	49,829	5,636	235,054	926,836	18.6
60-64	5	34	1,090	2.5	0.03119	0.14468	44,193	6,394	204,979	691,781	15.7
65-69	5	25	701	2.5	0.03566	0.16372	37,799	6,188	173,524	486,802	12.9
70-74	5	34	466	2.5	0.07296	0.30853	31,611	9,753	133,671	313,278	9.9
75-79	5	15	278	2.5	0.05396	0.23772	21,858	5,196	96,299	179,608	8.2
80+		39	297	5.0	0.13131	1.00000	16,662	16,662	83,309	83,309	5.0

Table A4.24 Abridged Life Table for Lusaka female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	217	3,226	0.5	0.06727	0.06508	100,000	6,508	96,746	5,488,329	54.9
1-4	4	149	13,528	2.0	0.01101	0.04311	93,492	4,030	365,909	5,391,582	57.7
5-9	5	43	14,228	2.5	0.00302	0.01500	89,462	1,342	443,956	5,025,674	56.2
10-14	5	23	14,523	2.5	0.00158	0.00789	88,120	695	438,864	4,581,718	52.0
15-19	5	51	13,941	2.5	0.00366	0.01813	87,425	1,585	433,165	4,142,853	47.4
20-24	5	59	12,916	2.5	0.00457	0.02258	85,841	1,938	424,357	3,709,688	43.2
25-29	5	96	11,487	2.5	0.00836	0.04093	83,902	3,434	410,926	3,285,331	39.2
30-34	5	88	8,700	2.5	0.01011	0.04933	80,468	3,969	392,417	2,874,405	35.7
35-39	5	82	6,266	2.5	0.01309	0.06336	76,499	4,847	370,376	2,481,988	32.4
40-44	5	52	3,704	2.5	0.01404	0.06781	71,652	4,859	346,112	2,111,612	29.5
45-49	5	39	2,938	2.5	0.01327	0.06424	66,793	4,291	323,237	1,765,500	26.4
50-54	5	43	2,284	2.5	0.01883	0.08990	62,502	5,619	298,463	1,442,263	23.1
55-59	5	32	1,353	2.5	0.02365	0.11165	56,883	6,351	268,537	1,143,801	20.1
60-64	5	21	1,122	2.5	0.01872	0.08940	50,532	4,518	241,365	875,264	17.3
65-69	5	22	714	2.5	0.03081	0.14304	46,014	6,582	213,616	633,899	13.8
70-74	5	29	529	2.5	0.05482	0.24106	39,432	9,506	173,397	420,282	10.7
75-79	5	23	365	2.5	0.06301	0.27219	29,927	8,146	129,269	246,885	8.2
80+		30	436	5.4	0.06881	1.00000	21,781	21,781	117,617	117,617	5.4

Table A4.25 **Abridged Life Table for Muchinga both sexes, Zambia 2010**

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	233	2737	0.5	0.08513	0.08165	100,000	8,165	95,917	5,453,911	54.5
1-4	4	197	10651	2.0	0.01850	0.07134	91,835	6,552	354,235	5,357,994	58.3
5-9	5	56	11529	2.5	0.00486	0.02400	85,283	2,046	421,298	5,003,759	58.7
10-14	5	24	9988	2.5	0.00240	0.01194	83,236	994	413,696	4,582,462	55.1
15-19	5	27	7935	2.5	0.00340	0.01687	82,242	1,387	407,743	4,168,765	50.7
20-24	5	29	6181	2.5	0.00469	0.02319	80,855	1,875	399,587	3,761,023	46.5
25-29	5	37	5230	2.5	0.00707	0.03476	78,980	2,745	388,037	3,361,435	42.6
30-34	5	46	4056	2.5	0.01134	0.05514	76,235	4,204	370,665	2,973,398	39.0
35-39	5	41	3455	2.5	0.01187	0.05762	72,031	4,151	349,778	2,602,733	36.1
40-44	5	28	2486	2.5	0.01126	0.05477	67,880	3,718	330,107	2,252,955	33.2
45-49	5	13	2011	2.5	0.00646	0.03181	64,162	2,041	315,709	1,922,848	30.0
50-54	5	24	1432	2.5	0.01676	0.08043	62,121	4,996	298,116	1,607,139	25.9
55-59	5	17	997	2.5	0.01705	0.08177	57,125	4,671	273,947	1,309,023	22.9
60-64	5	15	1054	2.5	0.01423	0.06871	52,454	3,604	253,259	1,035,075	19.7
65-69	5	15	775	2.5	0.01935	0.09231	48,850	4,509	232,975	781,816	16.0
70-74	5	19	626	2.5	0.03035	0.14105	44,340	6,254	206,066	548,841	12.4
75-79	5	12	420	2.5	0.02857	0.13333	38,086	5,078	177,735	342,775	9.0
80+		19	440	5.0	0.04318	1.00000	33,008	33,008	165,040	165,040	5.0

Table A4.26 **Abridged Life Table for Muchinga male, Zambia 2010**

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	125	1,389	0.5	0.08999	0.08612	100,000	8,612	95,694	5,144,350	51.4
1-4	4	111	5,304	2.0	0.02093	0.08035	91,388	7,343	350,867	5,048,656	55.2
5-9	5	27	5,806	2.5	0.00465	0.02298	84,045	1,932	415,398	4,697,789	55.9
10-14	5	12	5,019	2.5	0.00239	0.01188	82,114	976	408,129	4,282,391	52.2
15-19	5	10	3,854	2.5	0.00259	0.01289	81,138	1,046	403,075	3,874,262	47.7
20-24	5	18	2,798	2.5	0.00643	0.03166	80,092	2,535	394,121	3,471,188	43.3
25-29	5	20	2,431	2.5	0.00823	0.04031	77,557	3,126	379,968	3,077,066	39.7
30-34	5	28	1,998	2.5	0.01401	0.06770	74,431	5,039	359,556	2,697,098	36.2
35-39	5	22	1,725	2.5	0.01275	0.06180	69,392	4,288	336,238	2,337,543	33.7
40-44	5	17	1,262	2.5	0.01347	0.06516	65,103	4,242	314,912	2,001,305	30.7
45-49	5	9	977	2.5	0.00921	0.04502	60,861	2,740	297,457	1,686,393	27.7
50-54	5	19	721	2.5	0.02635	0.12362	58,121	7,185	272,644	1,388,936	23.9
55-59	5	8	464	2.5	0.01724	0.08264	50,936	4,210	244,158	1,116,292	21.9
60-64	5	9	476	2.5	0.01891	0.09027	46,727	4,218	223,089	872,134	18.7
65-69	5	8	358	2.5	0.02235	0.10582	42,509	4,498	201,298	649,045	15.3
70-74	5	12	295	2.5	0.04068	0.18462	38,010	7,017	172,509	447,747	11.8
75-79	5	7	217	2.5	0.03226	0.14925	30,993	4,626	143,401	275,238	8.9
80+		10	244	5.0	0.04098	1.00000	26,367	26,367	131,837	131,837	5.0

Table A4.27 Abridged Life Table for Muchinga female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	108	1,348	0.5	0.08012	0.07703	100,000	7,703	96,148	5,804,378	58.0
1-4	4	86	5,347	2.0	0.01608	0.06233	92,297	5,753	357,681	5,708,230	61.8
5-9	5	29	5,723	2.5	0.00507	0.02502	86,544	2,165	427,306	5,350,548	61.8
10-14	5	12	4,969	2.5	0.00241	0.01200	84,379	1,013	419,361	4,923,242	58.3
15-19	5	17	4,081	2.5	0.00417	0.02061	83,366	1,718	412,533	4,503,881	54.0
20-24	5	11	3,383	2.5	0.00325	0.01613	81,647	1,317	404,945	4,091,348	50.1
25-29	5	17	2,799	2.5	0.00607	0.02991	80,331	2,403	395,646	3,686,403	45.9
30-34	5	18	2,058	2.5	0.00875	0.04280	77,928	3,335	381,301	3,290,757	42.2
35-39	5	19	1,730	2.5	0.01098	0.05345	74,593	3,987	362,997	2,909,457	39.0
40-44	5	11	1,224	2.5	0.00899	0.04395	70,606	3,103	345,273	2,546,460	36.1
45-49	5	4	1,034	2.5	0.00387	0.01916	67,503	1,293	334,282	2,201,187	32.6
50-54	5	5	711	2.5	0.00703	0.03455	66,210	2,288	325,330	1,866,905	28.2
55-59	5	9	533	2.5	0.01689	0.08101	63,922	5,178	306,665	1,541,575	24.1
60-64	5	6	578	2.5	0.01038	0.05059	58,744	2,972	286,290	1,234,910	21.0
65-69	5	7	417	2.5	0.01679	0.08055	55,772	4,493	267,629	948,620	17.0
70-74	5	7	331	2.5	0.02115	0.10043	51,279	5,150	243,522	680,992	13.3
75-79	5	5	203	2.5	0.02463	0.11601	46,129	5,351	217,268	437,470	9.5
80+		9	196	5.4	0.04592	1.00000	40,778	40,778	220,201	220,201	5.4

Table A4.28 Abridged Life Table for Northern both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	392	4391	0.5	0.08927	0.08546	100,000	8,546	95,727	5,329,206	53.3
1-4	4	298	17232	2.0	0.01729	0.06686	91,454	6,115	353,587	5,233,479	57.2
5-9	5	79	17823	2.5	0.00443	0.02192	85,339	1,871	422,020	4,879,892	57.2
10-14	5	54	15304	2.5	0.00353	0.01749	83,469	1,460	413,695	4,457,871	53.4
15-19	5	49	12189	2.5	0.00402	0.01990	82,009	1,632	405,965	4,044,177	49.3
20-24	5	62	9200	2.5	0.00674	0.03314	80,377	2,663	395,227	3,638,211	45.3
25-29	5	69	8439	2.5	0.00818	0.04006	77,714	3,113	380,784	3,242,985	41.7
30-34	5	70	6285	2.5	0.01114	0.05418	74,600	4,042	362,896	2,862,200	38.4
35-39	5	59	5535	2.5	0.01066	0.05191	70,558	3,663	343,635	2,499,304	35.4
40-44	5	44	3899	2.5	0.01128	0.05488	66,895	3,671	325,300	2,155,669	32.2
45-49	5	39	3248	2.5	0.01201	0.05829	63,224	3,685	306,909	1,830,370	29.0
50-54	5	31	2397	2.5	0.01293	0.06264	59,539	3,729	288,373	1,523,460	25.6
55-59	5	30	1675	2.5	0.01791	0.08571	55,810	4,784	267,090	1,235,088	22.1
60-64	5	33	1499	2.5	0.02201	0.10433	51,026	5,324	241,821	967,998	19.0
65-69	5	21	1201	2.5	0.01749	0.08377	45,702	3,828	218,942	726,177	15.9
70-74	5	28	907	2.5	0.03087	0.14330	41,874	6,000	194,370	507,235	12.1
75-79	5	23	617	2.5	0.03728	0.17050	35,874	6,116	164,078	312,865	8.7
80+		36	510	5.0	0.07059	1.00000	29,757	29,757	148,787	148,787	5.0

Table A4.29 Abridged Life Table for Northern male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	221	2,190	0.5	0.10091	0.09607	100,000	9,607	95,197	5,074,815	50.7
1-4	4	158	8,705	2.0	0.01815	0.07006	90,393	6,333	348,908	4,979,618	55.1
5-9	5	47	8,977	2.5	0.00524	0.02584	84,061	2,172	414,872	4,630,710	55.1
10-14	5	27	7,747	2.5	0.00349	0.01728	81,888	1,415	405,906	4,215,838	51.5
15-19	5	21	5,940	2.5	0.00354	0.01752	80,474	1,410	398,844	3,809,932	47.3
20-24	5	41	4,188	2.5	0.00979	0.04778	79,064	3,778	385,874	3,411,089	43.1
25-29	5	33	3,835	2.5	0.00860	0.04212	75,286	3,171	368,503	3,025,214	40.2
30-34	5	36	3,216	2.5	0.01119	0.05445	72,115	3,926	350,759	2,656,711	36.8
35-39	5	32	2,805	2.5	0.01141	0.05546	68,189	3,782	331,489	2,305,952	33.8
40-44	5	23	2,030	2.5	0.01133	0.05509	64,407	3,548	313,165	1,974,463	30.7
45-49	5	25	1,647	2.5	0.01518	0.07312	60,859	4,450	293,169	1,661,298	27.3
50-54	5	17	1,192	2.5	0.01426	0.06885	56,409	3,884	272,334	1,368,129	24.3
55-59	5	22	834	2.5	0.02638	0.12373	52,525	6,499	246,376	1,095,795	20.9
60-64	5	20	696	2.5	0.02874	0.13405	46,026	6,170	214,704	849,419	18.5
65-69	5	11	603	2.5	0.01824	0.08723	39,856	3,477	190,588	634,715	15.9
70-74	5	13	456	2.5	0.02851	0.13306	36,379	4,841	169,795	444,126	12.2
75-79	5	13	342	2.5	0.03801	0.17356	31,539	5,474	144,008	274,331	8.7
80+		23	266	5.0	0.08647	1.00000	26,065	26,065	130,323	130,323	5.0

Table A4.30 Abridged Life Table for Northern female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	171	2,201	0.5	0.07769	0.07479	100,000	7,479	96,261	5,606,469	56.1
1-4	4	140	8,527	2.0	0.01642	0.06359	92,521	5,883	358,319	5,510,208	59.6
5-9	5	32	8,846	2.5	0.00362	0.01793	86,638	1,553	429,309	5,151,889	59.5
10-14	5	27	7,557	2.5	0.00357	0.01771	85,085	1,507	421,660	4,722,580	55.5
15-19	5	28	6,249	2.5	0.00448	0.02216	83,579	1,852	413,264	4,300,920	51.5
20-24	5	21	5,012	2.5	0.00419	0.02073	81,727	1,694	404,399	3,887,656	47.6
25-29	5	36	4,604	2.5	0.00782	0.03835	80,033	3,069	392,491	3,483,256	43.5
30-34	5	34	3,069	2.5	0.01108	0.05390	76,964	4,148	374,447	3,090,766	40.2
35-39	5	27	2,730	2.5	0.00989	0.04826	72,815	3,514	355,292	2,716,319	37.3
40-44	5	21	1,869	2.5	0.01124	0.05464	69,301	3,787	337,040	2,361,027	34.1
45-49	5	14	1,601	2.5	0.00874	0.04279	65,514	2,803	320,564	2,023,987	30.9
50-54	5	14	1,205	2.5	0.01162	0.05645	62,711	3,540	304,706	1,703,423	27.2
55-59	5	8	841	2.5	0.00951	0.04646	59,171	2,749	288,983	1,398,717	23.6
60-64	5	13	803	2.5	0.01619	0.07780	56,422	4,390	271,137	1,109,733	19.7
65-69	5	10	598	2.5	0.01672	0.08026	52,033	4,176	249,723	838,596	16.1
70-74	5	15	451	2.5	0.03326	0.15353	47,857	7,347	220,915	588,873	12.3
75-79	5	10	275	2.5	0.03636	0.16667	40,509	6,752	185,667	367,958	9.1
80+		13	244	5.4	0.05328	1.00000	33,758	33,758	182,291	182,291	5.4

Table A4.31 Abridged Life Table for North Western both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	151	2709	0.5	0.05574	0.05423	100,000	5,423	97,289	5,604,370	56.0
1-4	4	101	11297	2.0	0.00894	0.03513	94,577	3,323	371,663	5,507,081	58.2
5-9	5	42	11603	2.5	0.00362	0.01794	91,254	1,637	452,180	5,135,418	56.3
10-14	5	27	10246	2.5	0.00264	0.01309	89,618	1,173	445,155	4,683,239	52.3
15-19	5	26	8418	2.5	0.00309	0.01532	88,444	1,355	438,834	4,238,084	47.9
20-24	5	37	6207	2.5	0.00596	0.02937	87,089	2,558	429,051	3,799,250	43.6
25-29	5	49	5511	2.5	0.00889	0.04349	84,531	3,676	413,467	3,370,199	39.9
30-34	5	34	4354	2.5	0.00781	0.03830	80,855	3,097	396,535	2,956,732	36.6
35-39	5	42	3460	2.5	0.01214	0.05891	77,759	4,580	377,342	2,560,197	32.9
40-44	5	31	2437	2.5	0.01272	0.06164	73,178	4,511	354,614	2,182,855	29.8
45-49	5	21	1913	2.5	0.01098	0.05342	68,667	3,668	334,166	1,828,240	26.6
50-54	5	25	1457	2.5	0.01716	0.08226	64,999	5,347	311,628	1,494,074	23.0
55-59	5	18	1064	2.5	0.01692	0.08115	59,652	4,841	286,157	1,182,447	19.8
60-64	5	28	915	2.5	0.03060	0.14213	54,811	7,790	254,579	896,289	16.4
65-69	5	25	712	2.5	0.03511	0.16139	47,021	7,589	216,131	641,711	13.6
70-74	5	32	566	2.5	0.05654	0.24768	39,432	9,766	172,743	425,580	10.8
75-79	5	18	412	2.5	0.04369	0.19694	29,665	5,842	133,721	252,837	8.5
80+		30	445	5.0	0.06742	1.00000	23,823	23,823	119,116	119,116	5.0

Table A4.32 Abridged Life Table for North Western male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	81	1,382	0.5	0.05861	0.05694	100,000	5,694	97,153	5,429,567	54.3
1-4	4	66	5,723	2.0	0.01153	0.04509	94,306	4,252	368,719	5,332,414	56.5
5-9	5	23	5,834	2.5	0.00394	0.01952	90,054	1,758	445,873	4,963,695	55.1
10-14	5	12	5,114	2.5	0.00235	0.01166	88,296	1,030	438,904	4,517,822	51.2
15-19	5	14	4,110	2.5	0.00341	0.01689	87,266	1,474	432,645	4,078,918	46.7
20-24	5	16	2,878	2.5	0.00556	0.02742	85,792	2,352	423,081	3,646,273	42.5
25-29	5	17	2,537	2.5	0.00670	0.03295	83,440	2,750	410,327	3,223,192	38.6
30-34	5	21	2,169	2.5	0.00968	0.04727	80,691	3,814	393,918	2,812,866	34.9
35-39	5	25	1,741	2.5	0.01436	0.06931	76,877	5,328	371,063	2,418,948	31.5
40-44	5	19	1,237	2.5	0.01536	0.07396	71,548	5,292	344,513	2,047,885	28.6
45-49	5	15	944	2.5	0.01589	0.07641	66,257	5,063	318,626	1,703,372	25.7
50-54	5	13	663	2.5	0.01961	0.09346	61,194	5,719	291,672	1,384,746	22.6
55-59	5	9	529	2.5	0.01701	0.08160	55,475	4,527	266,058	1,093,074	19.7
60-64	5	10	398	2.5	0.02513	0.11820	50,948	6,022	239,686	827,017	16.2
65-69	5	13	322	2.5	0.04037	0.18336	44,926	8,237	204,036	587,331	13.1
70-74	5	15	261	2.5	0.05747	0.25126	36,689	9,218	160,397	383,294	10.4
75-79	5	13	226	2.5	0.05752	0.25145	27,470	6,907	120,083	222,897	8.1
80+		12	213	5.0	0.05634	1.00000	20,563	20,563	102,814	102,814	5.0

Table A4.33 Abridged Life Table for North Western female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	70	1,327	0.5	0.05275	0.05140	100,000	5,140	97,430	5,812,487	58.1
1-4	4	35	5,574	2.0	0.00628	0.02481	94,860	2,353	374,736	5,715,057	60.2
5-9	5	19	5,769	2.5	0.00329	0.01633	92,507	1,511	458,760	5,340,321	57.7
10-14	5	15	5,132	2.5	0.00292	0.01451	90,997	1,320	451,682	4,881,561	53.6
15-19	5	12	4,308	2.5	0.00279	0.01383	89,676	1,240	445,281	4,429,879	49.4
20-24	5	21	3,329	2.5	0.00631	0.03105	88,436	2,746	435,315	3,984,598	45.1
25-29	5	32	2,974	2.5	0.01076	0.05239	85,690	4,489	417,227	3,549,283	41.4
30-34	5	13	2,185	2.5	0.00595	0.02931	81,201	2,380	400,053	3,132,056	38.6
35-39	5	17	1,719	2.5	0.00989	0.04825	78,820	3,803	384,594	2,732,003	34.7
40-44	5	12	1,200	2.5	0.01000	0.04878	75,017	3,659	365,937	2,347,410	31.3
45-49	5	6	969	2.5	0.00619	0.03049	71,358	2,176	351,350	1,981,473	27.8
50-54	5	12	794	2.5	0.01511	0.07282	69,182	5,038	333,317	1,630,123	23.6
55-59	5	9	535	2.5	0.01682	0.08072	64,145	5,178	307,779	1,296,806	20.2
60-64	5	18	517	2.5	0.03482	0.16014	58,967	9,443	271,227	989,027	16.8
65-69	5	12	390	2.5	0.03077	0.14286	49,524	7,075	229,932	717,800	14.5
70-74	5	17	305	2.5	0.05574	0.24460	42,449	10,383	186,287	487,868	11.5
75-79	5	5	186	2.5	0.02688	0.12594	32,066	4,039	150,233	301,580	9.4
80+		18	232	5.4	0.07759	1.00000	28,027	28,027	151,348	151,348	5.4

Table A4.34 Abridged Life Table for Southern both sexes, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	382	5881	0.5	0.06495	0.06291	100,000	6,291	96,854	5,729,331	57.3
1-4	4	220	23461	2.0	0.00938	0.03682	93,709	3,450	367,935	5,632,476	60.1
5-9	5	94	24458	2.5	0.00384	0.01903	90,259	1,718	446,998	5,264,541	58.3
10-14	5	42	22218	2.5	0.00189	0.00941	88,541	833	440,621	4,817,543	54.4
15-19	5	50	19264	2.5	0.00260	0.01289	87,708	1,131	435,711	4,376,922	49.9
20-24	5	47	14735	2.5	0.00319	0.01582	86,577	1,370	429,459	3,941,211	45.5
25-29	5	101	12325	2.5	0.00819	0.04015	85,207	3,421	417,482	3,511,751	41.2
30-34	5	104	9896	2.5	0.01051	0.05120	81,786	4,188	398,460	3,094,269	37.8
35-39	5	104	7854	2.5	0.01324	0.06409	77,598	4,973	375,559	2,695,809	34.7
40-44	5	65	5310	2.5	0.01224	0.05939	72,625	4,313	352,344	2,320,250	31.9
45-49	5	56	4311	2.5	0.01299	0.06291	68,312	4,297	330,818	1,967,907	28.8
50-54	5	51	3121	2.5	0.01634	0.07850	64,015	5,025	307,512	1,637,089	25.6
55-59	5	26	1921	2.5	0.01353	0.06546	58,990	3,861	285,296	1,329,577	22.5
60-64	5	32	1719	2.5	0.01862	0.08894	55,128	4,903	263,385	1,044,281	18.9
65-69	5	26	1362	2.5	0.01909	0.09110	50,225	4,576	239,688	780,896	15.5
70-74	5	44	1116	2.5	0.03943	0.17945	45,650	8,192	207,770	541,208	11.9
75-79	5	25	791	2.5	0.03161	0.14646	37,458	5,486	173,576	333,438	8.9
80+		52	802	5.0	0.06484	1.00000	31,972	31,972	159,861	159,861	5.0

Table A4.35 Abridged Life Table for Southern male, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	187	2,961	0.5	0.06315	0.06122	100,000	6,122	96,939	5,498,682	55.0
1-4	4	115	11,686	2.0	0.00984	0.03860	93,878	3,624	368,263	5,401,743	57.5
5-9	5	54	12,129	2.5	0.00445	0.02202	90,254	1,987	446,302	5,033,480	55.8
10-14	5	23	11,017	2.5	0.00209	0.01038	88,267	917	439,043	4,587,178	52.0
15-19	5	31	9,555	2.5	0.00324	0.01609	87,350	1,406	433,237	4,148,135	47.5
20-24	5	18	6,945	2.5	0.00259	0.01288	85,945	1,107	426,957	3,714,898	43.2
25-29	5	50	5,760	2.5	0.00868	0.04248	84,838	3,604	415,181	3,287,941	38.8
30-34	5	57	4,871	2.5	0.01170	0.05685	81,234	4,618	394,626	2,872,760	35.4
35-39	5	57	3,981	2.5	0.01432	0.06912	76,616	5,295	369,843	2,478,134	32.3
40-44	5	37	2,621	2.5	0.01412	0.06818	71,321	4,862	344,448	2,108,292	29.6
45-49	5	30	2,151	2.5	0.01395	0.06739	66,458	4,478	321,096	1,763,844	26.5
50-54	5	32	1,473	2.5	0.02172	0.10303	61,980	6,386	293,936	1,442,748	23.3
55-59	5	18	907	2.5	0.01985	0.09454	55,594	5,256	264,833	1,148,812	20.7
60-64	5	18	721	2.5	0.02497	0.11749	50,339	5,914	236,907	883,979	17.6
65-69	5	16	581	2.5	0.02754	0.12882	44,424	5,723	207,814	647,072	14.6
70-74	5	26	480	2.5	0.05417	0.23853	38,701	9,231	170,428	439,258	11.3
75-79	5	9	362	2.5	0.02486	0.11704	29,470	3,449	138,726	268,830	9.1
80+		23	361	5.0	0.06371	1.00000	26,021	26,021	130,104	130,104	5.0

Table A4.36 Abridged Life Table for Southern female, Zambia 2010

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	195	2,920	0.5	0.06678	0.06462	100,000	6,462	96,769	5,973,158	59.7
1-4	4	105	11,775	2.0	0.00892	0.03504	93,538	3,278	367,595	5,876,389	62.8
5-9	5	40	12,329	2.5	0.00324	0.01609	90,260	1,452	447,668	5,508,794	61.0
10-14	5	19	11,201	2.5	0.00170	0.00845	88,807	750	442,162	5,061,127	57.0
15-19	5	19	9,709	2.5	0.00196	0.00974	88,057	857	438,143	4,618,965	52.5
20-24	5	29	7,790	2.5	0.00372	0.01844	87,200	1,608	431,979	4,180,822	47.9
25-29	5	51	6,565	2.5	0.00777	0.03810	85,592	3,261	419,806	3,748,842	43.8
30-34	5	47	5,025	2.5	0.00935	0.04570	82,331	3,762	402,247	3,329,037	40.4
35-39	5	47	3,873	2.5	0.01214	0.05889	78,568	4,627	381,274	2,926,790	37.3
40-44	5	28	2,689	2.5	0.01041	0.05074	73,941	3,752	360,327	2,545,516	34.4
45-49	5	26	2,160	2.5	0.01204	0.05843	70,189	4,101	340,694	2,185,189	31.1
50-54	5	19	1,648	2.5	0.01153	0.05603	66,088	3,703	321,185	1,844,495	27.9
55-59	5	8	1,014	2.5	0.00789	0.03868	62,385	2,413	305,894	1,523,310	24.4
60-64	5	14	998	2.5	0.01403	0.06776	59,972	4,064	289,700	1,217,416	20.3
65-69	5	10	781	2.5	0.01280	0.06203	55,908	3,468	270,870	927,716	16.6
70-74	5	18	636	2.5	0.02830	0.13216	52,440	6,930	244,873	656,846	12.5
75-79	5	16	429	2.5	0.03730	0.17058	45,509	7,763	208,140	411,973	9.1
80+		29	441	5.4	0.06576	1.00000	37,747	37,747	203,832	203,832	5.4

Table A4.37 **Abridged Life Table for Western both sexes, Zambia 2010**

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	266	3206	0.5	0.08297	0.07966	100,000	7,966	96,017	4,785,255	47.9
1-4	4	180	13387	2.0	0.01345	0.05238	92,034	4,820	358,494	4,689,238	51.0
5-9	5	64	13780	2.5	0.00464	0.02296	87,213	2,002	431,061	4,330,744	49.7
10-14	5	38	12047	2.5	0.00315	0.01565	85,211	1,333	422,723	3,899,683	45.8
15-19	5	55	9981	2.5	0.00551	0.02718	83,878	2,280	413,690	3,476,960	41.5
20-24	5	75	7912	2.5	0.00948	0.04630	81,598	3,778	398,546	3,063,270	37.5
25-29	5	100	6874	2.5	0.01455	0.07019	77,820	5,462	375,447	2,664,724	34.2
30-34	5	97	5374	2.5	0.01805	0.08635	72,358	6,248	346,171	2,289,277	31.6
35-39	5	98	4279	2.5	0.02290	0.10831	66,110	7,160	312,649	1,943,105	29.4
40-44	5	70	3147	2.5	0.02224	0.10536	58,950	6,211	279,221	1,630,456	27.7
45-49	5	57	2523	2.5	0.02259	0.10692	52,739	5,639	249,597	1,351,235	25.6
50-54	5	45	2246	2.5	0.02004	0.09540	47,100	4,493	224,266	1,101,638	23.4
55-59	5	34	1465	2.5	0.02321	0.10968	42,607	4,673	201,350	877,372	20.6
60-64	5	33	1436	2.5	0.02298	0.10866	37,934	4,122	179,363	676,021	17.8
65-69	5	24	1116	2.5	0.02151	0.10204	33,812	3,450	160,433	496,658	14.7
70-74	5	46	909	2.5	0.05061	0.22461	30,362	6,819	134,759	336,225	11.1
75-79	5	28	658	2.5	0.04255	0.19231	23,542	4,527	106,392	201,466	8.6
80+		53	970	5.0	0.05464	1.00000	19,015	19,015	95,074	95,074	5.0

Table A4.38 **Abridged Life Table for Western male, Zambia 2010**

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	152	1,589	0.5	0.09566	0.09129	100,000	9,129	95,435	4,493,457	44.9
1-4	4	89	6,745	2.0	0.01319	0.05142	90,871	4,673	354,138	4,398,022	48.4
5-9	5	32	6,977	2.5	0.00459	0.02267	86,198	1,954	426,104	4,043,884	46.9
10-14	5	20	5,965	2.5	0.00335	0.01663	84,244	1,401	417,717	3,617,780	42.9
15-19	5	25	4,939	2.5	0.00506	0.02499	82,843	2,070	409,040	3,200,062	38.6
20-24	5	35	3,513	2.5	0.00996	0.04860	80,773	3,926	394,049	2,791,023	34.6
25-29	5	56	3,128	2.5	0.01790	0.08568	76,847	6,584	367,773	2,396,974	31.2
30-34	5	55	2,479	2.5	0.02219	0.10510	70,263	7,385	332,851	2,029,201	28.9
35-39	5	48	2,088	2.5	0.02299	0.10870	62,878	6,835	297,303	1,696,350	27.0
40-44	5	43	1,503	2.5	0.02861	0.13350	56,043	7,482	261,512	1,399,047	25.0
45-49	5	31	1,084	2.5	0.02860	0.13345	48,562	6,480	226,607	1,137,534	23.4
50-54	5	23	925	2.5	0.02486	0.11705	42,081	4,926	198,092	910,928	21.6
55-59	5	16	646	2.5	0.02477	0.11662	37,156	4,333	174,945	712,836	19.2
60-64	5	18	568	2.5	0.03169	0.14682	32,823	4,819	152,065	537,890	16.4
65-69	5	16	477	2.5	0.03354	0.15474	28,004	4,333	129,185	385,825	13.8
70-74	5	24	425	2.5	0.05647	0.24742	23,670	5,857	103,710	256,640	10.8
75-79	5	13	312	2.5	0.04167	0.18868	17,814	3,361	80,666	152,930	8.6
80+		26	475	5.0	0.05474	1.00000	14,453	14,453	72,263	72,263	5.0

Table A4.39 Abridged Life Table for Western female, Zambia 2010

Age	n	${}_nD_x$	${}_nPY_x$	${}_na_x$	${}_nM_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
0	1	114	1,617	0.5	0.07050	0.06810	100,000	6,810	96,595	5,073,464	50.7
1-4	4	91	6,642	2.0	0.01370	0.05334	93,190	4,971	362,818	4,976,869	53.4
5-9	5	32	6,803	2.5	0.00470	0.02325	88,219	2,051	435,969	4,614,051	52.3
10-14	5	18	6,082	2.5	0.00296	0.01469	86,168	1,266	427,678	4,178,082	48.5
15-19	5	30	5,042	2.5	0.00595	0.02931	84,903	2,489	418,291	3,750,404	44.2
20-24	5	40	4,399	2.5	0.00909	0.04445	82,414	3,664	402,910	3,332,113	40.4
25-29	5	44	3,746	2.5	0.01175	0.05705	78,750	4,493	382,518	2,929,203	37.2
30-34	5	42	2,895	2.5	0.01451	0.07000	74,257	5,198	358,291	2,546,685	34.3
35-39	5	50	2,191	2.5	0.02282	0.10794	69,059	7,455	326,659	2,188,394	31.7
40-44	5	27	1,644	2.5	0.01642	0.07888	61,605	4,859	295,875	1,861,735	30.2
45-49	5	26	1,439	2.5	0.01807	0.08644	56,745	4,905	271,465	1,565,860	27.6
50-54	5	22	1,321	2.5	0.01665	0.07994	51,840	4,144	248,842	1,294,395	25.0
55-59	5	18	819	2.5	0.02198	0.10417	47,696	4,968	226,060	1,045,554	21.9
60-64	5	15	868	2.5	0.01728	0.08283	42,728	3,539	204,792	819,493	19.2
65-69	5	8	639	2.5	0.01252	0.06070	39,189	2,379	189,998	614,701	15.7
70-74	5	22	484	2.5	0.04545	0.20408	36,810	7,512	165,270	424,704	11.5
75-79	5	15	346	2.5	0.04335	0.19557	29,298	5,730	132,165	259,433	8.9
80+		27	495	5.4	0.05455	1.00000	23,568	23,568	127,268	127,268	5.4

Table A4.40 Abridged Life Table -SAVVY both sexes, Zambia 2010-2012

Age	n	${}_nD_x$	${}_nPY_x$	${}_na_x$	${}_nM_x$	${}_nq_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
0	1	491	5740	0.5	0.08553	0.08202	100,000	8,202	95,899	4,733,126	47.3
1-4	4	417	23076	2.0	0.01806	0.06970	91,798	6,399	354,394	4,637,227	50.5
5-9	5	105	25225	2.5	0.00416	0.02057	85,399	1,757	422,603	4,282,833	50.2
10-14	5	38	24497	2.5	0.00156	0.00777	83,642	650	416,587	3,860,230	46.2
15-19	5	67	21515	2.5	0.00313	0.01555	82,993	1,291	411,736	3,443,643	41.5
20-24	5	108	16670	2.5	0.00646	0.03180	81,702	2,598	402,016	3,031,906	37.1
25-29	5	164	14104	2.5	0.01160	0.05635	79,104	4,458	384,377	2,629,891	33.2
30-34	5	169	11457	2.5	0.01473	0.07104	74,646	5,303	359,974	2,245,514	30.1
35-39	5	195	9550	2.5	0.02041	0.09709	69,343	6,732	329,887	1,885,540	27.2
40-44	5	119	6595	2.5	0.01799	0.08608	62,611	5,389	299,582	1,555,653	24.8
45-49	5	104	5124	2.5	0.02021	0.09620	57,222	5,504	272,348	1,256,071	22.0
50-54	5	94	3706	2.5	0.02533	0.11912	51,717	6,160	243,186	983,723	19.0
55-59	5	62	2652	2.5	0.02337	0.11039	45,557	5,029	215,212	740,537	16.3
60-64	5	79	2166	2.5	0.03632	0.16649	40,528	6,747	185,770	525,325	13.0
65-69	5	101	1595	2.5	0.06308	0.27244	33,780	9,203	145,894	339,555	10.1
70-74	5	101	1065	2.5	0.09473	0.38297	24,577	9,412	99,356	193,660	7.9
75-79	5	99	734	2.5	0.13483	0.50419	15,165	7,646	56,710	94,305	6.2
80+		249	755	5.0	0.32965	1.00000	7,519	7,519	37,595	37,595	5.0

Table A4.41 Abridged Life Table -SAVVY male, Zambia 2010-2012

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	261	2,853	0.5	0.09155	0.08754	100,000	8,754	95,623	4,536,245	45.4
1-4	4	233	11,641	2.0	0.02004	0.07706	91,246	7,031	350,922	4,440,622	48.7
5-9	5	56	12,519	2.5	0.00448	0.02215	84,215	1,866	416,411	4,089,700	48.6
10-14	5	20	12,019	2.5	0.00164	0.00816	82,349	672	410,068	3,673,288	44.6
15-19	5	31	10,402	2.5	0.00295	0.01463	81,678	1,195	405,401	3,263,221	40.0
20-24	5	46	7,631	2.5	0.00605	0.02980	80,483	2,398	396,417	2,857,820	35.5
25-29	5	85	6,302	2.5	0.01351	0.06533	78,084	5,101	377,668	2,461,403	31.5
30-34	5	91	5,723	2.5	0.01595	0.07669	72,983	5,597	350,922	2,083,735	28.6
35-39	5	124	4,860	2.5	0.02555	0.12009	67,386	8,092	316,699	1,732,812	25.7
40-44	5	59	3,487	2.5	0.01698	0.08146	59,294	4,830	284,393	1,416,113	23.9
45-49	5	54	2,601	2.5	0.02082	0.09896	54,463	5,390	258,843	1,131,720	20.8
50-54	5	60	1,823	2.5	0.03265	0.15094	49,074	7,407	226,851	872,876	17.8
55-59	5	33	1,275	2.5	0.02560	0.12029	41,667	5,012	195,803	646,025	15.5
60-64	5	43	1,033	2.5	0.04149	0.18796	36,654	6,890	166,048	450,223	12.3
65-69	5	47	719	2.5	0.06601	0.28328	29,765	8,432	127,744	284,175	9.5
70-74	5	61	505	2.5	0.12019	0.46211	21,333	9,858	82,019	156,431	7.3
75-79	5	46	373	2.5	0.12243	0.46869	11,475	5,378	43,928	74,412	6.5
80+		126	368	5.0	0.34289	1.00000	6,097	6,097	30,483	30,483	5.0

Table A4.42 Abridged Life Table -SAVVY female, Zambia 2010-2012

Age	n	$_nD_x$	$_nPY_x$	$_na_x$	$_nM_x$	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
0	1	230	2,887	0.5	0.07958	0.07654	100,000	7,654	96,173	4,944,661	49.5
1-4	4	183	11,435	2.0	0.01604	0.06216	92,346	5,740	357,904	4,848,488	52.5
5-9	5	49	12,706	2.5	0.00384	0.01901	86,606	1,647	428,912	4,490,584	51.9
10-14	5	19	12,478	2.5	0.00148	0.00739	84,959	628	423,225	4,061,672	47.8
15-19	5	37	11,113	2.5	0.00331	0.01641	84,331	1,384	418,196	3,638,447	43.1
20-24	5	62	9,039	2.5	0.00681	0.03348	82,947	2,777	407,794	3,220,251	38.8
25-29	5	78	7,802	2.5	0.01006	0.04904	80,170	3,932	391,022	2,812,456	35.1
30-34	5	77	5,734	2.5	0.01352	0.06537	76,239	4,984	368,734	2,421,434	31.8
35-39	5	71	4,690	2.5	0.01508	0.07265	71,255	5,177	343,333	2,052,700	28.8
40-44	5	59	3,108	2.5	0.01912	0.09123	66,078	6,028	315,321	1,709,366	25.9
45-49	5	49	2,523	2.5	0.01958	0.09334	60,050	5,605	286,239	1,394,045	23.2
50-54	5	34	1,883	2.5	0.01824	0.08724	54,445	4,750	260,352	1,107,806	20.3
55-59	5	29	1,377	2.5	0.02131	0.10114	49,695	5,026	235,911	847,455	17.1
60-64	5	36	1,133	2.5	0.03161	0.14645	44,669	6,542	206,991	611,544	13.7
65-69	5	53	876	2.5	0.06068	0.26344	38,127	10,044	165,526	404,553	10.6
70-74	5	40	560	2.5	0.07177	0.30427	28,083	8,545	119,053	239,027	8.5
75-79	5	53	361	2.5	0.14764	0.53918	19,538	10,535	71,354	119,974	6.1
80+		123	387	5.4	0.31707	1.00000	9,004	9,004	48,620	48,620	5.4

CHAPTER 5: APPENDIX

Cause-deleted life tables-Zambia

Table A5.1 Life Table Eliminating the Risk of HIV/AIDS-SAVVY both sexes, Zambia 2010-2012

Age	Age Group	nMx	nMx (HIV)	ASDR (All Causes)	ASDR (HIV)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-HIV	ex_0 All Causes	Gain	nqx(All-Cause)	Percentage Reduction in Probability of Dying
0	< 1	85.33101	4.88153	0.08533	0.00488	1	0.08045	0.5	0.07734	100000	7734	96133	5308264	53.08	47.33	5.75	0.08202	5.7
1	1 - 4	18.01005	1.62810	0.01801	0.00163	4	0.01638	2.0	0.06345	92266	5854	357356	5212131	56.49	50.52	5.97	0.06970	9.0
5	5-9	4.14668	0.36817	0.00415	0.00037	5	0.00378	2.5	0.01872	86412	1617	428017	4854775	56.18	50.15	6.03	0.02057	9.0
10	10-14	1.55570	0.08074	0.00156	0.00008	5	0.00147	2.5	0.00735	84795	623	422416	4426759	52.21	46.15	6.05	0.00777	5.4
15	15-19	3.12666	0.73716	0.00313	0.00074	5	0.00239	2.5	0.01188	84172	1000	418359	4004343	47.57	41.49	6.08	0.01555	23.6
20	20-24	6.44271	2.02699	0.00644	0.00203	5	0.00442	2.5	0.02184	83172	1816	411319	3585984	43.12	37.11	6.01	0.03180	31.3
25	25-29	11.57119	4.34416	0.01157	0.00434	5	0.00723	2.5	0.03549	81356	2888	399559	3174665	39.02	33.25	5.78	0.05635	37.0
30	30-34	14.69844	6.91455	0.01470	0.00691	5	0.00778	2.5	0.03818	78468	2996	384851	2775105	35.37	30.08	5.28	0.07104	46.3
35	35-39	20.36649	11.07853	0.02037	0.01108	5	0.00929	2.5	0.04539	75472	3425	368799	2390254	31.67	27.19	4.48	0.09709	53.3
40	40-44	17.95299	9.04321	0.01795	0.00904	5	0.00891	2.5	0.04358	72047	3140	352386	2021455	28.06	24.85	3.21	0.08608	49.4
45	45-49	20.16003	7.78103	0.02016	0.00778	5	0.01238	2.5	0.06004	68907	4137	334194	1669069	24.22	21.95	2.27	0.09620	37.6
50	50-54	25.27793	8.20561	0.02528	0.00821	5	0.01707	2.5	0.08187	64770	5303	310595	1334875	20.61	19.02	1.59	0.11912	31.3
55	55-59	23.31071	4.99623	0.02331	0.00500	5	0.01831	2.5	0.08756	59468	5207	284321	1024279	17.22	16.26	0.97	0.11039	20.7
60	60-64	36.23730	5.66020	0.03624	0.00566	5	0.03058	2.5	0.14203	54261	7707	252037	739958	13.64	12.96	0.68	0.16649	14.7
65	65-69	62.94671	5.08903	0.06295	0.00509	5	0.05786	2.5	0.25273	46554	11766	203356	487922	10.48	10.05	0.43	0.27244	7.2
70	70-74	94.55399	4.49390	0.09455	0.00449	5	0.09006	2.5	0.36755	34788	12786	141976	284566	8.18	7.88	0.30	0.38297	4.0
75	75-79	134.49591	11.88283	0.13450	0.01188	5	0.12261	2.5	0.46923	22002	10324	84200	142590	6.48	6.22	0.26	0.50419	6.9
80+	80+	329.00662	14.52980	0.32901	0.01453		0.31448	5.0	1.00000	11678	11678	58390	58390	5.00	5.00	0.00	1.00000	0.0

Table A5.2 Life Table Eliminating the Risk of HIV/AIDS-SAVVY males, Zambia 2010-2012

Age	Age Group	nMx	nMx HIV	ASDR (All)	ASDR (HIV)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-HIV	ex_0 All Causes	Gain	nqx (All-Cause)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	4.46547	0.09082	0.00447	1	0.08635	0.5	0.08278	100000	8278	95861	5079549	50.80	45.36	5.43	0.08754	5.4
1	1 - 4	20.00687	2.02130	0.02001	0.00202	4	0.01799	2.0	0.06944	91722	6370	354150	4983688	54.33	48.67	5.67	0.07706	9.9
5	5-9	4.47400	0.16719	0.00447	0.00017	5	0.00431	2.5	0.02130	85353	1818	422217	4629538	54.24	48.56	5.68	0.02215	3.8
10	10-14	1.63574	0.16457	0.00164	0.00016	5	0.00147	2.5	0.00733	83534	612	416141	4207321	50.37	44.61	5.76	0.00816	10.2
15	15-19	2.94366	0.46020	0.00294	0.00046	5	0.00248	2.5	0.01234	82922	1023	412052	3791180	45.72	39.95	5.77	0.01463	15.7
20	20-24	6.04115	1.45066	0.00604	0.00145	5	0.00459	2.5	0.02269	81899	1858	404848	3379128	41.26	35.51	5.75	0.02980	23.8
25	25-29	13.48778	4.53507	0.01349	0.00454	5	0.00895	2.5	0.04378	80040	3504	391440	2974280	37.16	31.52	5.64	0.06533	33.0
30	30-34	15.92696	7.08544	0.01593	0.00709	5	0.00884	2.5	0.04325	76536	3310	374403	2582840	33.75	28.55	5.20	0.07669	43.6
35	35-39	25.51440	12.89095	0.02551	0.01289	5	0.01262	2.5	0.06119	73226	4480	354927	2208436	30.16	25.71	4.44	0.12009	49.0
40	40-44	16.96014	7.69429	0.01696	0.00769	5	0.00927	2.5	0.04528	68745	3113	335944	1853510	26.96	23.88	3.08	0.08146	44.4
45	45-49	20.79200	8.71972	0.02079	0.00872	5	0.01207	2.5	0.05859	65632	3846	318548	1517566	23.12	20.78	2.34	0.09896	40.8
50	50-54	32.60560	11.26166	0.03261	0.01126	5	0.02134	2.5	0.10131	61787	6260	293284	1199018	19.41	17.79	1.62	0.15094	32.9
55	55-59	25.56078	2.36392	0.02556	0.00236	5	0.02320	2.5	0.10963	55527	6087	262416	905734	16.31	15.50	0.81	0.12029	8.9
60	60-64	41.43272	8.26428	0.04143	0.00826	5	0.03317	2.5	0.15314	49440	7571	228270	643318	13.01	12.28	0.73	0.18796	18.5
65	65-69	65.91099	4.34771	0.06591	0.00435	5	0.06156	2.5	0.26676	41868	11169	181420	415048	9.91	9.55	0.37	0.28328	5.8
70	70-74	120.01980	5.48713	0.12002	0.00549	5	0.11453	2.5	0.44519	30700	13667	119330	233628	7.61	7.33	0.28	0.46211	3.7
75	75-79	122.25201	9.89812	0.12225	0.00990	5	0.11235	2.5	0.43858	17032	7470	66487	114298	6.71	6.48	0.23	0.46869	6.4
80+	80+	342.39130	15.97011	0.34239	0.01597		0.32642	5.0	1.00000	9562	9562	47812	47812	5.00	5.00	0.00	1.00000	0.0

Table A5.3 Life Table Eliminating the Risk of HIV/AIDS-SAVVY females, Zambia 2010-2012

Age	Age Group	nMx	nMx HIV	ASDR (All Cause)	ASDR (HIV)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-HIV	ex_0 All Causes	Gain	nqx (All-Cause)	Percentage Reduction in Probability of Dying
0	< 1	78.80152	5.29269	0.07880	0.00529	1	0.07351	0.5	0.07090	100000	7090	96455	5558387	55.58	49.45	6.14	0.07654	7.4
1	1 - 4	15.98601	1.22781	0.01599	0.00123	4	0.01476	2.0	0.05734	92910	5327	360984	5461932	58.79	52.50	6.28	0.06216	7.8
5	5-9	3.82654	0.56619	0.00383	0.00057	5	0.00326	2.5	0.01617	87582	1416	434371	5100948	58.24	51.85	6.39	0.01901	15.0
10	10-14	1.47860	0.00000	0.00148	0.00000	5	0.00148	2.5	0.00737	86166	635	429244	4666578	54.16	47.81	6.35	0.00739	0.3
15	15-19	3.29794	0.99613	0.00330	0.00100	5	0.00230	2.5	0.01144	85531	979	425210	4237334	49.54	43.14	6.40	0.01641	30.3
20	20-24	6.78726	2.51355	0.00679	0.00251	5	0.00427	2.5	0.02114	84553	1788	418294	3812124	45.09	38.82	6.26	0.03348	36.8
25	25-29	10.02179	4.18995	0.01002	0.00419	5	0.00583	2.5	0.02874	82765	2379	407878	3393830	41.01	35.08	5.92	0.04904	41.4
30	30-34	13.47053	6.74398	0.01347	0.00674	5	0.00673	2.5	0.03308	80386	2659	395284	2985952	37.15	31.76	5.38	0.06537	49.4
35	35-39	15.02772	9.20682	0.01503	0.00921	5	0.00582	2.5	0.02869	77727	2230	383062	2590668	33.33	28.81	4.52	0.07265	60.5
40	40-44	19.05405	10.55663	0.01905	0.01056	5	0.00850	2.5	0.04160	75498	3141	369636	2207606	29.24	25.87	3.37	0.09123	54.4
45	45-49	19.51645	6.81332	0.01952	0.00681	5	0.01270	2.5	0.06156	72357	4454	350647	1837970	25.40	23.21	2.19	0.09334	34.0
50	50-54	18.18375	5.24535	0.01818	0.00525	5	0.01294	2.5	0.06267	67902	4255	328874	1487323	21.90	20.35	1.56	0.08724	28.2
55	55-59	21.23457	7.42919	0.02123	0.00743	5	0.01381	2.5	0.06672	63647	4247	307619	1158449	18.20	17.05	1.15	0.10114	34.0
60	60-64	31.50044	3.28950	0.03150	0.00329	5	0.02821	2.5	0.13176	59400	7827	277435	850829	14.32	13.69	0.63	0.14645	10.0
65	65-69	60.47945	5.69749	0.06048	0.00570	5	0.05478	2.5	0.24092	51574	12425	226806	573394	11.12	10.61	0.51	0.26344	8.5
70	70-74	71.53571	3.59821	0.07154	0.00360	5	0.06794	2.5	0.29037	39149	11368	167325	346588	8.85	8.51	0.34	0.30427	4.6
75	75-79	147.14681	13.93352	0.14715	0.01393	5	0.13321	2.5	0.49966	27781	13881	104203	179263	6.45	6.14	0.31	0.53918	7.3
80+	80+	316.02067	13.16279	0.31602	0.01316		0.30286	5.4	1.00000	13900	13900	75060	75060	5.40	5.40	0.00	1.00000	0.0

Table A5.4 Life Table Eliminating the Risk of Injuries & Accidents-SAVVY both sexes, Zambia 2010-2012

Age	Age Group	nMx	nMx Injuries	ASDR (All)	ASDR (Injuries)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-Injuries	ex_0 All Causes	Gain	nqx (All causes)	Percentage Reduction in Probability of Dying
0	< 1	85.33101	0.93449	0.08533	0.00093	1	0.08440	0.5	0.08098	100000	8098	95951	4902674	49.03	47.33	1.70	0.08202	1.3
1	1 - 4	18.01005	0.88577	0.01801	0.00089	4	0.01712	2.0	0.06623	91902	6087	355435	4806723	52.30	50.52	1.79	0.06970	5.0
5	5-9	4.14668	0.33241	0.00415	0.00033	5	0.00381	2.5	0.01889	85815	1621	425025	4451288	51.87	50.15	1.72	0.02057	8.2
10	10-14	1.55570	0.36000	0.00156	0.00036	5	0.00120	2.5	0.00596	84194	502	419717	4026264	47.82	46.15	1.67	0.00777	23.3
15	15-19	3.12666	0.59819	0.00313	0.00060	5	0.00253	2.5	0.01256	83692	1051	415834	3606547	43.09	41.49	1.60	0.01555	19.2
20	20-24	6.44271	0.96401	0.00644	0.00096	5	0.00548	2.5	0.02702	82641	2233	407622	3190713	38.61	37.11	1.50	0.03180	15.0
25	25-29	11.57119	1.68321	0.01157	0.00168	5	0.00989	2.5	0.04825	80408	3879	392340	2783091	34.61	33.25	1.37	0.05635	14.4
30	30-34	14.69844	1.45937	0.01470	0.00146	5	0.01324	2.5	0.06407	76528	4904	370383	2390750	31.24	30.08	1.16	0.07104	9.8
35	35-39	20.36649	2.31414	0.02037	0.00231	5	0.01805	2.5	0.08636	71625	6186	342660	2020367	28.21	27.19	1.02	0.09709	11.0
40	40-44	17.95299	1.62396	0.01795	0.00162	5	0.01633	2.5	0.07844	65439	5133	314362	1677708	25.64	24.85	0.79	0.08608	8.9
45	45-49	20.16003	0.54489	0.02016	0.00054	5	0.01962	2.5	0.09349	60306	5638	287434	1363346	22.61	21.95	0.66	0.09620	2.8
50	50-54	25.27793	1.90799	0.02528	0.00191	5	0.02337	2.5	0.11040	54668	6035	258250	1075912	19.68	19.02	0.66	0.11912	7.3
55	55-59	23.31071	3.11425	0.02331	0.00311	5	0.02020	2.5	0.09613	48632	4675	231475	817661	16.81	16.26	0.56	0.11039	12.9
60	60-64	36.23730	1.90674	0.03624	0.00191	5	0.03433	2.5	0.15808	43957	6949	202415	586186	13.34	12.96	0.37	0.16649	5.0
65	65-69	62.94671	3.75862	0.06295	0.00376	5	0.05919	2.5	0.25779	37008	9541	161191	383772	10.37	10.05	0.32	0.27244	5.4
70	70-74	94.55399	3.04977	0.09455	0.00305	5	0.09150	2.5	0.37234	27468	10227	111771	222581	8.10	7.88	0.22	0.38297	2.8
75	75-79	134.49591	9.44005	0.13450	0.00944	5	0.12506	2.5	0.47635	17240	8213	65671	110810	6.43	6.22	0.21	0.50419	5.5
80+	80+	329.00662	22.46358	0.32901	0.02246		0.30654	5.0	1.00000	9028	9028	45139	45139	5.00	5.00	0.00	1.00000	0.0

Table A5.5 Life Table Eliminating the Risk of Injuries & Accidents-SAVVY male, Zambia 2010-2012

Age	Age Group	nMx	nMx Injuries	ASDR (All)	ASDR (Injuries)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Injuries	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	1.51455	0.09082	0.00151	1	0.08930	0.5	0.08549	100000	8549	95726	4765476	47.65	45.36	2.29	0.08754	2.3
1	1-4	20.00687	1.20265	0.02001	0.00120	4	0.01880	2.0	0.07249	91451	6629	352547	4669751	51.06	48.67	2.40	0.07706	5.9
5	5-9	4.47400	0.42447	0.00447	0.00042	5	0.00405	2.5	0.02004	84822	1700	419860	4317203	50.90	48.56	2.33	0.02215	9.5
10	10-14	1.63574	0.49214	0.00164	0.00049	5	0.00114	2.5	0.00570	83122	474	414425	3897343	46.89	44.61	2.28	0.00816	30.1
15	15-19	2.94366	1.05845	0.00294	0.00106	5	0.00189	2.5	0.00938	82648	775	411301	3482919	42.14	39.95	2.19	0.01463	35.9
20	20-24	6.04115	1.08151	0.00604	0.00108	5	0.00496	2.5	0.02449	81873	2005	404349	3071618	37.52	35.51	2.01	0.02980	17.8
25	25-29	13.48778	3.00540	0.01349	0.00301	5	0.01048	2.5	0.05107	79867	4079	389138	2667269	33.40	31.52	1.87	0.06533	21.8
30	30-34	15.92696	2.43054	0.01593	0.00243	5	0.01350	2.5	0.06528	75788	4947	366572	2278131	30.06	28.55	1.51	0.07669	14.9
35	35-39	25.51440	4.35391	0.02551	0.00435	5	0.02116	2.5	0.10049	70841	7119	336407	1911559	26.98	25.71	1.27	0.12009	16.3
40	40-44	16.96014	1.36708	0.01696	0.00137	5	0.01559	2.5	0.07504	63722	4782	306656	1575152	24.72	23.88	0.84	0.08146	7.9
45	45-49	20.79200	1.07343	0.02079	0.00107	5	0.01972	2.5	0.09396	58940	5538	280857	1268496	21.52	20.78	0.74	0.09896	5.1
50	50-54	32.60560	2.23862	0.03261	0.00224	5	0.03037	2.5	0.14112	53402	7536	248171	987639	18.49	17.79	0.71	0.15094	6.5
55	55-59	25.56078	3.14275	0.02556	0.00314	5	0.02242	2.5	0.10614	45866	4868	217160	739468	16.12	15.50	0.62	0.12029	11.8
60	60-64	41.43272	1.80833	0.04143	0.00181	5	0.03962	2.5	0.18026	40998	7390	186513	522309	12.74	12.28	0.46	0.18796	4.1
65	65-69	65.91099	7.21419	0.06591	0.00721	5	0.05870	2.5	0.25593	33607	8601	146534	335796	9.99	9.55	0.44	0.28328	9.7
70	70-74	120.01980	3.81980	0.12002	0.00382	5	0.11620	2.5	0.45021	25006	11258	96886	189262	7.57	7.33	0.24	0.46211	2.6
75	75-79	122.25201	10.27078	0.12225	0.01027	5	0.11198	2.5	0.43744	13748	6014	53706	92376	6.72	6.48	0.23	0.46869	6.7
80+	80+	342.39130	34.89130	0.34239	0.03489		0.30750	5.0	1.00000	7734	7734	38671	38671	5.00	5.00	0.00	1.00000	0.0

Table A5.6 Life Table Eliminating the Risk of Injuries & Accidents-SAVVY female, Zambia 2010-2012

Age	Age Group	nMx	nMx Injuries	ASDR (All Cause)	ASDR (Injuries)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0 - Injuries	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	78.80152	0.36127	0.07880	0.00036	1	0.07844	0.5	0.07548	100000	7548	96226	5055869	50.56	49.45	1.11	0.07654	1.4
1	1-4	15.98601	0.56292	0.01599	0.00056	4	0.01542	2.0	0.05985	92452	5533	358742	4959643	53.65	52.50	1.14	0.06216	3.7
5	5-9	3.82654	0.24162	0.00383	0.00024	5	0.00358	2.5	0.01777	86919	1544	430735	4600901	52.93	51.85	1.08	0.01901	6.6
10	10-14	1.47860	0.23273	0.00148	0.00023	5	0.00125	2.5	0.00621	85375	530	425549	4170166	48.85	47.81	1.04	0.00739	16.0
15	15-19	3.29794	0.16773	0.00330	0.00017	5	0.00313	2.5	0.01553	84845	1318	420930	3744616	44.13	43.14	0.99	0.01641	5.4
20	20-24	6.78726	0.86492	0.00679	0.00086	5	0.00592	2.5	0.02918	83527	2437	411543	3323686	39.79	38.82	0.97	0.03348	12.8
25	25-29	10.02179	0.61471	0.01002	0.00061	5	0.00941	2.5	0.04595	81090	3726	396133	2912144	35.91	35.08	0.83	0.04904	6.3
30	30-34	13.47053	0.49023	0.01347	0.00049	5	0.01298	2.5	0.06286	77363	4863	374659	2516011	32.52	31.76	0.76	0.06537	3.8
35	35-39	15.02772	0.20023	0.01503	0.00020	5	0.01483	2.5	0.07149	72500	5183	349544	2141351	29.54	28.81	0.73	0.07265	1.6
40	40-44	19.05405	1.91248	0.01905	0.00191	5	0.01714	2.5	0.08219	67317	5533	322756	1791807	26.62	25.87	0.75	0.09123	9.9
45	45-49	19.51645	0.00000	0.01952	0.00000	5	0.01952	2.5	0.09304	61785	5749	294553	1469052	23.78	23.21	0.56	0.09334	0.3
50	50-54	18.18375	1.58736	0.01818	0.00159	5	0.01660	2.5	0.07968	56036	4465	269019	1174499	20.96	20.35	0.61	0.08724	8.7
55	55-59	21.23457	3.08715	0.02123	0.00309	5	0.01815	2.5	0.08680	51571	4476	246666	905480	17.56	17.05	0.50	0.10114	14.2
60	60-64	31.50044	1.99647	0.03150	0.00200	5	0.02950	2.5	0.13739	47095	6470	219300	658814	13.99	13.69	0.30	0.14645	6.2
65	65-69	60.47945	0.92215	0.06048	0.00092	5	0.05956	2.5	0.25919	40625	10530	176800	439514	10.82	10.61	0.21	0.26344	1.6
70	70-74	71.53571	2.35357	0.07154	0.00235	5	0.06918	2.5	0.29491	30095	8875	128288	262714	8.73	8.51	0.22	0.30427	3.1
75	75-79	147.14681	8.58172	0.14715	0.00858	5	0.13857	2.5	0.51457	21220	10919	78802	134426	6.33	6.14	0.19	0.53918	4.6
80+	80+	316.02067	10.64599	0.31602	0.01065		0.30537	5.4	1.00000	10301	10301	55624	55624	5.40	5.40	0.00	1.00000	0.0

Table A5.7 Life Table Eliminating the Risk of Tuberculosis-SAVVY both sexes, Zambia 2010-2012

Age	Age Group	nMx	nMx TB	ASDR (All)	ASDR (TB)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-TB	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	85.33101	0.19913	0.08533	0.00020	1	0.08513	0.5	0.08166	100000	8166	95917	4873378	48.73	47.33	1.40	0.08202	0.4
1	1-4	18.01005	0.18110	0.01801	0.00018	4	0.01783	2.0	0.06886	91834	6324	354690	4777461	52.02	50.52	1.51	0.06970	1.2
5	5-9	4.14668	0.00000	0.00415	0.00000	5	0.00415	2.5	0.02052	85511	1755	423166	4422771	51.72	50.15	1.57	0.02057	0.3
10	10-14	1.55570	0.11789	0.00156	0.00012	5	0.00144	2.5	0.00716	83756	600	417280	3999605	47.75	46.15	1.60	0.00777	7.8
15	15-19	3.12666	0.34055	0.00313	0.00034	5	0.00279	2.5	0.01383	83156	1150	412904	3582325	43.08	41.49	1.59	0.01555	11.0
20	20-24	6.44271	0.46119	0.00644	0.00046	5	0.00598	2.5	0.02947	82006	2416	403987	3169421	38.65	37.11	1.54	0.03180	7.3
25	25-29	11.57119	0.96001	0.01157	0.00096	5	0.01061	2.5	0.05168	79589	4114	387662	2765435	34.75	33.25	1.50	0.05635	8.3
30	30-34	14.69844	1.30750	0.01470	0.00131	5	0.01339	2.5	0.06479	75476	4890	365153	2377773	31.50	30.08	1.42	0.07104	8.8
35	35-39	20.36649	0.80796	0.02037	0.00081	5	0.01956	2.5	0.09323	70586	6581	336477	2012620	28.51	27.19	1.32	0.09709	4.0
40	40-44	17.95299	1.21274	0.01795	0.00121	5	0.01674	2.5	0.08034	64005	5142	307169	1676143	26.19	24.85	1.34	0.08608	6.7
45	45-49	20.16003	2.22092	0.02016	0.00222	5	0.01794	2.5	0.08585	58863	5053	281681	1368975	23.26	21.95	1.31	0.09620	10.8
50	50-54	25.27793	2.51241	0.02528	0.00251	5	0.02277	2.5	0.10770	53810	5795	254560	1087294	20.21	19.02	1.19	0.11912	9.6
55	55-59	23.31071	2.15950	0.02331	0.00216	5	0.02115	2.5	0.10044	48014	4823	228015	832734	17.34	16.26	1.09	0.11039	9.0
60	60-64	36.23730	6.33426	0.03624	0.00633	5	0.02990	2.5	0.13912	43192	6009	200937	604719	14.00	12.96	1.04	0.16649	16.4
65	65-69	62.94671	9.49216	0.06295	0.00949	5	0.05345	2.5	0.23577	37183	8766	163999	403782	10.86	10.05	0.81	0.27244	13.5
70	70-74	94.55399	12.21596	0.09455	0.01222	5	0.08234	2.5	0.34141	28417	9702	117828	239783	8.44	7.88	0.56	0.38297	10.9
75	75-79	134.49591	13.50409	0.13450	0.01350	5	0.12099	2.5	0.46447	18715	8692	71843	121955	6.52	6.22	0.30	0.50419	7.9
80+	80+	329.00662	28.10596	0.32901	0.02811		0.30090	5.0	1.00000	10022	10022	50112	50112	5.00	5.00	0.00	1.00000	0.0

Table A5.8 Life Table Eliminating the Risk of Tuberculosis-SAVVY males, Zambia 2010-2012

Age	Age Group	nMx	nMx TB	ASDR (All)	ASDR (TB)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-TB	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	0.00000	0.09082	0.00000	1	0.09082	0.5	0.08687	100000	8687	95656	4683452	46.83	45.36	1.47	0.08754	0.8
1	1-4	20.00687	0.09132	0.02001	0.00009	4	0.01992	2.0	0.07661	91313	6996	351260	4587795	50.24	48.67	1.58	0.07706	0.6
5	5-9	4.47400	0.00000	0.00447	0.00000	5	0.00447	2.5	0.02212	84317	1865	416923	4236535	50.25	48.56	1.68	0.02215	0.1
10	10-14	1.63574	0.08065	0.00164	0.00008	5	0.00156	2.5	0.00775	82452	639	410663	3819612	46.33	44.61	1.72	0.00816	5.0
15	15-19	2.94366	0.26120	0.00294	0.00026	5	0.00268	2.5	0.01332	81813	1090	406342	3408949	41.67	39.95	1.71	0.01463	8.9
20	20-24	6.04115	0.49876	0.00604	0.00050	5	0.00554	2.5	0.02733	80723	2206	398101	3002607	37.20	35.51	1.69	0.02980	8.3
25	25-29	13.48778	1.21200	0.01349	0.00121	5	0.01228	2.5	0.05955	78517	4676	380895	2604507	33.17	31.52	1.65	0.06533	8.8
30	30-34	15.92696	1.01573	0.01593	0.00102	5	0.01491	2.5	0.07188	73841	5307	355937	2223612	30.11	28.55	1.56	0.07669	6.3
35	35-39	25.51440	1.00206	0.02551	0.00100	5	0.02451	2.5	0.11548	68534	7915	322882	1867675	27.25	25.71	1.54	0.12009	3.8
40	40-44	16.96014	1.42673	0.01696	0.00143	5	0.01553	2.5	0.07476	60619	4532	291765	1544793	25.48	23.88	1.60	0.08146	8.2
45	45-49	20.79200	1.78970	0.02079	0.00179	5	0.01900	2.5	0.09070	56087	5087	267717	1253028	22.34	20.78	1.56	0.09896	8.3
50	50-54	32.60560	4.46572	0.03261	0.00447	5	0.02814	2.5	0.13145	51000	6704	238239	985311	19.32	17.79	1.53	0.15094	12.9
55	55-59	25.56078	4.49176	0.02556	0.00449	5	0.02107	2.5	0.10007	44296	4433	210396	747073	16.87	15.50	1.36	0.12029	16.8
60	60-64	41.43272	7.93901	0.04143	0.00794	5	0.03349	2.5	0.15453	39863	6160	183914	536676	13.46	12.28	1.18	0.18796	17.8
65	65-69	65.91099	10.62726	0.06591	0.01063	5	0.05528	2.5	0.24285	33703	8185	148052	352762	10.47	9.55	0.92	0.28328	14.3
70	70-74	120.01980	18.22970	0.12002	0.01823	5	0.10179	2.5	0.40571	25518	10353	101708	204709	8.02	7.33	0.69	0.46211	12.2
75	75-79	122.25201	13.43164	0.12225	0.01343	5	0.10882	2.5	0.42774	15165	6487	59609	103001	6.79	6.48	0.31	0.46869	8.7
80+	80+	342.39130	29.45652	0.34239	0.02946		0.31293	5.0	1.00000	8678	8678	43392	43392	5.00	5.00	0.00	1.00000	0.0

Table A5.9 Life Table Eliminating the Risk of Tuberculosis-SAVVY females, Zambia 2010-2012

Age	Age Group	nMx	nMx TB	ASDR (All)	ASDR (TB)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-TB	ex_0 All Causes	Gain	nqx(All Causes)	Percentage Reduction in Probability of Dying
0	< 1	78.80152	0.39591	0.07880	0.00040	1	0.07841	0.5	0.07545	100000	7545	96228	5081344	50.81	49.45	1.37	0.07654	1.4
1	1-4	15.98601	0.27250	0.01599	0.00027	4	0.01571	2.0	0.06094	92455	5634	358553	4985116	53.92	52.50	1.42	0.06216	2.0
5	5-9	3.82654	0.00000	0.00383	0.00000	5	0.00383	2.5	0.01895	86821	1645	429992	4626563	53.29	51.85	1.44	0.01901	0.3
10	10-14	1.47860	0.15379	0.00148	0.00015	5	0.00132	2.5	0.00660	85176	562	424473	4196571	49.27	47.81	1.46	0.00739	10.7
15	15-19	3.29794	0.41483	0.00330	0.00041	5	0.00288	2.5	0.01431	84613	1211	420039	3772099	44.58	43.14	1.44	0.01641	12.8
20	20-24	6.78726	0.42936	0.00679	0.00043	5	0.00636	2.5	0.03129	83402	2610	410487	3352059	40.19	38.82	1.37	0.03348	6.5
25	25-29	10.02179	0.75673	0.01002	0.00076	5	0.00927	2.5	0.04528	80793	3658	394818	2941572	36.41	35.08	1.33	0.04904	7.7
30	30-34	13.47053	1.59888	0.01347	0.00160	5	0.01187	2.5	0.05765	77135	4447	374556	2546755	33.02	31.76	1.26	0.06537	11.8
35	35-39	15.02772	0.60682	0.01503	0.00061	5	0.01442	2.5	0.06960	72688	5059	350793	2172199	29.88	28.81	1.08	0.07265	4.2
40	40-44	19.05405	0.97265	0.01905	0.00097	5	0.01808	2.5	0.08650	67629	5850	323522	1821406	26.93	25.87	1.06	0.09123	5.2
45	45-49	19.51645	2.66667	0.01952	0.00267	5	0.01685	2.5	0.08084	61779	4994	296411	1497884	24.25	23.21	1.03	0.09334	13.4
50	50-54	18.18375	0.62135	0.01818	0.00062	5	0.01756	2.5	0.08412	56785	4777	271983	1201473	21.16	20.35	0.81	0.08724	3.6
55	55-59	21.23457	0.00000	0.02123	0.00000	5	0.02123	2.5	0.10082	52008	5244	246933	929490	17.87	17.05	0.82	0.10114	0.3
60	60-64	31.50044	4.86937	0.03150	0.00487	5	0.02663	2.5	0.12484	46765	5838	219228	682557	14.60	13.69	0.91	0.14645	14.8
65	65-69	60.47945	8.56164	0.06048	0.00856	5	0.05192	2.5	0.22977	40927	9404	181124	463329	11.32	10.61	0.71	0.26344	12.8
70	70-74	71.53571	6.78571	0.07154	0.00679	5	0.06475	2.5	0.27864	31523	8784	135656	282205	8.95	8.51	0.44	0.30427	8.4
75	75-79	147.14681	13.57895	0.14715	0.01358	5	0.13357	2.5	0.50066	22739	11385	85235	146550	6.44	6.14	0.30	0.53918	7.1
80+	80+	316.02067	26.82171	0.31602	0.02682		0.28920	5.4	1.00000	11355	11355	61315	61315	5.40	5.40	0.00	1.00000	0.0

Table A5.10 Life Table Eliminating the Risk of Malaria-SAVVY both sexes, Zambia 2010-2012

Age	Age Group	nMx	nMx Malaria	ASDR (All)	ASDR (Malaria)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0-Malaria	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	85.33101	6.13066	0.08533	0.00613	1	0.07920	0.5	0.07618	100000	7618	96191	5001715	50.02	47.33	2.69	0.08202	7.1
1	1-4	18.01005	5.36055	0.01801	0.00536	4	0.01265	2.0	0.04935	92382	4559	360409	4905524	53.10	50.52	2.58	0.06970	29.2
5	5-9	4.14668	1.94807	0.00415	0.00195	5	0.00220	2.5	0.01093	87823	960	436713	4545116	51.75	50.15	1.60	0.02057	46.9
10	10-14	1.55570	0.28179	0.00156	0.00028	5	0.00127	2.5	0.00635	86862	552	432934	4108403	47.30	46.15	1.15	0.00777	18.2
15	15-19	3.12666	0.25894	0.00313	0.00026	5	0.00287	2.5	0.01424	86311	1229	428483	3675469	42.58	41.49	1.09	0.01555	8.4
20	20-24	6.44271	0.61008	0.00644	0.00061	5	0.00583	2.5	0.02874	85082	2446	419297	3246986	38.16	37.11	1.05	0.03180	9.6
25	25-29	11.57119	0.92811	0.01157	0.00093	5	0.01064	2.5	0.05184	82637	4284	402474	2827689	34.22	33.25	0.97	0.05635	8.0
30	30-34	14.69844	0.75962	0.01470	0.00076	5	0.01394	2.5	0.06735	78353	5277	378573	2425215	30.95	30.08	0.87	0.07104	5.2
35	35-39	20.36649	1.32147	0.02037	0.00132	5	0.01905	2.5	0.09090	73076	6642	348775	2046642	28.01	27.19	0.82	0.09709	6.4
40	40-44	17.95299	0.87111	0.01795	0.00087	5	0.01708	2.5	0.08191	66434	5442	318565	1697867	25.56	24.85	0.71	0.08608	4.8
45	45-49	20.16003	1.15749	0.02016	0.00116	5	0.01900	2.5	0.09070	60992	5532	291130	1379303	22.61	21.95	0.66	0.09620	5.7
50	50-54	25.27793	1.10389	0.02528	0.00110	5	0.02417	2.5	0.11398	55460	6321	261496	1088173	19.62	19.02	0.60	0.11912	4.3
55	55-59	23.31071	1.77715	0.02331	0.00178	5	0.02153	2.5	0.10217	49138	5020	233141	826677	16.82	16.26	0.57	0.11039	7.5
60	60-64	36.23730	3.56879	0.03624	0.00357	5	0.03267	2.5	0.15101	44118	6662	203935	593536	13.45	12.96	0.49	0.16649	9.3
65	65-69	62.94671	3.25517	0.06295	0.00326	5	0.05969	2.5	0.25970	37456	9727	162961	389601	10.40	10.05	0.35	0.27244	4.7
70	70-74	94.55399	6.70986	0.09455	0.00671	5	0.08784	2.5	0.36013	27728	9986	113678	226640	8.17	7.88	0.29	0.38297	6.0
75	75-79	134.49591	6.64033	0.13450	0.00664	5	0.12786	2.5	0.48443	17743	8595	67225	112962	6.37	6.22	0.15	0.50419	3.9
80+	80+	329.00662	7.15762	0.32901	0.00716		0.32185	5.0	1.00000	9147	9147	45737	45737	5.00	5.00	0.00	1.00000	0.0

Table A5.11 Life Table Eliminating the Risk of Malaria-SAVVY males, Zambia 2010-2012

Age	Age Group	nMx	nMx Malaria	ASDR (All)	ASDR (Malaria)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Malaria	ex_0 All Causes	Gain	nqx (All Cause)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	3.78899	0.09082	0.00379	1	0.08703	0.5	0.08340	100000	8340	95830	4800538	48.01	45.36	2.64	0.08754	4.7
1	1-4	20.00687	5.86290	0.02001	0.00586	4	0.01414	2.0	0.05502	91660	5043	356554	4704708	51.33	48.67	2.66	0.07706	28.6
5	5-9	4.47400	2.19027	0.00447	0.00219	5	0.00228	2.5	0.01135	86617	983	430627	4348154	50.20	48.56	1.64	0.02215	48.8
10	10-14	1.63574	0.24744	0.00164	0.00025	5	0.00139	2.5	0.00692	85634	592	426687	3917527	45.75	44.61	1.14	0.00816	15.2
15	15-19	2.94366	0.27351	0.00294	0.00027	5	0.00267	2.5	0.01326	85041	1128	422387	3490840	41.05	39.95	1.10	0.01463	9.4
20	20-24	6.04115	0.71655	0.00604	0.00072	5	0.00532	2.5	0.02627	83913	2205	414055	3068454	36.57	35.51	1.06	0.02980	11.8
25	25-29	13.48778	1.00032	0.01349	0.00100	5	0.01249	2.5	0.06055	81709	4947	396176	2654398	32.49	31.52	0.96	0.06533	7.3
30	30-34	15.92696	1.01800	0.01593	0.00102	5	0.01491	2.5	0.07187	76761	5517	370016	2258223	29.42	28.55	0.87	0.07669	6.3
35	35-39	25.51440	1.81543	0.02551	0.00182	5	0.02370	2.5	0.11187	71245	7970	336300	1888207	26.50	25.71	0.79	0.12009	6.8
40	40-44	16.96014	1.06854	0.01696	0.00107	5	0.01589	2.5	0.07642	63275	4836	304286	1551907	24.53	23.88	0.64	0.08146	6.2
45	45-49	20.79200	1.13995	0.02079	0.00114	5	0.01965	2.5	0.09366	58439	5473	278514	1247621	21.35	20.78	0.57	0.09896	5.4
50	50-54	32.60560	0.00000	0.03261	0.00000	5	0.03261	2.5	0.15074	52966	7984	244870	969108	18.30	17.79	0.51	0.15094	0.1
55	55-59	25.56078	2.10510	0.02556	0.00211	5	0.02346	2.5	0.11078	44982	4983	212451	724238	16.10	15.50	0.60	0.12029	7.9
60	60-64	41.43272	4.25073	0.04143	0.00425	5	0.03718	2.5	0.17010	39999	6804	182984	511786	12.80	12.28	0.51	0.18796	9.5
65	65-69	65.91099	4.26565	0.06591	0.00427	5	0.06165	2.5	0.26707	33195	8865	143812	328802	9.91	9.55	0.36	0.28328	5.7
70	70-74	120.01980	8.34059	0.12002	0.00834	5	0.11168	2.5	0.43652	24330	10620	95097	184991	7.60	7.33	0.27	0.46211	5.5
75	75-79	122.25201	3.09115	0.12225	0.00309	5	0.11916	2.5	0.45905	13709	6293	52813	89893	6.56	6.48	0.07	0.46869	2.1
80+	80+	342.39130	0.00000	0.34239	0.00000		0.34239	5.0	1.00000	7416	7416	37080	37080	5.00	5.00	0.00	1.00000	0.0

Table A5.12 Life Table Eliminating the Risk of Malaria-SAVVY females, Zambia 2010-2012

Age	Age Group	nMx	nMx Malaria	ASDR (All)	ASDR (Malaria)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Malaria	ex_0 All Causes	Gain	nqx (All Cause)	Percentage Reduction in Probability of Dying
0	< 1	78.80152	8.44475	0.07880	0.00844	1	0.07036	0.5	0.06797	100000	6797	96602	5223589	52.24	49.45	2.79	0.07654	11.2
1	1-4	15.98601	4.84827	0.01599	0.00485	4	0.01114	2.0	0.04358	93203	4062	364690	5126987	55.01	52.50	2.51	0.06216	29.9
5	5-9	3.82654	1.70943	0.00383	0.00171	5	0.00212	2.5	0.01053	89142	939	443361	4762297	53.42	51.85	1.57	0.01901	44.6
10	10-14	1.47860	0.31487	0.00148	0.00031	5	0.00116	2.5	0.00580	88203	512	439735	4318936	48.97	47.81	1.16	0.00739	21.5
15	15-19	3.29794	0.24539	0.00330	0.00025	5	0.00305	2.5	0.01515	87691	1328	435135	3879200	44.24	43.14	1.09	0.01641	7.7
20	20-24	6.78726	0.52063	0.00679	0.00052	5	0.00627	2.5	0.03085	86363	2664	425154	3444065	39.88	38.82	1.06	0.03348	7.9
25	25-29	10.02179	0.86926	0.01002	0.00087	5	0.00915	2.5	0.04474	83699	3745	409132	3018911	36.07	35.08	0.99	0.04904	8.8
30	30-34	13.47053	0.50174	0.01347	0.00050	5	0.01297	2.5	0.06281	79954	5022	387216	2609779	32.64	31.76	0.88	0.06537	3.9
35	35-39	15.02772	0.80959	0.01503	0.00081	5	0.01422	2.5	0.06865	74932	5144	361801	2222563	29.66	28.81	0.85	0.07265	5.5
40	40-44	19.05405	0.64961	0.01905	0.00065	5	0.01840	2.5	0.08797	69788	6140	333592	1860761	26.66	25.87	0.79	0.09123	3.6
45	45-49	19.51645	1.17558	0.01952	0.00118	5	0.01834	2.5	0.08768	63649	5581	304291	1527169	23.99	23.21	0.78	0.09334	6.1
50	50-54	18.18375	2.17260	0.01818	0.00217	5	0.01601	2.5	0.07697	58068	4470	279164	1222878	21.06	20.35	0.71	0.08724	11.8
55	55-59	21.23457	1.47422	0.02123	0.00147	5	0.01976	2.5	0.09415	53598	5046	255374	943714	17.61	17.05	0.55	0.10114	6.9
60	60-64	31.50044	2.94704	0.03150	0.00295	5	0.02855	2.5	0.13325	48552	6470	226584	688340	14.18	13.69	0.49	0.14645	9.0
65	65-69	60.47945	2.42694	0.06048	0.00243	5	0.05805	2.5	0.25348	42082	10667	183743	461756	10.97	10.61	0.36	0.26344	3.8
70	70-74	71.53571	5.23929	0.07154	0.00524	5	0.06630	2.5	0.28435	31415	8933	134743	278014	8.85	8.51	0.34	0.30427	6.5
75	75-79	147.14681	10.30748	0.14715	0.01031	5	0.13684	2.5	0.50980	22482	11461	83758	143270	6.37	6.14	0.23	0.53918	5.4
80+	80+	316.02067	13.96382	0.31602	0.01396		0.30206	5.4	1.00000	11021	11021	59513	59513	5.40	5.40	0.00	1.00000	0.0

Table A5.13 Life Table Eliminating the Risk of Diseases of the Circulatory System-SAVVY both sexes, Zambia 2010-2012

Age	Age Group	nMx	nMx Circulatory	ASDR (All)	ASDR (Circulatory)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Circulatory	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	0.00000	0.09082	0.00000	1	0.09082	0.5	0.08687	100000	8687	95656	4641122	46.41	45.36	1.05	0.08754	0.8
1	1-4	20.00687	0.00000	0.02001	0.00000	4	0.02001	2.0	0.07695	91313	7026	351198	4545466	49.78	48.67	1.11	0.07706	0.1
5	5-9	4.47400	0.08539	0.00447	0.00009	5	0.00439	2.5	0.02170	84286	1829	416859	4194267	49.76	48.56	1.20	0.02215	2.0
10	10-14	1.63574	0.00000	0.00164	0.00000	5	0.00164	2.5	0.00815	82457	672	410606	3777409	45.81	44.61	1.20	0.00816	0.1
15	15-19	2.94366	0.08667	0.00294	0.00009	5	0.00286	2.5	0.01418	81785	1160	406027	3366803	41.17	39.95	1.21	0.01463	3.1
20	20-24	6.04115	0.11276	0.00604	0.00011	5	0.00593	2.5	0.02921	80625	2355	397239	2960776	36.72	35.51	1.21	0.02980	2.0
25	25-29	13.48778	0.47033	0.01349	0.00047	5	0.01302	2.5	0.06304	78270	4934	379017	2563537	32.75	31.52	1.23	0.06533	3.5
30	30-34	15.92696	0.54779	0.01593	0.00055	5	0.01538	2.5	0.07405	73337	5430	353106	2184520	29.79	28.55	1.24	0.07669	3.4
35	35-39	25.51440	0.21173	0.02551	0.00021	5	0.02530	2.5	0.11899	67906	8080	319330	1831414	26.97	25.71	1.26	0.12009	0.9
40	40-44	16.96014	1.37195	0.01696	0.00137	5	0.01559	2.5	0.07502	59826	4488	287911	1512083	25.27	23.88	1.39	0.08146	7.9
45	45-49	20.79200	1.15110	0.02079	0.00115	5	0.01964	2.5	0.09361	55338	5180	263740	1224173	22.12	20.78	1.34	0.09896	5.4
50	50-54	32.60560	1.69007	0.03261	0.00169	5	0.03092	2.5	0.14349	50158	7197	232797	960433	19.15	17.79	1.36	0.15094	4.9
55	55-59	25.56078	5.60941	0.02556	0.00561	5	0.01995	2.5	0.09502	42961	4082	204600	727635	16.94	15.50	1.43	0.12029	21.0
60	60-64	41.43272	6.79187	0.04143	0.00679	5	0.03464	2.5	0.15940	38879	6197	178901	523036	13.45	12.28	1.17	0.18796	15.2
65	65-69	65.91099	11.68985	0.06591	0.01169	5	0.05422	2.5	0.23874	32682	7803	143902	344134	10.53	9.55	0.98	0.28328	15.7
70	70-74	120.01980	14.29901	0.12002	0.01430	5	0.10572	2.5	0.41810	24879	10402	98391	200232	8.05	7.33	0.72	0.46211	9.5
75	75-79	122.25201	23.69169	0.12225	0.02369	5	0.09856	2.5	0.39538	14477	5724	58076	101842	7.03	6.48	0.55	0.46869	15.6
80+	80+	342.39130	75.76087	0.34239	0.07576		0.26663	5.0	1.00000	8753	8753	43766	43766	5.00	5.00	0.00	1.00000	0.0

Table A5.14 Life Table Eliminating the Risk of Diseases of the Circulatory System-SAVVY male, Zambia 2010-2012

Age	Age Group	nMx	nMx Circulatory	ASDR (All)	ASDR (Circulatory)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Circulatory	ex_0 All Causes	Gain	nqx (All Causes)	Percentage Reduction in Probability of Dying
0	< 1	90.81668	0.00000	0.09082	0.00000	1	0.09082	0.5	0.08687	100000	8687	95656	4641122	46.41	45.36	1.05	0.08754	0.8
1	1-4	20.00687	0.00000	0.02001	0.00000	4	0.02001	2.0	0.07695	91313	7026	351198	4545466	49.78	48.67	1.11	0.07706	0.1
5	5-9	4.47400	0.08539	0.00447	0.00009	5	0.00439	2.5	0.02170	84286	1829	416859	4194267	49.76	48.56	1.20	0.02215	2.0
10	10-14	1.63574	0.00000	0.00164	0.00000	5	0.00164	2.5	0.00815	82457	672	410606	3777409	45.81	44.61	1.20	0.00816	0.1
15	15-19	2.94366	0.08667	0.00294	0.00009	5	0.00286	2.5	0.01418	81785	1160	406027	3366803	41.17	39.95	1.21	0.01463	3.1
20	20-24	6.04115	0.11276	0.00604	0.00011	5	0.00593	2.5	0.02921	80625	2355	397239	2960776	36.72	35.51	1.21	0.02980	2.0
25	25-29	13.48778	0.47033	0.01349	0.00047	5	0.01302	2.5	0.06304	78270	4934	379017	2563537	32.75	31.52	1.23	0.06533	3.5
30	30-34	15.92696	0.54779	0.01593	0.00055	5	0.01538	2.5	0.07405	73337	5430	353106	2184520	29.79	28.55	1.24	0.07669	3.4
35	35-39	25.51440	0.21173	0.02551	0.00021	5	0.02530	2.5	0.11899	67906	8080	319330	1831414	26.97	25.71	1.26	0.12009	0.9
40	40-44	16.96014	1.37195	0.01696	0.00137	5	0.01559	2.5	0.07502	59826	4488	287911	1512083	25.27	23.88	1.39	0.08146	7.9
45	45-49	20.79200	1.15110	0.02079	0.00115	5	0.01964	2.5	0.09361	55338	5180	263740	1224173	22.12	20.78	1.34	0.09896	5.4
50	50-54	32.60560	1.69007	0.03261	0.00169	5	0.03092	2.5	0.14349	50158	7197	232797	960433	19.15	17.79	1.36	0.15094	4.9
55	55-59	25.56078	5.60941	0.02556	0.00561	5	0.01995	2.5	0.09502	42961	4082	204600	727635	16.94	15.50	1.43	0.12029	21.0
60	60-64	41.43272	6.79187	0.04143	0.00679	5	0.03464	2.5	0.15940	38879	6197	178901	523036	13.45	12.28	1.17	0.18796	15.2
65	65-69	65.91099	11.68985	0.06591	0.01169	5	0.05422	2.5	0.23874	32682	7803	143902	344134	10.53	9.55	0.98	0.28328	15.7
70	70-74	120.01980	14.29901	0.12002	0.01430	5	0.10572	2.5	0.41810	24879	10402	98391	200232	8.05	7.33	0.72	0.46211	9.5
75	75-79	122.25201	23.69169	0.12225	0.02369	5	0.09856	2.5	0.39538	14477	5724	58076	101842	7.03	6.48	0.55	0.46869	15.6
80+	80+	342.39130	75.76087	0.34239	0.07576		0.26663	5.0	1.00000	8753	8753	43766	43766	5.00	5.00	0.00	1.00000	0.0

Table A5.15 Life Table Eliminating the Risk of Diseases of the Circulatory System-SAVVY females, Zambia 2010-2012

Age	Age Group	nMx	nMx Circulatory	ASDR (All)	ASDR (Circulatory)	n	nMx*	nax	nqx*	lx	ndx	nLx	Tx	ex_0- Circulatory	ex_0 All Causes	Gain	nqx (All Cause)	Percentage Reduction in Probability of Dying
0	< 1	78.80152	0.00000	0.07880	0.00000	1	0.07880	0.5	0.07581	100000	7581	96209	5135605	51.36	49.45	1.91	0.07654	0.9
1	1-4	15.98601	0.00000	0.01599	0.00000	4	0.01599	2.0	0.06196	92419	5727	358221	5039396	54.53	52.50	2.02	0.06216	0.3
5	5-9	3.82654	0.00000	0.00383	0.00000	5	0.00383	2.5	0.01895	86692	1643	429353	4681175	54.00	51.85	2.15	0.01901	0.3
10	10-14	1.47860	0.00000	0.00148	0.00000	5	0.00148	2.5	0.00737	85049	626	423679	4251822	49.99	47.81	2.19	0.00739	0.3
15	15-19	3.29794	0.08073	0.00330	0.00008	5	0.00322	2.5	0.01596	84423	1347	418745	3828143	45.34	43.14	2.20	0.01641	2.7
20	20-24	6.78726	0.32183	0.00679	0.00032	5	0.00647	2.5	0.03181	83075	2643	408770	3409397	41.04	38.82	2.22	0.03348	5.0
25	25-29	10.02179	0.51628	0.01002	0.00052	5	0.00951	2.5	0.04642	80433	3734	392828	3000627	37.31	35.08	2.23	0.04904	5.3
30	30-34	13.47053	0.34496	0.01347	0.00034	5	0.01313	2.5	0.06354	76699	4874	371309	2607799	34.00	31.76	2.24	0.06537	2.8
35	35-39	15.02772	0.55778	0.01503	0.00056	5	0.01447	2.5	0.06982	71825	5015	346587	2236491	31.14	28.81	2.33	0.07265	3.9
40	40-44	19.05405	0.93629	0.01905	0.00094	5	0.01812	2.5	0.08666	66810	5790	319574	1889904	28.29	25.87	2.42	0.09123	5.0
45	45-49	19.51645	3.45026	0.01952	0.00345	5	0.01607	2.5	0.07723	61020	4713	293318	1570330	25.73	23.21	2.52	0.09334	17.3
50	50-54	18.18375	2.26182	0.01818	0.00226	5	0.01592	2.5	0.07656	56307	4311	270759	1277012	22.68	20.35	2.33	0.08724	12.2
55	55-59	21.23457	2.96369	0.02123	0.00296	5	0.01827	2.5	0.08736	51996	4543	248625	1006252	19.35	17.05	2.30	0.10114	13.6
60	60-64	31.50044	9.20565	0.03150	0.00921	5	0.02229	2.5	0.10559	47454	5011	224742	757627	15.97	13.69	2.28	0.14645	27.9
65	65-69	60.47945	16.07306	0.06048	0.01607	5	0.04441	2.5	0.19985	42443	8482	191011	532885	12.56	10.61	1.94	0.26344	24.1
70	70-74	71.53571	16.86786	0.07154	0.01687	5	0.05467	2.5	0.24047	33961	8167	149388	341874	10.07	8.51	1.56	0.30427	21.0
75	75-79	147.14681	55.78947	0.14715	0.05579	5	0.09136	2.5	0.37186	25794	9592	104992	192486	7.46	6.14	1.32	0.53918	31.0
80+	80+	316.02067	71.75711	0.31602	0.07176		0.24426	5.4	1.00000	16203	16203	87494	87494	5.40	5.40	0.00	1.00000	0.0

CHAPTER 6: APPENDIX

Figure A6.1 Kaplan-Meier survival estimates by HIV/AIDS for adults between age 15 and 60 years, Zambia 2010-2012 SAVVY

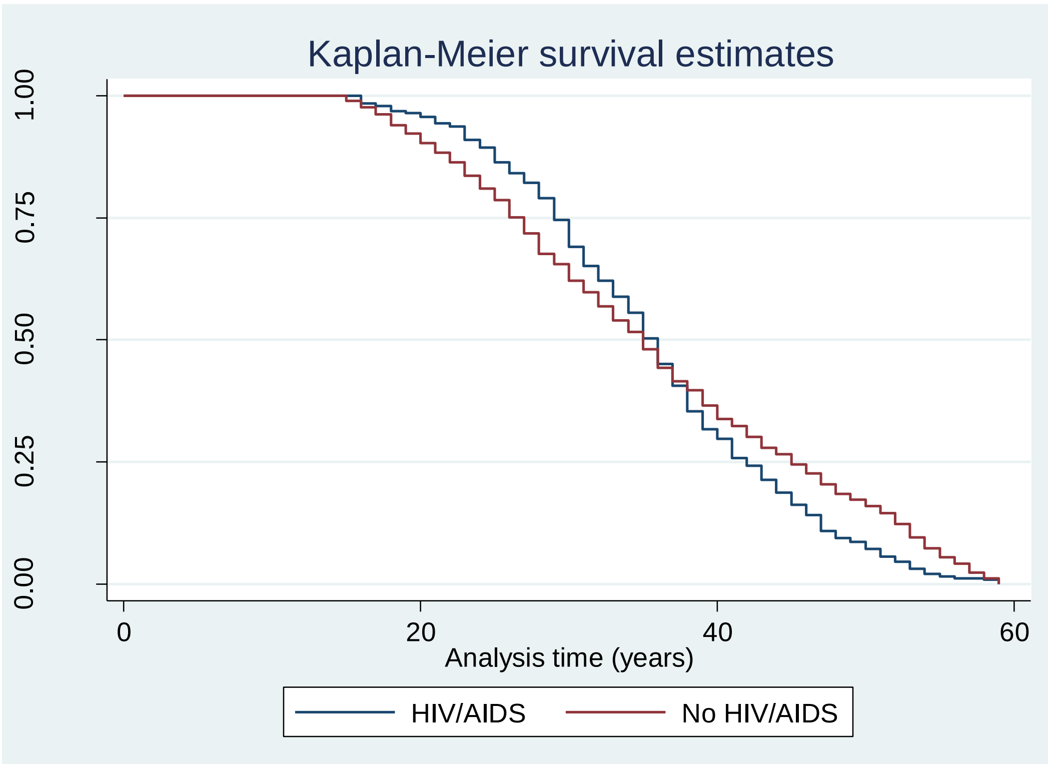


Figure A6.2 Kaplan-Meier survival estimates by education level for adults between age 15 and 60 years, Zambia 2010-2012 SAVVY

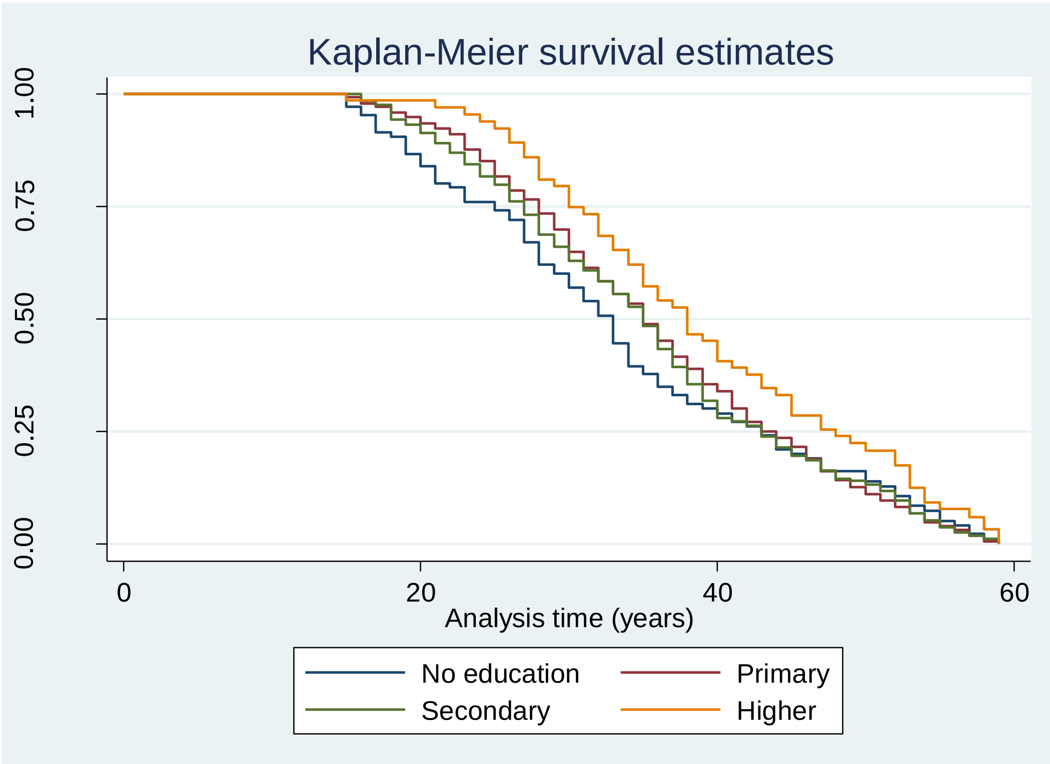


Figure A6.3 Kaplan-Meier survival estimates by family relationship for adults between age 15 and 60 years, Zambia 2010-2012 SAVVY

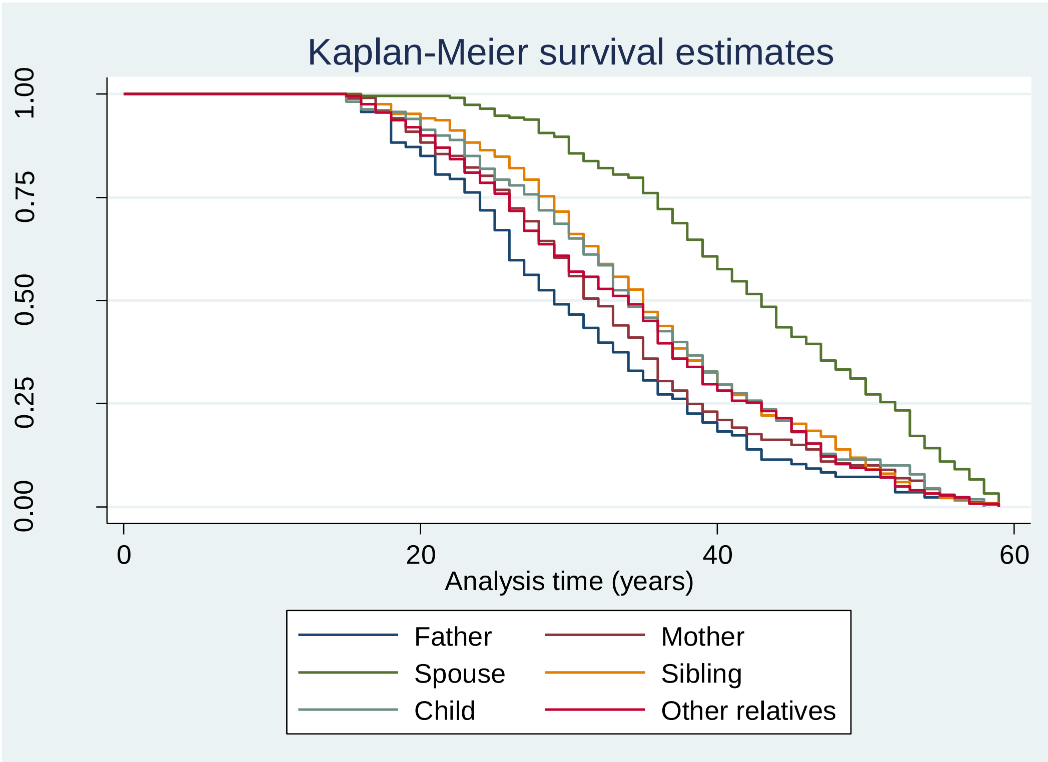
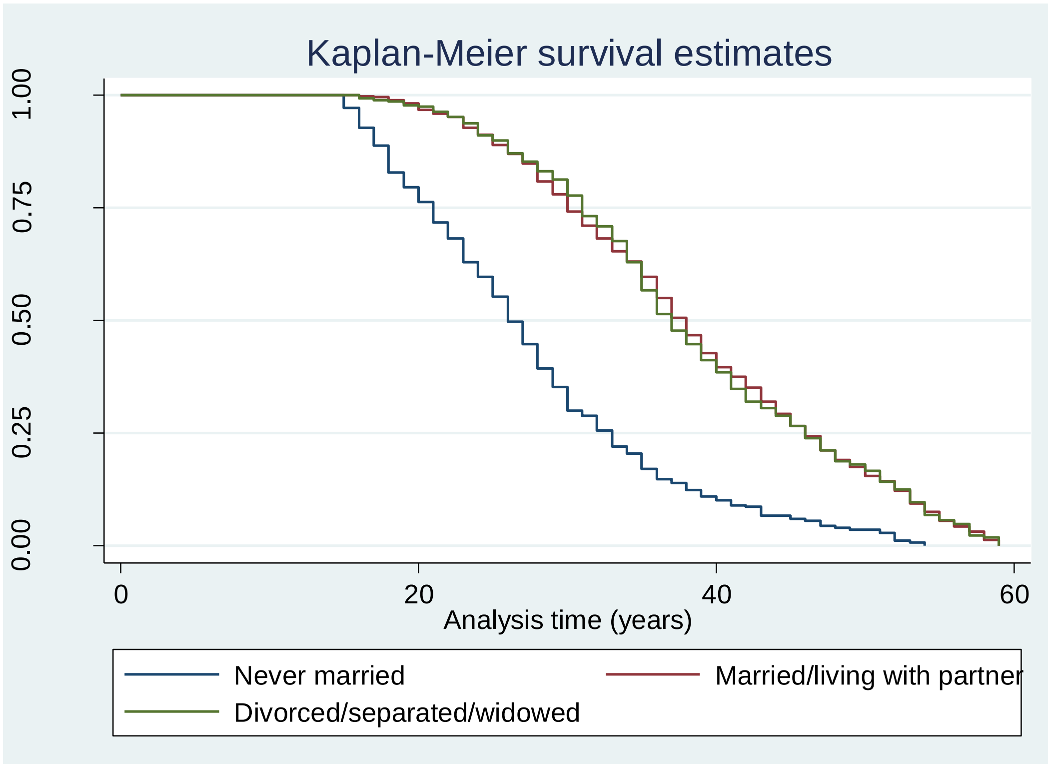


Figure A6.4 Kaplan-Meier survival estimates by marital status for adults between age 15 and 60 years, Zambia 2010-2012 SAVVY



LITERATURE REVIEW MATRIX APPENDIX

Literature Review Matrix: Multilevel determinants of adult mortality variations in Zambia

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
1.	"The impact of adult mortality and parental deaths on primary schooling in North-Western Tanzania," *The Journal of Development Studies*, **41**(3), 412-439.	Ainsworth, M., K. Beegle, & G. Koda. 2005.	Panel household survey	Mean, standard deviations, Regression	Adult morbidity and mortality led to reduced school attendance among children	The study did not examine causes of death and determinants of adult mortality
2.	"Measuring and explaining the change in life expectancies", *Demography*, **21**(1), 83-96.	Arriaga, E. E. 1984.		Decomposition	Assesses and sums direct and indirect effects of age- and cause-specific mortality into total effects	The study did not apply multilevel analysis
3.	. "Income inequality and mortality: a multilevel prospective study of 521 248 individuals in 50 US states", *International Journal of Epidemiology*, **36**(3), 590-596.	Backlund, E., G. Rowe, J. Lynch, et al., 2007	US National Longitudinal Mortality Study	Multilevel regression	Income inequality and mortality relationship is only robust after adjustment of compositional factors in men and women under age 65	Cause-specific mortality was not examined in the study
4.	"HIV Development Assistance and Adult Mortality in Africa", *Journal of American Medical Association* **307**(19): 2060-2067	Bendavid, E., C.B. Holmes, J. Bhattacharya, and G. Miller. 2012.	DHS sibling survival data of African countries ART clinic data in PEPFAR countries	Logistic regression and difference-in-difference design	All-cause adult mortality declined more in PEPFAR focus countries relative to nonfocus countries	Multilevel analysis was not applied in the study Only HIV cause-specific deaths were examined
5.	"Estimating the Completeness of Death Registration in a Closed Population", *Population Index* **47**(2):202-221.	Bennett, N. G. and S. Horiuchi. 1981.	Sweden census 1965-1970; Korea	Synthetic Extinct Generations	Method estimates completeness of	The study proposes a

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
			census 1970-1975		adult death reporting using age-specific growth rates applicable in destabilized populations	method of estimating adult mortality. It does not examine predictors of adult mortality
6.	"Mortality Estimation from Registered Deaths in Less Developed Countries", *Demography* **21**(2):217-233.	Bennett, N. G. and S. Horiuchi. 1984.	Census data 1960-1970	Synthetic Extinct Generations mortality estimation	Method uses growth rates to transform a set of incompletely recorded deaths by age into a life table that accurately reflects the mortality experience of the population under study	There is no multilevel analysis or cause specific mortality rates
7.	"Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents", *American journal of Epidemiology*, **109**(2), 186-204.	Berkman, L. F., & S.L. Syme. 1979.	Human Population Laboratory Survey, 1965	Age-adjusted relative risks	People who lacked social and community ties were more likely to die than those with more extensive contacts	The study did not examine cause-specific mortality
8.	"No association of income inequality with adult mortality within New Zealand: a multi-level study of 1.4 million 25–64 year olds", *Journal of Epidemiology and Community Health*, **57**(4), 279-284.	Blakely, T., J. Atkinson, & D. O'Dea. 2003.	Census and mortality data linked 1991-1994	Logistic Regression	No association of income inequality with all-cause mortality	Considered only small area socioeconomic deprivation
9.	"The effects of regional characteristics on alcohol-related mortality—a register-based multilevel analysis of 1.1 million men", *Social Science & Medicine*, **58**(12), 2523-2535.	Blomgren, J., P. Martikainen, P. Mäkelä, & T. Valkonen. 2004.	Finland 1990 Census linked to death records 1991-1996	Poisson regression	Regional characteristics had an effect on alcohol related mortality, although the effects were	The study focused only on alcohol related mortality

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					smaller than those of individual-level characteristics	
10.	"Levels and Trends in Adult Mortality," in Jamison, D.T., R. G. A. Feachem, M.W. Makgoba*, et al.* (eds). *Disease and Mortality in Sub-Saharan Africa*. Washington, D.C., USA: The International Bank for Reconstruction and Development/The World Bank, pp.	Bradshaw, D. and I. M. Timaeus. 2006.	WHO life tables for Africa, 2000	Probability of dying between exact ages 15 and 60 (45q15)	Adult mortality varies across Africa. Southern and Eastern Africa have high adult mortality than West Africa	The study did not examine any determinants
11.	"Estimating adult mortality in Zambia using information on survival of parents from surveys", *African Population Studies*, **25**, 1.	Chisumpa, V. H., & R. Dorrington. 2011.	Demographic and Health Survey; Living Conditions Monitoring Survey	Orphanhood adult mortality estimation	Adult mortality increased overtime for both males and females	The study did not consider neither cause-specific mortality not predictors of adult mortality
12.	"Socioeconomic Status, Marital Status Continuity and Change, Marital Conflict, and Mortality", *Journal of Aging and Health*, **23**(4), 714-742.	Choi, H., & N.F Marks. 2011.	National Survey of Families and Households 1987-2002	Logistic regression	Being continuously married lowers mortality risks among men with low income	The study did not apply multilevel analysis
13.	"Socioeconomic differentials in mortality and health at the older ages", *Genius* **62**: 163-176.	Crimmins, E.M. 2005.	Longitudinal Study of Aging II	Age-specific mortality rates	Socioeconomic differentials reflect mortality differentials among the poor and less educated	Multilevel analysis was not applied
14.	"Socioeconomic status and injury mortality: individual and neighbourhood determinants", *Journal of Epidemiology and Community Health*, **54**(7), 517-524.	Cubbin, C., F.B. LeClere, & G.S. Smith. 2000.	National Health Interview Survey 1987-1995	Cox proportional hazards models	Increased risk of homicide associated with living in a neighbourhood characterized by low social economic status,	The study did not examine health care utilization in the neighbourhood

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					after controlling for individual demographic and socioeconomic characteristics	
15.	"For whom is income inequality most harmful? A multi-level analysis of income inequality and mortality in Norway", *Social Science & Medicine*, **63**(10), 2562-2574.	Dahl, E., J.I. Elstad, D. Hofoss, et al. 2006.	Administrative registers 1994-1999	Multilevel logistic regression models	Higher levels of regional income inequality were associated with higher mortality	Cause-specific mortality was not examined in the study
16.	"The Socioeconomic Distribution of Adult Mortality during Conflicts in Africa", *Peace Economics, Peace Science, and Public Policy*, **18**(3), 1-12.	de Walque, D., & D. Filmer. 2012.	Multiple sources	Descriptive analysis	Higher adult mortality rates in southern African countries with high HIV prevalence than countries that experienced civil war	Multilevel analysis was not applied in the study
17.	"The estimation of neighbourhood effects in the social sciences: An interdisciplinary approach", *Social Science Research*, **31**(4), 539-575.	Dietz, R. D. 2002.	Articles on neighbourhood effects	Systematic review	Neighbourhood effects are important, however, their influences are much smaller	This a systematic review article on neighbourhood effects
18.	"Multilevel analysis in public health research", *Annual Review of Public Health*, **21**(1), 171-192.	Diez-Roux, A. V. 2000.	Articles	Multilevel analysis statistical methodology	Reviews use of multilevel analysis, theoretical and methodological issues	Not a study but a review of the multilevel analysis methods
19.	"Adult mortality in the cities of Bulawayo and Harare, Zimbabwe: 1979-2008", *Journal of the International AIDS Society* **14**(Suppl 1):S2: 1-9	Dlodlo, R.A., P. I. Fujiwara, Z.E. Hwalima, et al. 2011.	1979-2008 Health service records	Crude death rates, age-and sex-specific death rates, cause-specific death rates	After a substantial rise in HIV/AIDS related mortality rates, there has been a decline associated with introduction of	The study did not consider place of death and no multilevel analysis was used

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					ART	
20.	"Marital trajectories and mortality among US adults", *American Journal of Epidemiology*, **170**(5), 546-555.	Dupre, M. E., A.N. Beck, & S.O. Meadows. 2009.	1992-2006 Prospective Cohort data for US adults	Multivariate hazard models	Significantly lower mortality risks among married men and women. Marriage duration was a robust predictor of survival	Cause-specific mortality was not examined
21.	"Religious involvement and mortality risk among African American adults", *Research on Aging*, **22**(6), 630-667.	Ellison, C. G., R.A. Hummer, S. Cormier, et al. 2000.	National Health Interview Survey linked to Multiple Cause of Death Public Use Data File	Cox proportional hazards models	Religious involvement is a significant protective factor that contributes to lower mortality and longer life	The study did not use multilevel analysis
22.	"Socioeconomic differentials in mortality in Finland and United States: The role of education and income", *European Journal of Population*, **22**: 179-203.	Elo, I., P. Martikainen, K. Smith. 2006.	Finnish Longitudinal Census Data File; US National Longitudinal Mortality Study	Cox proportional hazards models	Socioeconomic status, whether measured by education or family income is significantly associated with mortality at ages 35-64.	The study did not examine health care utilisation
23.	"Education differentials in mortality: United States, 1979-85", *Social Science and Medicine*, **42**(1): 47-57	Elo, I. T., and S.H. Preston. 1996.	National Longitudinal Mortality Survey	Multivariate analysis	Proportionate reductions in mortality for each one year increase in schooling among US men and women	The study did not use multilevel analysis
24.	"Population-level reduction in adult mortality after extension of free anti-retroviral therapy provision into rural areas in northern Malawi", *PloS One*, **5**(10), e13499.	Floyd, S., A. Molesworth, A. Dube, et al. 2010.	Demographic Surveillance Site 2002-2008	Age- and cause-specific mortality rates	All-cause mortality rate among 15-59 year olds and AIDS mortality rate	The study did not use multilevel analysis

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					decreased after the introduction of free anti-retroviral therapy	
25.	"Psychological disorder and mortality in French older adults: do social relations modify the association?", *American Journal of Epidemiology*, **149**(2), 116-126.	Fuhrer, R., C. Dufouil, T.C. Antonucci, et al. 1999.	Personnes Agees Quid 1988	Age-adjusted mortality rate ratios	Older men who are depressed and not socially connected are at increased risk of dying earlier	The study did not examine health care utilisation
26.	"Death By Survey: Estimating Adult Mortality without selection bias from Sibling Survival Data", *Demography* **43**(3):569-585.	Gakidou, E. and G. King. 2006.	Demographic and Health Survey, sibling history	Regression analysis	Proposes a new method of estimating adult mortality without biases of sibship size	The study did not consider predictors of adult mortality
27.	"Types of social capital resources and self-rated health among the Norwegian adult population", *International Journal for Equity in Health*, **9**(8), 1-9.	Gele, A. A., & Harsløf, I. 2010.	Living conditions and social networks study 2007	Generalized ordered logistic regression	Individuals who had someone to talk to when distressed were more likely to rate their health as good compared to those deprived of such persons	Not a mortality study but shows importance of social relationships to individual health outcomes
28.	"The effects of adult morbidity and mortality on household welfare and the well-being of children in Soweto", *Vulnerable Children and Youth Studies*, **1**(1), 15-28.	Gray, G. E., R. Van Niekerk, H. Struthers, et al. 2006.	Prospective Cross-sectional Household Survey	T-Statistic	Health, education and welfare of children is compromised when parents are sick or die.	The study focused on impact of adult mortality and not predictors.
29.	"Income distribution and mortality: implications from a comparison of individual-level analysis and multilevel analysis with Swedish data", *Scandinavian Journal of Public Health*, **34**(3), 287-294.	Henriksson, G., P. Allebeck, G.R. Weitoft, et al. 2006.	1990 Swedish census linked to national cause-of-death register	Multilevel regression	At individual level higher mortality was associated with higher income inequality. The association	The study did not examine health care utilization

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					was not significant at multilevel analysis	
30.	"Adult mortality and antiretroviral treatment roll-out in rural KwaZulu-Natal, South Africa", *Bulletin of the World Health Organization*, **87**: 754-762	Herbst, A.J., G.S. Cooke, T. Barnighausen, et al. 2009.	Verbal Autopsy data from Demographic Surveillance Site, 2000-2006	Age standardized mortality rate ratios	HIV-related age-standardized mortality declined significantly following ART roll-out in a community with high HIV prevalence	The study did not examine determinants of adult mortality
31.	"Estimating Census and Death Registration Completeness", *Asian and Pacific Population Forum* **1**(3):8-13.	Hill, K. 1987.	South Korea censuses 1970 and 1975	Generalised Growth Balance	Estimates the relative completeness of two census enumerations and of intercensal deaths in non-stable populations	The study did not examine determinants of adult mortality
32.	*Methods for Measuring Adult Mortality in Developing Countries: A Comparative Review*. The Global Burden of Disease 2000 in Aging Populations. Research Paper No.01.13. Cambridge, Massachusetts: Harvard Burden of Disease Unit. Centre for Population and Development Studies.	Hill, K. 2001.	Guatemala census, registration and survey data, 1981-1994	Intercensal Survival; Death distribution	Presents a new method of adjusting registered deaths for adult mortality estimation	Predictors of adult mortality are not considered
33.	"Levels and causes of adult mortality in rural South Africa: the impact of AIDS", *AIDS* **18**: 663-671	Hosegood, V., A.M. Vanneste, and I.M. Timaeus. 2004.	Verbal Autopsy Demographic Surveillance Site, KwaZulu Natal Province	Direct and indirect estimation of mortality (orphanhood)	Level of adult mortality sharply increased with HIV/AIDS as the leading cause of death in adulthood.	Multilevel analysis was not applied
34.	"Mortality differentials by marital status: an international comparison", *Demography*, **27**(2), 233-250.	Hu, Y., & N. Goldman. 1990.	Multiple data from developed countries (Marriage, death	Log-linear rate models	Excess mortality of unmarried persons relative to the married	Cause-specific mortality rates not examined

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
			records)		increased over the past two to three decades	
35.	"The Effect of Educational Attainment on Adult Mortality in The United States", *Population Bulletin* 68(1).	Hummer, R.A., and E.M. Hernandez. 2013.	National Health Interview Survey linked to Multiple Cause of Death file	Cox proportional hazards model	Less than a high school education is significantly associated with higher risk of dying	Multilevel analysis was not applied
36.	"Educational attainment and adult mortality", in Rogers, R.G. and E.M. Crimmins (eds), *International handbook of adult mortality*. 2: 241-261: Dordrecht, The Netherlands: Springer	Hummer, R.A. and J.T. Lariscy. 2011.	National Health Interview Survey linked to Multiple Cause of Death file	Cox proportional hazards model	Educational attainment is significantly associated with lower risk of dying	Multilevel analysis was not applied
37.	"Sociodemographic differentials in adult mortality: A review of analytic approaches", *Population and Development Review*, **24**: 553-578.	Hummer, R. A., R. G. Rogers and I.W. Eberstein. 1998.	Articles on adult mortality	Systematic review	Argues for use of multilevel analysis to better under determinants of adult mortality	It is a review article
38.	"Religious Involvement and U.S. Adult Mortality", *Demography* **36**(2):273-285	Hummer, R.A., R.G. Rogers, C.B. Nam, and C.G. Ellison. 1999.	1987 National Health Interview Survey linked to Multiple Cause of Death file	Cox proportional hazards model	Religious attendance is associated with adult mortality, people who never attend church or religious service exhibit higher risk of death	No multilevel analysis was applied
39.	"Marital status and mortality among Japanese men and women: the Japan Collaborative Cohort Study", *BMC Public Health*, **7**(1), 73.	Ikeda, A., H. Iso, H. Toyoshima, et al. 2007.	Prospective cohort study	Relative Risk Ratios	Unmarried status was associated with higher risk of mortality than was married status for both men and women	No multilevel analysis was applied
40.	"Population-level effect of HIV on adult mortality and early	Jahn, A., S. Floyd,	Demographic	Age-, sex- and	Adult mortality in	The study did

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
	evidence of reversal affair introduction of antiretroviral therapy in Malawi", *Lancet* 371:1603-1611	A.C. Crampin et al. 2009.	Surveillance Site, northern Malawi	cause-specific mortality rates	age group 15 and 59 years reduced after introduction of ART	not examine predictors of adult mortality
41.	"Inequalities in mortality by marital status during socio-economic transition in Lithuania", *Public Health*, **121**(5), 385-392.	Kalediene, R., J. Petrauskiene., & S. Starkuviene. 2007.	Routine mortality statistics and census data, 1989-2001	Age-, sex- and cause-specific mortality rates	Widowed, divorced, and never married populations were at higher risk of mortality than the married	Multilevel analysis was not applied
42.	"High adult mortality in Lusaka", *Lancet* **351**(9106):883-883.	Kelly, P., R. Feldman, P. Ndubani *et al.* 1998.	Single round cross-sectional survey	Age-and cause-specific rates, probability of dying between ages 15 and 60	High adult mortality in Lusaka with no difference in adult death rates between males and females	The study did not examine determinants of adult mortality
43.	"Alcohol drinking and total mortality risk", *Annals of Epidemiology*, **17**(5), S63-S67.	Klatsky, A. L., & N. Udaltsova. 2007.	Health Examination Survey	Cox proportional hazards models	Alcohol drinking is associated with total mortality with increased risk for drinkers	The study did not apply multilevel analysis
44.	"Neighbourhoods and homicide mortality: an analysis of race/ethnic differences", *Journal of Epidemiology and Community Health*, **58**(3), 223-230.	Krueger, P. M., S.B. Huie, R.G. Rogers et al. 2004.	National Health Interview Survey (1986-1994) linked to National Death Index (1986-1997)	Cox proportional hazards models	Homicide mortality risks are higher in areas that have economic inequality, more Mexican American, non-Hispanic black, households headed by single parents	The study did not examine health care utilisation
45.	"Socioeconomic and behavioural risk factors for mortality in a national 19-year prospective study of US adults", *Social Science &*	Lantz, P. M., E. Golberstein, J.S.	Americans' Changing Lives	Cox proportional hazards models	Low educational was not associated	Multilevel analysis was

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
	Medicine, **70**(10), 1558-1566.	House, et al. 2010.	Longitudinal Study		with mortality when income and health risk behaviours were included in the model. Association of low income and mortality remained after controlling for major behavioural risks	not applied
46.	"Socioeconomic factors, health behaviours, and mortality: results from a nationally representative prospective study of US adults", *Jama*, **279**(21), 1703-1708.	Lantz, P. M., J.S. House, J. M. Lepkowski, et al. 1998.	Americans' Changing Lives Longitudinal Study	Cox proportional hazards models	Educational differences in mortality were explained fully by the strong association between education and income. When health risk behaviours were considered, the risk of dying was higher for the lowest-income group	Multilevel analysis was not applied
47.	"Alcohol intake and mortality: findings from the National Health Interview Surveys (1988 and 1990)", *American Journal of Epidemiology*, **151**(7), 651-659.	Liao, Y., D.L. McGee, G. Cao, et al. 2000.	National Health Interview Survey, 1988 and 1990	Cox proportional hazards model	Alcohol was related mortality with a U-shaped for men and J-shaped for women pattern	The study only considered all-cause mortality and it was not multilevel
48.	"Marital status and mortality: The role of health", *Demography*, **33**(3), 313-327.	Lillard, L. A., & C.W. Panis. 1996.	Panel Study on Income Dynamics	Continuous-time hazards modle	Healthier individuals tend to	The study did not examine

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					be married which protects them from poor health and mortality risks	cause-specific mortality
49.	"Till death do us part: Marital status and US mortality trends, 1986–2000", *Journal of Marriage and Family*, **71**(5), 1158-1173.	Liu, H. 2009.	National Health Interview Survey-Longitudinal Mortality Follow-up	Cox proportional hazards model	Divergent mortality trends between the married and unmarried with the widowed having higher mortality	The study did not examine cause-specific mortality
50.	"The Relationship Between Education and Adult Mortality in the United States", *Review of Economic Studies* **72**:189-221	Lleras-Muney, A. 2005.	US Censuses 1960,1970, 1980 and National Health and Nutrition Examination	Regression discontinuity; Econometric model	Education has a causal effect on mortality	The study did not use multilevel analysis
51.	"State-level income inequality and individual mortality risk: a prospective, multilevel study", *American Journal of Public Health*, **91**(3), 385.	Lochner, K., E. Pamuk, D. Makuc, et al. 2001.	National Health Interview Study linked to National Death Index	Multilevel analysis	State-level income inequality exerts a contextual effect on mortality risks. Individuals living in high-income-inequality states were at increased risk of mortality	The study examined all-cause mortality and did not consider health care utilization
52.	"Sociodemographic differentials of adult death in a rural population", *Ethiopian Medical Journal*, **40**(4), 375-385.	Lulu, K., Y. Berhane, & F. Tesfaye. 2002.	Demographic Surveillance Site, Meskan and Mareko District. Ethiopia	Odds Ratios	Living in rural lowlands was significantly associated with adult mortality	The study was not a multilevel and did not examine cause-specific mortality
53.	"Perceived social support and mortality in older people", *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, **61**(3), S147-S152.	Lyyra, T. M., & R.L. Heikkinen. 2006.	10-year follow-up study in Finland	Social Provision Scale	The risk of death was higher in women in the lowest tertile of	The study examined the relationship between social

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					non-assistance-related social support than in women in the highest tertile	support and mortality, but was not multilevel
54.	"Educational Differences in U.S. Adult Mortality: A Cohort Perspective", *American Sociological Review* **77**(4):548-572	Masters, R.K., R.A. Hummer, and D.A. Powers. 2012.	National Health Interview Surveys, 1986-2004	Hierarchical age-period-cohort models	Reductions in all-cause mortality were driven by cohort processes. reductions in mortality risk were significantly associated with educational attainment	The study did not examine place of death and heath care use
55.	"The burden of non-communicable diseases in South Africa", *The Lancet*, **374**(9693), 934-947.	Mayosi, B. M., A.J. Flisher, U.G. Lalloo, et al. 2009.	National Burden of Disease Study; Demographic and Health Survey; Demographic Surveillance Site, Surveillance Studies	Relative Risk Ratios, Age- and cause-specific rates	Non-communicable diseases are emerging in both rural and urban areas, mostly among poor people in urban areas	The study is did not use multilevel analysis
56.	"An ecological perspective on health promotion programs", *Health Education Q*: **15**: 351-378	McLeroy, KR et al. 1988.			Proposes an ecological model for health promotion with a focus on individual and social environmental factors	
57.	. "Do neighbourhoods affect individual mortality? A systematic review and meta-analysis of multilevel studies", *Social Science & Medicine*, **74**(8), 1204-1212.	Meijer, M., J. Röhl, K. Bloomfield, et al. 2012	Peer-reviewed multilevel articles from high income countries	Meta-analysis	Higher mortality among inhabitants living in areas with low area	No place of death No multilevel analysis

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					socioeconomic status	Systematic review article
58.	"Association of socioeconomic and behavioural factors with Adult mortality: analysis of data from verbal autopsy in Addis Ababa, Ethiopia", *BMC Public Health* **13**: 634	Misganaw et al. 2013.	Burial Surveillance with Verbal Autopsy	Relative Risk Ratios	Low educational status, being female, alcohol and tobacco consumption, age group 25-44 years were significantly associated with HIV/AIDS related mortality	The study was not multilevel and did not consider place of death and health care use.
59.	"Early life conditions and later life mortality", In Rogers, R. G., & E.M. Crimmins, (Eds.). 2011. *International Handbook of Adult Mortality* (Vol. 1) (pp. 187-206). Springer Netherlands.	Montez, J. K., & M.D. Hayward. 2011.	Health and retirement study 1998-2006	Multivariate logistic regression models	Educational attainment is inversely related to adult mortality risks. having a father with low education increases risk of death	No place of death No cause-specific mortality
60.	"Trends in the educational gradient of US adult mortality from 1986 through 2006 by race, gender, and age group", *Research on Aging*, **33**(2), 145-171.	Montez, J. K., R.A. Hummer, M.D. Hayward, et al. 2011.	National Health Interview Study Linked Mortality File, 1986-2006	Poisson regression	mortality risk decreased more among highly educated whites men and women compared to black men and women in older ages	The study was not multilevel and only considered all-cause mortality
61.	. "Educational Attainment and Adult Mortality in the United States: A Systematic Analysis of Functional Form", *Demography* **48**: 315-336.	Montez, J.K., R.A. Hummer, and M.D. Hayward. 2012	National Health Longitudinal Mortality Study, 1979-1998	Functional Forms	Linear decline in mortality risk from 0 to 11 years of education	The study looked at all-cause mortality and it's not multilevel
62.	"Feasibility of using a World Health Organization-standard methodology for Sample Vital Registration with Verbal Autopsy (SAVVY) to report leading causes of death in Zambia: results of a	Mudenda, S. S., S. Kamocha, R. Mswia, et al. 2011.	Pilot data for 2010 verbal autopsy in four provinces	Cause-specific mortality fractions	HIV/AIDS leading cause of death	No multilevel analysis, only descriptive

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
	pilot in four provinces, 2010", *Population Health Metrics*, **9**(1), 40.			Pearson chi-squares tests	High mortality among males, no education, unmarried, widowed, divorced, half of deaths occurred at home	statistics
63.	"Mortality by cause for eight regions of the world: Global Burden of Disease Study", *The Lancet*, **349**(9061), 1269-1276.	Murray, C. J., & A.D. Lopez. 1997.	Vital-registration, Sample-registration, small-scale population-study	Lorenz-curve analysis, age-sex and cause-specific mortality rates, probabilities of dying	The probability of dying between ages 15 and 60 year was higher in sub-Saharan Africa than in established market economies	The study was not a multilevel and did not look at predictor factors of mortality
64.	"Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013", *The Lancet*, **384**(9947), 1005-1070.	Murray, C. J., K.F. Ortblad, C. Guinovart, et al. 2014.	Vital registration, verbal autopsy data	UNAIDS Spectrum model, Bayesian meta-regression	Increase in mortality attributable to NCDs, and leading causes of death were HIV/AIDS, TB in sub-Saharan Africa	The study did not examine determinants and multilevel analysis was not used
65.	"Attendance at religious services and mortality in a national sample", *Journal of Health and Social Behaviour*, **45**(2), 198-213.	Musick, M. A., J.S. House, & D.R. Williams. 2004.	Longitudinal 7.5 year follow-up Study	Cox proportional hazards regression model	Individuals who reported attending religious services once a month or more had a reduced risk of death	The study only examined one predictor variable, religion, and did not use multilevel analysis
66.	"The socio-economic impact of adult mortality and morbidity on households in urban Zambia", *SAfAIDS News*, **6**(3), 14-5.	Mutangadura, G., & D. Webb. 1998.	Cross-sectional survey	Descriptive analysis	Impact of adult morbidity and mortality on households	The study did not examine determinants of adult

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					income, capital and work	mortality
67.	"Education and adult cause-specific mortality-examining the impact of family factors shared by 871 367 Norwegian siblings", *International Journal of Epidemiology*, **41**: 1683-1691	Naess O, Hoff, A.D, Lawlor, D, Mortensen, L.H. 2012.	Longitudinal 1960-1991 and follow-up 1991-2008	Cox proportional hazards regression model	Less educated siblings were more likely to die during the follow-up period than more educated siblings	The study examined education as the predictor variable only and did not use multilevel analysis
68.	"Underlying and multiple causes of death related to smoking", *Population Research and Policy Review* **13**:305-325	Nam, C.B., R.A. Hummer, and R.G. Rogers. 1994.	National Mortality Followback Survey	Cause-specific death ratios	Smoking is associated with several causes of death, especially circulatory diseases	The study did not examine determinants of adult mortality
69.	"Impact of future cigarette smoking scenarios on mortality of the adult population in the U.S., 2000-2050", *Social Biology* **43**:155-168.	Nam, C.B., R.G. Rogers, and R.A. Hummer. 1996.	National Mortality Followback Survey	Projection models	Scenarios reflecting higher levels of smoking prevalence produce more deaths than scenarios of lower levels	The study is a prediction of the relationship between smoking and mortality. It examined only smoking as a proximate determinant
70.	"Neighborhood effects on mortality", In Rogers, R. G., & E.M. Crimmins, (Eds.). 2011. *International Handbook of Adult Mortality* (Vol. 2) (pp. 413-439). Springer Netherlands.	Nandi, A., & I. Kawachi. 2011.	Articles on Small-area units and mortality	Systematic review	An excess risk of mortality among residents in deprived neighbourhoods	No place of death Systematic review chapter
71.	"Effect of AIDS on children: the problem of orphans in Uganda", *Health Transition Review*, 23-40.	Ntozi, J. P. 1997.	Qualitative	Qualitative analysis	AIDS orphans were being cared for by their extended family members who	The study examines the impact of adult mortality, however, it is

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					needed assistance to cope with increased needs.	not a multilevel analysis
72.	"Mortality levels and trends by HIV serostatus in rural South Africa", *AIDS* 21 (Suppl 6): S73-S79.	Nyirenda, M., V. Hosegood, T. Barnighausen, et al. 2007.	Prospective population-based HIV surveys, 2003 and 2006	Cox proportional hazards model	HIV-infected individuals had a nine-fold greater hazard of dying than uninfected individuals	The study only considered one cause of death and did not perform multilevel analysis
73.	"Measuring Adult Mortality Using Sibling Survival: A New Analytical Method and New Results for 44 Countries, 1974-2006," *PLoS Med* **7**(4): e1000260. doi: 10.1371/Journal.pmed.1000260	Obermeyer, Z., J.K. Rajaratnam, C.H. Park *et al.* 2010.	Demographic and Health Survey, sibling history survival data	Logistic regression (Corrected Sibling Survival method)	Estimated adult mortality rates are higher in southern Africa, than in Asia and Latin America because of HIV/AIDS	The study focused on estimating corrected adult mortality levels and did not examine predictor factors
74.	"On the decomposition of changes in expectation of life and differentials in life expectancy", *Demography*, **25**(2), 265-276.	Pollard, J. H. 1988.		Decomposition	Assesses change in life expectancy attributed to age- and cause-specific mortality	The study did not examine any determinants and no multilevel analysis was applied
75.	"Worldwide mortality in men and women aged 15-59 years from 1970 to 2010: a systematic analysis", *The Lancet* **375**: 1704-1720	Rajaratnam,J.K., J.R. Markus, A. L. Rector, A.N. Chalupka, H. Wang. L. Dwyer, M. Costa, A.D. Lopez, and C.J.L. Murray. 2010.	Vital registration data, census data, survey data on household deaths; sibling history data for 187 countries, 1970 to 2010	Gaussian process regression to estimate probability of dying between ages 15 and 60 years	Adult mortality varied substantially across countries overtime. Between 1970 and 2010, a substantial increase in adult mortality occurred in sub-Saharan	Multilevel analysis was not applied in the study. Predictors factors were not identified

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					Africa due to HIV/AIDS epidemic	
76.	"Steep declines in population-level AIDS mortality following the introduction of antiretroviral therapy in Addis Ababa, Ethiopia", *AIDS* **23**: 511-518.	Reniers, G., T. Araya, A. Davey, et al. 2009.	Surveillance of Burial Sites with verbal autopsy	Age-sex and cause-specific mortality rates	AIDS mortality declined by more than half following the introduction of free ART in 2005. However, AIDS mortality still remains high	The study did not examine any determinants of adult mortality
77.	"Adult Mortality in Africa", In Rogers, R. G., & E.M. Crimmins, (Eds.). 2011. *International Handbook of Adult Mortality* (Vol. 1) (pp. 151-170). Springer Netherlands.	Reniers, G., B. Masquelier, & P. Gerland. 2011.	Pooled African DHS data on sibling survival histories	Quasi-Poisson regression	High adult mortality in 1990s attributed to HIV/AIDS. Reduction in adult mortality following introduction and availability of antiretroviral therapy Noted increasing burden of non-communicable diseases in African countries	The study did not apply multilevel analysis Determinants of adult mortality were not examined
78.	"Life expectancies of cigarette smokers and non-smokers in the United States", *Social Science & Medicine*, **32**(10), 1151-1159.	Rogers, R. G., & E. Powell-Griner. 1991.	National Health Interview and National Mortality Followback Surveys	Life tables	Life expectancies are higher for never smokers than for former smokers, and higher for former smokers than current smokers	The study did not decompose the contribution of smoking to life expectancy changes
79.	"Marriage, sex, and mortality", *Journal of Marriage and the Family*	Rogers, R.G. 1995.	National Health	Logistic	Marital status is	The study did

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
	57(2):515-526		Interview and National Mortality Followback Surveys	regression	differentially associated to mortality	not apply multilevel analysis
80.	*Living and dying in the USA: Social, behavioural, and health differentials in adult mortality*. New York: Academic Press	Rogers, R.G., R.A. Hummer, and C.B. Nam. 2000.	National Health Interview and National Mortality Followback Surveys	Cox proportional hazards models	Sociodemographic factors (age, sex, marital status, family size, income) significantly affect black and white mortality. Blacks have higher risks of mortality from infectious diseases, homicide, and diabetes; white have higher mortality risks from respiratory diseases, accidents, and suicide	The study was at individual level and not multilevel
81.	"Mortality attributable to cigarette smoking in the United States", *Population and Development Review*, **31**(2), 259-292.	Rogers, R. G., R.A. Hummer, P.M. Krueger, et al. 2005.	National Health Interview Survey Health Promotion and Disease Prevention linked National death Index File	Discrete-time hazard models	Smoking significantly increases the risk of death in adults	Multilevel analysis was not applied
82.	"Social, behavioral, and biological factors, and sex differences in mortality", *Demography*, **47**(3), 555-578.	Rogers, R. G., B.G. Everett, J.M. Saint Onge, et al. 2010a.	National Health and Nutritional Examination Survey III Linked Mortality File	Cox proportional hazards models	Social and behavioural characteristics are associated with the sex gap in adult mortality.	The study did not examine community-level variables

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					Men have a higher risk of dying than women	
83.	"Educational degrees and adult mortality risk in the United States", *Biodemography and Social Biology*, **56**(1), 80-99.	Rogers, R. G., B.G. Everett, A. Zajacova, et al. 2010b.	National Health Interview Survey Linked Mortality Files, 1997-2002	Cox proportional hazards model	Advanced educational degrees are associated with lower risk of dying than fewer years of schooling	The study examined only one predictor and multilevel analysis was not applied
84.	"Educational differentials in US adult mortality: An examination of mediating factors", *Social Science Research* **42**: 465-481	Rogers, R.G., R.A. Hummer, R.A. and B.G. Everett. 2013.	National Health and Nutrition Examination Survey (1988-1994) linked Mortality file, 2006	Cox proportion hazards model	Education differences in mortality are mostly explained by family income and health behaviour. Higher education is associated with low mortality risk	The study examined did not examine community-level factors
85.	Adult Mortality-Chapter 10. in D.L. Poston and M. Micklin (eds). *Handbook of Population*. New York: Kluwer/Plenum Publisher	Rogers, R.G., R.A Hummer and P.A. Krueger. 2005.			Proposes the proximate determinants conceptual framework for adult mortality	
86.	"Coping or struggling? a journey into the impact of HIV/AIDS in southern Africa?" Review of African Political Economy, 27(86): 537-545	Rugalema, G., 2000	Articles	Content analysis	HIV/AIDS has significant impact on households	
87.	"Determinants of Adult Mortality in India", *Asian Population Studies* **6**(2): 153-171	Saikia, N and Ram, F. 2010.	1998-1999 National Family Household Survey	Poisson Regression	Age, literacy composition, religion, region of residence, standard of living were determinants of adult mortality	The study did not examine causes of death and did not apply multilevel analysis
88.	"Trends and geographic differentials in mortality under age 60 in	Saikia, N., D.	Sample	Demographic	Slow mortality	The study did

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
	India", *Population Studies*, **65**(1), 73-89.	Jasilionis, F. Ram, et al. 2011.	Registration System	estimation methods	improvements in both young and adult age groups. Convergence of mortality across regions	not use multilevel analysis
89.	"Mortality impact of AIDS in Addis Ababa, Ethiopia", *AIDS* **17**: 1209-1216	Sanders, E.J., T, Araya, D, Schaap, et al. 2003.	Prospective Surveillance of Burial Sites, 1987-2001	Logistic regression	An increase in mortality in the age group 15-60 attributed to HIV/AIDS. Adult mortality was five times higher in 2001 than in 1984	The study did not examine any determinants or apply multilevel analysis
90.	"Identifying and Targeting Mortality Disparities: A framework for sub-Saharan Africa Using Adult Mortality Data from South Africa.", *PLoS ONE* **8**(8): e71437. doi:10.1371/Journal.pone.0071437	Sartorius, B, Sartorius, K. 2013.	National Cross-sectional Survey, 2007	Spatial analysis, Population attributable fractions	Significant determinants of adult mortality were HIV antenatal sero prevalence, low SES and lack of formal marital union status	The study did not use multilevel analysis
91.	"Violence and injuries in South Africa: prioritising an agenda for prevention", *The Lancet*, **374**(9694), 1011-1022.	Seedat, M., A. Van Niekerk, R. Jewkes, et al. 2009.	National Injury Mortality Surveillance System	Descriptive analysis	Violence and injuries are the second leading cause of death	Multilevel analysis was not used
92.	"Translating Social Ecological Theory into Guidelines for Community Health Promotion", *American Journal of Health Promotion*: **10**(4): 282-298	Stokols, D. 1996.		Social ecological theory translation	Transformation of the social ecological theory into the social ecological model. Programmes emphasize focused behaviour change strategies	The study translates the social ecological theory into a social ecological model. The study is

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
					while neglecting the environmental underpinnings of health and illness	theoretical as it proposes a framework to guide programmes
93.	"Estimated HIV Trends and Program Effects in Botswana", *PloS ONE* **3**:e3729	Stover, J., B. Fidzani, B.C. Moloma, et al. 2008.	Antenatal sentinel surveillance, national population survey	Estimation and Projection Package and Spectrum models	Annual number of adult deaths declined following the introduction of ART	The study did not examine any determinants
94.	"Adult mortality in sub-Saharan Africa: Evidence from Demographic and Health Surveys", *Demography* **41**(4):757-772.	Timaeus, I. M. and M. Jasseh. 2004.	Demographic and Health Survey, sibling history survival and orphanhood data	Poisson regression	Adult mortality increased sharply due to HIV/AIDS. Excess mortality was concentrated in age group 25-39 for women and 30-44 among men.	The study did not examine any predictors and multilevel analysis was not applied
95.	"Implications of mortality transition for primary health care in rural South Africa: a population-based surveillance study", *The Lancet*, **372**(9642), 893-901.	Tollman, S. M., K. Kahn, B. Sartorius, et al. 2008.	Health and sociodemographic surveillance with verbal autopsy, Agincourt	Age-standardized analysis	Mortality from chronic non-communicable diseases increased among adults.	Determinants of adult mortality were not examined
96.	"Socioeconomic differences in mortality among US adults: insights into the Hispanic paradox", *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, **62**(3), S184-S192.	Turra, C. M., & N. Goldman. 2007.	National Health Interview Survey 1989-1994	Poisson regression models	Mortality advantage for Hispanics is concentrated at lower levels of socioeconomic status, with little or no advantage at higher levels	The study did not examine cause-specific mortality and no multilevel analysis
97.	"Does marriage matter?", *Demography*, **32**(4), 483-507.	Waite, L. J. 1995.	National Survey of Families and Households	Descriptive analysis, probabilities of	Married men and women exhibited the highest	The study did not examine health care use

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
				dying	probabilities of surviving and the lowest chance of dying	
98.	"The Direct and Indirect Effects of Metropolitan Area Inequality on Mortality: A Hierarchical Analysis", *Annals of the New York Academy of Sciences*, **896**(1), 347-349.	Waitzman, N. J., K.R. Smith, & A. Stroup. 1999.	National Health Interview Survey Linked to Mortality File	Hierarchical Linear Modeling	Metropolitan area statistical and spatial economic inequalities significantly increased mortality for residents	The study did not examine cause-specific mortality
99.	"Mortality in the year following antiretroviral therapy initiation in HIV-infected adults and children in Uganda and Zimbabwe", *Clinical Infections Diseases*, **55**(12): 1707-1718	Walker, S.A., A.J. Prendergast, P. Mugyenyi, et al. 2012.	Longitudinal Study Follow-up	Flexible Parametric hazard models	High mortality risks in the first 3 months after ART initiation	The study did not examine place of death
100.	"Mortality level and predictors in a Rural Ethiopian Population: community based longitudinal study", *PloS One*, **9**(3), e93099.	Weldearegawi, B., M. Spigt, Y. Berhane. 2014.	Longitudinal health and demographic surveillance data 2009-2012	Poisson regression and Cox-regression analysis	Mortality was higher in males, rural population, widowed and divorced	No cause-specific mortality No multilevel analysis
101.	"The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China", *Demography*, **48**(1), 153-181.	Wen, M., & D. Gu. 2011.	Chinese Longitudinal healthy Longevity Survey, 2002-2005	Logistic regression models, Weibull hazard regression models	Mortality at older ages is influenced by long-term and dynamic processes structured by social stratification system	No cause-specific mortality No place of death
102.	"Influence of individual and neighbourhood socioeconomic status on mortality among black, Mexican-American, and white women and men in the United States", *Journal of Epidemiology and Community Health*, **57**(6), 444-452.	Winkleby, M. A., & C. Cubbin. 2003.	National Health Interview Survey (1987-1994) linked to 1990 census and mortality data 1997	Age adjusted all-cause mortality rates Cox proportional hazards regression Population Attributable Risk	Living in a low SES neighbourhood is associated with increased mortality risk beyond individual SES	The study only examined all-cause mortality

No.	Study topic	Author (s)	Data	Methods	Findings	Gaps
103.	"Marital Status, Self-Rated Health, and Mortality Overestimation of Health or Diminishing Protection of Marriage?", *Journal of Health and Social Behavior*, **54**(1), 128-143.	Zheng, H., & P.A. Thomas. 2013.	National Health Interview Survey 1986-2004 with 1986-2006 Mortality follow-up	Cox proportional hazards model, Ordered logistic regression models	Protective effect of marriage against mortality decreases with deteriorating health hence married and unmarried in poor health are almost at same risk of death	The study did not use multilevel analysis

POLICY BRIEF APPENDIX

Adult mortality in Zambia: An ecological model

By

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Demography and Population Studies
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POLICY BRIEF

Policy Users: Ministry of Health, Ministry of Community Development and Social Services, Ministry of Gender and Women's Development, National HIV/AIDS Council of Zambia, Road Transport and Safety Agency, United Nations Population Fund, Churches Health Association of Zambia, Family Life Movement of Zambia

Introduction

This policy brief highlights the findings and policy recommendations emanating from a study that examined the influence of individual and ecological factors on the risk of adult mortality among decedents in the age group 15 to 59 years in Zambia using 2010 census data and 2010-2012 Sample Vital Registration with Verbal Autopsy (SAVVY) data by applying demographic estimation methods and multivariate multilevel survival analysis. The purpose of the policy brief is to bring to the attention of policy-makers, planners, and programme managers in government and related institutions as well as non-governmental organisations, about the health burden of adult mortality and the need to accelerate programmes aimed at reducing mortality in the productive and reproductive age group 15-59 years.

Context

Adult mortality has largely remained a major health concern and an under-researched area thus it does not feature prominently on the national development agenda of Zambia, even in development plans, health policy, national health strategic plan, consequently there are no specific programmes to address adult mortality in the country. Equally, the past Millennium Development Goals (MDGs) did not have a specific focus on adult mortality; the Sustainable Development Goals (SDGs) as well have a broader health agenda but no specifics on adult mortality. Adult mortality just like child mortality is also linked to the socioeconomic development of a country. In Zambia, adult mortality has remained among the highest in southern Africa as noted by the National Population Policy of Zambia. The probability of dying between ages 15 and 60 years for the period 2010-2015 was estimated at 306.5 deaths per 1,000 persons alive at age 15 and above. Yet the adult population in age group 15 to 59 years constitutes about 50 per cent of Zambia's total population of over 13 million. Adult mortality has been an issue of public health concern for several decades now because of its impact at individual, household, community and national level in development terms as the consequences are immense to be neglected. Studies have shown that the community context plays a mediating role by influencing the type of life style which eventually determines individual outcomes like adult mortality. Previous studies have also argued that adult mortality is associated with factors such as education, income, marital status, religion, age, sex, neighbourhoods, smoking, and alcohol among others. However, these studies did not adequately address some of the contextual factors such as place of death, community health care utilisation, and community illness treatment received as they relate to adult mortality. This study addresses these issues with special attention to their effects on adult mortality at community level by applying an ecological model to reveal the previously unexamined associations between contextual factors and adult mortality variations.

Specific Findings

- The level of adult mortality remains high and varies by province in Zambia. Adult mortality is concentrated in age group 25-39 years, with higher mortality for females than males. Copperbelt province had the highest level of adult mortality among females whereas Western province had the highest level of adult mortality among males.

- The top five leading causes of death among adults were HIV/AIDS, injuries and accidents, tuberculosis, malaria, and diseases of the circulatory system.

- The epidemiological transition is underway in Zambia as the proportion of deaths attributable to non-communicable diseases is on the increase, especially in age groups 40 years and above.

- Eliminating HIV/AIDS would have the most impact in additional years of life and a significant reduction in adult mortality rates.

- Injuries and accidents were the major contributors to widening the gap in life expectancy between males and females.

- Marriage has a protective effect against the risk of adult mortality. The risk of adult mortality was significantly lower among the married compared with the never married.

- Education is a strong predictor of the risk of adult mortality. The risk of adult mortality significantly decreased with an increase in the level of educational attainment.

- Occupation type is associated with the risk of adult mortality. Low status occupation types had a significantly elevated risk of adult mortality compared with high status occupation types.

- The risk of dying was lower among adult who did not have HIV/AIDS.

- Family relationships have a protective effect against the risk of adult mortality. The risk of dying was significantly lower among decedents who had a spouse, mother, child and other relative living with them prior to death.

- The risk of adult mortality was significantly higher in Luapula and Northern province after performing multivariate multilevel survival analysis.

- Living in a community with a high proportion of health care utilisation significantly reduced the risk of adult mortality among females, whereas for males, the risk of dying was elevated. Ecological factors influenced the risk of adult mortality.

- The findings of the study reaffirm the socioecological theory and the ecological argument that societal context has an influence on individual health outcomes. Socialisation by gender in Zambian communities differentiates health seeking behaviour between females and males.

Policy Recommendations

- The high level of adult mortality in Zambia means that adult mortality should be recognised as a health burden and that there is need to accelerate health programmes and interventions to reduce mortality in the productive and reproductive age group 15-59 years.

- Adult mortality variations by province indicate the socioeconomic inequalities in development. There is need for deliberate investment in social and health infrastructure and implementation of health programmes and interventions that are target specific and unique to each province's social ecological environment. For example in Luapula and Northern provinces.

- The growing NCDs epidemic is anticipated to be a huge health burden and costly financially. The current NCD strategic plan should be revised to comprehensively embrace all major NCDs. Health promotion programmes through behavioural change and communication should be developed and implemented to raise public awareness of NCDs and encourage healthy and active lifestyles.

- Sustained investment in education by government will ensure that the country continues to reap the benefits of the effect of education in lowering the risk of mortality, and hence, in the long-term a healthy population and low adult mortality risk.

- Agencies responsible for road safety should develop effective and sustainable programmes and interventions to reduce the needless loss of the productive adult lives through road traffic accidents. Public educational promotion campaigns on road safety for pedesterians and motorists, roadworthiness of vehicles, good driving behaviour (no drinking and driving), and wearing of seat belts should be intensified.

- Government should deliberately develop and implement programmes to promote and improve family welfare so that the family continues to provide the protective effect against mortality risks. For example, re-introduce tax relief incentives for families to help in improving their welfare.

- There is need for investment in data collection systems and infrastructure in order to provide accurate and reliable mortality estimates for monitoring and evaluating the implementation of health programmes and interventions at national and sub-national levels. For instance, investing in improving and modernising the civil registration and vital statistics system so that its coverage can be expanded from the lowest administrative level to the national level. There is renewed interest in improving the civil registration and vital statistics systems in sub-Saharan African countries among United Nations agencies and bilateral donors, therefore funds could be mobilised for this purpose through development assistance.

- Community health initiatives should be strengthened and adequately supported to effectively function. Health programmes and interventions should go beyond targeting individuals but communities as well. For example, the community health neighbourhood committees require continued support by the Ministry of Health to function effectively in improving and promoting the health status of the population at community level.

Central Statistical Office [Zambia] Approval to Access Census and Survey Datasets

THE UNIVERSITY OF ZAMBIA
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29th December, 2014.

The Director, Census and Statistics
Central Statistical Office
Lusaka

The Director:

RE: PERMISSION TO ACCESS CENSUS AND SURVEY DATASETS

With reference to the above subject, I hereby write to request permission to have access to the following datasets 2010 census (10% sample) and 2009-2012 Zambia Sample Vital Registration with Verbal Autopsy (SAVVY). The purpose of accessing the datasets is purely academic. I am a Zambian and a Lecturer in Demography at University of Zambia, currently pursuing a doctoral degree (PhD) in Demography and Population Studies at University of Witwatersrand, South Africa. My research work is on determinants of adult mortality in Zambia using death distribution methods and multilevel modeling.

For me to proceed with my research work, I need to have access to the named data sets. I will be grateful if I can be availed an opportunity to have access to the datasets.

Yours faithfully,

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