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RESEARCH REPORT

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A RESEARCH REPORT SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG IN PARTIAL FULIFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MEDICINE FOR THE YEAR 2010.

TITLE:

Association between HIV/AIDS related adult deaths and migration of household members in rural Rufiji District, Tanzania.

Declaration:

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

28th Day of October, **2010**. Sign:. 

Dedication:

This is to God Almighty who has lifted me from the very bottom and placed me where I can glorify His name even more. For Lazarus and Maggie: my dear pastor and parents and my 6 siblings who have always looked up to me to show them the way and teach them what it means to believe. To my daughter JP, who has lived the first year of her life without daddy around. And last but not least, to all those who had faith and confidence in me as I endeavored to reach this point: I will always love you.

ABSTRACT

Introduction: The spread and prevalence of the HIV epidemic has resulted in extensive demographic, social and economic impacts among families in the communities affected in Sub Saharan Africa which increase with the severity and duration of the epidemic. The dramatic increase in adult mortality attributable to HIV/AIDS in households in these communities may increase the number of households that do not survive as a functional and cohesive social group in the years to come. The migration of household members and possible dissolution of these households are the challenges stemming from the epidemic. We therefore require rigorous empirical research on the socioeconomic effects of HIV/AIDS in order to develop appropriate strategies to mitigate these impacts and ultimately improve living standards in these communities. This report describes the extent at which these impacts are felt by a rural community using data from the Rufiji HDSS in rural Tanzania.

Design: The study will use a longitudinal study design to identify antecedent events and dynamics and trans-temporal aspects in establishing the effects HIV/AIDS, and particularly how adult deaths from the disease determine migration of individual household members, controlling for other individual level and household factors.

Objectives: The main objectives of the study include the description of the adult mortality patterns in the area with an emphasis on the HIV/AIDS related adult deaths, the description of the socio-economic and demographic characteristics of households experiencing these adult deaths; the characterisation of the members migrating from the households as a result of these adult deaths or otherwise. We also estimate the proportion of household members migrating following the deaths of adult members and further compare these rates of migrations from households experiencing adult HIV/AIDS, Non-HIV/AIDS deaths and where there is no experience of death.

Methods: Migrating individuals from 4,019 households that experienced at least one adult death were compared with migrating individuals from other households experiencing Non-HIV/AIDS deaths and those from households without deaths. A total of 32, 787 households were included in the study. An adult death was defined as a death of a household member aged 18 years and above. Those aged 60+ years were considered elderly deaths. A total of 4,603 adult deaths were recorded over the period 1st January 2000 to 31st December 2007. The mortality trends were shown by the rates calculated by Kaplan-Meier survival estimates expressed per 1000 PYO. Migration rates were computed while the association between adult mortality and out-migration of household members was assessed using Cox proportional Hazard model controlling for other individual level and household level factors.

Results: Adult deaths increase by about 9% the chance of a child, male or female, to migrate within or without the DSA while HIV/AIDS adult deaths increase by a further 19 percentage point the risk of

the child to migrate out of the DSA. The results also show that HIV/AIDS adult deaths enhance the risk of adult female internal migration by 6% (adj. HR 1.06; 95% CI 0.91-1.23, p-value 0.01) but is not significantly associated with adult male migration. Non-HIV/AIDS adult deaths also enhance the risk for female internal migration by 5% albeit hardly significantly (adj. HR 1.05; 95% CI 1.0-1.10, p-value 0.05) but decreases the chance of male internal migration by 13% (adj. HR 0.87; 95% CI 0.81-0.93, p-value 0.01).

Additionally, HIV/AIDS adult death is strongly associated with out-migration of adults, whatever the gender. They predispose female out-migration to 19% (adj. HR 1.19; 95% CI 1.09-1.30, p-value <0.001) and male migration to 30% increased risk (adj. HR 1.30; 95% CI 1.16-1.45, p-value <0.001). This gender difference is however non-significant (the confidence intervals overlap). Non-HIV/AIDS adult death has the inverse effect on out-migration, and the gender difference is significant: 18% increased risk for males (adj. HR 1.18 95% CI 1.14-1.22, p-value <0.001) and 29% for females (adj. HR 1.29; 95% CI 1.26-1.33, p-value <0.001).

Conclusion: Adult deaths have a positive impact on out-migration, with some variation by gender. The effect of HIV/AIDS death on out-migration is not very different from other deaths' effect.

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DEFINITION OF TERMS

Household: Households are characterised by their shared economic basis and by all members recognising a single head of household. The household identifies one place as its primary residency base which will be the primary residence of some or all members. Household members may also live away from the primary residence, for example, labour migrants or school children. Non-household members may share and/or contribute to the household's resources, for example, tenants or domestic workers.

Residency: residency and membership statuses are assigned at the start of the DSS. A person is considered a resident 4 months after the beginning of a residency episode, while the current residency may end 6 months after the out migration status of the individual has been verified or following a death of the individual.

Internal migrant: an internal migrant leaves from one residency point for a new point of residency within the DSA. This is established 6 months after the event has occurred.

Out migrant: also referred to as an external migrant, the individual changes residency location from the DSA to a point outside the DSA. This status is also established 6 months after the event is reported. It is usually difficult to trace these individuals to their new locations especially because their destination is not under surveillance.

Adult: An individual 18 years and older, usually a parental head with additional responsibility either as a household head or a carer of other household members and a breadwinner. An adult can be charged with both responsibilities. Teenage parents and teenage household heads are included here.

HIV/AIDS death: A death resulting from an illness or cause that was either confirmed to be HIV/AIDS or strongly consistent with an HIV/AIDS related aetiology. HIV/AIDS related deaths will comprise deaths caused by Pulmonary Tuberculosis, all unspecified TB, all other forms of TB and AIDS. To make the diagnosis for AIDS physicians followed the clinical case definition from WHO ICD 10: two major symptoms such as at least one month of fever, diarrhoea, or weight loss; and one minor sign: persistent cough, generalized body itching, multiple body swelling as a sign of lymphadenopathy, history of herpes zoster, dysphagia or white spots in the mouth, neckstiffness, more than five skin abscesses, recent tuberculosis.

Adult Mortality Rates: The probability that a 15 year old person will die before celebrating his/her 65th birthday expressed per 1000 person years of observation (PYO). In this study, adult mortality rates are calculated as the probability that a 18 year old person will die before celebrating his/her 60th birthday, while elderly mortality rates are the probability that a 60 year old person will die after celebrating his/her 60th birthday.

Demographic Surveillance System: A combination of field and computer operations in which individual and household demographic records (births, deaths, migrations etc.) are captured and updated on a systematic continuous and regular basis within a geographically defined area known as the Demographic Surveillance Area (DSA).

Socioeconomic Status: A hierarchy of wealth quintiles (Poorest, Poorer, Least poor etc.) dividing groups of people into different levels of living standards as indicated by the PCA of the households' assets and income.

LIST OF ABBREVIATIONS AND ACRONYMS

LDCs Least Developed Countries

HIV Human Immuno Deficiency Virus

AIDS Acquired Immuno Deficiency Syndrome

UNAIDS Joint United Nations Programme on HIV and AIDS

DSA Demographic Surveillance Area

HDSS Health and Demographic surveillance System

VA Verbal Autopsy

SES Socio Economic Status

PCA Principal Component Analysis

HRS Household Registration System

DSS Demographic Surveillance Site

SSA Sub Saharan Africa

IRB Institutional Review Board.

TB Tuberculosis

PLWHA People Living With HIV and AIDS

WHO World Health Organisation

PYO Person Years Observed

IHI Ifakara Health Institute

CD Communicable Diseases

NCD Non communicable Diseases

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1 INTRODUCTION

1.1 Background Information

There is increasing evidence of the spread and magnitude of the HIV epidemic in the world. Literature shows that the worst of the epidemic and the region where the reality has most out-stripped the predictions is sub-Saharan Africa. The region accounts for around three-quarters of the global death toll from HIV/AIDS (Piot, Bartos et al. 2001). The latest update from UNAIDS (2009) reports that the number of people living with HIV worldwide continued to grow in 2008, reaching an estimated 33.4 million [31.1 million–35.8 million]. The total number of people living with the virus in 2008 was more than 20% higher than the number in 2000, and the prevalence was roughly threefold higher than in 1990. In 2008, HIV prevalence in SSA was still high as well with 22.4 million PLWHA and an estimated 1.4 million AIDS-related deaths. Advances have been made to avail drugs to prevent the quick progression to AIDS status for those infected and thus reducing AIDS mortalities. However, the cost and dissemination of these drugs remains a big burden to governments in SSA. This spread and prevalence of the epidemic has resulted in extensive demographic, social and economic impacts among families in the communities affected which increase with the severity and duration of the epidemic. Over time the far reaching effects of the epidemic are getting more and more burdensome and costly as the world community ponders on what next to be done to alleviate the desperate situation. Even as the situation persists other factors serve to make it more desperate. Foster (2000) writes, "the impact of HIV/AIDS on families is compounded by the fact that many families live in communities which are already disadvantaged by poverty, poor infrastructure and limited access to basic services" (Foster 2000).

From the outset therefore one can argue that the "dramatic increase in adult mortality attributable to AIDS may increase the number of households that do not survive as a functional and cohesive social group" (Hosegood 2004). This will happen in the few years to come and will be heavily felt in Sub Saharan Africa (SSA). To be able to validate the assertion, this study will investigate the downstream effects of HIV/AIDS and HIV/AIDS related adult deaths in households affected and the communities they are resident in, in an attempt to portray the demographic compositional changes to the households brought about by this epidemic. One expects that these changes are intermediate and that they will subsequently lead to social and economic rearrangements on the same families in the period following the deaths of these adults. However, very few findings have lent their support to the hypothesis, while others have completely refuted any association (Hosegood 2004; Ford and Hosegood 2005).

1.2 HIV/AIDS and affected household incomes

HIV is dependant in the context in which it occurs. The overall effects of such an epidemic in rural households are different from the effects attendant in urban households. Their individual abilities to deal with the epidemic are different. When asking questions on how far-reaching the effects are, we find that the burden of HIV/AIDS on affected families may be higher than can be quantified. Incomes are hugely affected by the medical and funeral costs attendant to HIV/AIDS deaths. These unexpected costs may lead families take specific measures for the surviving members following the deaths of the infected adults. These measures include decreasing household size through migration or fostering out children to alleviate the cost of upbringing. Declining income potentially elicits efforts to decrease consumption such as withdrawing children from school (particularly girls), selling off assets, begging, forgoing essential services (such as medical attention), incurring debt and even engaging in out-migration (Neves. 2008).

Waal et al (2003) describes a model to explain how prime age adult incapacity and death from HIV/AIDS exerts heavy losses on the material basis of rural households. The model identifies four factors that are associated with the epidemic with respect to the loss of adult productivity: household level labour shortages and rising household dependency ratios; the loss of assets and skills crucial to providing for the families needs; elevated care burdens; and finally, the 'vicious interactions' between malnutrition and HIV (Alex De Waal 2003). This formulation helps to draw attention to the temporal dimensions of the changes in rural and urban livelihoods and the manner in which the devastating effects of HIV/AIDS render the epidemic qualitatively different from other shocks. Notably, its multidimensionality and irreversibility render HIV/AIDS non-conducive to speedy or early recovery for the households in question. A report by Hosegood (2008) looks at it differently. The scientist proposes the epidemic's "induced shocks" to "embody a reciprocal determinism: the insecurity, poverty and hunger that stems from HIV/AIDS elevates the probability of high risk migratory and sexual behaviours. The triad of illness, environmental factors and human behaviour effectively co-evolves over time. The epidemic thereby reinforces the conditions of its own perpetuation" (Hosegood 2008).

1.3 HIV/AIDS in context of other demographic, social and economic trends

It is important to reiterate that HIV and AIDS should not be considered as phenomena separate from demographic, social and economic trends, but rather as an integral part of their direction and force. The HIV epidemic is among a plethora of structural and behavioural processes and events that shape

contemporary African families and the effects of the epidemic on family and household demography are far from easily isolated from other demographic, social, economic and political determinants.

From the foregoing it is imperative therefore that knowledge of prevailing or normative family and household social and residential arrangements in each population is established to check whether, and if so how, HIV and AIDS have changed families and households survival and cohesiveness following a death of an adult in these households.

1.4 DSS and longitudinal data

The demographic surveillance systems represent valuable sources of longitudinal data on migration of families and individuals within, in or out of the study site. Since vital events including death of members of the community are collected regularly and in-depth verbal autopsy interviews are done to establish cause of death, it is possible to link HIV/AIDS related adult deaths to household events including migration of its members in order to observe trends of interest.

With that possible then, the demographic data on the socioeconomic impact of HIV/AIDS epidemic can be measured using conceptual and methodological data obtained by the DSS. The measurement and presentation of empirical evidence of the contribution of HIV/AIDS mortalities to household socioeconomic environment including migration and dissolution is of fundamental importance in estimating the current and future impact of the epidemic on populations in Least Developed Countries (LDCs). It is important to note that economic and social factors are crucial determinants in decisions made concerning migration. There is need to better understand migration practices in household experiencing HIV/AIDS adult deaths in order to mitigate their deleterious effects upon families.

1.5 Statement of the problem

The impoverishing effect of the HIV/AIDS epidemic on households in communities living in sub-Saharan Africa is far devastating, yet interventions that have been put in place by different governments have done very little to address the situation. According to Beegle et al, "Rigorous empirical research on the socioeconomic effects of HIV/AIDS is important for developing appropriate strategies to mitigate impacts and ultimately improve living standards" in these communities (Beegle and De Weerdt 2008). Of keen interest is the resulting household members' migration and dissolution of households following a death of an adult from the disease, which shifts the care-giving burden of the survivors to other households within and without the community.

1.6 Justification of the study

Yamano et al (2004) concludes that there is paucity of survey information on the economic effects of HIV/AIDS because of the difficulty and cost of obtaining reliable clinical assessments of AIDS-related mortalities and linking this to socio-economic surveys typically employed by social scientists. Because of these difficulties therefore, the few available micro-level studies of the effects of HIV/AIDS on rural households are almost always drawn from specific geographical sites purposively chosen because they were known to have high HIV infection rates. A case in question is Kwa Zulu-Natal in South Africa. While providing valuable insights into how afflicted households respond to the disease, such studies are limited in their ability to be extrapolated in order to understand national level impacts of HIV/AIDS (Yamano and Jayne 2004). The same insufficiency extends to communities resident in countries with different cultural settings and where the prevalence of the epidemic is relatively lower. This study therefore aims to investigate the effects of the epidemic in a rural community with low HIV prevalence rates and where few studies of this kind have been done. Study findings will be compared for consistency in theory with similar studies done in other areas with different HIV/AIDS profiles.

2 LITERATURE REVIEW

Is migration a coping strategy that households employ to mitigate against the shock and impacts of an adult HIV/AIDS related death in the household? It is evident that most households employ survival strategies in the wake of a death of a parental head or an adult member from HIV/AIDS. Findings have shown that despite the widely-held perception that household dissolution is a common occurrence in households affected by HIV and AIDS, a few longitudinal population-based household studies report a strong predisposition for household survival using strategies such as individual in- or out-migration. The findings indicate that households vulnerable to dissolution are those that experience *multiple* or *sudden deaths*, or events unrelated to HIV and AIDS, such as the death of an older household head from old age or divorce worries.

2.1 Forms of Migration

A number of studies have postulated migration to represent a strategy to help the household survive or to enhance the household's socio-economic status in order to cope with the impacts of the epidemic. Such coping mechanisms include employment migration, the inter-household reallocation of labour, child fostering and migration in order to access support from the extended family (Young 2003; Ansell and Blerk 2004).

Other studies show that adult labour migration has commonly been identified as a way to increase income to stressed households particularly where there is a history of migration. For instance, research in both India and Malawi has shown that men are often the first to leave their households in search of work, sometimes abandoning the household to impoverishment. The case is however different in the Philippines, where teenage women engage in migration in support of the household both to make a financial contribution and to remove from the household the cost of their support. Whether these forms of migration relate to circumstances surrounding households ravaged by HIV/AIDS is something worth investigating, and more so since some researchers have discussed 'altering household composition' as a coping strategy in relation to AIDS (Young 2003).

2.2 Migration in response to household HIV/AIDS

Studies on mobility across southern Africa and their relationship to the spread of HIV/AIDS abound, with much of this literature focusing on the spread of the disease and therefore highlighting the particular vulnerability of migrant populations due to the "social (and sexual) disruption that accompanies migration" (Lurie, Williams et al. 2003). These theories portray migration as the starting point for the spread of the epidemic. The reverse association where HIV/AIDS is the starting point of the migration events is the focus of this study, where we consider studies that offer insight into

migration as a household coping strategy in response to the HIV/AIDS epidemic in southern Africa (Chris Desmond 2000). UNAIDS (1999) demonstrates that migration is a response for raising household income to maintain expenditures on health care, with male members migrating in search of employment (Haan 1999). Inter-household family re-allocation of both male and female members also occurs to alleviate loss of household labour and reduce any increased caring burden. Alternatively, members may be relocated to other households in the extended family for support, typically meeting basic needs (Chris Desmond 2000). This may take the form of child fostering as well.

2.3 Child migration and Child fostering in dealing with HIV/AIDS adult deaths

Some studies demonstrate how the emerging use of children's migration as a household coping strategy is growing in several parts of the world. When they migrate, children's needs are taken care of by other families while they also use their abilities elsewhere for paid work to contribute to household survival. These needs take basic forms like food, clothing and shelter to welfare and health issues like treatment when ill; adult care/supervision; psychosocial support; and, ideally, the opportunity to attend school. It is true that most AIDS affected rural households may have fewer resources to meet material needs for the children and older members while experiencing time constraints, reducing the ability for adults to provide care. It follows therefore that if there is additional work to be undertaken or additional money that must be earned, children may take on roles normally reserved for adults to alleviate the needs of the household. In this regard therefore children are able to contribute to the coping strategies of a household in response to HIV/AIDS, migrating in order for their needs to be met or to make use of their abilities in helping the household cope with income problems. Study has shown that depending on the gender and sex of the children, they will undertake different forms of migration in response to HIV/AIDS and propagate a series of distinct migrations as they grow older (Ansell and Blerk 2004).

The effect of parental death on child migration has been studied in KwaZulu Natal province of South Africa (Ford and Hosegood 2005). Findings show parental mortality from all causes prior to and during follow-up increased the risk of a child moving by nearly two times after controlling for the age and gender of the child and household characteristics. However in the follow-up period child mobility following maternal deaths from AIDS was lower than child mobility following maternal deaths from other causes. The study also finds out that younger children, boys, and children whose mothers or fathers were resident members of the children's households were also less likely to move.

2.4 Household dissolution as a result of HIV/AIDS adult deaths

Study has shown that HIV and AIDS increases the risk of household dissolution and migration through many pathways including death of the last adult member around which the household was arranged, widowhood and survival, widowhood and remarriage and economic vulnerability due to increased costs and reduced incomes. Hosegood asserts that "in many populations widowhood of the head or head's spouse is a key event signalling a transition into a new stage of the family and household life-cycle, or occasioning dissolution as the surviving partner joins another household" (Hosegood 2008).

A study by the Africa Centre DSS, South Africa, examined the impact of cause-specific adult mortality in 10,612 households during a two and- a-half-year period in 2000-2002 (Hosegood 2004). The findings showed that households were four times more likely to *dissolve* if they experienced *one or more adult deaths*. However, there were no significant differences in the risk of dissolution between AIDS and non-AIDS deaths, or by the age or sex of the deceased. On the contrary, the study further finds that the experience of violent or accidental deaths was associated with a higher risk of household dissolution than HIV/AIDS or any cause of adult death. The authors suggest that sudden deaths, or deaths pre-figured by related violence or alcohol use, may make it more difficult for households to survive than deaths occurring after periods of chronic illness such as AIDS **(**Hosegood 2004**).**

2.5 HIV/AIDS Related versus Non AIDS Adult Deaths

A stratified baseline household census was conducted in Zimbabwe where 9,842 adults were interviewed and tested for HIV infection and followed up for 3 years. Of 374 out of 404 respondents who died, verbal autopsies were conducted with caregivers and data were collected on among others household dissolution and relocation. The household impact of HIV/AIDS and non- HIV/AIDS deaths was compared. The results showed that overall and for *village households*, fewer households that had experienced an HIV/AIDS death had continued to stay together in the same homestead than was the case for other causes of death. Of the households that did not survive in the same location, those with HIV/AIDS and non-AIDS deaths were equally likely to have dissolved rather than out migrated (Simon Gregson 2007).

A different study in South Africa done in the year 2000 assessed the impact of HIV/AIDS on children's living arrangements and migration in rural South Africa. Results showed 5% or 447 of households experiencing at least one adult HIV/AIDS death. Consequently, adult HIV/AIDS deaths had an impact on several individual and household level outcomes, including household dissolution and child migration. Subsequently, households that experienced the HIV/AIDS death of an adult

member in 2000 were nearly three times more likely to have dissolved by the end of the year than other households that experienced parental death from other causes. Household dissolution in the community appeared to be a more common consequence of adult death. The study further showed that even with combining migration and dissolution as an outcome, adult HIV/AIDS deaths were not significantly associated with the probability that a household had ended residence in the DSA during the study period.

Form the foregoing it is safe to conclude that migration of the whole household may be a less common response to an adult AIDS death than migration of its members for several reasons. If the adult death is a critical shock to the household, when for example, the deceased was the sole income earner or the main carer for other household members, the household may cease to be a viable social unit. In this scenario the surviving household members will probably join other household(s), resulting in the household dissolving rather than migrating. However even after such a finding it is evident that there are many competing reasons why households migrate, some of them positive, such as the employment of one of the members, or the purchase or building of a house (Hosegood V 2003).

Urassa et al, in a study done in rural Tanzania did not show any significant difference on the migration and dissolution patterns of households following an HIV/AIDS related death and a death following any other cause. Their work shows that a large proportion of households dissolved within one year of the death of the *parental* head of the household. The statistics showed that overall, in 21 households (7% of the households) all members moved after the death of an adult member leading to a household dissolution. However, households only dissolved if the deceased was a household head, and dissolution was more common if the head was under 60 years of age (Urassa, Boerma et al. 2001).

With data from a surveillance system that uses verbal autopsies to identify cause of death in rural South Africa, Madhavan et al investigated whether mortality from HIV/AIDS differs from other causes of death in its effect on household dependency ratio, and to what extent the effect is mediated by the baseline dependency ratio. Their findings were that: (i) the impact of death from HIV/AIDS on the dependency ratio is marginally positive compared with other causes of death, but (ii) the impact is overpowered by the effect of death at working age, and (iii) the baseline dependency ratio mediates the effects on the ratio of cause of death and of the individual's sex and age at death. They therefore concluded that migration into and out of the household--anticipating or responding to a death--seems to be a key source of change in the household dependency ratio (Madhavan, Schatz et al. 2009).

2.6 Lessons learned

The review brings to the fore the understanding that households experiencing adult deaths employ survival strategies in the form of individual in and out migration. Migration may take the form of inter-household family re-allocation of both male and female members to alleviate loss of household labour and reduce any increased caring burden. Alternatively, members may be relocated to other households or children are fostered in the extended family for support, typically meeting basic needs.

We also find out that HIV/AIDS and non- HIV/AIDS deaths shows extensive household impacts for rural population as opposed to urban population and that overall and for *village households*, fewer households that had experienced an HIV/AIDS deaths had continued to stay together in the same homestead than was the case for other causes of death. This suggests the disintegration of the households which may take the form of individual out migration to find alternative residences to fend for themselves and thus reducing the burden on the household. Household dissolution will therefore be a probable outcome in such scenarios.

These findings that show that the migration of individuals from affected households is the most common response to the HIV/AIDS deaths form the basis for this study where we propose to investigate the impact caused by the epidemic in a rural Rufiji district of Tanzania.

3 STUDY OBJECTIVES

3.1 Study question

Do household members migrate after an HIV/AIDS related adult death in the rural district of Rufiji, Tanzania?

3.2 Aim of the study

To determine the extent and impact of HIV/AIDS related adult mortalities on households leading to individual migrations of household members in Rufiji HDSS between January 1 2000 and December 31st 2007.

3.3 Specific objectives

- To describe the adult mortality patterns in the area with an emphasis on the HIV/AIDS related adult deaths.
- Describe the socio-economic and demographic characteristics of households experiencing adult deaths.
- Describe the characteristics of the members migrating from the households as a result of these deaths.
- To estimate the proportion of household members migrating following the death of an adult member.
- To compare the rates of migrations of individuals in households with adult deaths, HIV/AIDS or otherwise and from those households without adult deaths.

3.4 Hypotheses

The study aims to test for various hypotheses related to the HIV/AIDS related adult deaths and the resultant migration of individuals resident in these households. Migration in a household is determined by a number of factors of which the death of the adult member is the main one. If the deceased adult was the breadwinner, then the household may experience an economic downturn that may make it hard for individuals in the family to hold on together as a cohesive social group.

The age and gender of the survivors will also determine who from the family members will migrate to go their different ways or join other households. Young children, especially girls and those not of school going age are more likely to move compared to the other older children. This argument is

consistent with study that has shown that age is a pointer to the child's involvement in the household and the community. Thus age and gender may affect the migration pattern of the children and other household members that take care of these children in these households.

The size of the household and the size and number of the assets, both of which are indicators of the social economic status of the family will also determine the extent of migration in the household (Ford and Hosegood 2005).

4 METHODOLOGY

4.1 Background Setting

The study will be conducted using data from the Rufiji Health and Demographic Surveillance Study (HDSS) in rural Tanzania. Rufiji HDSS commenced field operations in November 1998. It is located in Rufiji district which has a population size about 182,000 of which about 47% (85,000 people) are part of the Demographic Surveillance Area (DSA). Average household size in the DSA is 4.8. Approximately a quarter of the population (26%) has migrated out of, or into the DSA. Males are more likely to be heads of households than females (73% and 57%), respectively.

4.1.1 Economic activities and socioeconomic status

The majority of the people in Rufiji District are subsistence farmers. Some residents are involved in fishing while others in small-scale commercial activities such as selling wood products (e.g. charcoal, timber, furniture and carvings) (Mrema 2009).

The household dwellings are simple. Tap water supply is very limited and the majority of people rely on communal boreholes or use natural spring or river water for domestic purposes, while a few use harvested rainwater.

4.1.2 Health and Health Facilities

Malaria and waterborne diseases such as cholera and diarrhoea are the major health problems of the area. Major causes of mortality include acute febrile illnesses including malaria, acute lower respiratory infections, Tuberculosis, AIDS, and perinatal causes. About 89% of the population live within 5 kilometres of a formal health facility.

Very little is known about the HIV prevalence of the area under surveillance. The national outlook however shows the HIV & AIDS epidemic to portray strong regional variation ranging from the highest HIV & AIDS prevalence in Iringa (18.2%) Mbeya (15.9%) and Dar es Salaam (10.9%) to the lowest prevalence in Kigoma (3.5%) and Kagera (4.7%). The national adult HIV prevalence is put at 6.2%. (AIDS. 2008.)

By 2006 adult mortality rates in Rufiji District were put at 24.67 per 1000 while the maternal mortality rate for the same time was estimated at 4.6 per 1000 live births (Ministry of Health and Social Welfare 2007).

4.1.3 Study design

Since the consequences of HIV/AIDS are cumulative and longitudinal, area-based forms of inquiry such as Demographic and Heath Surveillance Systems are of utility to identify antecedent events and dynamics and trans-temporal aspects of HIV/AIDS in affected households. The study will use a longitudinal study design to establish the factors associated with migration of individual household members and dissolution of households following adult deaths in these households, with a keen interest on the impact of HIV/AIDS related adult deaths.

4.2 Data source

The study population incorporates all household members in all the households in the DSA with household heads both resident and non-resident. Data collection is such that demographic and health information is collected from all resident and registered households and individuals at four month intervals.

The data includes information on vital statistics which are reports of all births, deaths, and migrations of household individuals and complete households within and without the DSA.

4.2.1 Concepts and design of Rufiji DSS data collection

The Rufiji DSS employs a non-randomised, purposive technique in selecting the wards under survey. It covers the total population in the six contiguous wards of Bungu, Kibiti, Ikwiriri, Mchukwi, Mgomba and Umwe. Data collected is on registered and mapped households where the term bounded structure is used to refer to dwelling structures and other facilities including hospitals, schools, shops and churches. Each eligible bounded structure is visited and data is collected on household members.

The Rufiji DSS employs the Household Registration System (HRS) which involves collecting and documenting data on pregnancies and births, deaths, causes of death, in and out-migrations and including demographic information on age and sex and household socioeconomic data which shows education status, occupation and income, and environmental (source of drinking water and sanitation facility). Longitudinal data collection of demographic, household, socioeconomic, and environmental characteristics is maintained through subsequent update rounds. These rounds take 4 months to complete; the day after one round finishes the next round begins, and households are visited in sequence. Each registered household and members of the household are assigned a unique identification number that serves to permanently identify these individuals and households (Mrema 2009). In their periodic visits, enumerators register new people found in the households. These include unregistered individuals who could have been missed during the initial census. During the rounds the enumerators verify the status of each household and individual, using the household-

registration books (HRBs), and, if necessary, change their records. The enumerators make all alterations in the respective HRBs, in conjunction with filling in a changes form.

From 1st January to 31st December 2007, which forms the duration of the study, Rufiji DSS had had 24 rounds of data collection and updates.

4.2.2 Study population and sample

The study will use all households in the DSA between 1st Jan 2000 and 31st December 2007, including those that experience deaths and which had at least one household member. The period of observation is eight years.

Households that report adult(s) death(s) will be followed up over time to observe and describe household outcomes including migration of individual members. A comparison will be made between households that experience adult deaths from HIV/AIDS and those that experience adult deaths from any other cause to determine the impact of the HIV/AIDS adult deaths on the households. A third comparison will be made with households experiencing no death, adult or otherwise.

4.2.3 Inclusion and exclusion criteria

All households in the DSA between 1st Jan 2000 and 31st December 2007 will be included in the study.

4.3 Measurement variables

4.3.1 Socio Demographic characteristics and confounders

The study aims to investigate the association between adult deaths and the migration of household members with an emphasis on adult deaths from HIV/AIDS, adjusted for other factors at individual and household level.

4.3.1.1 Individual level characteristics

Apart from the personal data on age and sex, other variables collected at an individual level include their education, marital status, employment. These variables are considered time varying covariates and may not remain the same at two points in this 8 year longitudinal study especially to the individuals being followed up for migration in this study.

4.3.1.2 Household level characteristics

The measurement variables at household level include information on the household head: the sex, age, education and employment. The size of the household will be used as a proxy for supply of labour in the household while the socioeconomic status is measured by the assets and income of the household. We can be bale to determine the total deaths in the households including adult and children deaths, adult HIV/AIDS and Non-HIV/AIDS deaths in the households from the family identity that every individual bears aside from their permanent identities. Other information measured at household level includes source of water, type of sanitation and household source of power. This data is important in determining the characteristics of the individuals in the study, and how these factors collected potentially determine the outcomes of interest including deaths and migrations. They will finally be used in analysis for adjusting for the effect of adult deaths on the risk of migration of the household members.

4.3.2 Cause of death data

In collecting cause of death data in a DSS, verbal autopsies are performed on all DSS registered and notified deaths of residents and non-residents. These verbal autopsies are then used to assign causes of death. To conduct a verbal autopsy, a trained interviewer conducts an interview with the closest relative and/or caregiver of the deceased to establish the cause and circumstances leading to the death. Two physicians were given the disease history, as reported by the respondent, with the structured questionnaires, to make the diagnosis. If they failed to agree, a third physician was given the same disease history to make an independent diagnosis. The three diagnoses were put together and a final diagnosis was made if at least two of the three diagnoses were in agreement. If this was not the case, the cause of death was considered undetermined.

Verbal autopsies have been shown to have sufficient sensitivity and specificity for a wide range of causes of adult death, including tuberculosis and AIDS (Chandramohan, Maude et al. 1994).

4.3.3 Socioeconomic status data

Socioeconomic data and information on sanitation, source of power and household water, wall material of the housing structure, roofing and household assets was not available for all households and for all the years covered in this study, and was therefore not used in this study for all individuals. Socioeconomic data for the households experiencing deaths was however available, and has been described in the relevant section in this report. Where used, the SES has been divided into quintiles of Poorest, Poorer, Poor, Less Poor and Least Poor which became the proxy measure of the socioeconomic status.

4.3.4 Outcome variables

The outcome variable of interest is the migration of household individuals within and without the DSA following adult deaths from HIV/AIDS or other causes compared with migration of household members from households without experiences of death. These migrations may lead to the dissolution of the entire household if every member out migrated from the household. As much as dissolution of households would be desirable to investigate, we were not able to do that due to data and other technical constraints, and the fact that it would fall beyond the scope of this study.

4.4 Data processing methods and data analysis

4.4.1 Data Extraction and Data Cleaning

Data extraction and management was done by the Fox Pro database engine tool. Data cleaning involved checking for missing data, data inconsistencies, and duplicate or multiple entries in the data. STATA version 11 was used in data manipulation and analysis at all levels. All analysis results/ findings are reported at 95% confidence levels.

4.4.2 Descriptive Analysis

Descriptive tables are constructed for mortality patterns, mortality rates, migration patterns and migration rates. Mean characteristics of the measurements on individuals and households and their characteristics are shown while we present the 95% confidence intervals for relevant measurements in the inferential statistics.

Time to event descriptive statistics were computed using the Kaplan-Meier survival analysis (KMSA) by generating tables and plots of survival or hazard functions for event history data (time to event data). Kaplan-Meier survival analysis (KMSA) is a method that involves generating tables and plots of the survival or the hazard function for the event history data. However, the method does not determine the effect of the covariates on either function.

Nelson Aalen cumulative hazard estimates are presented for competing risks data in mortality rates from different causes (HIV vs. Non HIV deaths), and migration of the individuals from these households due to different causes. Results are reported together with their 95% Confidence Intervals.

4.4.3 Regression Survival Analysis

A Cox model provides an estimate of the treatment effect on survival after adjusting for other explanatory variables. In addition, it allows one to estimate the hazard (or risk) of an event for an individual, given their other socio-economic and demographic variables. In this study the Cox

regression models are used to examine the relationship of multiple risk factors including causes of adult deaths (HIV/AIDS vs. Non-HIV/AIDS), individual level characteristics and household level characteristics to the out-migration of household members between 1st January 2000 and 31st December 2007.
Multivariate models are used to examine the effect of HIV/AIDS related adult mortality on the risk of migration of household individuals controlling for those individual and household factors.

The risk of individual member internal and out-migration according to the individual and household level factors and adult mortality experience for the household residents in the DSA are presented along with their Hazard Ratios at 5% significance level. Differences between Survival experiences are tested for statistical significance by appropriate non parametric tests including Mantel Haenszel Log Rank test and the generalised Wilcoxon test.

4.5 Ethical considerations

Prior ethical approval was given by IRB sitting in IHI for the permission to conduct secondary analysis of routine data collected by the Rufiji HDSS while the approval for the study was granted by the University of the Witwatersrand Health Research Ethical Committee. Permission was also sought from the Rufiji DSS site leader to use the data for the study intended. Caution was taken such that identifiers were dropped from the data and only unique individual and household identities were used in the analysis. Information and the data sets were used only for the purposes intended for in this research, and were not shared with any other party not involved in the research.

5 RESULTS

Residential and survival data was available for 161, 213 individuals from 32,847 households in the DSA. We describe the characteristics of the 154,284 resident individuals from 1st January 2000 to 31st December 2007 who neither migrated nor died from 30,228 households. The sex and age distribution of the population is described in the table below. Between 1st January 2000 and 31st December 2007 5,946 households in the DSA experienced at least one death. From these households verbal autopsies were done to establish the cause of death for 7,324 deaths. The characteristics of the dead and the migrants are also described.

5.1 Characteristics of the study population

A resident population of 154,284 composed of 81,939 (53.11%) females and 72,345 (46.89%) males were recorded in the community.

Table 1: The socio-demographic characteristics of the resident population

	Female N=81,939	**Male N=72,345**
Socio Demographic composition	**N (%)**	**N (%)**
Marital Status		
Single	54,034 (65.94)	54,716 (75.63)
Married with resident spouse	16,211 (19.78)	15,030 (20.78)
Married with non resident spouse	3,017 (3.68)	524 (0.72)
Widowed/ Divorced	8,677 (10.59)	2075 (2.87)
Household type		
Household with death	22,742 (27.75)	19,485 (26.96)
Household without death	59,197 (72.25)	52,842 (73.04)
Employment		
Self employed/Farmer	29,729 (36.28)	23,717 (32.78)
Salaried	3327 (4.06)	3299 (4.56)
Retired/ Unemployed / Inactive	48,883 (59.66)	45329 (62.66)
Education		
Little/No Education	78,623 (95.95)	67,361 (93.11)
Primary	1720 (2.10)	2477 (3.42)
Secondary	1260 (1.54)	1930 (2.67)
Tertiary	336 (0.41)	577 (0.80)

The resident population includes 53.11% (81,939) female and 46.89% (72,345) male. Over 70% of the population are single or not married while the rest are either living with their spouses, married with non-resident spouses, divorced or widowed. More women are married with non resident spouse

than those with resident spouses which could mean that their husband have out migrated out of the area in search for jobs or involved in fishing or shifting cultivation which is practised in the district.

Majority of the population have no education or little education, i.e. less than 8 years of primary education or adult education. Generally, more men have acquired education beyond primary level than women (6.89% vs 4.05%). Unemployed, inactive or retired form 61% of the residents, while 34% are self-employed mostly as farmers on small subsistence farms.

5.2 Verbal Autopsy to ascertain cause of deaths

As indicated above, verbal autopsies were done for 7,324 deaths .Of the deaths with completed verbal autopsies, 3,704 (50.57%) were females while 3,620 (49.43%) were males. For the purposes of this study, we divide the categories of the ages into three age-groups, those deaths among those aged below 18 years referred to here as young deaths, those aged between 18 and 59 years referred to as adult deaths and those aged 60 years and above referred to as elderly deaths. The mean age of the individuals was 40.67 and 39.21 for females and males respectively. Of all deaths, 2,721 (37.15%) were experienced in individuals aged below 18 years, while 4,603 deaths happened in individuals aged 18 years or older: 1,810 (39.32%) are those aged 18-59 years while elderly deaths (59 years and older) account for 2,793 (60.68%). Of all adult deaths 2,425 (52.68%) are female while 2,178 (47.32%) are male deaths.

Two physicians were given the disease history, as reported by the respondent, with the structured questionnaires, to make the diagnosis. If they failed to agree, a third physician was given the same disease history to make an independent diagnosis. The three diagnoses were put together and a final diagnosis was made if at least two of the three diagnoses were in agreement. If this was not the case, the cause of death was considered undetermined.

According to classification used in this study based on The Global Burden of Disease classification, communicable diseases account for 4,360 (59.53%) of the deaths, non communicable diseases account for 1,607 (21.94%), external causes including violence, accidents and injuries (intentional and unintentional) making up 203 of all deaths which forms 2.77% of the deaths. Undetermined causes of death comprise a big number of deaths as well, accounting for 1,154 deaths (15.76%). This is shown in Figure 1. A similar trend is seen among adult deaths. Out of 4,360 communicable disease deaths 645 are due to HIV/AIDS.

HIV Aids related deaths will comprise deaths caused by Pulmonary Tuberculosis, all unspecified TB, all other forms of TB and AIDS. To make the diagnosis for AIDS physicians followed the clinical case definition from WHO (1994): two major symptoms such as at least one month of fever,

diarrhoea, or weight loss; and one minor sign: persistent cough, generalized body itching, multiple body swelling as a sign of lymphadenopathy, history of herpes zoster, dysphagia or white spots in the mouth, neckstiffness, more than five skin abscesses, recent tuberculosis.

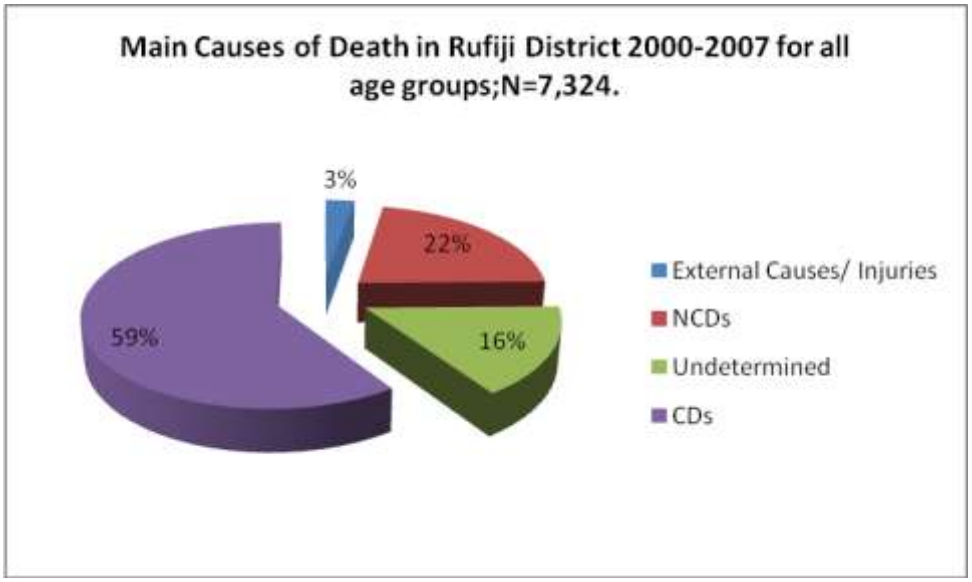

Figure 1: Main causes of death in all age groups in Rufiji HDSS for 2000-2007 period

5.3 Mortality in Rufiji HDSS 2000-2007

Mortality rates were calculated using the number of deaths occurring between the 1st January 2000 and 31st December 2007. The calculations were restricted to the resident population. This implied that a person had to be listed at least once as a resident for him to be included as a participant in the study. If a person moved into the area after 1st January 2000 and died on or before 31st December 2007 he or she was also included in the analysis. With regard to the calculations of the person-years of observation, the time between 1st January 2000 and 31st December 2007 in which the person was listed as living in the household was taken for survivors. If a person had moved out for at least two rounds and later returned this person was considered a new resident. Adult mortality calculations are limited to deaths of adults aged 18-59 years, and elderly adults for those aged 60 years and above, in line with other studies in adult mortality (Murray 1992; Timaeus 1997).

5.3.1 Overall mortality rates by socio economic and demographic indicators

The overall mortality rate was 9.31 per 1000 PYO (Person Years of Observation) with a Total PYO of 786049.19 and 95% CI 9.09-9.52. The mortality rates by the other socioeconomic indicators are described in the table below.

Table 2: Mortality Rates for all age groups
by socio economic and demographic indicators

Factor.	Deaths	PYO	Mortality Rates
Sex			
Female	3,704	407529.6	9.07 (8.78-9.37)
Male	3,620	378519.6	9.56 (9.25-9.87)
Head Sex			
Female	1,463	147401.5	9.89 (9.40-10.41)
Male	5,610	623829.7	8.99 (8.75-9.22)
Missing	251	14818.1	16.94 (14.97-19.17)
Education			
Little/No Education	7,168	739576.7	9.68 (9.46-9.91)
Primary	57	26196.2	2.18 (1.68-2.82)
Secondary	73	16107.8	4.53 (3.60-5.70)
Tertiary	26	4168.5	6.24 (4.25-9.16)
Head Education			
Little/No Education	6,684	717579.6	9.30 (9.08-9.53)
Primary	123	13139.6	9.36 (7.85-11.17)
Secondary	191	25790.2	7.41 (6.43-8.53)
Tertiary	75	14721.9	5.10 (4.06-6.39)
Missing	251	14818.1	16.94 (14.97-19.17)
Marital Status.			
Single/ Missing	4,934	501536.4	9.83 (9.56-10.10)
Married-Resident Spouse	1195	199573.4	5.98 (5.65-6.33)
Married Non-Resident Spouse	168	20924.1	7.98 (6.86-9.29)
Widowed/ Divorced	1027	64015.3	16.01 (15.06-17.02)
Employment			
Self Employed/ Farmer	2,851	312376.4	9.11 (8.79-9.46)
Salaried	470	20467.3	22.92 (20.93-25.09)
Retired/ Unemployed	4,003	453205.6	8.82 (8.55-9.10)

There is no significant difference between the sexes in the mortality rates registered, with female mortality rates being 9.07 per 1000 PYO (95% CI 8.78-9.37) compared to the male mortality rates of 9.56 per 1000 PYO (95% CI 9.25-9.87).

Household headed by females registered a significantly different overall mortality rates of 9.89 per 1000 PYO (95% CI 9.40-10.41) as compared to households headed by males that registered mortality rates of 8.99 per 1000 PYO (95% CI 8.75-9.22) . However, the most significant difference is the difference in mortality rates registered in households missing household head sex information which registered a very high mortality rate of 16.94 per 1000 PYO (95% CI 14.97-19.17). This significant

jump in mortality rates in households missing household head education information could be indicative of a loss of information due to the dissolution of a household following the death of the household head, whose information is missing in this case.

The widowed and divorced group registered the highest mortality rate by marital status. A rate of 16.01 per 1000 PYO (95% CI 15.06-17.02) was registered in this group, followed by the single and non-married individuals with 9.83 per 1000 PYO (95% CI 9.56-10.10) while the married with non-resident spouse had a rate of 7.98 per 1000 PYO (95% CI 6.86-9.29) . Those who were married and living with their spouses registered a mortality rate was 5.98 per 1000 PYO (95% CI 5.65-6.33).

5.3.2 Mortality survival in Rufiji HDSS

Figure 2 shows that mortality survival is similar for both sexes but the survival of the female population improves over that of the male after age 45. Approximately 10% of the residents survive their 100th year but it is likely that rates at older ages are underestimated. From this understanding therefore we decide to only analyse mortality rates up to 80 years old.

Figure 3 shows the hazard associated with mortality for the two sexes. Males are more likely to die between their 1st and 18th birthday as compared to the females, but the female hazard overtakes that for the male at 18 and remains consistently higher to the age of 40. After 40 years of age, male hazards to death again overtakes the female hazard and remains consistently higher up to the age of 75 from which point they remain similar to beyond that age.

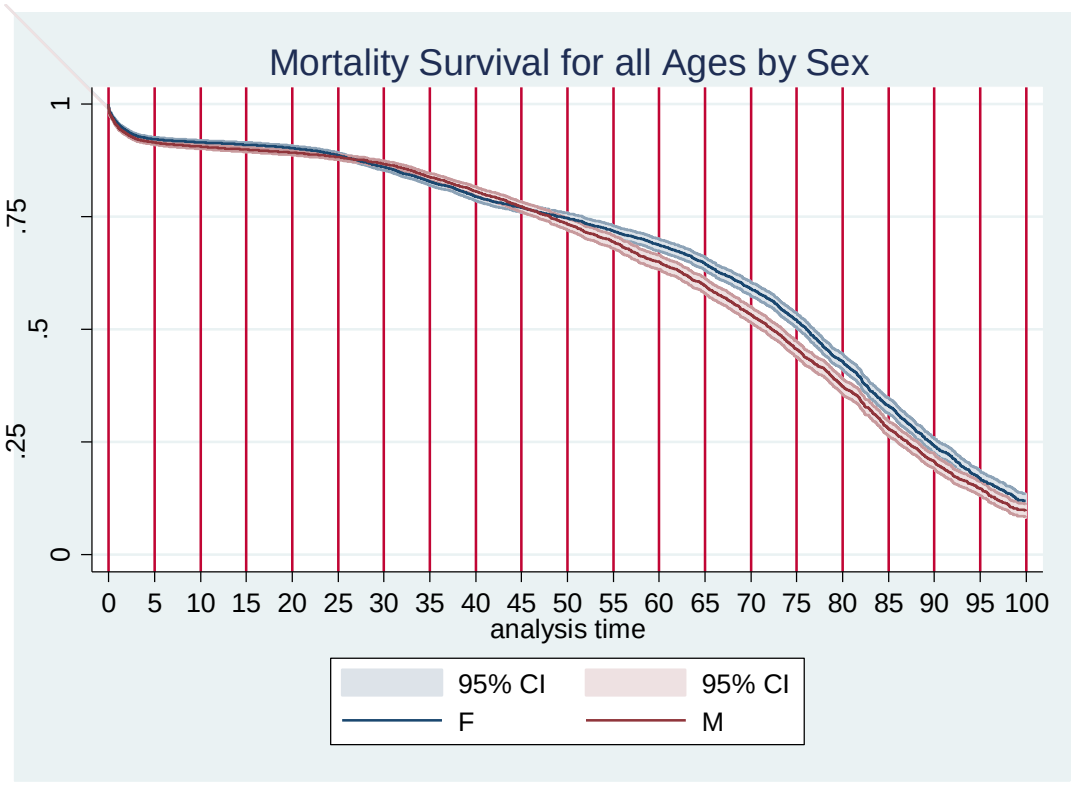

Figure 2: Mortality Kaplan-Meier survival curve by Sex

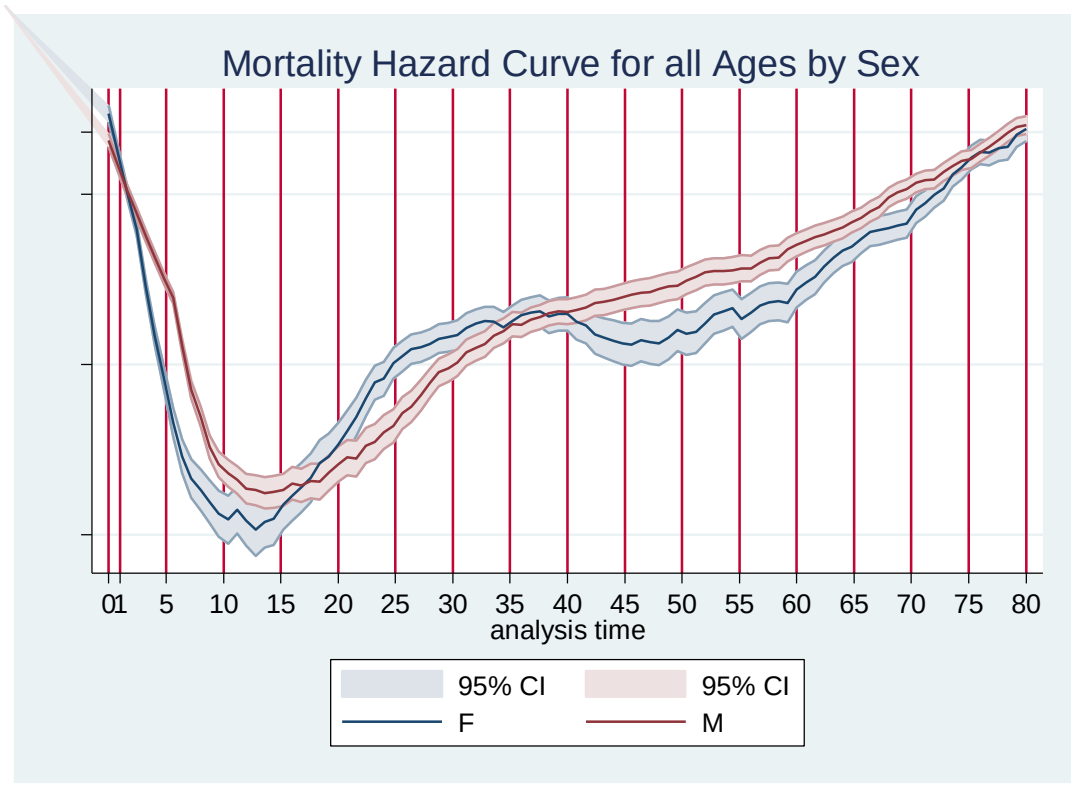

Figure 3: Mortality Hazard Curves by Sex

5.3.3 Mortality rates by specific causes of death: direct maternal cause, malaria and HIV

The unusual surge in the female mortality hazard curve in Figure 3 was investigated to find out the possible cause of the shift from the 'linear' curve. To achieve that, we produced mortality curves for the females including and excluding select causes of death (maternal, malaria, and HIV/AIDS) to investigate their effect on the curve.

Direct maternal causes contribute to a smaller proportion of women deaths as compared to other causes of death. The rate of death is 0.11 per 1000 PYO (95% CI 0.08-0.15) on women aged between 15 and 50. The rates of death among women of reproductive age group by these causes are less as compared to malaria deaths and HIV/AIDS among the same age group of women. The risk of death from a direct maternal cause of death increases with age from 18 years but decreases after the 35th birthday. This means more women will die from direct maternal causes of death between the ages of 18 and 35 than beyond that point, while they remain productive which essentially decreases with advancing age. It is lowest in this community while approaching age 45. However, the direct maternal causes of death do not significantly increase the hazard to female mortality than the other female causes of death in this age group. Figure 4 below shows that even after excluding direct maternal causes of death, the shape of the curve remained similar to the one with the cause included, and as such we conclude that maternal causes are not the major cause for the shift shown above.

The same exercise was repeated for other known and measured causes of death including malaria and HIV/AIDS among women, but the shape of the graph remained the same. Thus we can conclude that the higher female mortality hazard between the ages of 20-45 as compared to males is general and not due to a particular cause of death. Although this is not the primary objective of the present research, this excess female mortality is worth investigating further.

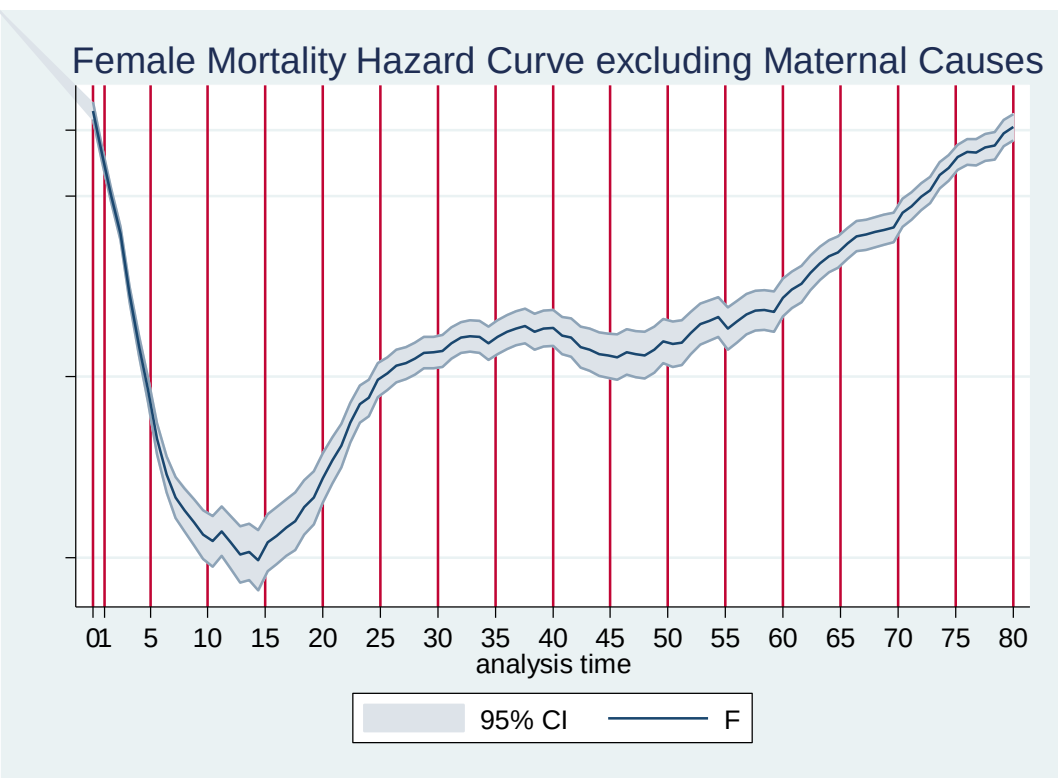

Figure 4: Mortality hazard curve excluding risk for direct maternal cause of death among women for all ages

Malaria mortality rates show no significant difference by sex in the general. The overall mortality rate due to malaria is 1.33 per 1000 PYO (95% CI 1.25- 1.42). Male mortality rates are 1.39 per 1000 PYO while female mortality rates are 1.27 per 1000 PYO (95% CI 1.28-1.52 & 1.17-1.39) respectively. However, as shown in Figure 5 the hazards curve for malaria mortality suggest that males are more predisposed to malaria mortality before the age of 15 than the female counterparts. After this age, the differences are not significant between the sexes although the hazards for the males remain marginally higher that for the males. The females show an interesting but non-significant dip in their mortality hazards for malaria between 40 and 45 years

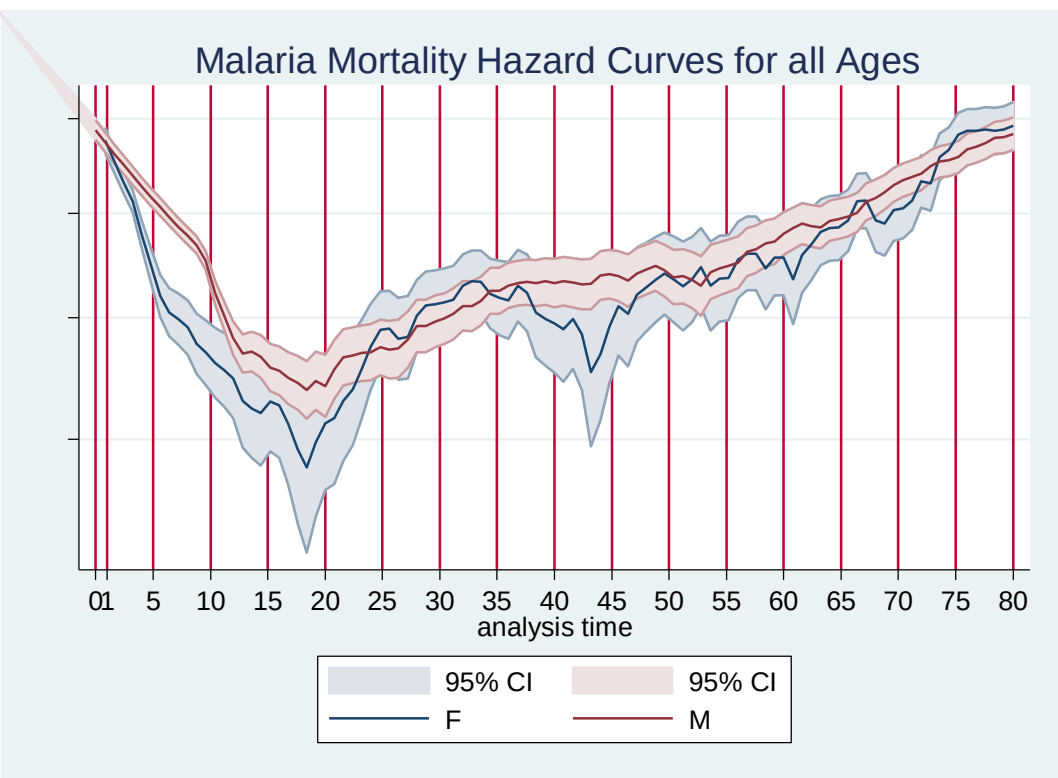

Figure 5: Hazards for Malaria Mortality by sex for all ages

The overall mortality rates from HIV/AIDS are 0.82 per 1000 PYO (95% CI 0.76-0.88). There is a significant difference between female mortality rates from HIV/AIDS which were higher as compared to the male mortality rates from the disease. The mortality rates are 0.90 per 1000 PYO (95% CI 0.81-0.99) for females and 0.73 per 1000 PYO (95% CI 0.65-0.82) for males. In this population, the hazards to die from HIV/AIDS begin from birth. Adult mortality rates from HIV/AIDS was 1.59 per 1000 PYO (95% CI 1.43-1.68) which is twice as much as what is observed in the general population. This clearly shows that the HIV/AIDS epidemic which is at an early stage in the study area, affects more adults that it affects the children whose rate is half of what is observed among the adults. Female mortality rates were not significantly different from the male rates since the confidence intervals overlap: 1.62 per 1000 PYO (95% CI 1.45-1.80) and 1.48 per 1000 PYO (95% CI 1.31-1.67) respectively. The risk of death from HIV/AIDS before the age of 15 is also no significantly different across gender. The hazards however rise after the age of 15 for both sexes, but are higher for the female as compared to the male up to the age 40. At this point, the male hazard to HIV/AIDS overtakes that of the female, and it is clear from the Figure 6 below that more men will die from HIV/AIDS at their later stages than the females beyond the sexually active age of 40. The differences are however not significant at advanced ages, with wide confidence bands overlapping at those ages.

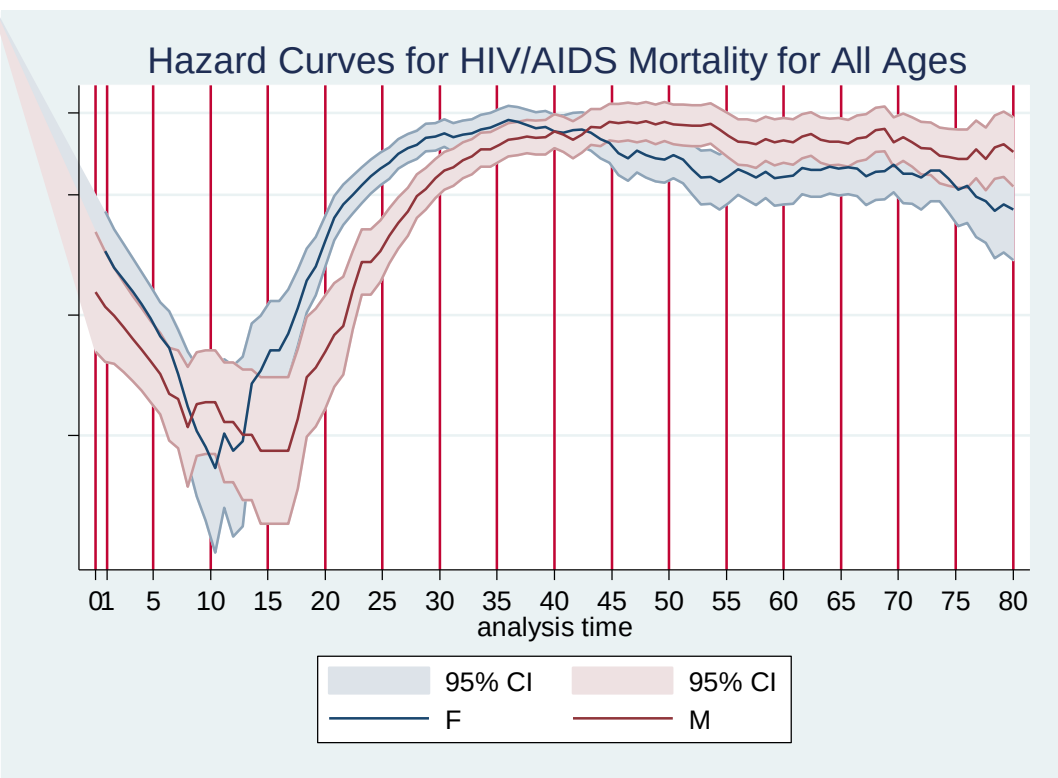

Figure 6: Hazard Curves for HIV/AIDS mortality for all age groups

5.3.4 Adult Deaths in Rufiji HDSS

We consider the 4,603 adult deaths from 4,019 households that experienced at least one adult death over the study period: 513 (12.76%) experienced at least one HIV death while 3,506 (87.24 %) households experienced adult deaths from other causes. Table 3 shows the distribution of adult deaths by cause. An extra category of HIV/AIDS-related adult deaths which form 25% of the communicable diseases and 13% of all adult deaths has been extracted from communicable diseases and is shown separately in the table.

Table 3: Adult Cause of death in Rufiji HDSS for 2000-2007; N=4,603

Cause of Death	Number	Percentage of Total
CDs & Direct Maternal Causes	1,191	25.87
HIV AIDS Related deaths	604	13.12
NCDs	1,086	23.59
External Causes	135	2.93
Undetermined Deaths	1,587	34.48

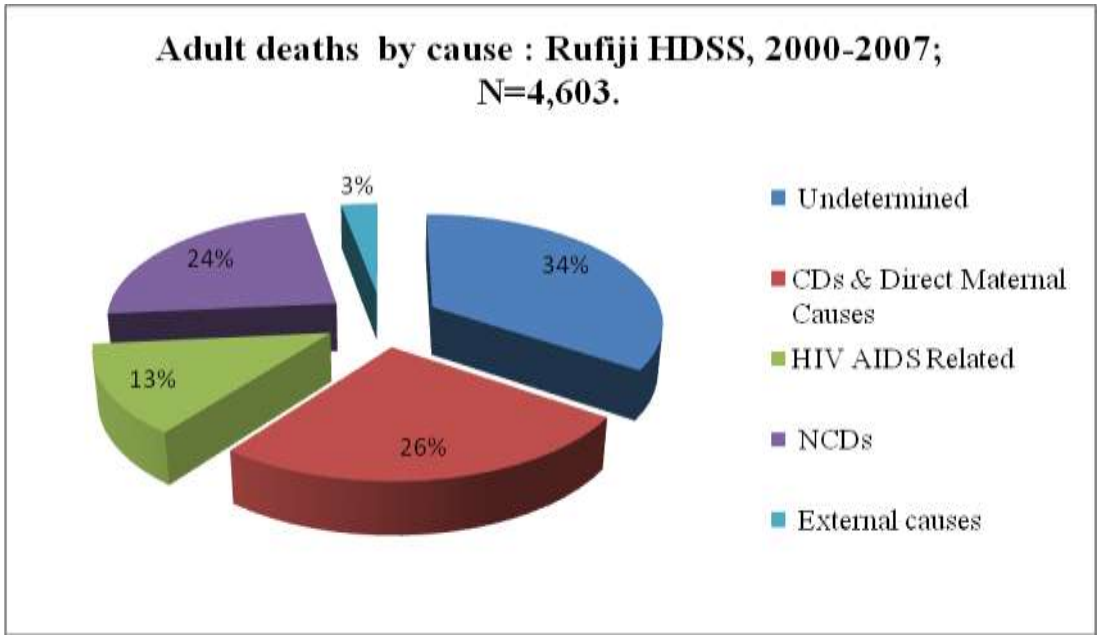

Figure 7: Adult causes of deaths in Rufiji HDSS 2000-2007

HIV/AIDS-related deaths are 604 (13.12% of the total). Of these, 345 (57.12 %) are female deaths while 259 (42.88%) are male deaths. Of the 604 adults deaths from HIV/AIDS, 460 (76.16 %) occur in the age group 18-59 and the other 144 (23.84 %) deaths occur in the elderly age-group for 60 years or older. Communicable diseases make up 1,191 (25.87%) of the deaths, Non communicable diseases are 1,086 (23.59%) while only 2.93% (135) deaths are caused by external factors including intentional and unintentional injuries and deaths from accidents. The remaining 1,587 (34.48%) adult deaths are undetermined. Figure 7 shows adult deaths by proportion of the total adult deaths.

We present the socio-demographic characteristics that potentially explain variation in the causes of death among adults in this community in the table in the Appendix 3. The overall adult mortality rates from all causes of death were 11.88 per 1000 PYO. The total PYO was 383110.18 contributed by 4,603 individuals. There is a significantly higher adult mortality rates among the male with 12.42 per 1000 PYO (95% CI 11.91-12.96) as compared to the rate among the female whose mortality rate averaged 11.44 per 1000 PYO (95% CI 10.99-11.90).

Table 4 shows the adult mortality rates by socio-demographic factors. Adult mortality rates decreases with increased years of education, with those individuals with little education experiencing significantly higher mortality of 12.18 per 1000 PYO while those with primary education experienced 8.09 per 1000 PYO. There is no significant difference in the mortality rates of those with secondary education (6.30 per 1000 PYO) and tertiary education (6.56 per 1000 PYO) whose mortality rates are lower compared to the two groups above.

Table 4: Adult Mortality Rates by socio economic indicators and demographic characteristics

Socio-Demographic Factors	Deaths (N=4,603)	PYO (Total=383110.18)	Mortality Rates
SEX			
Female	2,425	211629.4	11.44 (10.99-11.90)
Male	2,178	175259.4	12.42 (11.91-12.96)
Head Sex			
Female	1,022	78639.9	12.97 (12.20-13.79)
Male	3,464	301455.0	11.48 (11.10-11.87)
Missing	117	6793.8	17.22 (14.37-20.64)
Education			
Little/No Education	4,453	365112.9	12.18 (11.83-12.54)
Primary	53	6548.0	8.09 (6.18-10.60)
Secondary	71	11262.8	6.30 (5.00-7.96)
Tertiary	26	3965.1	6.56 (4.47-9.63)
Head education			
Little/No Education	4,232	354626.7	11.92 (11.56-12.28)
Primary	83	6270.7	13.23 (10.67-16.41)
Secondary	123	12043.6	10.21 (8.56-12.18)
Tertiary	48	7154.0	6.71 (5.06-8.90)
Missing	117	6793.8	17.22 (14.37-20.64)
Marital Status			
Single/ missing	2,223	114306.5	19.43 (18.64-20.26)
Married-Resident Spouse	1,189	190588.1	6.23 (5.89-6.60)
Married Non-Resident Spouse	167	19743.0	8.41 (7.22-9.79)
Widowed/ Divorced	1024	62251.1	16.42 (15.44-17.46)
Employment			
Self Employed/ Farmer	1,796	267758.4	6.70 (6.40-7.02)
Salaried	414	12593.8	32.79 (29.78-36.11)
Retired/ Unemployed	2,393	106536.5	22.43 (21.55-23.35)

Employment types show the most significant differences in adult mortality rates with as high as 32.79 per 1000 PYO (95% CI 29.78-36.11) experienced among those who are salaried jobs, followed by 22.43 per 1000 PYO (95% CI 21.55-23.35) among those unemployed or retired, while the self employed experienced the least mortality rates of 6.70 which is far less compared to the overall adult mortality rate of 11.88 per 1000 PYO.

Highest mortality rates are shown in the different marital groups in the population, with the single experiencing highest mortality rates of 19.43 per 1000 PYO (95% CI 18.64-20.26). The widowed and

divorced have the second highest mortality rates of 16.42 per 1000 PYO (95% CI 15.44-17.46) while those married and living with their spouses experience the least mortality, 6.23 per 1000 PYO (95% CI 5.89-6.60), those married with non resident spouse with 8.41 per 1000 PYO (95% CI 7.22-9.79).

The socioeconomic characteristics of households that experience at least one adult death are presented below. In total, 4,019 households experience at least one adult death, defined to be HIV/AIDs related death or otherwise. The socioeconomic and demographic characteristics of the households are described by the number of household deaths they experienced. Household deaths are categorised as single or multiple deaths, where multiple deaths will be 2 or more deaths.

Most household that experienced HIV/AIDS deaths were also single death households as opposed to multiple death households: 74.13 vs. 25.87% of the households respectively. There is little variation of single vs. multiple deaths by household characteristics.

Table 5: Socio-economic and demographic characteristics of households (N=4,019) experiencing adult deaths

	Single Deaths'=3,099	**Multiple Deaths; n=920**
SES	**N (%)**	**N (%)**
Poorest	691 (77.73)	198 (22.27)
Poorer	630 (80.25)	155 (19.75)
Poor	634 (77.70)	182 (22.30)
Less Poor	620 (74.88)	208 (25.12)
Least Poor	524 (74.75)	177 (25.25)
HOUSEHOLD HEAD EDUCATION		
Little/ No Education	2,829 (76.69)	860 (23.31)
Primary	48 (72.73)	18 (27.27)
Secondary	83 (76.15)	26 (23.85)
Tertiary	41 (91.11)	4 (8.89)
Missing	98 (89.09)	12 (10.91)
HOUSEHOLD HEAD EMPLOYMENT		
Self Employed/ Farmer	1,876 (75.80)	599 (24.20)
Salaried	162 (81.41)	37 (18.59)
Casual/ Retired	963 (77.98)	272 (22.02)
Student/ Unemployed/ Other	98 (89.09)	12 (10.91)
HOUSEHOLD HEAD SEX		
Female	725 (70.94)	297 (29.06)
Male	2,276 (65.70)	1188 (34.30)
Missing	98 (83.76)	19 (16.24)
SANITATION		
Flush Private	439 (81.00)	103 (19.00)

Flush Public	428 (76.84)	126 (23.16)
Pit Latrine	1,230 (78.39)	339 (21.61)
Neighbour/ Woods	1,002 (74.17)	349 (25.83)
HOUSEHOLD FUEL		
Electricity/gas/solar	364 (6.31)	113 (23.69)
Firewood	2,360 (77.07)	702 (22.93)
Paraffin/ Biogas	375 (78.13)	375 (21.88)
HOUSEHOLD DEATHS		
HIV Deaths	384 (74.13)	134 (25.87)
Non HIV Deaths	2,715 (77.55)	786 (22.45)
STRUCTURE MATERIAL		
Bricks/ Concrete	389 (78.59)	106 (21.41)
Mud Bricks/ wood	378 (77.78)	108 (22.22)
Mud/ Iron sheet	1,542 (76.41)	476 (23.59)
Grass/ Carton	790 (77.45)	230 (22.55)
HOUSEHOLD SOURCE OF WATER		
Piped Water/ Private Borehole	710 (77.01)	212 (22.99)
Public Borehole	470 (76.67)	143 (23.33)
Water Vendor	402 (77.01)	120 (22.99)
River/ Dam/ Other	1,517 (77.32)	445 (22.68)

5.4 Migration rates of individuals from the households in the DSA between 1st Jan 2000 to 31st Dec 2007

In this study, we investigate two types of migration, the out-migration of the individual out of the DSA to a different place of residence, and the movement of individuals within the DSA which we call internal migration. Both movements however involve members moving from their respective households to other households. The death of a household member precedes the outcome of interest which in this case is the migration of the household members. Migration is treated as a renewable event and gaps are allowed in the analysis. A threshold period of 180 days (6 months) for both out and internal migration is used in this analysis. Their description in terms of different socioeconomic and demographic factors is given in Appendix 4.

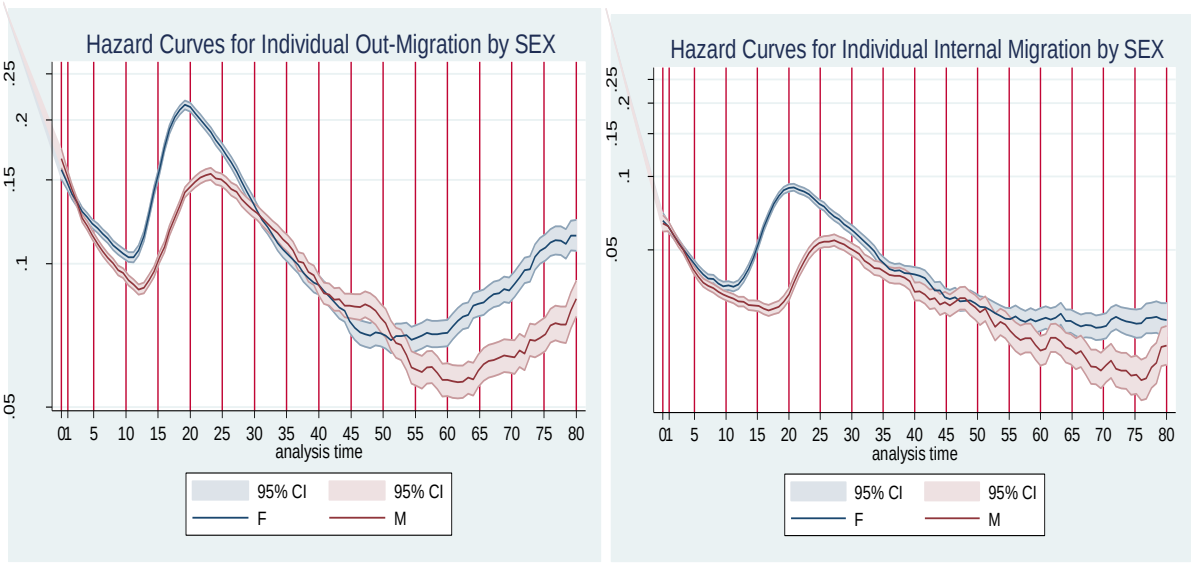

Figure 8: Hazard Curves for individual Migrations by Sex

5.4.1 Hazards for Out-migration of individuals

The overall out-migration rate for individuals outside the DSA is 117 per 1000 PYO (95% CI 116.54-118.05). The Figure 8 above (left-hand curves) shows the differences in hazards by sex of the individual at different age points. The risk to migrate from a household was higher for the females children compared to the male counterparts but decreased gradually at an earlier ages between 0-10 years, after which it increased between the ages of 10-20 for the same sex. The hazards fell gradually for both sexes after the age of 20 and remained similarly low to the age of 50. Female risk of migration at an advanced age of 55 was however greater than that for the males though it marginally rose for both sexes. Compared with internal migration of individuals (Figure 8, right-hand curves), hazards remain higher for out-migration of the two sexes compared to their internal migrations. Table 6 gives a summary of the out-migration rates by the socioeconomic and demographic characteristics of the out-migrants

Migration rates between the sexes are significantly different. Female migration rates are 125.68 per 1000 PYO (95% CI 124.60- 126.77) compared to the male rates of 108.25 per 1000 PYO (95% CI 107.21-109.30).

There is a significant high migration rates among employment groups in this rural community. Individuals with salaried jobs registered the highest migration rates of 313.97 per 1000 PYO (95% CI 306.40-321.72) while the unemployed came a distant second with 118.18 per 1000 PYO (95% CI 117.18-119.18). The self employed group including farmers migrated the least, with rates of 103.11 per 1000 PYO (95% CI 101.99-104.24).

Table 6: Out-migration rates by characteristics of the migrants

Socio Demographic Characteristics	Out-migrations N=92,504	PYO (Total=788193)	Migration Rates
SEX			
Female	51,411	408850.0	125.68 (124.60- 126.77)
Male	41,093	379342.7	108.25 (107.21-109.30)
HEAD SEX			
Female	19,529	147740.4	132.11 (130.27-133.98)
Male	68,789	625549.9	109.9 (109.08-110.73)
Missing	4,186	14902.4	280.63 (272.25-289.26)
INDIVIDUAL EDUCATION			
Little/ No Education	87,974	741630.5	118.55 (117.77-119.34)
Primary	1,874	26230.5	71.44 (68.28-74.75)
Secondary	2,074	16157.0	128.37 (122.96-134.01)
Tertiary	582	4174.8	139.41 (128.53-151.21)
HEAD EDUCATION			
Little/ No Education	80,386	719528.6	111.65 (110.88-112.43)
Primary	1,709	13186.2	129.61 (123.60-135.90)
Secondary	3,927	25832.2	151.94 (147.26-156.77)
Tertiary	2,296	14743.3	155.73 (149.49-162.23)
Missing	4,186	14902.4	280.63 (272.25-289.26)
INDIVIDUAL EMPLOYMENT			
Self Employed/ Farmer	32,323	313388.2	103.11 (101.99-104.24)
Salaried	6,453	20553.2	313.97 (306.40-321.72)
Unemployed/ Retired	53,728	454251.4	118.18 (117.18-119.18)
MARITAL STATUS			
Single/ Missing	69,548	502814.2	138.22 (137.19-139.25)
Married with Resident Spouse	14,148	200212.6	70.66 (69.51-71.83)
Married with Non Resident Spouse	2,160	20967.2	102.88 (98.62-107.31)
Widowed/ Divorced	6,648	64198.8	103.54 (101.08- 106.06)
ADULT HIV DEATHS			
No Deaths	91,091	778806.7	116.90 (116.14-117.66)
Single Death	1,351	9099.2	147.93 (140.23-156.04)
Two Deaths or more	62	286.9	212.65 (165.46-273.31)
ADULT NON HIV DEATHS			
No Deaths	79,000	685499.5	115.20 (114.40-116.01)
Single Death	12,226	92599.4	131.78 (129.47-134.14)
Two Deaths	1,185	9037.1	131.02 (123.76-138.70)
3 and More Deaths	93	1056.8	88 (71.81-107.84)

Members tended to migrate more from households experiencing any deaths compared to those households experiencing no death. Households with single deaths had migration rates of 130.74 per 1000 PYO (95 % CI 128.46-133.07) which was not much different from household experiencing two deaths. Households experiencing 3 deaths or more had lower migration rates of its household members with a rate of 116.21 per 1000 PYO (95% CI 105.98-127.41). Households without any deaths had lower migration rates of 115.02 per 1000 PYO (95% CI 114.21-115.83).

Migration rates accompanying single adult deaths from HIV/AIDS in households were 147.93 per 1000 PYO (95% CI 116.14-117.66) while those with two or more HIV/AIDS adult deaths had a higher migration rate of 212.65 per 1000 PYO which is almost twice as much. Households with no HIV/AIDS adult death had the lowest migration rates of 116.90 per 1000 PYO (95% CI 116.14-117.66).

However, the use of number of deaths in the households as a factor in analysing migration rates is biased. This comes about since households that do not report deaths between 1st January 2000 and 31st December 2007 may themselves be victims of deaths in the households before that period and thus still affected by the loss, especially at the beginning of this observation period. In the regression analysis, we use the death count as a continuous variable, to show what an effect an extra death in the household will have on the rates of migrations of the household members. This factor is less affected by the bias and is shown in the Cox regression table for factors predicting migration.

5.4.2 Internal migration of individuals from households in Rufiji HDSS

The shape of the migration hazard rates follows the same pattern as for out-migration, albeit at a lower level. We look at the migration rates on the internal migrants by different factors in the Table 7 below.

It is clear from the findings and consistent with the out-migration results, those females will migrate more than the males. Internally, female rates for migration were higher compared to the male rates of migration, but far less that the rates of out-migration, at 47.91 per 1000 PYO (95% CI 47.25-48.59) compared to 36.50 per 1000 PYO (95% CI 35.90-37.12)

Migration rates by marital status were significantly different from each other as shown in table above. Single and on married individuals had the lowest rates of 38.15 per 1000 PYO (95% CI 37.61-38.70)followed by the married individuals living with their spouses with a rate of 47.48 per 1000 PYO (95% CI 46.54-48.45). Married individuals not living with their spouses had a rate of 53.70 per 1000 PYO compared to those who were divorced or widowed who registered the highest rates of 56.40 per 1000 PYO (95% CI 54.60-58.27).

Table 7: Internal Migration Rates by Socio Economic and Demographic Characteristics

Socio Demographic Characteristics	Internal Migrations N= 33,456	PYO (Total=788193)	Migration Rates (per 1000 PYO) 95% CI
SEX			
Female	19,596	408850.0	47.91 (47.25-48.59)
Male	13,860	379342.7	36.50 (35.90-37.12)
HEAD SEX			
Female	7,181	147740.8	48.60 (47.48- 49.73)
Male	24,204	625549.5	38.67 (38.19-39.16)
Missing	2,071	14902.4	138.57 (132.72-144.68)
INDIVIDUAL EDUCATION			
Little/ No Education	31,356	741630.5	42.25 (41.79-42.72)
Primary	979	26230.5	37.32 (35.06-39.74)
Secondary	853	16157.0	52.80 (49.37-56.46)
Tertiary	268	4174.8	64.20 (56.95-72.36)
HEAD EDUCATION			
Little/ No Education	28,564	719529.0	39.68 (39.22-40.14)
Primary	580	13186.2	43.99 (40.55-47.72)
Secondary	1,454	25831.8	56.29 (53.47-59.26)
Tertiary	787	14743.3	53.38 (49.78-57.24)
Missing	2,071	14902.4	138.57 (132.72-144.68)
EMPLOYMENT			
Self Employed/ Farmer	14,805	313388.2	47.22 (46.67-47.99)
Salaried	1,322	20553.2	64.32 (60.95-67.88)
Unemployed/ Retired	17,329	454251.4	38.12 (37.55-38.69)
MARITAL STATUS			
Single/ Missing	19,195	502814.2	38.15 (37.61-38.70)
Married with Resident Spouse	9,512	200212.6	47.48 (46.54-48.45)
Married with Non Resident Spouse	1,126	20967.2	53.70 (50.66-56.93)
Widowed/ Divorced	3,623	64198.8	56.40 (54.60-58.27)
ADULT HIV DEATHS			
No Deaths	33,034	778806.7	42.39 (41.94-42.85)
Single Death	410	9099.2	44.95 (40.80-49.52)
Two Deaths	12	286.9	41.83 (23.76-73.66)
ADULT NON HIV DEATHS			
No Deaths	29,112	685499.5	42.46 (41.98-42.95)
Single Death	3,816	92599.4	41.08 (39.80-42.41)
Two Deaths	447	9037.1	49.13 (44.77-53.92)
3 and More Deaths	81	1056.8	75.70 (60.81-94.25)
TOTAL RATE	**33456**	**788192.7**	**42.45 (41.97- 42.88)**

There was no significant difference among rates as a result of the number of adult HIV/AIDS household deaths. However, single HIV/AIDS adult deaths had a marginal higher impact on the migration than two adult HIV/AIDS household deaths. The rates were 44.95 per 1000 PYO (95% CI 40.80-49.52) vs. 41.83 per 1000 PYO (95% CI 23.76-73.66) but were quite similar to when there was no death in the household. The bias however arises as discussed earlier for out-migration, where the use of number of household deaths will underestimate the effects of household deaths in the internal migration of the members, as opposed to the use of deaths as a continuous variable to investigate the impact of one extra death. Non-AIDS adult deaths on the other hand had a much higher impact on the migration of the individuals from these household. There is no significant difference between households experiencing no death and those experiencing a single adult Non-HIV/AIDS adult death: 42.46 per 1000 PYO (95% CI 41.98-42.95) compared to 41.08 per 1000 PYO (95% CI 39.80-42.41). Two Non-HIV/AIDS adult deaths corresponded to rates of 49.13 per 1000 PYO (95% CI 44.77-53.92) while 3 or more Non-HIV/AIDS adult deaths had the highest rates at 75.70 per 1000 PYO (95% CI 60.81-94.25).

5.5 Relative Hazard Migration rates for all age groups by sex following adult deaths

It can be deduced from the results presented in Table 8 that there is no significant effect for either gender of HIV/AIDS adult death on internal migration rates. On the contrary adult non-HIV/AIDS death increases the risk of female internal migration by 6% (adj. HR 1.06; 95% CI: 1.03-1.10, p-value <0.001) while it is not significantly associated with male internal migration.

Out-migration of household female members is significantly and strongly associated with HIV/AIDS adult deaths, while male migration is not. One more HIV/AIDS death in the households increases by 42% the risk of female out-migration (adj. HR 1.42, 95% CI 1.15-1.74, p-value <0.001). A less pronounced effect is observed for adult Non-HIV/AIDS adult deaths, which increases by 34% female out-migration (adj. HR 1.34 95% CI 1.27-1.45, p-value <0.001). The evidence is much less pronounced for males, whose risk to out-migrate increased but significantly after an HIV/AIDS adult death and significantly by 15% (adj. HR 1.15, 95% CI 1.06-1.23, p-value <0.001) after a non-HIV/AIDS adult death.

These effects could hide important differences by age groups. Our hypothesis here is that children's migration might be differently affected than adult's migration by an adult death in the household. In the following we make a distinction between children aged 0-17, and adults aged 18 and above.

5.5.1 Migration rates for children by sex following adult deaths

Table 8 presents the Hazards for the explanatory variables adult HIV deaths and adult Non HIV deaths on the migration of male and female household members (all ages), male and female children and male and female adults separately. Other hazards for the other explanatory variables are presented in the Appendices 6-11. The results show that there is very little difference between the sexes and between HIV/AIDS and non-HIV/AIDS adult deaths on the internal migration patterns of children. HIV/AIDS adult deaths are not significantly associated with children internal migration. The death effect is positive but only significant for non-HIV/AIDS deaths: the risk of internal migration increases by 8% for female children (adj. HR 1.08; 95% CI 1.02-1.13, p-value 0.005) and by 9% for male children (adj. HR 1.09; 95% CI 1.03-1.15, p-value 0.003).

Table 8: Adjusted hazard ratios (aHR) of adult deaths predicting migration by sex and large age groups

	Female All Ages		**Male All Ages**	
Factor	**aHR (95% CI)**	**p value**	**aHR (95% CI)**	**p value**
Internal Migration				
Adult HIV deaths	1.05 (0.94-1.18)	0.396	1.03 (0.88-1.19)	0.737
Adult Non HIV deaths	1.06(1.03-1.10)	<0.001	0.99 (0.95-1.03)	0.579
Out-migration				
Adult HIV deaths	1.42(1.15-1.74)	0.001	1.24(0.96-1.60)	0.097
Adult Non HIV deaths	1.34(1.27-1.45)	<0.001	1.15(1.06-1.23)	<0.001
	Female Children		**Male Children**	
Factor	**aHR (95% CI)**	**p value**	**aHR (95% CI)**	**p value**
Internal Migration				
Adult HIV deaths	1.05 (0.88-1.26)	0.590	1.10 (0.91-1.33)	0.344
Adult Non HIV deaths	1.08 (1.02-1.13)	0.005	1.09 (1.03-1.15)	0.003
External Migration				
Adult HIV deaths	1.29 (1.17-1.42)	<0.001	1.27 (1.14-1.40)	<0.001
Adult Non HIV deaths	1.10 (1.07-1.13)	<0.001	1.09 (1.06-1.13)	<0.001
	Female Adults		**Male Adults**	
Factor	**aHR (95% CI)**	**p value**	**aHR (95% CI)**	**p value**
Internal Migration				
Adult HIV deaths	1.06 (0.91-1.23)	<0.001	0.92 (0.72-1.17)	0.493
Adult Non HIV deaths	1.05 (1.0-1.10)	0.052	0.87 (0.81-0.93)	<0.001
External Migration				
Adult HIV deaths	**1.19 (1.09-1.30)**	**<0.001**	**1.30 (1.16-1.45)**	**<0.001**
Adult Non HIV deaths	**1.29 (1.26-1.33)**	**<0.001**	**1.18 (1.14-1.22)**	**<0.001**

For out-migration, however, HIV/AIDS and non-HIV/AIDS adult death effects act very differently on children's migration patterns. HIV/AIDS adult death increase their hazard to out-migrate by 27% (adj. HR 1.27; 95% CI 1.14-1.40, p-value <0.001) and 29% (adj. HR 1.29; 95% CI 1.17-1.42, p-value <0.001) for males and females respectively, while the out-migration risk after non-HIV/AIDS deaths is comparable to that observed for internal migration: 9% (adj. HR 1.09; 95% CI 1.06-1.13, p-value <0.001) and 10% (adj. HR 1.10; 95% CI 1.07-1.13, p-value <0.001) for males and females respectively.

In short, an adult death increases by about 9% the chance of a child, male or female, to migrate within or without the DSA, and HIV/AIDS adult death increases by a further 19 percentage point the risk to migrate out of the DSA.

5.5.2 Migration rates for adults by sex following adult deaths

Table 8 shows that HIV/AIDS adult deaths enhance the risk of adult female internal migration by 6% (adj. HR 1.06; 95% CI 0.91-1.23, p-value 0.01) but is not significantly associated with adult male migration. Non-HIV/AIDS adult deaths also enhances the risk for female internal migration by 5% albeit hardly significantly (adj. HR 1.05; 95% CI 1.0-1.10, p-value 0.05) but decreases the chance of male internal migration by 13% (adj. HR 0.87; 95% CI 0.81-0.93, p-value 0.01). There is therefore a significant gender difference of adult deaths on the internal migration pattern: adult death reduces the risk of males to migrate within the DSA, while it increases this risk for females.

HIV/AIDS adult death is however strongly associated with out-migration of adults, whatever the gender. They predispose female out-migration to 19% (adj. HR 1.19; 95% CI 1.09-1.30, p-value <0.001) and male migration to 30% increased risk (adj. HR 1.30; 95% CI 1.16-1.45, p-value <0.001). This gender difference is however non-significant (the confidence intervals overlap). Non-HIV/AIDS adult death has the inverse effect on out-migration, and the gender difference is significant: 18% increased risk for males (adj. HR 1.18 95% CI 1.14-1.22, p-value <0.001) and 29% for females (adj. HR 1.29; 95% CI 1.26-1.33, p-value <0.001). To sum-up, adult death has a positive impact on out-migration, with some variation by gender. The effect of HIV/AIDS death on out-migration is not very different from other deaths' effect.

6 DISCUSSION

The present study is a micro impact study conducted using longitudinal data. Compared with macro-level empirical studies micro-impact studies have appeal because they offer more direct evidence of the impact of HIV/ AIDS epidemic on the population. We have used data collected over a period of time on the same individuals and households thereby offering consistency and continuity of measurements in order to quantify the migration impact of the disease. We herein inform parameters that underlie projections of social cohesiveness and demographic re-arrangements and their social implications on these households. The results here may be used to validate the predictions in national surveys and macroeconomic models from these national surveys.

6.1 Adult Mortality

The main cause of adult mortality in the community is communicable diseases which form 39% of all adult deaths. Communicable diseases include malaria, HIV and some direct maternal causes. Other deaths are due to non communicable diseases (24%) and deaths due to external causes and injuries (3%). However, a bigger proportion of deaths are considered undetermined which could be as a result of how deaths happen, where they happen and how they are documented. We have seen that many individuals die before getting to a health facility which can be the main reason why it may be hard to make a clear diagnosis on their causes of death, especially if the individuals in question never at the point nearing their deaths sought medical attention at a health a facility. Without medical records, determining a cause of death is left merely to unclear descriptions by next of kin on the circumstances leading to the deaths.

HIV/AIDS mortality is high in the area: 13% of all adult deaths in the area are due to HIV/AIDS. The number could however be higher due to the high proportion of undetermined causes of death. Bearing in mind this data limitation, HIV/AIDS mortality rates are 0.82 per 1000 PYO for the general population but averaged 1.59 per 1000 PYO for the adults in the population. Female adult mortality rates from HIV/AIDS at 1.62 per 1000 PYO were significantly different from the males whose rates were 1.48 per 1000 PYO. The results are consistent with other studies that show females to be at a higher risk from HIV infection and suffering the scourge much more than their male counterparts especially if they come from rural communities rampart in cultural activities, tradition and violence against women (Dunkle, Jewkes et al. 2004).

Malaria mortality rates are 1.33 per 1000 PYO and are similar for both sexes. The DSS is located in the coastal strip and is a known Malaria endemic area. It is therefore not surprising that Malaria deaths remain closely as many as HIV/AIDS deaths.

Adult mortality rates do not differ much by sex in this community around 12 per 1000 PYO. The mortality rates by marital status portray the single and non-married individuals to have the highest mortality rates, followed by the widowed and divorced and last by the other married individuals. In this case it seems marriage plays an important protective role. Salaried individuals, although a minority (7%), are more exposed to death and experience a mortality rate of 32.8 per 1000 PYO, which is three times the general mortality rate. This can be due to high risk jobs that put them at risk.

6.2 Migration

Migration is high in this community with an overall out-migration of 117 per 1000 PYO. Out-migrants are three times as many as the internal migrants (42 per 1000 PYO). Generally, females migrate more than the males, especially out of the DSA, with female migration rate equalling 125.68 per 1000 PYO compared to male out-migration rate of 108.25 per 1000 PYO. This can be an indication that young women are moving out of their households to get married and thus join other households, or mature women are moving out to join their husbands working elsewhere. Migration among older women is also higher than the migration among older men. This suggests widows may be shifting residences to join their surviving children for upkeep and care. This rural conservative community giving high importance to children' responsibility to take care of their parents at old age, we expect practices like those to persist.

The rates for out-migration remain high among household members. The highly migrant group are the salaried ones, who register up to 314 out-migrations per 1000 PYO. As expected, the single individuals out-migrate more (138 per 1000 PYO) than the married: most of the singles move out to look for employment and a source of income to help their families back home.

The pattern for internal migration and out-migration hazards remained similar, with higher and significant hazards between the ages of 12 and 20 but decreasing after that, but remaining higher for the females as opposed to the males in the population during the later years. Internal migration of adults however was not a function of the individual's education and the employment of the household head for the internal migration of the males.

6.3 Effect of adult deaths on migration

The death of adult members from HIV/AIDS is strongly associated with individual out-migration after controlling for other risk factors such as sex, education, household head sex, employment and marital status. This findings are consistent with a study done in Free State province of South Africa where it was shown that migration represented an important strategy for poorer households having to cope

with the HIV/AIDS epidemic, both as an economic survival strategy and as a social strategy aimed at accessing support from the extended family (Booysen 2006).

The analysis of the death effect was stratified by sex and large age-groups (children under 18 vs. Adults). Adult deaths significantly affected the out-migration of female household members from all age groups but were not a factor of out-migration for males. Non-HIV/AIDS adult deaths were instrumental to provoke the out-migration of both male and female.

Internal migration for the females and males was not affected by the adult death in the household from HIV/AIDS while adult non-HIV/AIDS adult deaths were only relevant in the migration of female household members from these households.

Children under 18 seemed to respond to only adult non-HIV/AIDS adult deaths for their internal migration patterns. The hazard ratios were very similar by gender. This may come about since the decision to migrate for children is not their own and those who make the decision do not base it on the child's gender. Children are fostered in other households to alleviate the cost of upkeep at their homes, and most of the time it would be relatives who approach the families to offer their help in this way, or families may send their kids to live with these same relatives after consultations with those families and not the kids themselves.

Children out migrate by responding to both HIV/AIDS and non-HIV/AIDS adult deaths in their respective households, although the effect is seen more in the response to HIV/AIDS than non-HIV/AIDS adult deaths. This is clearly an indication that HIV/AIDS adult deaths have a specific migration impact on children. It would be worth investigating further what make HIV/AIDS death different from other cause of deaths.

Adults' migrations patterns from households experiencing adult deaths is more complex though. This is because adults make a conscious decision to migrate and more so following a death of an adult in their respective households, and depending on the cause of death. Gender differences may appear due to cultural reasons, as males may well make decisions to migrate more freely than females in this rural setting.

Adult deaths are significantly associated with the migration of adults, whatever the cause of death and the gender. However, an interesting observation in this community is that females and males respond inversely to the effect of HIV/AIDS and non-HIV/AIDS adult deaths. While for females the effect of non-HIV/AIDS deaths is higher than the effect of HIV/AIDS deaths by 11 percentage points, it is the exact opposite for males.

6.4 Study limitation

There were possible inaccuracies of the verbal autopsy data arising from information obtained from close relatives of the deceased as opposed from hospital records that are more accurate may lead to the underestimation of causes of deaths in the community. A lot more deaths may also be misclassified especially deaths from HIV/AIDS that were never diagnosed in a health facility.

Additionally, non availability of the SES data for all the years used in the study poses a difficulty in ascertaining the socioeconomic status of the households and individuals involved in the study. SES data was only collected for the households experiencing deaths and not for all the households used in the study.

6.5 Conclusion

6.5.1 Policy implications of the findings

HIV/AIDS remains the number one killer of African adults in their prime which will keep destroying the social cohesiveness of African families, especially those living in the rural areas. This study finds an association between adult deaths and the migration of household members following these deaths. This is therefore expected to persist with the present situation.

The overwhelming majority of the households in these rural Rufiji district of Tanzania are poor, which may be an important factor contributing to the high levels of short term mobility and out migration and internal migrations. Males appear to be involved in the bulk of external migration and internal migration as opposed to the female counterparts. Additionally, most of the migrants from this community are among those with little or no education coming from poor households. Assuming a typical rural-urban migration pattern for the migrants then they will most certainly end up in the neighbouring city of Dar es Salaam in search for alternative sources of livelihood, income and housing. An out pouring of unskilled labour into the city with little chance of getting a good job may weigh heavily on the material and security resources of the urban areas.

6.5.2 Research implications for the study

These findings bring to the fore the need for follow up research work to show how the HIV/AIDS adult deaths lead to other forms of household demographic rearrangements in this community including possible household migration and dissolution as it has been shown elsewhere. It would have been desirable to cover that in this report but it fell beyond the scope of our objectives. There is also need for the integration of such results of migration analysis into meaningful policy analysis. More research work needs to be done to investigate the effect of the characteristics of the dead beyond

HIV/AIDS on household viability, with such factors as household head characteristics, gender, age-group, marital status and more covered.

The DSS can collect data on the motivation for migration from among the migrants. Such research can entail the identification of absent household members, or former village residents who have migrated in a certain period, say 5 years, to enable follow-up studies to obtain information on the motives of their migration and of their return if any.

6.5.3 Concluding remarks

Our results point to a considerable higher rate of erosion of household viability following out-migrations from households experiencing adult deaths. We have shown that an adult death increases by about 9% the chance of a child, male or female, to migrate within or without the DSA, and HIV/AIDS adult death increases by a further 19 percentage point the risk to migrate out of the DSA. With regard to adults, adult death is strongly associated with their out-migration whatever the gender, increasing the chance to out-migrate by about 25%. Whatever the cause of the adult deaths, we see a propensity for migration of household members. HIV/AIDS adult deaths effect on out-migration varies significantly by gender.

We conclude that adult HIV/AIDS have an impact in the demographic rearrangement of households involving migrations of children and adult surviving members. The migrants may be in search of income to alleviate the void left by the death of a household breadwinner, or to relieve the family of the burden and cost of upkeep of the survivors.

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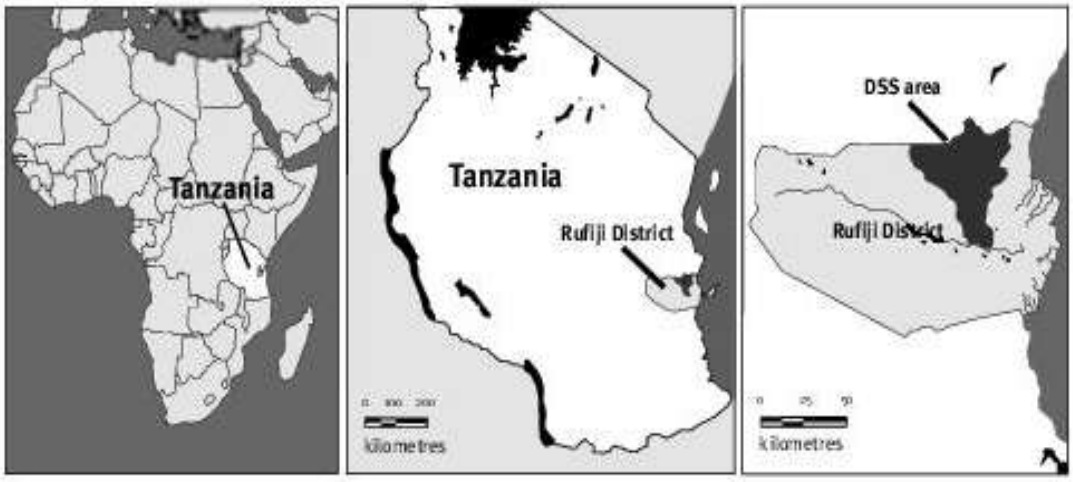
Appendix 1: Location of Rufiji HDSS, Tanzania



Source: POPULATION AND HEALTH IN DEVELOPING COUNTRIES Population, Health, and Survival at INDEPTH Sites. INDEPTH Network, IDRC 2002.

Appendix 2: Human Research Ethics Clearance Certificate from Wits

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mr Frederick W Murunga

CLEARANCE CERTIFICATE	**M090964**
PROJECT	Association between HIV/AIDS Related Parental Death and Migration of Household Members in Rural Rufiji District, Tanzania
INVESTIGATORS	Mr Frederick W Murunga.
DEPARTMENT	School of Public Health
DATE CONSIDERED	2009/10/02
DECISION OF THE COMMITTEE*	Approved unconditionally

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

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

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr P Bocquier

DECLARATION OF INVESTIGATOR(S)

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

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

.....

Appendix 3: Ethics Clearance Certificate from The Ifakara Health Institute/ Rufiji HDSS, Tanzania

IFAKARA HEALTH INSTITUTE
research | training | services

Murunga, Frederick Wekesah
University of Witwatersrand, SA
School of Public Health
Johannesburg

27th January 2010

Re: PERMISSION TO USE PART OF THE RUFIJI HDSS DATA The above heading refers Ifakara Health and Demographic Surveillance System data is owned by Ifakara Health Institute. Data sharing policies are in place Sharing of data is solely guided by specific policies.
Your application to use dataset for your study entitled "**Do household members migrate after an HIV Aids related parental/ adult death: the case of Rufiji HDSS in rural Tanzania.** " has been accepted. You will work with the IHDSS data manager to extract the dataset that is needed to address your study objectives.

The following conditions apply:

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

Sincerely

Dr Honorati Masanja

Ifakara
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Appendix 4: Adult Mortality Patterns by cause of death; 2000-2007 in Rufiji HDSS (N=4,603)

Socio-demographic factors	Undetermined N=1,587	CDs and Direct Maternal Factors N=1,191	HIV/AIDS (including PTB) N=604	NCDs N=1,086	Accidents/ Sudden Deaths N=135
	n (%)	n (%)	n (%)	n (%)	n (%)
AGE; Mean (sd)	63.81 (22.10)	66.63 (22.43)	45.67 (17.87)	67.21 (19.00)	46.67(21.56)
Sex					
Female	843 (34.76)	672 (27.71)	345 (14.23)	536 (22.10)	**29 (1.20)**
Male	744 (34.16)	519 (23.83)	259 (11.89)	550 (25.25)	**106 (4.87)**
Age group.					
Adult Death (18-59)	581 (32.10)	376 (20.77)	460 (25.41)	301 (16.63)	92 (5.08)
Elderly Deaths (60+)	1006 (36.02)	815 (29.18)	144 (5.16)	785 (28.11)	43 (1.54)
Education					
Little/ No Educ	1542 (34.63)	1157 (25.98)	575 (12.91)	1053 (23.65)	126 (2.83)
Primary Level	19 (35.85)	12 (22.64)	7 (13.21)	12 (22.64)	3 (5.66)
Secondary Level	19 (26.76)	14 (19.72)	18 (25.35)	17 (23.94)	3 (4.23)
Tertiary	7 (26.92)	8 (30.77)	4 (15.38)	4 (15.38)	3 (11.54)
Place of death					
Health facility	166 (29.54)	164 (29.18)	67 (11.92)	139 (24.73)	26 (4.63)
Home	1198 (32.85)	994 (27.26)	515 (14.12)	908 (24.90)	32 (0.88)
Other	223 (56.60)	33 (8.38)	22 (5.58)	39 (9.90)	77 (19.54)
Deaths Household					
Single death	1079 (34.82)	785 (25.33)	384 (12.39)	751 (24.23)	100 (3.23)
Multiple Deaths	508 (33.78)	406 (26.99)	220 (14.63)	335 (22.27)	35 (2.33)
Employment					
Self Employed.	624 (34.74)	424 (23.61)	265 (14.76)	415 (23.11)	68 (3.79)
Salaried.	126 (30.43)	113 (27.29)	62 (14.98)	102 (24.64)	11 (2.66)
Unemployed/ Retired	837 (34.98)	654 (27.33)	277 (11.58)	569 (23.78)	56 (2.34)
Marital status					
Single	712 (32.43)	589 (26.50)	315 (14.17)	528 (23.75)	70 (3.15)
Married Resident spouse	418 (35.16)	280 (23.55)	149 (12.53)	294 (24.73)	48 (4.04)
Married Non Resident spouse	62 (37.13)	34 (20.36)	29 (17.37)	39 (23.35)	3 (1.80)
Widowed/ Divorced	386 (37.70)	288 (28.13)	111 (10.84)	225 (21.97)	14 (1.37)
HEAD CHARACTERISTICS					
Sex					
Female	383 (37.48)	237 (23.19)	150 (14.68)	235 (22.99)	16 (1.66)
Male.	1165 (33.63)	919 (26.53)	438 (12.64)	827 (23.87)	115 (3.32)
Missing	39 (33.33)	35 (29.91)	16 (13.68)	24 (20.51)	3 (2.56)

Employment					
Self Employed.	971 (34.43)	753 (26.70)	370 (13.12)	643 (22.80)	83 (2.94)
Salaried.	68 (30.22)	57 (25.33)	32 (14.22)	61 (27.11)	7 (3.11)
Casual/ Retired	509 (35.32)	346 (24.01)	186 (12.91)	358 (24.84)	42 (2.91)
Unemployed/ other.	39 (33.33)	35 (29.91)	16 (13.68)	24 (20.51)	3 (2.56)
Education					
Little/ No Educ.	1466 (34.64)	1098 (25.95)	551 (13.02)	998 (23.58)	119 (2.81)
Primary Level	28 (33.73)	19 (22.89)	7 (8.43)	26 (31.33)	3 (3.61)
Secondary Level.	41 (33.33)	24 (19.51)	23 (18.70)	28 (22.76)	7 (5.69)
Tertiary	13 (27.08)	15 (31.25)	7 (14.58)	10 (20.83)	3 (6.25)
Missing	39 (33.33)	35 (29.91)	16 (13.68)	24 (20.51)	3 (2.56)
Household Member					
Head	741 (34.72)	490 (22.96)	273 (12.79)	553 (25.91)	77 (3.61)
Other	846 (34.26)	701 (28.39)	331 (13.41)	533 (21.59)	58 (2.35)

Appendix 5: Socioeconomic and demographic indicators of the internal migrants and out-migrants

Socio Demographic Characteristics	**Out-Migrants; n=70,931**	**Internal Migrants; n=24,002**	**X2 Test (P value)**
SEX			
Female	38,517 (74.03)	13,515 (25.97)	
Male	32,414 (75.56)	10,487 (24.44)	29.13 (< 0.001)
AGE OF MIGRANT Mean (sd);	22.53 (21.39)	20.30 (18.20)	
INDIVIDUAL EDUCATION			
Little/ No Education	67,585 (75.06)	22,451 (24.94)	
Primary	1,404 (66.04)	722 (33.96)	
Secondary	1,528 (71.24)	617 (28.76)	
Tertiary	414 (66.13)	212 (33.87)	128.70 (<0.001)
HEAD EDUCATION			
Little/ No Education	62,064 (75.04)	20,606 (24.93)	
Primary	1,329 (75.77)	425 (24.23)	
Secondary	2,950 (73.55)	1,061 (26.45)	
Tertiary	1,761 (73.50)	635 (26.50)	
Missing	2,827 (68.92)	1,275 (31.08)	84.44 (<0.001)
INDIVIDUAL EMPLOYMENT			
Self Employed/ Farmer	23,580 (69.57)	10,313 (30.43)	
Salaried	5,095 (84.38)	943 (15.62)	
Unemployed/ Retired	42,256 (76.83)	12,746 (23.17)	903.08 (<0.001)
MARITAL STATUS			
Single/ Missing	55,162 (79.30)	14,399 (20.70)	
Married with Resident Spouse	9,763 (59.31)	6,698 (40.69)	3100 (<0.001)

Married with Non Resident Spouse	1,488 (66.28)	757 (33.72)	
Widowed/ Divorced	4,518 (67.78)	2,148 (32.22)	
HOUSEHOLD DEATHS			
Single Death	17,876 (80.66)	4,285 (19.34)	
Multiple Deaths	6,606 (83.76)	1,281 (16.24)	
No Deaths	46,449 (71.59)	18,436 (28.41)	1100 (<0.001)
HEAD SEX			
Female	14,421 (74.66)	4,895 (25.34)	
Male	53,683 (75.07)	17,832 (24.93)	
Missing	2,827 (68.92)	1,275 (31.08)	77.66 (<0.001)
HEAD EMPLOYMENT			
Self Employed/ Farmer	45,895 (72.94)	17,029 (27.06)	
Salaried	3,736 (70.58)	1,557 (29.42)	
Unemployed/ Retired	18,473 (81.69)	4,141 (18.31)	
Missing	2,827 (68.92)	1,275 (31.08)	808.19 (<0.001)

Appendix 6: Cox Regression for factors predicting out-migration of individuals stratified by sex for all age groups

	Female		**Male**		**Female**		**Male**	
	Unadjusted Hazard Ratio				**Adjusted Hazard Ratio**			
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	0.61 (0.57-0.65)	<0.001	0.58 (0.54-0.62)	<0.001	0.56 (0.52-0.59)	<0.001	0.60 (0.56-0.64)	<0.001
Secondary Level	0.87 (0.81-0.93)	<0.001	1.09 (1.0-1.12)	0.075	0.55 (0.51-0.59)	<0.001	0.76 (0.72-0.82)	<0.001
Tertiary	1.20 (1.05-1.37)	<0.001	1.35 (1.22-1.50)	<0.001	0.43 (0.38-0.50)	<0.001	0.60 (0.53-0.68)	<0.001
EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	3.08 (2.97-3.20)	<0.001	2.92 (2.81-3.04)	<0.001	2.05 (1.97-2.14)	<0.001	2.44 (2.33-2.55)	<0.001
Unemployed/ Retired	1.18 (1.16-1.21)	<0.001	1.02 (0.987-1.04)	0.29	0.76 (0.74-0.78)	<0.001	0.68 (0.66-0.70)	<0.001
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1			
Salaried	1.24 (1.20-1.29)	<0.001	1.32 (1.26-1.36)	<0.001	1.00 (0.95-1.05)	0.967	0.85 (0.81-0.90)	<0.001
Unemployed/ Retired	1.22 (1.1-1.24)	<0.001	1.43 (1.40-1.47)	<0.001	0.97 (0.95- 0.99)	0.006	1.18 (1.16-1.12)	<0.001
MARITAL STATUS								
Single/ missing	1		1		1		1	
Married-Resident Spouse	0.38 (0.37-0.39)	<0.001	0.38 (0.36-0.39)	<0.001	0.33 (0.31-0.34)	<0.001	0.33 (0.32-0.35)	<0.001
Married Non-Resident Spouse	0.54 (0.52-0.57)	<0.001	0.78 (0.70-0.87)	<0.001	0.44 (0.42-0.47)	<0.001	0.61 (0.55-0.68)	<0.001
Widowed/ Divorced	0.62 (0.60-0.64)	<0.001	0.54 (0.51-0.58)	<0.001	0.52 (0.50-0.54)	<0.001	0.47 (0.44-0.51)	<0.001
HEAD SEX								
Female	1		1		1		1	
Male	0.83 (0.81-0.85)	<0.001	0.77 (0.75-0.79)	<0.001	0.93 (0.91-0.95)	<0.001	0.81 (0.78-0.83)	<0.001

Missing	1.91 (1.83-2.00)	<0.001	1.91 (1.81-2.01)	<0.001	1.95 (1.86-2.03)	<0.001	1.88 (1.78-1.98)	<0.001
HEAD EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.11 (1.04-1.19)	<0.001	1.18 (1.10-1.27)	<0.001	1.18 (1.10-1.26)	<0.001	1.28 (1.19-1.37)	<0.001
Secondary Level	1.24 (1.18-1.29)	<0.001	1.38 (1.32-1.45)	<0.001	1.31 (1.25-1.37)	<0.001	1.49 (1.41-1.58)	<0.001
Tertiary	1.35 (1.27-1.42)	<0.001	1.38 (1.29-1.47)	<0.001	1.45 (1.35-1.54)	<0.001	1.56 (1.44-1.69)	<0.001
Household Deaths								
Adult HIV deaths	1.25 (1.17-1.33)	<0.001	1.27 (1.18-1.37)	<0.001	1.42 (1.15-1.74)	0.001	1.24 (0.96-1.60)	0.097
Adult Non HIV deaths	1.13 (1.10-1.15)	<0.001	1.08 (1.05-1.10)	<0.001	1.34 (1.27-1.45)	<0.001	1.15 (1.06-1.23)	<0.001

Appendix 7: Cox Regression for factors for internal migration stratified by sex of the migrants

	Female		**Male**		**Female**		**Male**	
	Unadjusted Hazard Ratio				**Adjusted Hazard Ratio**			
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	0.89 (0.82-0.98)	0.019	1.06 (0.97-1.16)	0.205	0.97 (0.88-1.06)	0.466	1.08 (0.98-1.19)	0.116
Secondary Level	0.94 (0.84-1.04)	0.214	1.43 (1.30-1.57)	<0.001	0.89 (0.80-1.00)	0.049	1.17 (1.05-1.31)	0.004
Tertiary	1.42 (1.18-1.71)	<0.001	1.68 (1.43-1.98)	<0.001	1.02 (0.83-1.26)	0.854	1.10 (0.88-1.36)	0.405
EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	1.15 (1.07-1.25)	<0.001	1.52 (1.40-1.65)	<0.001	1.37 (1.26-1.50)	<0.001	1.30 (1.17-1.43)	<0.001
Unemployed/ Retired	0.66 (0.64-0.69)	<0.001	0.69 (0.66-0.72)	<0.001	0.92 (0.88-0.96)	<0.001	0.81 (0.77-0.86)	<0.001
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	1.22 (1.15-1.30)	<0.001	1.50 (1.40-1.60)	<0.001	1.24 (1.15-1.33)	<0.001	1.22 (1.12-1.34)	<0.001

Unemployed/ Retired	0.82 (0.79-0.85)	<0.001	0.85 (0.82-0.89)	<0.001	1.04 (1.00-1.08)	0.071	1.02 (0.97-1.07)	0.464
MARITAL STATUS								
Single/ missing	1		1		1		1	
Married-Resident Spouse	1.89 (1.80-1.98)	<0.001	1.82 (1.71-1.94)	<0.001	2.02 (1.91-2.14)	<0.001	1.72 (1.61-1.85)	<0.001
Married Non-Resident Spouse	2.28 (2.12-2.46)	<0.001	2.10 (1.74-2.52)	<0.001	2.01 (1.86-2.18)	<0.001	1.76 (1.46-2.12)	<0.001
Widowed/ Divorced	3.09 (2.93-3.27)	<0.001	2.24 (2.04-2.47)	<0.001	2.88 (2.71-3.06)	<0.001	2.10 (1.89-2.32)	<0.001
HEAD SEX								
Female	1		1		1		1	
Male	0.72 (0.70-0.75)	<0.001	0.88 (0.84-0.93)	<0.001	0.74 (0.71-0.76)	<0.001	0.85 (0.81-0.89)	<0.001
Missing	2.36 (2.22-2.51)	<0.001	2.90 (2.67-3.15)	<0.001	2.54 (2.38-2.70)	<0.001	2.87 (2.64-3.12)	<0.001
HEAD EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.12 (1.01-1.25)	0.034	1.05 (0.93-1.20)	0.436	1.18 (1.06-1.31)	0.003	1.03 (0.90-1.18)	0.635
Secondary Level	1.20 (1.11-1.28)	<0.001	1.52 (1.41-1.64)	<0.001	1.18 (1.09-1.28)	<0.001	1.30 (1.18-1.43)	<0.001
Tertiary	1.15 (1.04-1.26)	0.006	1.48 (1.34-1.65)	<0.001	1.10 (0.98-1.23)	0.12	1.20 (1.04-1.39)	0.015
Household Deaths								
Adult HIV deaths	1.08 (0.96-1.21)	0.208	1.01 (0.87-1.17)	0.943	1.05 (0.94-1.18)	0.396	1.03 (0.88-1.19)	0.737
Adult Non HIV deaths	1.07 (1.03-1.10)	<0.001	0.98 (0.94-1.03)	0.405	1.06 (1.03-1.10)	<0.001	0.99 (0.95-1.03)	0.579

Appendix 8: Cox regression for factors predicting internal migration of children stratified by sex

	Female		**Male**		**Female**		**Male**	
	Unadjusted HR		**Unadjusted HR**		**Adjusted Hazard Ratio**		**Adjusted Hazard Ratio**	
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	

Salaried	1.12 (1.06-1.19)	<0.001	1.09 (1.02-1.16)	0.008	1.02 (0.96- 1.09)	0.493	1.02 (0.95-1.09)	0.66
Unemployed/ Retired	1.17 (1.13-1.20)	<0.001	1.31 (1.27-1.36)	<0.001	1.16 (1.12-1.19)	<0.001	1.31 (1.27-1.35)	<0.001
HEAD SEX								
Female	1		1		1		1	
Male	0.81 (0.78-0.83)	<0.001	0.76 (0.74-0.79)	<0.001	0.80 (0.77-0.82)	<0.001	0.76 (0.73-0.78)	<0.001
HEAD EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.08 (0.99- 1.19)	0.095	1.06 (0.96-1.17)	0.229	1.09 (0.99-1.19)	0.088	1.05 (0.95-1.16)	0.362
Secondary Level	1.16 (1.09-1.24)	<0.001	1.15 (1.08-1.24)	<0.001	1.17 (1.10-1.26)	<0.001	1.16 (1.08-1.25)	<0.001
Tertiary	1.24 (1.14-1.35)	<0.001	1.16 (1.06-1.27)	0.002	1.26 (1.15-1.38)	0.002	1.18 (1.07-1.31)	0.002
HOUSEHOLD DEATHS								
Adult HIV deaths	1.29 (1.17-1.42)	<0.001	1.28 (1.16- 1.42)	<0.001	1.29 (1.17-1.42)	<0.001	1.27 (1.14-1.40)	<0.001
Adult Non HIV deaths	1.08 (1.05-1.11)	<0.001	1.07 (1.04-1.11)	<0.001	1.10 (1.07-1.13)	<0.001	1.09 (1.06-1.13)	<0.001

Appendix 9: Cox regression for factors predicting internal migration of children stratified by sex

	Female		**Male**		**Female**		**Male**	
	Unadjusted HR		**Unadjusted HR**		**Adjusted Hazard Ratio**		**Adjusted Hazard Ratio**	
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	1.27 (1.16-1.38)	<0.001	1.46 (1.34-1.60)	<0.001	1.22 (1.10-1.36)	<0.001	1.36 (1.22-1.52)	<0.001
Unemployed/ Retired	0.85 (0.80-0.90)	<0.001	1.0 (0.94-1.06)	0.999	0.85 (0.80-0.90)	**<0.001**	1.0 (0.94-1.06)	**0.864**
HEAD SEX								
Male	1		1		1		1	
Female	0.80 (0.76-0.84)	<0.001	0.77 (0.73-0.82)	<0.001	0.79 (0.75-0.83)	<0.001	0.76 (0.72-0.80)	<0.001
HEAD EDUCATION								

Little/ No Education	1		1		1		1	
Primary Level	1.07 (0.91-1.26)	**0.396**	1.01 (0.85-1.21)	**0.878**	1.09 (0.93-1.28)	**0.271**	1.03 (0.86-1.22)	**0.779**
Secondary Level	1.19 (1.07-1.32)	**0.001**	1.37 (1.23-1.53)	**<0.001**	1.12 (1.0-1.25)	**0.047**	1.23 (1.09-1.38)	**0.001**
Tertiary	1.19 (1.03-1.37)	**0.016**	1.37 (1.18-1.59)	**<0.001**	1.06 (0.90-1.24)	**0.497**	1.14 (0.96-1.35)	**0.137**
HOUSEHOLD DEATHS								
Adult HIV deaths	1.03 (0.86-1.23)	0.764	1.10 (0.91-1.33)	0.333	1.05 (0.88-1.26)	0.59	1.10 (0.91-1.33)	0.344
Adult Non HIV deaths	1.04 (0.99-1.10)	0.1	1.06 (1.0-1.12)	0.051	1.08 (1.02-1.13)	0.005	1.09 (1.03-1.15)	0.003

Appendix 10: Cox regression for factors predicting out-migration of adults stratified by sex

	Female		**Male**		**Female**		**Male**	
	Unadjusted HR		**Unadjusted HR**		**Adjusted Hazard Ratio**		**Adjusted Hazard Ratio**	
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.21 (1.10-1.33)	<0.001	1.22 (1.12-1.32)	<0.001	0.90 (0.82-0.99)	0.025	0.89 (0.81-0.98)	0.012
Secondary Level	1.19 (1.11-1.28)	<0.001	1.39 (1.31-1.47)	<0.001	0.69 (0.63-0.74)	<0.001	0.77 (0.71-0.84)	<0.001
Tertiary	1.33 (1.17-1.52)	<0.001	1.43 (1.28-1.59)	<0.001	0.55 (0.47-0.64)	<0.001	0.56 (0.47-0.65)	<0.001
EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	2.94 (2.79-3.10)	<0.001	2.59 (2.45-2.73)	<0.001	2.37 (2.23-2.53)	<0.001	2.87 (2.67-3.09)	<0.001
Unemployed/ Retired	2.03 (1.98-2.09)	<0.001	2.07 (2.01-2.13)	<0.001	1.58 (1.53-1.64)	<0.001	1.63 (1.55-1.70)	<0.001
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	1.37 (1.30-1.45)	<0.001	1.62 (1.53-1.73)	<0.001	0.85 (0.79-0.91)	<0.001	0.62 (0.57-0.68)	<0.001
Unemployed/ Retired	1.27 (1.23-1.30)	<0.001	1.57 (1.52-1.62)	<0.001	0.64 (0.62-0.66)	<0.001	0.71 (0.68-0.74)	<0.001
MARITAL STATUS								

Single/ missing	1		1		1		1	
Married-Resident Spouse	0.35 (0.34-0.36)	<0.001	0.37 (0.36-0.39)	<0.001	0.39 (0.37-0.40)	<0.001	0.42 (0.40-0.44)	<0.001
Married Non-Resident Spouse	0.51 (0.48-0.54)	<0.001	0.77 (0.69-0.86)	<0.001	0.56 (0.53-0.60)	<0.001	0.77 (0.69-0.86)	<0.001
Widowed/ Divorced	0.60 (0.58-0.62)	<0.001	0.54 (0.50-0.57)	<0.001	0.65 (0.62-0.68)	<0.001	0.59 (0.55-0.63)	<0.001
HEAD SEX								
Female	1		1		1		1	
Male	0.85 (0.82-0.87)	<0.001	0.79 (0.75-0.83)	<0.001	1.02 (0.99-1.05)	**0.202**	0.94 (0.89-0.99)	**0.016**
HEAD EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.14 (1.04-1.25)	0.006	1.34 (1.21-1.48)	<0.001	1.13 (1.03-1.24)	0.009	1.36 (1.22-1.52)	<0.001
Secondary Level	1.31 (1.23-1.39)	<0.001	1.65 (1.55-1.76)	<0.001	1.28 (1.19-1.37)	<0.001	1.84 (1.69-2.01)	<0.001
Tertiary	1.46 (1.35-1.57)	<0.001	1.62 (1.49-1.76)	<0.001	1.37 (1.24-1.50)	<0.001	1.93 (1.70-2.21)	<0.001
DEATHS								
Adult HIV deaths	1.21 (1.10-1.32)	<0.001	1.26 (1.13-1.41)	<0.001	1.19 (1.09-1.30)	<0.001	1.30 (1.16-1.45)	<0.001
Adult Non HIV deaths	1.17 (1.14-1.20)	<0.001	1.08 (1.04-1.12)	<0.001	1.29 (1.26-1.33)	<0.001	1.18 (1.14-1.22)	<0.001

Appendix 11: Cox regression for factors predicting internal migration of adults stratified by sex

	Female		**Male**		**Female**		**Male**	
	Unadjusted HR		**Unadjusted HR**		**Adjusted Hazard Ratio**		**Adjusted Hazard Ratio**	
Factor	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**	**HR (95% CI)**	**p value**
EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	0.97 (0.83-1.13)	0.664	0.92 (0.77-1.10)	0.354	0.98 (0.84-1.15)	0.803	0.83 (0.67-1.03)	0.084
Secondary Level	1.02 (0.91-1.15)	0.738	1.45 (1.30-1.61)	<0.01	0.92 (0.80-1.05)	0.204	1.01 (0.85-1.19)	0.957
Tertiary	1.50 (1.24-1.81)	<0.01	1.71 (1.45-2.01)	<0.01	1.13 (0.89-1.43)	0.329	1.05 (0.76-1.47)	0.765
EMPLOYMENT								

Self Employed/ Farmer	1		1		1		1	
Salaried	1.27 (1.15-1.41)	<0.01	1.61 (1.45-1.78)	<0.01	1.40 (1.24-1.59)	<0.01	1.47 (1.23-1.74)	<0.01
Unemployed/ Retired	0.76 (0.73-0.80)	<0.01	0.71 (0.66-0.75)	<0.01	1.07 (1.01-1.14)	0.02	1.11 (1.01-1.23)	0.046
HEAD EMPLOYMENT								
Self Employed/ Farmer	1		1		1		1	
Salaried	1.18 (1.08-1.28)	<0.01	1.55 (1.40-1.71)	<0.01	1.17 (1.04-1.30)	0.007	0.99 (0.82-1.18)	0.875
Unemployed/ Retired	0.80 (0.76-0.84)	<0.01	0.69 (0.64-0.74)	<0.01	1.09 (1.02-1.16)	0.007	0.91 (0.82-1.01)	0.079
MARITAL STATUS								
Single/ missing	1		1		1		1	
Married-Resident Spouse	1.51 (1.43-1.51)	<0.01	1.87 (1.76-2.0)	<0.01	1.87 (1.75-2.0)	<0.01	1.96 (1.80-2.12)	<0.01
Married Non-Resident Spouse	2.0 (1.85-2.16)	<0.01	2.27 (1.88-2.76)	<0.01	1.97 (1.80-2.16)	<0.01	2.05 (1.68-2.50)	<0.01
Widowed/ Divorced	2.67 (2.51-2.84)	<0.01	2.31 (2.09-2.56)	<0.01	2.80 (2.61-3.01)	<0.01	2.39 (2.14-2.67)	<0.01
HEAD SEX								
Male	1		1		1		1	
Female	0.67 (0.64-0.70)	<0.01	1.44 (1.28-1.62)	<0.01	0.72 (0.68-0.76)	<0.01	1.25 (1.11-1.42)	<0.01
HEAD EDUCATION								
Little/ No Education	1		1		1		1	
Primary Level	1.17 (1.01-1.35)	0.035	1.11 (0.91-1.35)	0.307	1.25 (1.08-1.45)	0.002	1.25 (0.99-1.58)	0.063
Secondary Level	1.20 (1.09-1.32)	<0.01	1.71 (1.53-1.91)	<0.01	1.20 (1.07-1.34)	0.002	1.57 (1.31-1.88)	<0.01
Tertiary	1.11 (0.97-1.27)	0.124	1.62 (1.40-1.88)	<0.01	1.02 (0.86-1.22)	0.788	1.34 (0.99-1.82)	0.063
DEATHS								
Adult HIV deaths	1.11 (0.96-1.30)	0.161	0.89 (0.70-1.13)	0.323	1.06 (0.91-1.23)	<0.01	0.92 (0.72-1.17)	0.493
Adult Non HIV deaths	1.09 (1.04-1.14)	<0.01	0.88 (0.82-0.94)	<0.01	1.05 (1.0-1.10)	0.052	0.87 (0.81-0.93)	<0.01