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TITLE:

EFFECT OF MARITAL STATUS AND EDUCATION LEVEL ON HIV/AIDS MORTALITY IN ADULTS IN RURAL KWAZULU-NATAL, SOUTH AFRICA.

A research report submitted to the School of Public Health, University of the Witwatersrand, Johannesburg, for the partial fulfillment of the requirements for the degree of Master of Science in Medicine in [Population Based Field Epidemiology].

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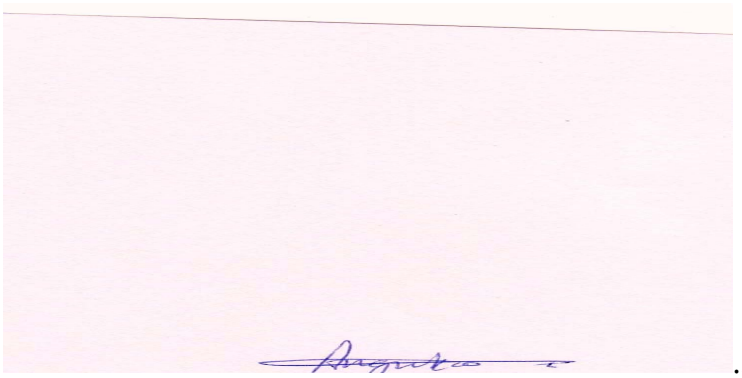
DECLARATION

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

Signature.  .....

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2 day of November, 2009.

DEDICATION

This work is dedicated to the Almighty God for his wisdom and grace, my wife Anne and the entire family for their support and encouragement during my studies and subsequent writing of this report.

ABSTRACT

Background

HIV/AIDS continues to have devastating effects on people in sub Saharan Africa as there is no cure for the disease. This calls for a study of important risk factors that can reduce mortality at the population level. The effect of marital status and education levels on HIV/AIDS mortality among adults is increasingly attracting attention from researchers and policy makers. However policies aimed at reducing HIV/AIDS mortality need to be based on a sound assessment of the nature, magnitude and determinants of the problem as policy decisions based on intuition are likely to be misguided.

Objectives

The study investigated the relationship between marital status and education level on HIV/AIDS mortality in rural KwaZulu-Natal in the period 2002-2007. The specific objectives were;

1. To calculate and compare death rates due to HIV/AIDS by education levels among adults in KwaZulu-Natal in the period 2002-2004 and 2005-2007;
2. To calculate and compare death rates due to HIV/AIDS by marital status among adults in KwaZulu-Natal in the period 2002-2004 and 2005-2007;
3. To examine association between marital status and education level on adult mortality due to HIV/AIDS in rural KwaZulu-Natal.

Methods

Data from Africa Centre Demographic Information Systems (ACDIS) was used for the analysis. The study design was a population based prospective cohort and follow-up period was 2002-2007. Eligible individuals were 20 years or older but less or equal to 64 years old

and resident on January 1, 2002. All independent variables were measured at baseline and were assumed to be time in-invariant. HIV/AIDS mortality during the period was ascertained using Verbal Autopsy (VA). The entire period was divided into 2002-2004 and 2005-2007 to examine the effect of antiretroviral drugs (ARVs) rolled out towards end of 2004. Kaplan-Meier (K-M) survival estimates of incidence (mortality) rates were used to estimate and compare mortality rates per 100 Person Years of Observation (PYOs) for the categories of marital status and education levels for the two periods. Survival curves by gender, marital status and education categories were constructed. Parametric regression based on the Weibull function was used to model the impacts of marital status and education level on HIV/AIDS mortality taking into account potential confounders.

Results

A total of 25738 adults who were 20 years or older but less or equal to 64 years old were residents of the demographic surveillance area on 1stJan 2002. There were 69726.9 PYOs with 1171 HIV/AIDS deaths giving an overall rate of 1.68/100 PYOs; 95% CI (1.59, 1.78) in the first period (2002-2004). Individuals with tertiary education had the lowest mortality rates in both the first period [0.61/100 PYOs; 95% CI (0.39, 0.95)] and the second period [0.47/100 PYOs; 95% CI (0.27, 0.83)]. Individuals who were married had lowest mortality rates both in the first period [(0.87/100 PYOs; 95% CI (0.75, 1.03)] and in the second period [0.71/100 PYOs; 95% CI (0.58, 0.85)]. In the second period (2005-2007) there were 58093.5 PYOs with 803 HIV/AIDS deaths giving an overall rate of 1.38/100 PYO; 95% CI (1.29, 1.48). HIV related mortality significantly reduced by 18% in the second period [Mortality Rate Ratio (MRR) = 0.82, 95% CI (0.76, 0.87)]. Individuals in the primary level education category had a 17% significant decrease in mortality in the second period [MRR =0.83,95% CI (0.77,0.88)]. The Never married and not engaged had a 18% significant decrease in mortality in the second

period [MRR = 0.82,95% CI (0.24,0.99)]. In the multivariate analysis females had significantly lower hazards than males [Adjusted HR = 0.86, P = 0.002, 95% CI (0.79, 0.95)]. The Never been married and not engaged had a significantly higher hazard [Adjusted HR = 2.30, P = 0.000, 95% CI (1.92, 2.76)] compared to the married category. Compared to individuals with no education, those in the secondary and tertiary education categories had significantly lower hazards of 0.73, P = 0.000, 95% CI (0.62, 0.85) and 0.34, P = 0.000, 95% CI (0.24, 0.49) respectively.

Conclusion

Marital status and education level were significantly associated with HIV/AIDS mortality in adults. Married individuals and persons with secondary and tertiary education had lower risk of HIV/AIDS mortality and hence higher survival. Increasing access to secondary education and strengthening the marriage institution may be critical in reducing HIV/AIDS deaths. HIV/AIDS mortality reduced significantly in the second period after the roll out of Anti-Retroviral drugs. Addressing access to ARVs by all those who need them is therefore critical.

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DEFINITIONS OF TERMS

Verbal autopsy: A tool used to determine probable cause of death in areas lacking a vital registration system. (Kahn, et al, 2000)

Married: People of opposite sex staying together as husband and wife for a period not less than 3 months.

Never Married and not engaged: Persons 20 years or older who are living alone and have never been attached to any person for future prospects of marriage

Never Married but engaged: Persons 20 years and above that are living alone but have identified persons to be their future partners.

Widowed: Persons whose partners have died and currently living alone

Divorced/Separated: Persons who were married but are currently living alone due to disagreements with the spouse

Educational Level Categories:

None: People who have never had any formal education

Primary: People who have attended school but not necessarily completed seven years of education

Secondary: People who have attended secondary school but not successfully completed 12 years of education

Tertiary: People who have completed 12 years and joined/completed studies in a post secondary institution

Hazard Ratio (HR): The risk at time (t) divided by the risk at baseline "For health risks that have a Hazard Ratio greater than one, it means that the chances of getting that health risk increased with the treatment. For health risks that have a Hazard Ratio less than one, it means that the chances of getting that health risk decreased with the treatment." A measure of how often a particular event happens in one group compared to how often it happens in another group, over time. In cancer research, hazard ratios are often used in clinical trials to measure survival at any point in time in a group of patients who have been given a specific treatment compared to a control group given another treatment or a placebo. A hazard ratio of one means that there is no difference in survival between the two groups. A hazard ratio of greater than one or less than one means that survival was better in one of the groups.

Demographic Surveillance System: This is a set of field and computing operations to handle the longitudinal follow-up of well-defined entities or primary subjects (individuals, households, and residential units) and all related demographic and health outcomes within a clearly circumscribed geographic area (INDEPTH Network).

Household: This is a social group of one or more individual members living together, sharing a residence/compound. They are usually but not always related.

Adult mortality rate: the probability of dying between 20 and 65 years expressed per 100 person years of observation

Wealth Index: Proxy measure of the wealth of households which is based on household characteristics, ownership of assets (house ownership, source of drinking water, electricity, sanitation facility (toilet), floor material type, roof material type etc.)

Economically active population. The term refers to all those people who are available for work. It includes both the employed and the unemployed. People who are not available for work, for example, those under the age of 15 years, students, scholars, housewives or homemakers, retired people, pensioners, disabled people and others who are permanently unable to work are excluded from the definition of the economically active population. In principle, housewives or homemakers can be considered to be part of the economically active population as well

LIST OF ACRONYMS AND ABBREVIATIONS

ARVs Antiretroviral drugs

AIDS Acquired Immunodeficiency Syndrome

ACDIS Africa Centre Demographic Information System

DHS Demographic and Health Survey

DSA: Demographic Surveillance Area

DSS: Demographic Surveillance System

HRS Household Registration System

HR Hazard Ratio

HIV Human Immunodeficiency Virus

INDEPTH International Network for Continuous Demographic Evaluation of Populations and Their impact on Health in Developing Countries

MDG Millennium Development Goals

MRR Mortality Rate Ratio

PCA Principal Component Analysis

PYO Person Years of observation

SES Socio-Economic Status

UNICEF United Nations Children's Fund

UNDP United Nations Population Division

UNAIDS: The Joint United Nations Programme on HIV/AIDS

WHO: World Health Organization

VA: Verbal Autopsy

PEPFAR Presidential Emergency Fund for Aids Relief

EGPAF Elizabeth Glazer Pediatric Aids Fund

PACT Priorities in Aids Care and Treatment

HAART Highly Active Anti-Retroviral Therapy

KZN KwaZulu- Natal

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CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW.

1.0 Introduction

Currently, more than 40 million people worldwide are living with HIV/AIDS, including 2.3 million children under the age of 15. There were approximately 2.5 million new infections with more than 2.1 million deaths recorded worldwide at the end of 2007. An estimated 26 million people are living with the disease in sub-Saharan Africa where the epidemic has hit the hardest, thus retarding economic growth and destroying human capital[1, 2]. Although treatments for AIDS and HIV can slow the course of the disease there is currently no vaccine or cure.

While data from Asia show lower national prevalence rates, the epidemic is also spreading quickly there, with 1.1 million new infections in 2005. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), India is second to South Africa in the number of people currently infected. HIV infections are spreading most quickly within young adult populations. An estimated 11.8 million young people aged 15–24 were living with HIV/AIDS, and half of all new infections – over 5,000 daily – are occurring among them[3].

HIV/AIDS is one of the leading causes of mortality and morbidity among adults in the African continent[1]. Since its appearance more than two decades ago the virus has spread to almost every country in the world. HIV/AIDS is a major burden especially in the developing world with a massive social and economic development challenge facing human societies today. The HIV/AIDS epidemic in South Africa has had a major socioeconomic impact particularly in high prevalence areas[5]. South Africa faces enormous challenges in scaling up its response to the now-mature and generalized HIV/AIDS epidemic[4]. The age groups which appear to be least affected is 5-19 and over 65 years[5].

Adult mortality in Northern KwaZulu-Natal, South Africa has risen markedly since the early 1990s. By 2000 the probability of dying between ages 15 and 60 years was 58% for women and 75% for men. This represents extraordinarily high adult mortality but is comparable with other African populations experiencing severe HIV epidemics. In Zimbabwe, for example, by the late 1990s the same index had risen to 50% for women and 65% for men for the population as a whole[6, 7, 8]. The sharp rise in adult mortality in the second half of the 1990s is in line with other research suggesting that the HIV epidemic has reversed earlier mortality declines among the African population of South Africa[9, 10]. HIV dominates in causes of mortality in South Africa which contrasts with other malaria endemic countries in Sub Saharan Africa[11].

Mortality data in South Africa have serious limitations. While routinely collected vital statistics are of poor quality, reflecting marked under-reporting of deaths and misclassification of their cause[12, 13], unreliable census data undermine the population base necessary for calculation of rates[14]. In middle level and low income countries Verbal Autopsy (VA) is the only method currently available to obtain estimates of the distribution of causes of death[13]. The Africa Centre Demographic Information System (ACDIS) in rural KwaZulu-Natal (KZN) uses Verbal Autopsy to determine cause of death. Each recorded death was subject to a VA in which trained fieldworkers conducted interview with the caregivers of those who died to identify the cause of death in the community. The validity of Verbal Autopsy (VA) diagnosis has been shown to be highest for direct maternal causes, tetanus, rabies and injuries but not for HIV/AIDS/TB[5, 15, 16, 17].

Little attention has been given to the impact of education and marital status on HIV mortality and the consequences this may have on adult health[19]. Few studies have attempted to examine the potential links between education, marital status and AIDS mortality[19, 20]. The main objective of the study was to investigate the hypothesis that individuals who are not married

and those with low educational level have a higher HIV mortality than those who are married or have high education level.

Adult mortality is considered an indicator of the health status of a population. High adult mortality means low life expectancy. Sub Saharan Africa is faced with high adult mortality and an accompanying large number of orphans[21]. Most of these adult deaths occur at the prime age thus removing an economically productive group from the population. The death of adults has severe consequences for families, dependants and the community. Adults are responsible for the support of children and elderly dependants. Improved knowledge is potentially of great value for health policy, allocation of resources and formulation of intervention strategies.

The findings will be relevant to the government, non governmental organisations and researchers for influencing public health policy on HIV/AIDS with regard to education and conjugal unions in adults.

1.1 HIV/AIDS and Mortality in South Africa

South Africa is estimated to have the largest number of people living with HIV/AIDS in the world. The Nelson Mandela study of HIV/AIDS[22] reported an estimated HIV prevalence of 4.5 million persons aged two years and older. The total number of South Africans living with the virus at the end of 2005, was estimated by UNAIDS to be in the region of 5.7 million showing an increasing trend. The UNAIDS Global Report[2], estimated that 320 000 people died of AIDS related deaths in South Africa during 2005. At the end of 2008 it was estimated that 5.7 million people were living with HIV/AIDS and about 1.8 million AIDS orphans in South Africa[23]. The province of KwaZulu- Natal continues to have the highest prevalence in South Africa at 39.1% followed by Mpumalanga at 34.8%.

This region provides an appropriate empirical setting in which to identify the effect of education and marriage in determining the role of AIDS excess mortality[24, 25]. Gender, education, age, partnership patterns, socioeconomic status, employment and marital status play a decisive role in determining susceptibility/vulnerability to HIV/AIDS. For this reason, the interplay between these factors needs to be considered at each stage of policy and programme development.

A combination of factors seems to be responsible for high prevalence of HIV: poverty, illiteracy and social instability, high levels of sexually transmitted infections, the low status of women, sexual violence and high mobility (particularly migrant labor). New infections are still increasing with no signs of reaching a natural limit [26]. The national average of HIV positive women attending antenatal clinics in 2005 was 30.2%. Efforts to stem the tide of new infections have only had limited success, as behavior change and social change are long-term processes, and the factors that predispose people to infection – such as poverty, illiteracy, and gender inequalities – cannot be addressed in the short term. Vulnerability to, and the impact, of the HIV/AIDS epidemic is proving to be most catastrophic at community and household level[5].

In South Africa mortality rates for the early period 1992—93 and a decade later, 2002— 03, indicated significant increases in mortality for both sexes since the mid-1990s, with a rapid decline in life expectancy of 12 years in females and 14 years in males[5]. The increases are most prominent amongst adults between 21 and 49 years of age, in which increases of up to five-fold has been observed in the past decade. Sex differences in mortality patterns are evident with increases more marked in females in most adult age groups. The simultaneous emergences of HIV/AIDS and TB together with increasing non-communicable disease in older adults are believed to be responsible[5].

In keeping with the rest of South Africa anti-retroviral treatment (ART) first became available in KwaZulu-Natal through private health care services[27]. It is difficult to determine exact numbers but small numbers of patients received care from 2003 onwards through local private practitioners with support from employers, medical scheme membership or local NGOs. The local public ART programme enrolled its first patient in the second semester of 2004[27.] It was a government programme with additional support through grants from the United States Presidential Emergency Fund for Aids Relief (PEPFAR) administered through Elizabeth Glazer Pediatric Aids Fund (EGPAF) and, more recently priorities in AIDS care and treatment (Pact). Since late 2004, approximately 40 patients a month had initiated treatment in the local ART programme and a total of 1092 were receiving treatment at clinics within the surveillance area by end of 2006[28,58].

In a recent study in Malawi, it was found that mortality reduced by 35% in adults aged 15-59 years after ARVs treatment with no change in those older than 60 years. This suggests that deaths from AIDS were averted by the rapid scale up of free antiretroviral therapy in rural Malawi which led to a decline in adult HIV mortality that was detectable at the population level[29].

1.2 Marital Status and HIV Mortality in adults.

It has been reported that the advantage of longevity enjoyed by married people increased over the 1990s in almost all cases. The widowed, divorced, separated and never married all had higher mortality rates than the married. Most of the partners of the widows are likely to have died of HIV/AIDS while most people divorce due to unfaithfulness which is a risk factor for HIV infection. While mortality is associated with these states, infection could very well have been in marriage. The relative risks were largest for younger age groups. Men and women under 65 years who lived with others had lower mortality than those who lived alone. People

who remain married are at lower risk of early death than people who remain unmarried or divorced[30, 31,32,33,34]. The institution of marriage plays some role in determining ones risk to HIV. Since transmission of HIV in the population is mainly through sexual activity, avoiding infection depends on risk avoiding behaviour. Empirical results show that excess mortality is concentrated in not yet married adults among both men and women[20].

It is generally believed that married individuals have higher hopes and aspirations. There is a growing body of research particularly over the last 10 years, showing hope and expectations for the future to be significantly related to lower mortality, either directly or through enhanced subjective evaluation of health[35, 36]. A number of reports coming out of the Alameda county study in California and the Kuopio Ischemic Heart disease study in Finland have indicated a positive relation between hopelessness, measured by negative expectations about the future and goal realization, and hypertension[37, 38].

There is compelling evidence that for women most HIV infections occur within marriage even though the incidence rates might be lower in the period that precedes marriage. The reason is that women spend a greater share of their active sexual life in marriage[39].I also possible that multiple sexual partners in and out of marriage may also contribute to high infection rates This being the case we would expect more HIV deaths for women who are married than those who are single. According to Georges Reniers[40], there is usually selection done by people who want to marry based on their perception as to whether the intended partner is infected or not. Again if these selection mechanisms are true then we would expect lower HIV mortality in married than the never married.

The never married effect has been found to be significant for both sexes and stronger for men than women after controlling for socioeconomic characteristics especially for HIV mortality. Having never been married was the strongest predictor of premature mortality[41, 42]. In a recent

study, it was reported that holding other factors constant individuals who were not married but had a partner faced more than double the hazard of HIV acquisition than married people or people without partners[26]. A national survey carried out in South Africa found that HIV incidence peaked up in the age group 20-29 in women and in the age group 30-39 in men. It also identified single and widowed individuals as at higher risk of acquiring HIV than married people[43]. This means that HIV/AIDS mortality will be higher in the above age groups and that people who are not married are at an increased risk of dying from HIV/AIDS.

Studies carried out in rural KwaZulu-Natal using ACDIS data revealed that 27% of men and 18% of women aged 50 years or older were reported to have never been married. These rates are among the highest in the world. Specific features of the Zulu marriage and child bearing tradition may make marriage more vulnerable than in other population and language groups. The high cost of bride wealth in this community has been argued to be a barrier to marriage.[74]If marriage is protective against HIV then this could partly explain the high HIV related mortality observed in this community. There is therefore a need to provide more evidence base for the protective effect of marriage observed in these studies.

1.3 Educational Level and HIV Mortality in adults.

Evidence shows that early in the AIDS epidemic, there was a positive correlation between levels of education and HIV mortality meaning that people with higher educational level had higher HIV mortality. What is less evident is whether this correlation is a global pattern or country-specific, i.e. countries where the epidemic has had a later start could initially experience the same positive correlation between level of education and HIV mortality at the population level, and over time show evidence that the higher educated respond more quickly to the epidemic through sexual behavior changes than the less educated. It would be

interesting to see the evidence and analysis correlating education and HIV mortality over time in countries with late incidences of HIV, such as South Africa[19].

While various stakeholders advocate increasing educational attainment levels for youth in order to halt the spread of the pandemic, there has been relatively little research on the correlation between levels of education and actual HIV mortality. In contrast, much has been published on the socio-economic impacts of the HIV/AIDS epidemic on the education sector for current and future generations[44.]

There has been more examination of the influence of a formal education (both primary and secondary) on sexual behavior patterns such as condom use, number of non-marital sexual relationships and age of first sexual experience than levels of education on HIV mortality. Examining the effect that years of educational attainment have on HIV/AIDS mortality is therefore vital in understanding the complex relationship between levels of educational attainment and HIV prevalence rates and of mortality. More recent evidence in countries such as Zambia and Uganda suggests that now, more years of education are increasingly associated with safer sexual behavior and lower HIV prevalence and mortality. This was particularly true for young women with secondary education, who demonstrated significantly lower HIV prevalence rates than their peers who had dropped out of school earlier[19, 45].

Other studies done in Zambia and Tanzania between 1995 and 2007 also indicated a shift in the association between educational attainment and HIV infection and death with low mortality in those with secondary education and above. The reduced risks appear to be more prominent in urban than rural areas. The most convincing sign was the risk reduction among more educated younger groups where most infections can be assumed to be recent. The changes in older groups are probably largely influenced by differential mortality rates. Decreased risk among educated men may have an impact on HIV-1 transmission and

mortality. Improving education sector in rural areas might be instrumental in the fight against the HIV epidemic[34, 46, 47, 48]. It is therefore important to investigate educational level effects on HIV mortality in rural KwaZulu-Natal, South Africa.

1.4 Research Question

In adults aged 20 years or older but less or equal to 64 years, what is the association between a person's (a) marital status and (b) educational level and subsequent death from HIV/AIDS in rural KwaZulu-Natal, South Africa in the period 2002-2007?

1.5 Aim of the study

To determine the relationship between marital status and educational level on HIV/AIDS mortality among residents in rural KwaZulu-Natal, South Africa in the period 2002-2007.

1.6 Specific Objectives

The study was guided by the following specific objectives:

(1) To calculate and compare death rates due to HIV/AIDS by Educational levels among adults in KwaZulu-Natal in the period 2002-2004 and 2005-2007.

(2) To calculate and compare death rates due to HIV/AIDS by Marital status categories among adults in KwaZulu-Natal in the period 2002-2004 and 2005-2007.

(3) To examine associations between educational level and marital status on adult mortality due to HIV/AIDS in rural KwaZulu-Natal.

CHAPTER TWO: METHODOLOGY

2.0 Demographic characteristics of the study area

The Africa Centre Demographic Surveillance area covers part of two rural districts of KwaZulu-Natal, 250 kilometres north of Durban. The study area includes tribal authority land and a former black township. The study population of approximately 90,000 people has membership in about 11,000 households located in the rural district of UMkhanyakude in northern KwaZulu-Natal. The area of 435 square kilometres includes deep rural areas, a township and peri-urban informal settlements.

The population is predominantly Zulu. Although it is a largely rural area, few people are involved in subsistence agriculture. The primary sources of income for most households are waged labour and pensions. Most employment opportunities are located outside the area in neighboring towns and Durban and in commercial farms, forestry and nature conservation. The DSA is heterogeneous with respect to topography, density of settlement, and infrastructure. Unlike most other rural areas of southern Africa, Zulu homesteads are scattered across tribal land with no identifiable villages. In much of the tribal land infrastructure is poor, with less than 14% of households having access to private or public piped water and half having no toilet or pit latrine. The mean household size is 5 persons. The few households that are engaged in agriculture produce sugarcane which is sold to the local sugar milling company.

2.1 Africa Centre Demographic Information System (ACDIS)

The Africa Centre Demographic Information Systems (ACDIS) is a longitudinal Demographic Surveillance System (DSS) which is situated in the municipalities of Hlabisa and Mtubatuba in the UMkhanyakude District of Northern KwaZulu-Natal, South Africa.

ACDIS started data collection on 1 January 2000. The study area was mapped and all households registered. The study population includes all household members, both resident and non resident in the area. Demographic and health information is collected every six months from all registered households, with one senior household member reporting on all resident and non resident individual members of the household.

Data is collected prospectively on births, deaths, migration, education, pregnancies, employment status, partnership patterns, marital status, conjugal relationships and family composition. Household socio-economic, education and employment data are collected once a year. Teams of trained field workers collect this information from each household using structured and unstructured questionnaire in the local language. There are also field supervisors who do quality control checks by visiting a random sample of these households. There is also a tracking team of fieldworkers who ensure that people moving within the DSS are reconciled with their records already captured into the database to avoid duplication of individuals moving within the study area.

In addition to ACDIS research role, its aim is to provide sentinel data to the district health authorities and the Ministry of Health to inform evidence based planning and resource allocation as well as to quantify the burden of disease and document impact of health system interventions and innovations.

2.2 Verbal Autopsy data

Verbal Autopsy (VA) is a method of ascertaining causes of death from the circumstances, events, symptoms and signs of illness experienced by the deceased before death as reported by the caretaker. All deaths identified through the half yearly visits were notified by the DSS regular supervisors to the nurses. Five nurses specifically trained and under strict supervision collected the data. Two physicians with local experience independently reviewed each VA

questionnaire and indicated the most likely causes of death. Most of the VA forms are coded only with one main underlying cause of death. In some, the physicians may report two causes of death. When there are discordances between the physicians about the cause of death, they meet and discuss to reach a consensus with a third physician[58]. The physicians are also provided with an abridged list of ICD-10 (International Classification of Diseases, 10th version) to classify causes of death. INDEPTH standard VA questionnaire[75] is used to collect this information. HIV and TB deaths were combined based on research that have been done in the same area. A study by Gandhi et al (2006) in rural KZN found that HIV and TB co-infection is high in this area. They reported that the epidemics of HIV-1 and tuberculosis in South Africa are closely related. For example, all 44 patients with XDR tuberculosis who were tested for HIV were co-infected. This study and that of Hosegood et al (2004) in the same area therefore necessitated combining HIV and TB deaths together.

2.3 Study Population

The study population was selected from all the residents of the Africa Centre DSA site during the period 2002-2007.

2.4 Study Design

This was secondary data analysis and the study design was a population-based prospective cohort. Persons contributed exposure from January 1, 2002, until death, out-migration or end of study. The whole period (2002-2007) was divided into two (2002-2004 and 2005-2007) in order to examine the effect on HIV/AIDS mortality of ARVs that were rolled out towards end of 2004.

2.5 Inclusion and Exclusion Criteria

A person was eligible if she/he was resident on January 1, 2002 and 20 years or older but less or equal to 64 years. The lower age limit of 20 years was chosen because primary and secondary education is mostly complete by age 20. The upper limit of 64 years of age was chosen because people are potentially economically active up to this age. The retirement age in South Africa is 65 years.

2.6 Data Source

Data for this secondary data analysis was extracted from the ACDIS database which includes information on all individuals, education level, household assets, employment status, partnership patterns, sex, marital status and HIV/AIDS related deaths which occurred to the selected individuals between January 1, 2002 and December 31, 2007.

2.7 Description of Outcome and Explanatory Variables

Explanatory:

All explanatory variables were measured at baseline and assumed to be time invariant.

1. Educational levels were categorized into None, Primary (1-7), Secondary (8-12), Tertiary (over 12 years). The education data collected in 2001 was used for the analysis. This represents good approximation of their educational level as at January 1, 2002 since education status changes minimally in the selected age group.

2. Marital status: This was categorized into married, divorced/separated, never been married and engaged, never been married and not engaged, widowed, and polygamy. Traditional marriage is also included. Marital status data is collected half yearly and therefore the marital status collected in the first half of 2002 was used for this cohort.

3. Potential confounders

The potential confounders were selected after a literature search to identify risk factors for HIV/AIDS mortality in adults.

Age: was categorised into five year age groups namely: 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64.This was done in order to identify the age groups at risk.

Sex: Male or Female.

Partnership Patterns: This was categorised into non marital, regular, casual, and no partnership. This data is collected biannually in ACDIS and therefore the data collected in the first half of 2002 was used for the analysis.

Wealth status was measured using an index, based on ownership of assets, water and sanitation facilities, power source and housing quality. The household characteristics and assets were included in the Principal component analysis model (PCA). Based on PCA SES of households was assigned to the residents of those households, and the resulting households were divided into quintiles (i.e. poorest, very poor, poor, less poor, and least poor) that represent the proxies for SES. The asset data collected in 2001 was used for the analysis.

Employment status: This referred to whether an individual was formally employed full time, employed part time or unemployed. The employment status assigned to an individual was the observation during 2001 as closely as possible to January 1, 2002.

Outcome:

Adult HIV/AIDS mortality: The mortality rate was measured by dividing the total number of HIV/AIDS related deaths in each of the marital status and educational level categories by the calculated Person Years of Observation (PYOs) for all individuals in each category in the period 2002-2004 and 2005-2007. It was expressed per 100 person years observed. A binary variable was generated that took the value 1 if an individual died from HIV/AIDS related

causes and 0 if alive. Individuals who died from other causes were excluded and were set to missing.

2.8 Data Extraction, Cleaning and Management

Household demographic surveillance data are handled by a custom-designed relational database based on the "Reference data model" blueprint designed specifically for longitudinal population data[49]. It has a strong focus on the temporal nature of the data and facilitates linkage between episodes (periods of time in a given state) and events (an occurrence which opens or closes an episode). The core "entity" in this model is the individual; each is computer-assigned a unique identity number when first encountered in the field. This provides a link between the "Individuals" table and the information that describes them. Each individual is thus linked to events and episodes, stored in other tables, which together comprise their life history while under surveillance. Manipulation of this database allows calculation of person-time at risk and counts of various events; together this allows the calculation of probabilities and rates, and supports the range of multivariate analyses[76].

The data extraction and joining of tables were done using SQL. Cleaning and statistical analysis was done using STATA 10. Verbal Autopsy data was linked to the main tables in the longitudinal data containing individuals' characteristics. All tables were linked together and the required variables selected through an internal individual ID which is unique to every individual in the database.

The variables were put into three datasets. Individuals' dataset containing all the variables concerning an individual like id, Sex, Education, Marital status, Last date observed, Date of birth and End Of Observation which indicated date of death (all causes) if the individual died during the period or last date on which this individual was still under surveillance. The second

dataset contained household assets variables. The third was the HIV/AIDS related deaths dataset (see Appendix 2). In this dataset underlying cause of death due to HIV related ICD-10 codes 'B24', 'B20','B20.0', 'B20.8', 'A15', 'A17', 'A18', 'A18.3', 'A19', 'M49.0' were used. Socio-economic index was constructed from the assets dataset. Marital status, education, employment status were recoded. The household assets dataset was merged with the individual dataset using the common identifier household id (HHIntId). The deaths dataset was merged with the dataset containing individuals' variables and assets using the individual identifier (IIntId). Cleaning involved the checking of quality of the data in terms of missing values, duplicate records, internal consistencies and validity of responses. Missing observations for the variables were coded as "Unknown" and used in the analysis.

2.9 Sample for analysis

A person was eligible if she/he was resident on January 1, 2002 and 20 years or older but less or equal to 64 years. A total of 25738 adults in 11000 households yielding 127820.3 PYOs were included in the analysis. A total of 1974 HIV/AIDS deaths were recorded in the DSA during the period (2002-2007) of which 1171 occurred in the first period (2002-2004) and 803 occurred in the second period (2005-2007). Individuals who died from other causes other than HIV/AIDS were excluded and set to missing in the analysis.

Data Analysis

2.9.1 Descriptive statistics

The data for analysis was entered in STATA version 10 (STATA Corporation, Texas, USA). Descriptive statistics were used to indicate number and percentage of people in the various categories of marital status and education level, employment, partnerships, sex and age

categories. The number and percentage of people who died of HIV/AIDS related causes from the two periods were tabulated by sex.

2.9.2 Mortality rates

As far as possible all deaths due to HIV related causes, obtained from VA using ICD-10 coding system were used and classified or grouped by education classes, by marital status and by age categories. Individuals contributed to Person-years denominator from 1st January, 2002 until 31st December, 2007. Individuals ceased to contribute to the denominator at death, termination of household membership, household out-migration or end of the study. First, mortality rates were generated for each year starting from 2002 to 2007. Similar rates were calculated for the individuals by age group, sex, marital status and educational level categories. Mortality rates were estimated separately for the 2002-2004 and 2005-2007 periods by Kaplan-Meier (K-M) survival estimates of incidence (mortality) rates and were expressed per 100 person years of observation. To allow comparison with other studies, the mortality rates in the 5 year age groups were standardized with direct standardization to the INDEPTH standard population for sub Saharan Africa [50].

2.9.3 Survival curves

Survival curves were estimated using Kaplan-Meier (K-M) survival methods and the log-rank test was used to test for equality of survival functions between covariates marital status, education level, and gender.

2.9.4 Univariate and Multivariate Weibull parametric regression analysis

To assess the risk of dying from AIDS related complications among the various groups, the covariates were put in the Weibull parametric regression model one by one to assess their individual effect on HIV mortality at 5% significant level.

Stata estimates Weibull models with three estimates of P, the failure velocity. The failure velocity (P) determines the shape of the underlying hazard function. If P>1, the hazard is monotonically increasing i.e. the observations are failing at a fast rate as time goes on. If P<1, the hazard is monotonically decreasing meaning observations are failing at a slower rate with time which was what the data revealed here (P = 0.9406). Unlike the Cox model which assumes proportional hazards, the Weibull function allows the hazard function to either increase or decrease monotonically over time.

A Multivariate Weibull parametric regression analysis was performed to assess the possible association between marital status categories and educational level on HIV/AIDS mortality. Adjusted models included covariates found to be significant at P<0.05 in univariate analyses. This multivariate model controlled for potential confounders namely age, sex, employment status, partnership pattern and socioeconomic status.

2.10 Ethical Approval

Ethical approval was obtained from the Human Research Ethics Committee of University of the Witwatersrand with Protocol Number R14/49 (appendix 3). Ethical approval was given for the use of the ACDIS dataset by the Ethics Committee of the University of KwaZulu-Natal with number E009/00 (appendix 5). A copy of the findings of this report was presented to Africa Centre Demographic Information System for dissemination at Africa Centre DSA, in accordance with Institutional Review Board guidelines for conducting health research.

CHAPTER THREE: RESULTS

This chapter presents the results of the analysis of this study. Analysis was done for two separate periods namely period 1 (2002-2004) and period 2 (2005-2007). This was done to compare HIV/AIDS related mortality rates before and after the roll out of ARVs towards end of 2004. The analyses were in four parts. The first part reported the baseline characteristics of the individuals in the various categories of the selected variables. The second part involved the calculation and comparisons of mortality rates in the various categories of age group, sex, marital status and education level for the two periods. Kaplan Meier (K-M) incidence estimates were used for the calculation of mortality rates and the rates were expressed per 100 person years of observation (PYO). In the third part Kaplan Meier survival curves by gender, marital status, and education level were constructed. The fourth part investigated the association between marital status and education level on HIV/AIDS mortality by the use of Weibull parametric regression model taking into account potential confounders.

3.0 Socio-Demographic Characteristics

The socio-demographic characteristics of the adults in the study are shown in table 3.0. A total of 25738 individuals were included in the study. There were 10268 (39.89%) males compared to 15470 (60.11%) females. About half of the total population had Primary education 11969 (46.5%). Individuals with secondary education were 6177 (23.99%) while a smaller percentage had Tertiary education 1155 (4.49%). The number of individuals having no education was 4192 (16.29%). The mean age was 36.38 and the age group 20-24 and 25-29 contained the highest number of individuals 5670 (22.03%) and 4407 (17.12%) respectively. Less than a quarter of the individuals 6140 (23.86%) were married. The data revealed that Divorce/separation and Polygamy are low among the residents. The Divorced/separated were 255 (0.99%) and polygamous marriages were 196 (0.76%).

Individuals who had never been married and not engaged were the biggest group 14263 (55.42%) while those who had never been married and engaged were 2549 (9.90%). It can be seen that these two groups of never married individuals constituted more than 65% of individuals in the age group 20-64 years. The occupational profile showed that more than half of the population were unemployed 14416 (56.01%) with the employed constituting slightly more than a quarter of the population 6811 (26.46%). The partnership profile revealed that there were few individuals with casual partners 879 (3.42%) with those having regular partners taking about half 12642 (49.11%) of the total.

Table 3.1 shows mortality background characteristics of the participants in the two periods. The total number of HIV related deaths recorded during the whole period (2002-2007) was 1974 (54.65%) while non HIV/AIDS deaths were 1638 (45.35%). Out of these HIV deaths 857 (8.35%) were males while 1117 (7.22%) were females. In the first period (2002-2004) there were 1171 HIV/AIDS deaths out of which 497 (4.84%) were males and 674 (4.36%) were females. In the second period (2005-2007) there were a total of 803 HIV/AIDS related deaths with males accounting for 360 (4.39%) and females 443 (3.42%).

Table 3.0 Background characteristics of participants included in the HIV mortality analysis 2002-2007(Age: 20 years or older but less or equal to 64 years; n = 25738)

Variables	**Frequency (n)**	**Percentage (%)**
Sex		
Male	10268	39.89
Female	15470	60.11
Education		
None	4192	16.29
Primary	11969	46.50
Secondary	6177	23.99
Tertiary	1155	4.49
Other	26	0.10
Unknown	2219	8.63
Age category: (both sexes)		
20-24	5670	22.03
25-29	4407	17.12
30-34	3413	13.26
35-39	3106	12.07
40-44	2789	10.84
45-49	2044	7.94
50-54	1686	6.55
55-59	1219	4.74
60-64	1404	5.45
Marital Status		
Married	6140	23.86
Widowed	1736	6.74
Divorced/Separated	255	0.99
Never been married & not engaged	14263	55.42
Never been married but engaged	2549	9.90
Polygamous marriage	196	0.76
Unknown	599	2.33

Employment status		
Not employed	14516	56.40
Employed full time	6811	26.46
Employed part time	994	3.86
Unknown	3417	13.28
Partnership patterns		
No partners	11658	45.29
Casual partners	879	3.42
Regular partners	12642	49.11
Others	66	0.26
Unknown	493	1.92

Table 3.1 Mortality background characteristics of the participants in the two periods

Variables	**Frequency (n)**	**Percentage (%)**
MORTALITY		Denominator: all deaths
Other causes	1638	45.35
HIV/AIDS deaths	1974	54.65
TOTAL	**3612**	**100**
	Denominator for males: all males Denominator for females: all females	
Males (HIV/AIDS deaths)	857	8.35
Females (HIV/AIDS deaths)	1117	7.22
HIV/AIDS Mortality **Period 1** (2002-2004) Males Females	 497 674	 4.84 4.36
HIV/AIDS Mortality **Period 2** (2005-2007) Males Females	 360 443	 4.39 3.42

HIV/AIDS Mortality: Period 1.Denominator: Males (all males in first period); Females (all females in first period)

HIV/AIDS Mortality: Period2.Denominator: Males (all males in period 1); Females (all females in period 2)

Table 3.2 Trends in HIV/AIDS Mortality rates per 100 Person Years of Observations (PYOs)

YEAR	HIV Deaths	PYOs	Mortality rates/100; 95%CI
2002	438	24835	1.76 (1.60,1.93)
2003	403	23096	1.75 (1.58,1.92)
2004	330	21781	1.52 (1.37,1.69)
2005	307	20476	1.50 (1.34,1.68)
2006	233	19341	1.21 (1.06,1.36)
2007	263	18198	1.45 (1.29,1.63)

3.1 Trends in HIV/AIDS mortality rates

The mortality rates calculated for each year are displayed in table 3.2. There was a general decline in HIV/AIDS mortality rates from 2004 to 2006. Mortality rate decreased from 1.75/100 PYOs; 95% CI (1.58, 1.92) in 2003 to 1.52/100 PYOs; 95% CI (1.37, 1.69) in 2004. This represented a 13% decrease in mortality rate. The mortality rate further decreased from 1.52/100 PYOs; 95% CI (1.37, 1.69) in 2004 to 1.50/100 PYOs; 95% CI (1.34, 1.68) in 2005. Mortality rate fell from 1.50/100 PYOs; 95% CI (1.34, 1.68) in 2005 to 1.21/100 PYOs; 95% CI (1.06, 1.36) in 2006. This represented a decrease of 19.3%. There was an increase in mortality rate from 1.21/100 PYOs; 95% CI (1.06, 1.36) in 2006 to 1.45/100 PYOs; 95% CI (1.29, 1.63) in 2007. This represented an increase of 19.8%. There was a significant decline in mortality between the year 2004 [1.52/100 PYOs; 95% CI (1.37, 1.69)] and the year 2006 [1.21/100 PYOs; 95% CI (1.06, 1.360)] as shown by the non-overlapping confidence bands in Figure 3.1 below.

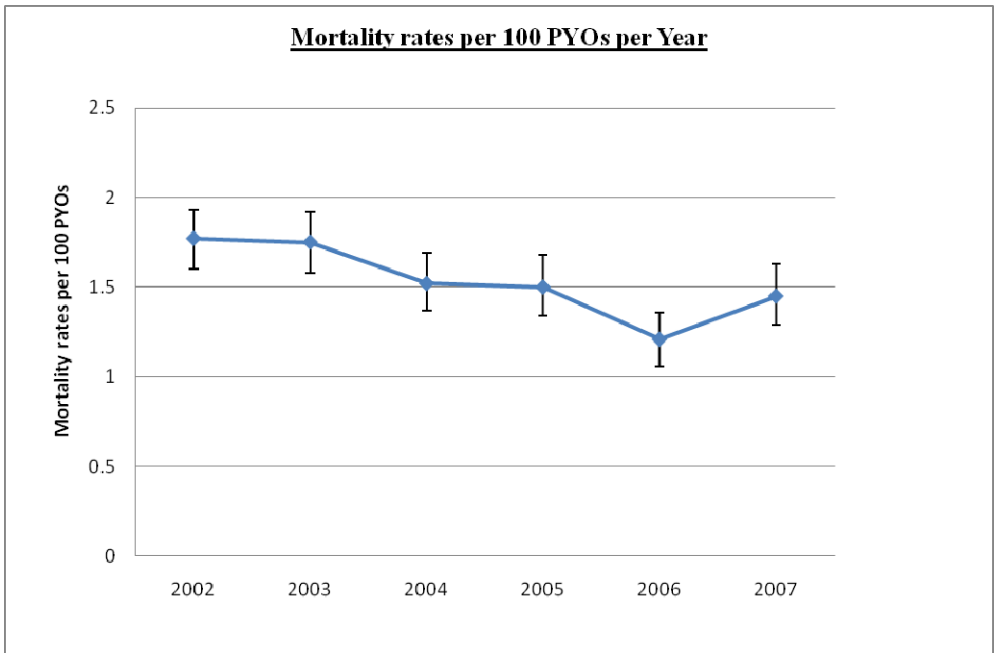

Figure 3.1: HIV/AIDS mortality rates/100 PYOs from 2002-2007

3.2 HIV/AIDS mortality rates by sex and age groups for the periods 2002-2004 and 2005-2007

All mortality rates referred to in this section are HIV/AIDS related. The significance of mortality rates in both periods was judged by the confidence bands. When the confidence bands overlap in both periods then the change in mortality rates are not significant. The categories of covariates where confidence bands do not overlap were marked with an asterisk to show significant change in HIV mortality rates in the two periods (Tables 3.3, 3.5 and 3.6).

Mortality rates by age groups were standardized by direct standardization using the INDEPTH standard population for Sub-Saharan Africa and are shown in table 3.3. There were 69726.9 PYOs with 1171 HIV related deaths in the first period giving an overall rate of 1.68/100 PYOs. In the second period there were 58093.5 PYOs with 803 HIV related deaths giving an overall rate of 1.38/100 PYOs. This represented a significant decrease of 18% in mortality rate

in the second period [Mortality Rate Ratio (MRR) = 0.82, 95% CI (0.76, 0.87)]. There was a 10% decrease in mortality in males from 1.81/100 PYO; 95% CI (1.66, 1.98) in the period 2002-2004 to 1.62/100 PYO; 95% CI (1.46, 1.79) in the period 2005-2007 and was not significant as indicated by the overlapping confidence bands in Figure 3.2. Females had a 22% significant decrease in mortality from 1.59/100 PYO; 95% CI (1.48, 1.72) in period 1 to 1.24/100 PYO; 95% CI (1.12, 1.36) in period 2 [MRR = 0.78, 95% CI (0.18, 0.98)].

The age group 30-34 had the highest mortality rate of 2.79/100 PYO; 95% CI (2.46, 3.16) in the first period and 1.99/100 PYO; 95% CI (1.69, 2.35) in the second period. This represented a significant decrease of 19% in mortality rate as indicated by the non overlapping confidence bands in Figure 3.3 [MRR = 0.71, 95% CI (0.22, 0.96)]. Mortality rates for all age groups declined in the second period except the age groups 20-24, 50-54 and 60-64 which recorded increases in mortality rate.

Analysis of age-standardized HIV related mortality rates stratified by gender are shown below (table 3.4). Mortality rates for females decreased for all age groups in the second period except the age groups 20-24, 50-54 and 60-64. Mortality rate declined significantly for females in the age group 25-29 from 2.41/100 PYO; 95% CI (2.07, 2.81) in period 1 to 1.49/100 PYO 95% CI (1.20, 1.85) in period 2. In males HIV/AIDS related mortality rates decreased for all age groups in the second period except the age groups 20-24, 25-29 and 60-64 where mortality rates increased.

Figure 3.2 shows mortality rates by gender in the period 2002-2004 compared with the period 2005-2007. Within males there was no significant difference in mortality rates in the two periods. Between males and females there was no significant difference in mortality in the first period. However in the second period there was a significant difference in HIV mortality

between males and females as indicated by the non overlapping confidence bands. Within females there was a significant decline in mortality in the second period.

Table 3.3 Age-Standardized HIV/AIDS mortality rates by sex and age groups in both periods

Variable	**2002-2004**			**2005-2007**		
	PYOs	**Deaths**	**MR/100PYOs (95%CI)**	**PYOs**	**Deaths**	**MR/100PYOs (95%CI)**
Gender						
Male	27424.9	497	1.81(1.66, 1.98)	22228.6	360	1.62(1.46, 1.79)
Females*****	42301.9	674	1.59(1.48, 1.72)	35864.9	443	1.24(1.13,1.36)
Total*	**69726.8**	**1171**	**1.68 (1.59,1.78)**	**58093.5**	**803**	**1.38 (1.29,1.48)**
Age groups						
20-24	15462.7	131	0.85 (0.71, 1.00)	13212.9	135	1.02(0.86,1.21)
25-29	11575.9	253	2.19(1.93, 2.47)	9294.1	158	1.70(1.45, 1.99)
30-34*****	8964.8	250	2.79(2.46, 3.16)	7121.3	142	1.99(1.69,2.35)
35-39	8409.6	167	1.99(1.71,2.31)	6960.0	103	1.48(1.22, 1.79)
40-44	7617.9	151	1.98(1.69, 2.32)	6365.2	96	1.51(1.23,1.84)
45-49	5667.5	88	1.55(1.26, 1.91)	4866.9	60	1.23(0.96, 1.59)
50-54	4742.4	62	1.31(1.02, 1.68)	4102.4	55	1.34(1.03, 1.75)
55-59	3374.5	45	1.33(0.99, 1.79)	2865.2	29	1.01(0.70, 1.46)
60-64	3911.6	24	0.61(0.41, 0.92)	3305.4	25	0.76(0.51, 1.12)
Total	**69726.9**	**1171**	**1.68(1.59,1.78)**	**58093.4**	**803**	**1.38(1.29,1.48)**

*** Significant difference in HIVAIDS related mortality rates in the two periods**

Table 3.4 Male and female HIV mortality rates for the periods 2002-2004 and 2005-2007

Variable	2002-2004			2005-2007		
	PYOs	**Failure**	**MR/100PYOs (95%CI)**	**PYOs**	**Failure**	**MR/100PYOs (95%CI)**
MALES						
Age groups						
20-24	7097.7	30	0.42 (0.29,0.60)	6108.3	45	0.74(0.55,0.99)
25-29	4732.2	88	1.86(1.51,2.29)	3805.1	76	1.99(1.59,2.50)
30-34	3505.4	112	3.19(2.65,3.85)	2672.9	58	2.17(1.68,2.81)
35-39	3147.5	78	2.48(1.98,3.09)	2450.4	50	2.04(1.55,2.69)
40-44	2637.1	66	2.50(1.97,3.19)	2100.8	41	1.95(1.44,2.65)
45-49	2210.1	51	2.31(1.75,3.04)	1791.5	34	1.90(1.36,2.66)
50-54	1657.7	34	2.05(1.47,2.87)	1376.5	22	1.60(1.05,2.43)
55-59	1210.2	25	2.07(1.30,3.06)	966.8	20	2.07(1.33,3.21)
60-64	1227.1	13	1.06(0.62,1.82)	956.3	14	1.46(0.87,2.47)
TOTAL	**27424.9**	**497**	**1.81(1.66,1.98)**	**22228.3**	**360**	**1.62(1.46,1.79)**
FEMALES						
Age groups						
20-24	8365.0	101	1.21(0.99,1.47)	7104.6	90	1.27(1.03,1.56)
25-29	6843.7	165	2.41(2.07,2.81)	5489.0	82	1.49(1.20,1.85)
30-34	5459.4	138	2.53(2.14,2.99)	4448.5	84	1.89(1.52,2.34)
35-39	5261.9	89	1.69(1.37,2.08)	4509.6	53	1.18(0.89,1.54)
40-44	4980.9	85	1.71(1.38,2.11)	4264.4	55	1.29(0.99,1.68)
45-49	3457.4	37	1.07(0.78,1.48)	3075.3	26	0.85(0.58,1.24)
50-54	3084.6	28	0.91(0.63,1.31)	2725.9	33	1.21(0.86,1.70)
55-59	2164.3	20	0.92(0.59,1.43)	1898.4	9	0.47(0.25,0.91)
60-64	2684.5	11	0.41(0.23,0.74)	2349.2	11	0.46(0.26,0.85)
TOTAL	**42301.9**	**674**	**1.59(1.48,1.72)**	**35864.9**	**443**	**1.24(1.13,1.36)**

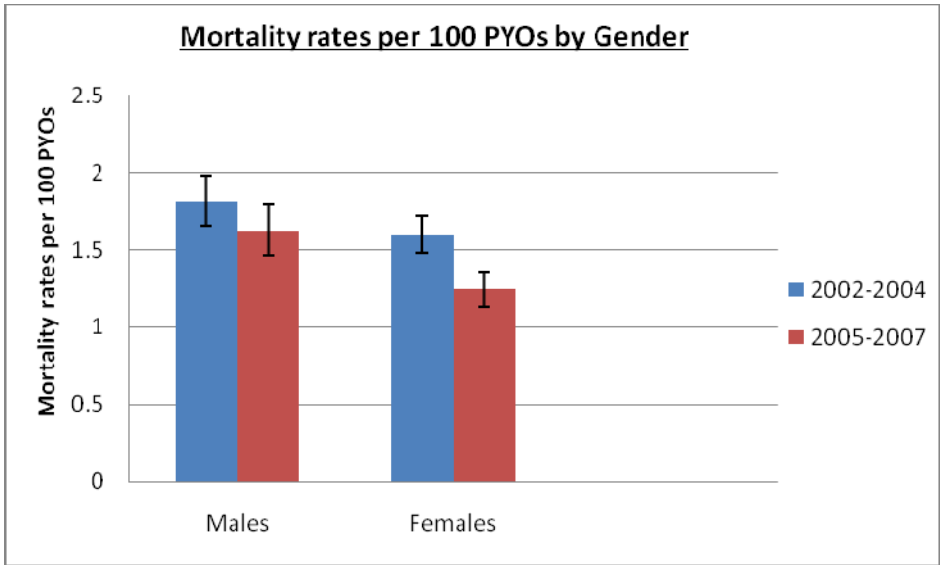

Figure 3.2 HIV/AIDS Mortality Rates/100 PYOs by gender for the two periods

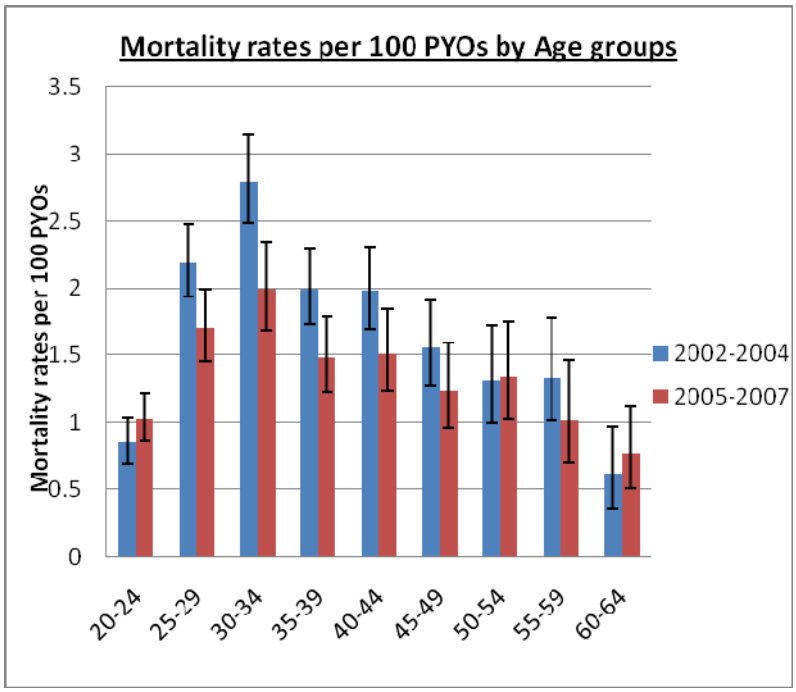

Figure 3.3 HIV/AIDS Mortality Rates/100 PYOs by age categories for the two periods

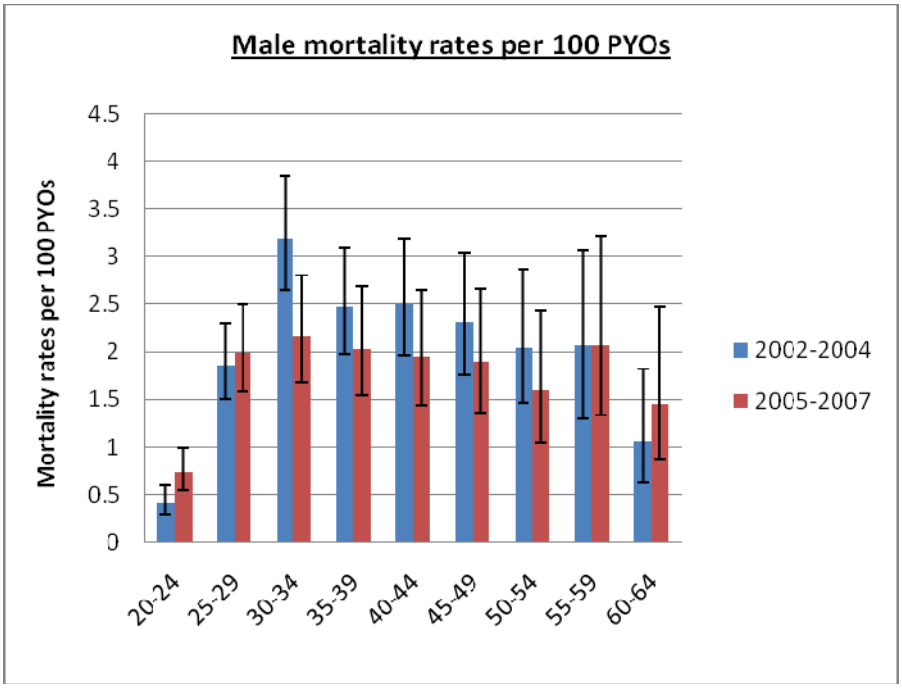

Figure 3.4 Male HIV mortality rates in KZN for the period 2002-2004 and 2005-2007

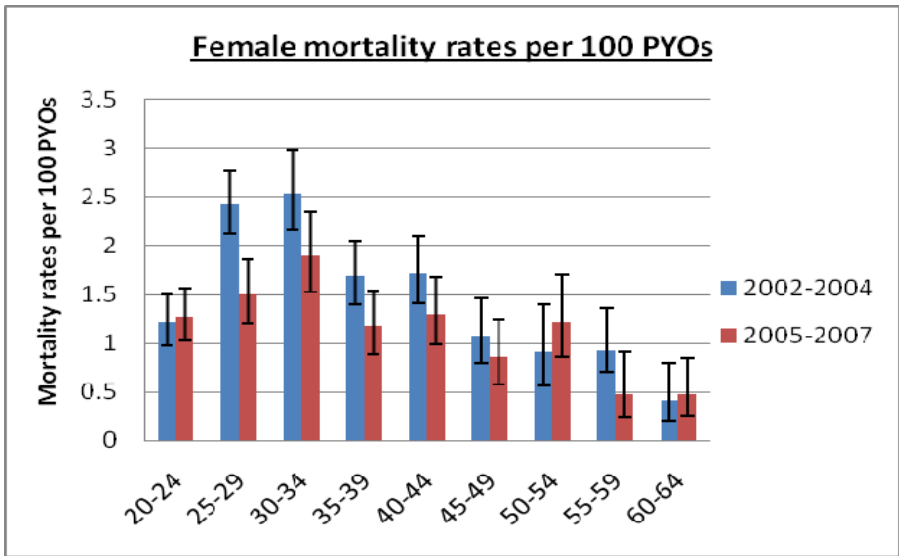

Figure 3.5 Female HIV mortality rates KZN for the period 2002-2004 and 2005-2007

Figure 3.3 shows the trend of mortality rates by age groups. There was a significant decline in mortality rate in the age group 30-34 in the second period. There was no significant difference in mortality for the other age groups in both periods as shown by the overlapping confidence

bands. Between age groups, there were significant differences in mortality rate in the age group 20-24 and the other age groups 25-29, 30-34, 35-39 and 40-44 in both periods. No significant difference in mortality rate was noted among the other age groups in both periods.

3.3 HIV/AIDS mortality rates by marital status categories for the periods 2002-2004 and 2005-2007

The HIV/AIDS mortality rates by marital status are shown in table 3.5 below. In the first period the Never married and not engaged had the highest mortality rate [2.08/100 PYO; 95% CI (1.94,2.23)]. In the second period the mortality rate for the same group decreased to 1.71/100 PYO; 95% CI (1.57,1.86). There was a significant decrease of 18% in mortality for individuals in this category [MRR = 0.82,95% CI (0.24,0.99)]. There were mortality declines for other categories of marital status in the second period except for polygamous unions where mortality rate increased. The declines and increases in mortality rates above were not significant. Individuals who were married had lower mortality rate of 0.87/100 PYO; 95% CI (0.75,1.03) in the first period and 0.71/100 PYO; 95% CI (0.58,0.85) in the second period. During the pre-ART time,the MR for the unknown marital status was highest(2.19/100PYOs;95% CI(1.53,3.31).

Figure 3.6 shows a similar trend in mortality rates by marital status. Between the categories, there were significant differences in mortality rates between those who were married and other marital status categories in both periods as shown by the non overlapping confidence bands. The other marital status categories did not show any significant difference in mortality rates among themselves in both periods. Within the categories of marital status, the Never married and not engaged category had a significant decline in mortality rates in the second period. The

other marital status categories did not show any significant difference in mortality rates within themselves in both periods.

Table 3.5 HIV/AIDS mortality rates in adults by marital status categories for the period 2002-2004 and 2005-2007(age: 20 years or older but less or equal to 64 years).

Variable	**2002-2004**			**2005-2007**		
	PYOs	**Deaths**	**MR/100PYOs (95%CI)**	**PYOs**	**Deaths**	**MR/100PYOs (95%CI)**
Marital S						
Married	17260.8	151	0.87(0.75,1.03)	15149.7	107	0.71(0.58, 0.85)
Widowed	4870.5	73	1.50(1.19, 1.89)	4150.9	61	1.47(1.14, 1.89)
Divorced/S	693.7	14	2.02(1.19,3.41)	565.3	11	1.95(1.08,3.51)
NBM(NE)*	37820.7	785	2.08(1.94, 2.23)	30802.5	527	1.71(1.57, 1.86)
NBM(E)	6937.4	115	1.66(1.38, 1.99)	5790.7	78	1.35(1.08, 1.68)
Polygamy	558.7	4	0.72(0.27,1.91)	488.8	6	1.22(0.55,2.73)
Unknown	1322.0	29	2.19(1.53,3.31)	940.3	13	1.38(0.81,2.35)
Total	**69460.8**	**1171**	**1.69(1.60,1.79)**	**57888.2**	**803**	**1.39(1.30,1.49)**

*** Significant difference in HIV related mortality rates in the two periods**

NBM (NE): Never been married and not engaged; **Marital(S):** Marital Status

NBM (E): Never been married but engaged; **Divorced/S**: Divorced/Separated

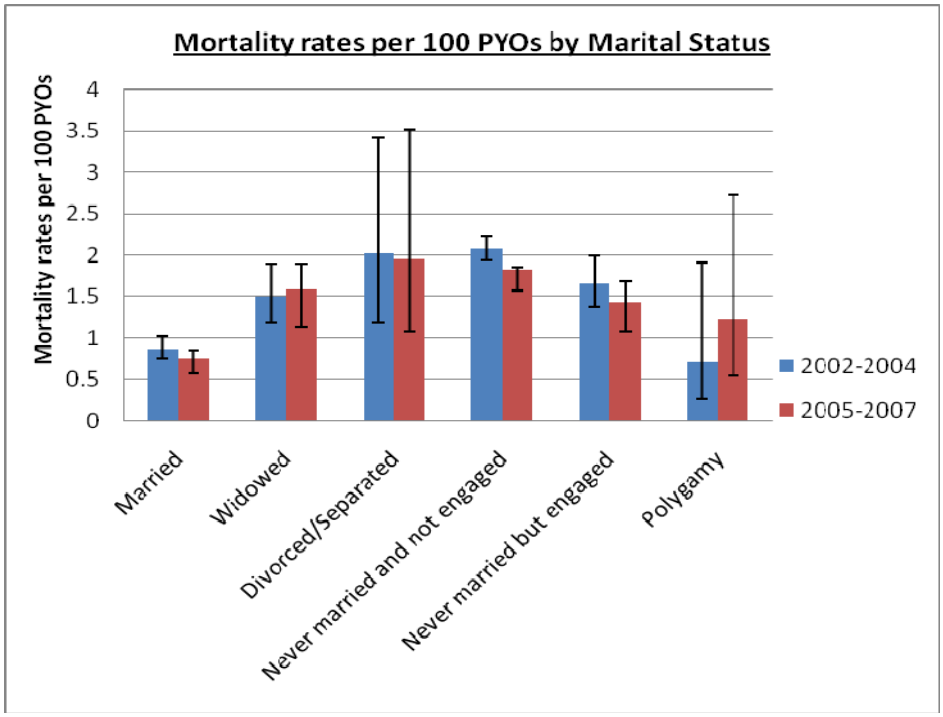

Figure 3.6 HIV/AIDS Mortality Rates/1000 PYOs by Marital status categories.

3.4 HIV/AIDS mortality rates by Education levels for the periods 2002-2004 and 2005-2007

Table 3.6 shows HIV related mortality rates by education categories for the periods 2002-2004 and 2005-2007 compared. There were declines in mortality rate for individuals in the None,Primary and Tertiary categories of education. In the Secondary education category, there was no change in mortality rates in both periods. Individuals in the primary level category had a 17% significant decline in mortality rate from 1.81/100 PYOs; 95% CI (1.67, 1.96) in the first period to 1.50/100 PYOs; 95% CI (1.36,1.65) in the second period [MRR = 0.83,95% CI (0.77,0.88)]. Individuals with tertiary education had the lowest mortality rate of 0.61/100 PYOs; 95% CI (0.39,0.95) in the first period and 0.47/100 PYOs; 95% CI (0.27, 0.83) in the second period. During the pre-ART time,the MR for the unknown education level was highest(3.53/100PYOs;95% CI(2.99,4.16).

Table 3.6 HIV/AIDS mortality rates in adults by education level categories for the periods 2002-2004 and 2005-2007 (age: 20 years or older but less or equal to 64 years).

Variable	**2002-2004**			**2005-2007**		
	PYOs	**Deaths**	**MR/100PYOs (95%CI)**	**PYOs**	**Deaths**	**MR/100PYOs (95%CI)**
Education(L)						
None	11531.5	194	1.68(1.46, 1.94)	9696.3	145	1.49(1.27, 1.76)
Primary*****	33032.8	599	1.81(1.67, 1.96)	27958.9	419	1.50(1.36,1.65)
Secondary	17148.4	222	1.29(1.34, 1.48)	14524.1	187	1.29(1.12, 1.49)
Tertiary	3128.1	19	0.61(0.39, 0.95)	2539.9	12	0.47(0.27, 0.83)
Others	72.6	1	1.38(0.19,9.78)	59.4	1	1.68(0.24, 11.9)
Unknown	3847.4	136	3.53(2.99,4.16)	2609.0	39	1.49(1.09,2.03)
Total	**68760.8**	**1171**	**1.70(1.61,1.80)**	**57387.6**	**803**	**1.40(1.31,1.50)**

Education (L): Education Level

*** Significant difference in HIV related mortality rates in the two periods**

Mortality trends by education level categories are further displayed in Figure 3.7 below. Between the education level categories, there were significant differences in mortality rates between individuals in Tertiary education and other education categories in both periods as shown by the non overlapping confidence bands. Similarly there was a significant difference in mortality rates between individuals with Primary and Secondary education in period 1 but not in period 2. Within the education level categories, individuals in the Primary education category showed a significant decrease in mortality in both periods.The other categories did not show any significant difference in mortality in the two periods

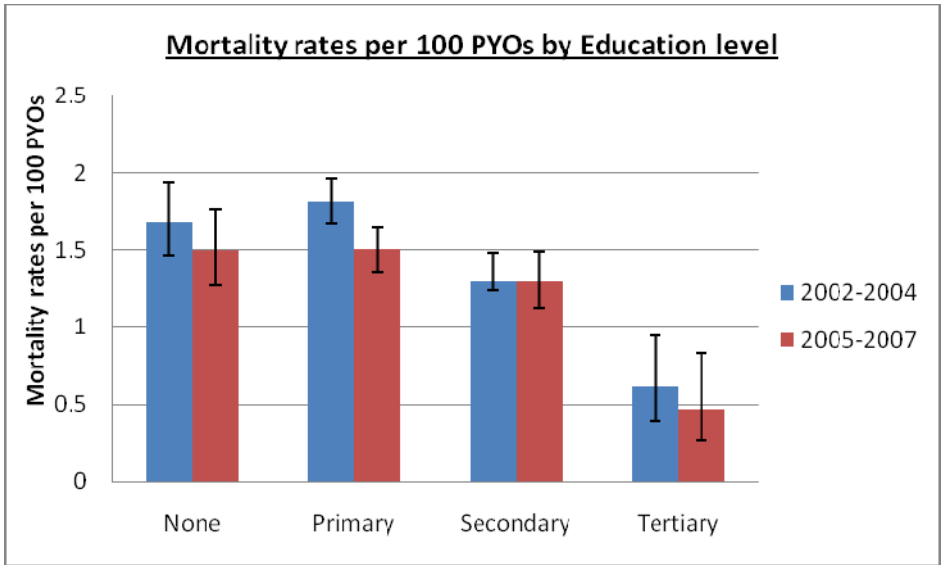

Figure 3.7 HIV/AIDS Mortality Rates/1000 PYOs by Education level categories

3.5 HIV/AIDS mortality and adult survival

Females had higher survival than males as shown by Kaplan Meier survival estimates in Figure 3.8. Log-rank test showed significant difference in the two survival functions (Chi2 (1) = 54.44, Pr > Chi2 = 0.0000). Figure 3.9 and 3.10 show survival curves by marital status and education levels respectively. Married individuals had higher survival than the other marital status categories. Log rank test showed significant difference (Chi2 (5) = 101.31, Pr > Chi2 = 0.0000). Similarly individuals with tertiary and secondary education had higher survival than the other education categories. There was a significant difference in the survival functions (Chi2 (3) = 115.96, Pr > Chi2 = 0.0000).

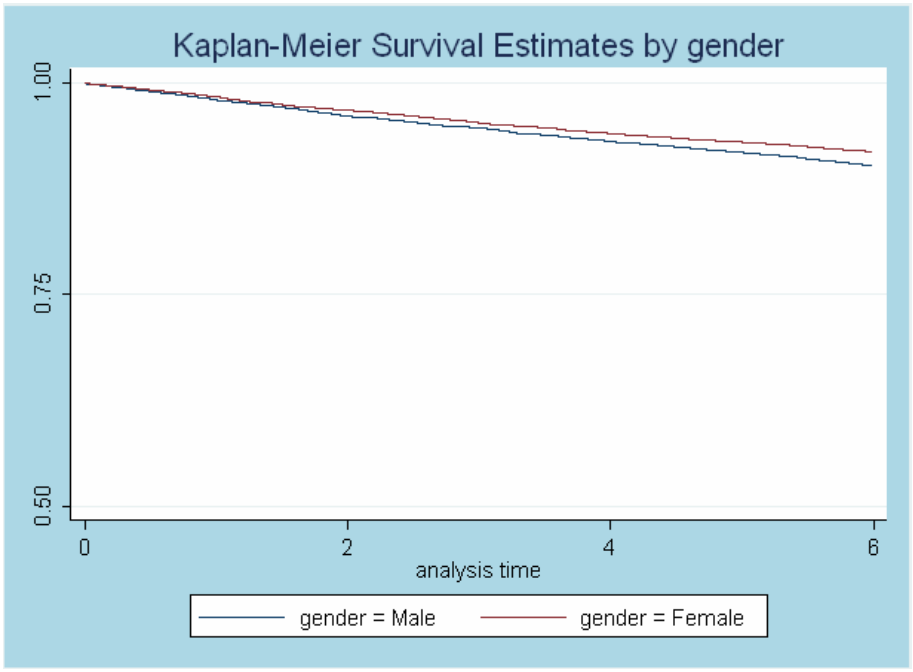

Figure 3.8 Survival curve of individuals by Gender

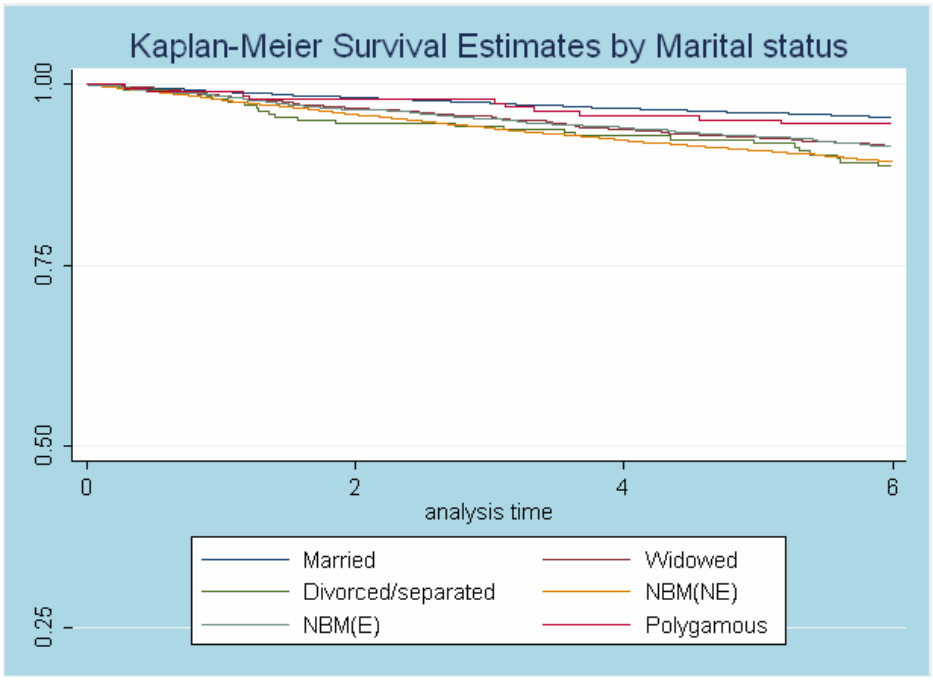

Figure 3.9 Survival curve of individuals by Marital Status

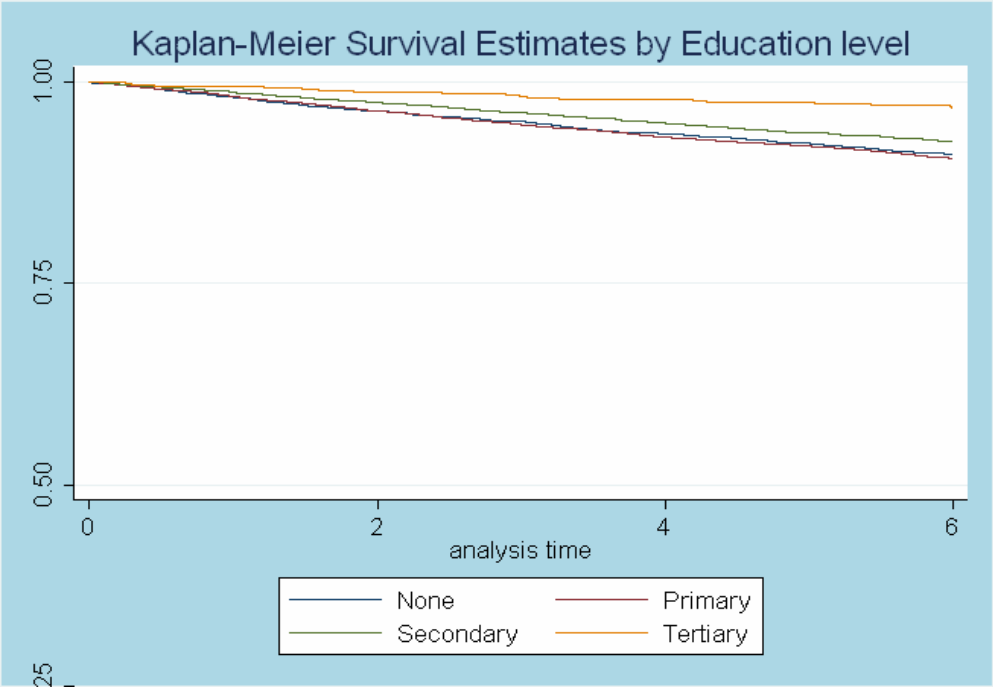

Figure 3.10 Survival curve of individuals by Education level

3.6 Univariate analysis of factors associated with HIV/AIDS mortality in adults

In a univariate Weibull parametric regression model shown in table 3.7 below, females had a 17% lower risk of death as compared to males [crude HR = 0.83,P < 0.0001, 95% CI (0.76, 0.91)]. The widowed had 86% increased risk of dying compared to those who were married [crude HR = 1.86, P < 0.0001, 95% CI (1.51, 2.30)] while the divorced/separated had a 148% increased risk of dying compared to the married [crude HR = 2.48, P < 0.0001, 95% CI (1.65, 3.75)]. Individuals in the never married and not engaged category had a 139% increased risk of dying compared to the married category [crude HR = 2.39, P < 0.0001, 95% CI (2.09, 2.73)] whereas those in the never been married but engaged category had 89% increased risk of death [crude HR = 1.89, P = 0.000, 95% CI (1.57, 2.28)]. The above increased risks in the four categories of marital status were statistically significant.

Table 3.7 Univariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 25738)

Variable	Hazard Ratio(HR)	95%CI	P-value
Sex of adult			
Males (Reference)	1		
Female*	0.83	(0.76, 0.91)	0.0001
Marital Status			
Married (Reference)	1		
Widowed*	1.86	(1.51, 2.30)	0.000
Divorced/Separated*	2.48	(1.65, 3.75)	0.000
Never been married & not engaged*	2.39	(2.09, 2.73)	0.000
Never been married but engaged*	1.89	(1.57, 2.28)	0.000
Polygamous marriage	1.19	(0.63, 2.25)	0.574
Education			
None (Reference)	1		
Primary	1.05	(0.93, 1.18)	0.456
Secondary*	0.81	(0.70, 0.93)	0.004
Tertiary*	0.34	(0.24, 0.49)	0.000
Age	0.99	(0.993, 1.000)	0.053
Socio-economic status			
Poorest (Reference)	1		
Poorer	0.38	(0.13, 1.05)	0.063
Poor	0.56	(0.23, 1.41)	0.222
Less poor*	0.32	(0.11, 0.99)	0.049
Least poor*	0.35	(0.13, 0.99)	0.048
Employment			
Not employed (Reference)	1		
Employed full time*	1.12	(1.01, 1.24)	0.026
Employed part time	0.95	(0.75, 1.21)	0.675

Partnership patterns			
No partners (Reference)	1		
Casual partners	1.29	(0.98,1.66)	0.060
Regular partners*	1.73	(1.58, 1.90)	0.000

*** Significant at 5% significance level**

In the education category individuals who had attained secondary level had a 19% reduction in risk of dying compared to those with no education [crude HR = 0.81, P = 0.004, 95% CI (0.70, 0.94)]. Individuals in the tertiary education category had a marked reduction in mortality risk of 66% compared to those with no education [crude HR = 0.34, P < 0.0001, 95% CI (0.24, 0.49)]. All the reductions in the two categories of education were statistically significant.

The less poor had a 68% reduction in risk compared to the poorest [crude HR = 0.32, P = 0.049, 95% CI (0.11, 0.99)] while the least poor had a risk reduction of 65% [crude HR = 0.35, P = 0.048, 95% CI (0.13, 0.99)] which were statistically significant. In the employment category, individuals who were employed full time had 12% increased risk of dying [crude HR = 1.12, P = 0.026, 95% CI (1.01, 1.24)]. On the other hand individuals with regular partners showed a 73% increased risk of death [crude HR = 1.73, P < 0.0001, 95% CI (1.57, 1.89)] which was statistically significant.

3.7 Multivariate analysis of factors associated with HIV/AIDS mortality in adults

In a multivariate Weibull model adjusted for sex, age, employment, socioeconomic status and partnerships, the observed association between education level, marital status and HIV/AIDS mortality was attenuated. The model is shown in table 3.8 below. In this model females had a 14% reduced risk of dying compared to their male counterparts [Adjusted HR = 0.86, P = 0.001, 95% CI (0.79, 0.95)].

The widows had a 72% increased risk of death compared to married individuals [Adjusted HR = 1.72, P = 0.000, 95% CI (1.39, 2.13)]. The divorced/separated had a 116% increased risk of dying compared to the married [Adjusted HR = 2.16, P < 0.0001, 95% CI (1.43, 3.27)]. There was a 130% increase in risk of dying for individuals who had never been married and not engaged [Adjusted HR = 2.30, P < 0.0001, 95% CI (1.92, 2.76)] whereas in the never married but engaged category the increase in the risk of dying was 48% [Adjusted HR = 1.48, P = 0.001, 95% CI (1.18, 1.86)]. The increased risks of dying in the four categories of marital status were statistically significant.

Table 3.8 Multivariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 25738)

Variable	**Hazard Ratio(HR)**	**95%CI**	**P-value**
Sex of adult			
Males (Reference)	1		
Females *	0.86	(0.79, 0.95)	0.002
Marital Status			
Married (Reference)	1		
Widowed*	1.72	(1.39, 2.13)	0.000
Divorced/Separated*	2.16	(1.43, 3.27)	0.000
Never been married & not engaged*	2.30	(1.92, 2.76)	0.000
Never been married but engaged*	1.48	(1.18, 1.86)	0.001
Polygamous marriage	0.93	(0.48, 1.81)	0.830

Education			
None (Reference)	1		
Primary	1.02	(0.89, 1.16)	0.805
Secondary*	0.73	(0.62, 0.85)	0.000
Tertiary *	0.34	(0.24, 0.49)	0.000
Age*	1.01	(1.005, 1.015)	0.000
Partnership patterns			
No partners (Reference)	1		
Casual partners	0.99	(0.76, 1.31)	0.979
Regular partners*	1.37	(1.21, 1.56)	0.000
Socio-economic status			
Poorest (Reference)	1		
Poorer	0.35	(0.12, 1.03)	0.432
Poor	0.63	(0.24, 1.66)	0.354
Less poor	0.35	(0.11, 1.10)	0.073
Least poor*	0.28	(0.09, 0.84)	0.023
Employment			
Not employed	1		
Employed fulltime*	1.21	(1.09,1.34)	0.000
Employed part time	0.93	(0.74,1.18)	0.545

*** Significant at 5% significance level**

In the education category, individuals in the secondary level had a 27% reduced risk of dying compared to those with no education [Adjusted HR = 0.73, P < 0.000, 95% CI (0.62, 0.85)]. Individuals with tertiary education had a 66% reduced risk of dying compared to those with no education [Adjusted HR = 0.34, P <0.0001, 95% CI (0.24, 0.49)]. The reductions in risk of dying for individuals in the secondary and tertiary levels of education were statistically significant. In the socioeconomic status category the least poor had a 72% reduction in risk of

dying compared to those in the poorest category [Adjusted HR = 0.28, P = 0.023, 95% CI (0.09, 0.84)] and showed statistical significance.

There was a 1% increase in risk of dying with one year increase in age [Adjusted HR = 1.01, P < 0.0001, 95% CI (1.005, 1.015)]. Individuals in the regular partnerships category had a 37% increased risk of dying compared to those with no partners [Adjusted HR = 1.37, P < 0.0001, 95% CI (1.21, 1.56)] and this was statistically significant. In the employment category, individuals who were employed full time had a 21% increased risk of dying compared to those who were not employed and this was statistically significant [Adjusted HR = 1.21, P < 0.0001,95% CI (1.09,1.34)].

Interactions were checked between age and sex, education and marital status. The interaction terms in the two cases were not significant. Interactions were also checked between marital status and partnership patterns, sex and education, sex and marital status, and sex and partnership patterns. In all the cases the interaction terms were not significant.

Multivariate models were generated separately for males and females to check if marital status was more protective for males than females. There was no significant difference between hazard ratios for the overall model and the hazard ratios obtained in the two separate models for males and females (table 3.9.1 and table 3.9.2 in Appendix 1). This means that marital status in this community was equally protective for both. The stratified analysis by period did not reveal different Hazard Ratios. The Hazard Ratios observed in period 1 (2002-2004) and period 2 are merely the same (see tables 3.93, table 3.94 and Appendix 1).

CHAPTER FOUR: DISCUSSION AND CONCLUSION

This is the first longitudinal population based cohort study in this community to investigate the relationship between marital status and education level on HIV/AIDS excess mortality in adults. The study also sought to find out changes in HIV/AIDS related mortality rates in adults both before and after the roll out of antiretroviral drugs (ARVs). The study illustrates that there was a significant decline in HIV/AIDS mortality in this part of rural KwaZulu-Natal after the roll out of ARVs. HIV/AIDS mortality seems to be rising in the older population, offsetting earlier gains made in this geographic area. Survival curves indicate that females had higher survival than males. Men could also present at advanced stages of HIV/AIDS and may subsequently have higher mortality rate. Marital status and education level were associated with HIV/AIDS mortality in adults in rural KwaZulu-Natal. Individuals who were married and those having secondary or tertiary level of education had reduced risk of dying from HIV/AIDS and hence higher survival.

4.1 Mortality rates and adult survival

There was a reduction in HIV/AIDS mortality rates by gender (Mortality reduced from 1.81/100PYOs to 1.62/100PYOs for men while the reduction for women was from1.59/100PYOs to 1.24/100PYOs), age groups, marital status categories and education levels in the second period (2005-2007) after the roll out of ARVs. The mortality decline observed in the second period is probably due to the roll-out of Anti-Retroviral drugs (ART) towards the end of 2004. Since the start of the ART programme in late 2004, approximately 1000 individuals had been initiated onto treatment by the end of 2005, and by the end of 2006 over 1800 individuals were receiving treatment[28, 58]. With respect to the substantial effect that antiretroviral therapy has on survival and the large number of eligible adults in the

surveillance population who had accessed antiretroviral therapy, findings about reductions in mortality may be attributed to antiretroviral therapy.

Alternative explanations for this mortality decline are unlikely. First, the temporal correspondence of the decline in mortality and the introduction of ART suggest that the ART programme may be causal in the decline observed as no other interventions have been introduced in this area. Second, results from other studies in the surveillance area show that HIV-infected individuals are not more likely to out-migrate compared to HIV un-infected individuals[51]. Thus, it is unlikely that migration effects gave rise to the observed decline in mortality observed in this study. Third, antenatal prevalence rates have not declined since the late 1990s [52], the current HIV incidence rate is high[26] and HIV prevalence in the community have been increasing steadily[53, 54]. It is thus most unlikely that the decrease in mortality is a late effect of a rapid decline in HIV incidence in the population.

A closed cohort study carried out in Brazil to determine the effect of HAART revealed that HIV mortality dropped from 18.32/100 PYOs; 95% CI (14.40, 23.20) before introduction of HAART to 2.63/100 PYOs; 95% CI (1.58-4.01) after the introduction[55]. In Europe, Amanda[56] et al reported in the AIDS issue of the Lancet that HIV/AIDS mortality dropped from 15.6/100 PYOs to 2.7/100 PYOs after introduction of HAART. In another prospective cohort study by Jahn et al[29] in Malawi, HIV/AIDS mortality rates in adults dropped from 4.3/100 PYOs; 95% CI (3.9-4.9) to 0.90/100 PYOs; 95% CI (0.70-1.14). These are consistent with results obtained for individuals in this study and may further strengthen the importance of ART provision.

Males have higher HIV/AIDS related mortality rates than females even though infection remains high in females in this community, consistent with reports from other studies[26, 57]. Up to November 2008, 6240 adults had been initiated on ART of whom 68% are female[58]. We would expect lower numbers of men on ART because there is a predominance of women in

the population and women are infected at lower age since they reach sexual debut earlier than men in this community[26]. Furthermore, studies reveal that individuals infected at lower age have higher survival[29, 55, 56]. On the other hand, even before the advent of ART, mortality was reported to be higher among HIV-infected men than HIV-infected women.[59, 60, 61]. The increase in mortality for men could be due to the fact that men are infected at older age where mortality is high.[62]

The results show a general increase in the pattern of mortality with age in the age groups 20-24, 25-29 and 30-34 in the two separate periods, consistent with recent results obtained in the same area[26]. This pattern is consistent with observations from similar demographic surveillance sites in Africa[62]. An earlier study in northern Malawi on the long term survival by HIV status also showed a general increase in mortality rates with increasing age[63]. It has been shown that a one year increase in age is associated with an additional 6% mortality risk [64]. Interventions that target these sexually active groups such as condom promotion and treatment of sexually transmitted infections may be critical. More recent studies have suggested that the African population is more vulnerable to HIV mortality than other races due to the presence of a gene found only in the African population[18]. Prevention necessitates the systematic study of other risk factors that may reduce the burden of HIV/AIDS mortality in the African population.

There was a levelling off of HIV/AIDS mortality in 2002 and 2003 just before the introduction of ARVs. This is consistent with previous studies in Rwanda[65] and may suggest the presence of a sub-group that is relatively resistant to HIV-1 disease progression. It could also be that viral, genetic and immunological factors [64] that favour slower HIV-1 disease progression may be more common than anticipated in this population.

AIDS mortality measure is just a proxy for the bigger problem which is infection. ARVs are prolonging the inevitable in the absence of viable curative and preventative measures. Therefore down the road, we may see the deaths increasing only that the frequency of death will be shifted to older ages as revealed by the data. The results of this study and that of others[64, 66, 67] highlight the need to initiate interventions that target older members of the population.

Reducing mortality and improving the health of adults has long been a concern of the international community. One of the eight Millennium Development Goals (MDGs) adopted after the Millennium Summit in 2000 is to reduce HIV/AIDS mortality (MDG6) by 2015. Two of the key indicators for monitoring progress towards this goal are the HIV/AIDS mortality rates by gender and age groups (UN Millennium Declaration). The findings therefore show that more effort is needed in scaling up the provision of ARVs if the destructive effects of HIV/AIDS are to be conquered.

4.2 Factors associated with HIV/AIDS mortality in adults

Studies have reported low rates of marriage and cohabitation in young adults in South Africa as one of the causes of high HIV infection and mortality[7, 74]. There is also a high average age at marriage in the population. Bradshaw[68] et al reported that the mean average age at marriage for men was 33.7 and 29.5 years in women. This leads to a long period of premarital sex during which partner changes are relatively common, thus facilitating the spread of HIV. In this study being married was significantly associated with low HIV/AIDS mortality in adults. The effect of marriage remained significant even after controlling for age, sex, education, socioeconomic status and employment. Individuals who were single had higher risk of dying than those who were married. This is consistent with various studies done elsewhere[20, 31, 34].

This study therefore provides more evidence for the protective effect of marriage observed in earlier studies. In Uganda relationships which neither are church or legal marriages, nor culturally approved through payment of bride price are not seriously respected. Where such marriages are common there is evidence for increased HIV/AIDS mortality among the married[69]. The effect of marital status is therefore influenced by cultural practices of a community. Unmarried persons usually tend to consider themselves free in sexual matters and so are at greater risk of HIV/AIDS related mortality in their search for partners. Being married also increases the likelihood that intimacy needs are being met, which may militate against seeking multiple partners. In my opinion individuals who are married are likely to receive good care when sick as compared to those who are single. Alternatively, marriage may confer economic stability in the family due to pooling of resources together and the specialisation of household tasks and this may have both direct and indirect effects on longevity. This is supported by a study that compared patterns of mortality by marital status in Hungary and in England and Wales. The study demonstrated that increases in premature mortality in Hungary have been greatest among men who are widowed, have never married and, in particular, are divorced, with married men appearing to be relatively protected. Among women, the greatest increase has been among widows. The authors explored competing explanations for this difference and concluded that economic factors were likely to have been of major importance[70].

Higher survival observed among the married may also be as a result of self selection and marriage market sorting. For example healthy individuals are more likely to get married than the less healthy and the difference in health endowment may explain the observed higher hazards among singles[20, 26, 40]. The high cost of Lobola (a gift from groom to bride) means

men and women stay longer in the single state in this community, potentially exposing them to AIDS excess mortality.

Compared with the unmarried, married individuals may view life with a lot of hope and enhanced aspirations for the future. They hope to build a happy family, raise children and have a stature among their contemporaries. This positive view of life together with love and affection between the couple may enhance survival chances[35, 36]. According to Abraham Maslow's theory of human motivation (1943) people need to love and be loved (sexually and non-sexually) by others[71]. In the absence of these elements, many people become susceptible to loneliness, social anxiety and clinical depression. This need for belonging can often overcome the physiological and security needs, depending on the strength of the peer pressure; an anorexic, for example, ignores the need to eat and the security of health for a feeling of control and belonging. Affection and love are essential to individuals as they move towards self actualization. A feeling of rejection by those who are single may lower their self esteem often leading to hopelessness with lower chances of survival.

There are chances that lower hazards among the married could be as a result of divorce and separation. Unfaithfulness which is a risk factor for HIV infection is usually a major cause for divorce and separation. It may be true that infection for these individuals actually occurs within marriage and when unfaithfulness is detected by a partner, divorce/separation ensues so that more individuals die eventually in the divorced/separated states compared to those who are married[58].

The findings also reveal that educational attainment was associated with HIV/AIDS mortality. Individuals having secondary or tertiary levels of education had lower risks of dying compared to those with no education. The findings are in agreement with previous studies[19, 34, 46, 47].

Most of the studies that have examined the relationship between education and HIV infection and death were conducted during the first period of the epidemic. There was a positive association of education with HIV infection and death. This means that the more education an individual had, the higher the risk of HIV infection and death. This was partly due to the fact that hardly any HIV information was available to the public during the early period (1980s) of the epidemic [44, 59]. It is important to note that during this period, education was a proxy for social status, putting people with higher status at higher risk of HIV infection and death. The more educated had more partners in any given period of time than the less educated[57].

In contrast, as the epidemic matured, the more educated may have adopted HIV risk-reducing behaviours more quickly than the less educated because they were more exposed to health promotion messages or more empowered to negotiate protective behaviours such as condom use with sexual partners[48].

Individuals who have higher education are more likely to get better jobs and higher incomes and increased access to quality health services. This together with increased access to HIV/AIDS information may confer better health and socioeconomic condition for the more educated than the less educated. Increased levels of educational attainment are also associated with higher levels of self control, efficacy and happiness. This increased hope for the future and positive self evaluation, as noted earlier, may confer longevity[35, 36].

As far as socioeconomic status is concerned, only the least poor group were associated with a significantly reduced risk of dying while the other categories showed no association. Though poverty reduction is important for obvious reasons it may not be as effective as anticipated in reducing HIV infection and death in this community since socioeconomic differences in this rural population may not be significant[57]. Individuals in full time employment have increased risk of dying. The individuals in fulltime employment are more likely to earn a higher

disposable income which may allow them to spend more in acquiring and maintaining regular partners. The higher hazards observed for those in full time employment could also be due to the fact that in this area people move outside (migratory labour) to find jobs. This makes them more vulnerable to increased risk of HIV infection and increased mortality[51].

I investigated several factors that could potentially bias the mortality rates and hazard ratio estimates. Individuals migrating out of the study area could be different from those remaining in terms of main exposure and outcome variables. Assuming those who migrated were infected and died soon afterwards, then under-estimate of mortality could occur. However previous studies reveal that HIV infected individuals are less likely to migrate compared to HIV un-infected individuals[51]. This means underestimation of HIV related deaths was unlikely. About 7% of the population out-migrated during the period of follow-up (2002-2007). These individuals were uniformly distributed across the categories of exposure variables and could not be linked to outcome or explanatory variables in any systematic way-thus minimizing any bias.

It is likely that some individuals changed their marital status during the period. This could only affect the mortality estimates and hazard ratios if they had different mortality patterns from those that were already married at baseline, which is unlikely since they are members of the same population in the same geographic location and ethnicity. Divorce and marriage rates are also low in this community and so changes in marriage would likely not be a significant factor[7, 74]. A closer look at the marital status of those who were alive at the end of the period revealed that less than 3% had changed their marital status and these were distributed uniformly among the marital status categories.

Participation rates in the demographic rounds that were used to ascertain HIV related mortality are very high. Not all those who migrate are lost to follow up as individuals are followed up to

major towns by a team of interviewers to ascertain their mortality status. Less than 1% of adults ever resident in the study area were censored because they were lost to follow up and so it is unlikely that the analysis was biased by the large scale omission of deaths.

To further validate the protective nature of marriage, data were reviewed to establish whether individuals who were married differ significantly from the other marital status categories in terms of education and socioeconomic status. There was no significant difference between married individuals and other marital status categories in terms of education level (Pr = 0.643). Similarly, there was no significant difference between married individuals and other categories of marital status in terms of socio-economic status (Pr = 0.427) and married individuals were distributed uniformly among the education levels and socioeconomic quintiles.

4.3 Implications of study

The findings of this study have major programmatic implications. First, achieving secondary education for all would be a critical contribution to HIV prevention. It is not just about meeting national goals but focusing on regions within the country that are falling behind. It requires strengthening country actions to achieve universal access to secondary education, addressing equity and retention, equality in gender, and geography. HIV/AIDS prevention programs need to be placed within a package that can be implemented sustainably by the education sector. A review of primary, secondary, and tertiary curricula is required to include appropriate reproductive health and HIV-related education, produce relevant education materials, and train teachers in the use of these materials. In the long run, HIV/AIDS- specific curricular and life skills programs should be combined with broader school health promotion programs.

There is a need to strengthen programs for ensuring participation and completion by orphans and vulnerable children at the primary and secondary levels, and to ensure that curriculums at

all levels address stigma and discrimination. Investment in education is vital because it promotes achievement of six of the eight Millennium Development Goals: reducing poverty, achieving universal primary education, improving gender equality, reducing infant and child mortality, improving maternal health, and lowering the prevalence of HIV/AIDS (MDG 6).

Secondly, Policies that make marriage more sustainable and attractive to young men and women could be formulated by the government especially in high HIV/AIDS prevalent areas. This could be in form of higher tax relief to those who are married with no relief to those who are single. Poverty alleviation programmes targeting the youth can improve their marriage capability and also empower women who are usually more vulnerable economically. There could be changes in traditional marriage practices that dictate high payment of lobola (bride wealth). Lobola presents an economic barrier to marriage in this community[74]. High cost of marriage exposes young people to the risk of HIV infection and death.

Thirdly, and perhaps more important, there is a need to address access to ARVs by all those who need them. More clinics in rural areas may be opened to address the gaps. There should be a policy shift regarding the training of health personnel as more clinics require more staff to achieve this goal. HIV/AIDS interventions need to target the old since they too are at increased risk of HIV infection and death [61].

4.4 Limitations of study

Previous studies have shown that analyses of verbal autopsies alone, without knowledge of HIV status, can underestimate deaths caused by AIDS[72]. Therefore, assessments of mortality due to AIDS by use of verbal autopsies alone may not be valid. Systematic assessments of the ascertainment of AIDS deaths by verbal autopsies have shown that their sensitivity ranges from 76% to 92% [73] and that they have a specificity of 66% compared with diagnoses based on HIV serostatatus[60]. There is a possibility of misclassification of AIDS deaths by verbal

autopsy procedures in this study leading to underestimate or overestimate of hazard ratios and mortality rates. Identifying methods for obtaining reliable information on cause-specific mortality using VA especially for HIV/TB remains an important research priority, as does the validation of such methods when used in different settings. However there is no reason to believe that such misclassification was not uniformly distributed among the education and marital status categories and so systematic bias is unlikely.

The other limitation was missing observations. Minimizing the number of missing observations is difficult when data is already collected (Secondary data). The problem is whether missing observations are randomly missing or missing because of some systematic or causal factor. Missing values were found to be uniformly distributed among the marital status and education categories. It may also be possible that a reasonable percentage of the missing values came from the categories of marital status and education levels with high risk of HIV/AIDS mortality Missing observations for each variable were coded as “Unknown” and used in the analysis.

Finally, this was not a representative sample of the population of KwaZulu-Natal province. Rather, the cohort under study comprised of a relatively homogeneous population with respect to age, sex, residence and ethnicity. In a homogeneous population it is possible that genetic, viral or immunological factors favoring long term survival could be overrepresented. The non representative nature of the sample and the possible homogeneity, may limit the applicability of my findings to other populations.

4.5 Conclusion

Marital status and education level may be predictors of HIV/AIDS mortality in adult populations. In the UMkhanyakude district of KwaZulu-Natal, individuals that were married and those with secondary and tertiary education had lower mortality rates, a lower risk of HIV

infection and hence longer survival than their counterparts. Exactly how marriage confers protection on individuals remains controversial and more research here is certainly needed.

The rapid and extensive introduction of antiretroviral therapy may be responsible for the reduction of HIV/AIDS mortality in this district of rural KwaZulu-Natal. However, these gains seem to be currently offset by the emergence of high HIV/AIDS mortality among the youth and the older population. Overall these results suggests that an ART programme, even when not yet fully covering all eligible people, may substantially improve HIV- related mortality in areas with high infection rates. Access to ARVs by those who need them is therefore critical to reducing HIV/AIDS deaths in this and similar communities.

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APPENDIX 1

Table 3.9.1 Multivariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 10268) stratified by gender (MALES)

Variable	**Hazard Ratio(HR)**	**95%CI**	**P-value**
Marital Status			
Married (Reference)	1		
Widowed*	1.76	(1.40, 2.21)	0.000
Divorced/Separated*	2.10	(1.32, 3.33)	0.002
Never been married & not engaged*	2.35	(1.93, 2.86)	0.000
Never been married but engaged*	1.63	(1.27, 2.08)	0.000
Polygamous marriage	0.84	(0.39, 1.79)	0.655
Education			
None (Reference)	1		
Primary	1.02	(0.88, 1.17)	0.807
Secondary*	0.75	(0.63, 0.89)	0.001
Tertiary *	0.35	(0.23, 0.52)	0.000
Age*	1.01	(1.004, 1.02)	0.000
Partnership patterns			
No partners (Reference)	1		
Casual partners	0.94	(0.69, 1.27)	0.671
Regular partners*	1.33	(1.15, 1.53)	0.000
Socio-economic status			
Poorest (Reference)	1		
Poorer	0.35	(0.12, 1.03)	0.432
Poor	0.63	(0.24, 1.66)	0.354

Less poor	0.35	(0.11, 1.10)	0.073
Least poor*	0.28	(0.09, 0.84)	0.023
Employment			
Not employed	1		
Employed fulltime*	1.21	(1.09,1.36)	0.001
Employed part time	0.96	(0.75,1.23)	0.768

*** Significant at 5% significance level**

Table 3.9.2 Multivariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 15470) stratified by gender (FEMALES)

Variable	**Hazard Ratio(HR)**	**95%CI**	**P-value**
Marital Status			
Married (Reference)	1		
Widowed*	1.76	(1.39, 2.21)	0.000
Divorced/Separated*	2.09	(1.32, 3.33)	0.002
Never been married & not engaged*	2.35	(1.93, 2.86)	0.000
Never been married but engaged*	1.63	(1.27, 2.08)	0.001
Polygamous marriage	0.84	(0.39, 1.79)	0.655
Education			
None (Reference)	1		
Primary	1.02	(0.88, 1.17)	0.807
Secondary*	0.75	(0.63, 0.89)	0.001

Tertiary *	0.35	(0.23, 0.52)	0.000
Age*	1.01	(1.004, 1.02)	0.000
Partnership patterns			
No partners (Reference)	1		
Casual partners	0.94	(0.69, 1.27)	0.671
Regular partners*	1.33	(1.15, 1.53)	0.000
Socio-economic status			
Poorest (Reference)	1		
Poorer	0.35	(0.12, 1.03)	0.432
Poor	0.63	(0.24, 1.66)	0.354
Less poor	0.35	(0.11, 1.10)	0.073
Least poor*	0.28	(0.09, 0.84)	0.023
Employment			
Not employed	1		
Employed fulltime*	1.21	(1.09,1.36)	0.001
Employed part time	0.96	(0.75,1.23)	0.768

*** Significant at 5% significance level**

Table 3.9.3 Multivariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 25738) stratified by period (PERIOD 1; 2002-2004)

Variable	**Hazard Ratio(HR)**	**95%CI**	**P-value**
Sex of adult			
Males (Reference)	1		
Females *	0.85	(0.76, 0.94)	0.001
Marital Status			
Married (Reference)	1		
Widowed*	1.76	(1.39, 2.21)	0.000
Divorced/Separated*	2.09	(1.32, 3.33)	0.000
Never been married & not engaged*	2.34	(1.93, 2.86)	0.000
Never been married but engaged*	1.63	(1.27, 2.08)	0.001
Polygamous marriage	0.84	(0.39, 1.79)	0.655
Education			
None (Reference)	1		
Primary	1.02	(0.88, 1.17)	0.807
Secondary*	0.75	(0.63, 0.89)	0.001
Tertiary *	0.35	(0.23, 0.52)	0.000
Age*	1.01	(1.004, 1.02)	0.000
Partnership patterns			
No partners (Reference)	1		
Casual partners	0.94	(0.69, 1.26)	0.671
Regular partners*	1.33	(1.54, 1.53)	0.000

Socio-economic status			
Poorest (Reference)	1		
Poorer	0.35	(0.12, 1.03)	0.432
Poor	0.63	(0.24, 1.66)	0.354
Less poor	0.35	(0.11, 1.10)	0.073
Least poor*	0.28	(0.09, 0.84)	0.023
Employment			
Not employed	1		
Employed fulltime*	1.21	(1.09,1.36)	0.001
Employed part time	0.96	(0.75,1.23)	0.768

*** Significant at 5% significance level**

Table 3.9.4 Multivariate Weibull parametric regression model for the analysis of risk factors for HIV/AIDS mortality in adults (Age: 20 years or older but less or equal to 64 years; n = 21428) stratified by period (period 2; 2005-2007)

Variable	**Hazard Ratio(HR)**	**95%CI**	**P-value**
Sex of adult			
Males (Reference)	1		
Females *	0.85	(0.76, 0.94)	0.001
Marital Status			
Married (Reference)	1		
Widowed*	1.76	(1.40, 2.21)	0.000
Divorced/Separated*	2.09	(1.32, 3.33)	0.002
Never been married & not engaged*	2.35	(1.93, 2.86)	0.000
Never been married but engaged*	1.63	(1.27, 2.08)	0.000
Polygamous marriage	0.84	(0.39, 1.79)	0.655

Education			
None (Reference)	1		
Primary	1.02	(0.88, 1.17)	0.805
Secondary*	0.75	(0.63, 0.89)	0.001
Tertiary *	0.35	(0.23, 0.52)	0.000
Age*	1.01	(1.004, 1.02)	0.001
Partnership patterns			
No partners (Reference)	1		
Casual partners	0.94	(0.69, 1.27)	0.671
Regular partners*	1.33	(1.15, 1.53)	0.000
Socio-economic status			
Poorest (Reference)	1		
Poorer	0.35	(0.12, 1.03)	0.432
Poor	0.63	(0.24, 1.66)	0.354
Less poor	0.35	(0.11, 1.10)	0.073
Least poor*	0.28	(0.09, 0.84)	0.023
Employment			
Not employed	1		
Employed fulltime*	1.21	(1.09,1.36)	0.001
Employed part time	0.96	(0.75,1.23)	0.768

*** Significant at 5% significance level**

APPENDIX 2

Datasets and variables used for the analysis

Entry criteria

- Resident as at January 1, 2002 and 20 years or older but less than 64 years.

Exit criteria –Indicates when the selected resident individuals are last observed

- Individuals still under observation by December 31,2007 i.e. period of observation is Jan. 1,2002 to Dec. 31,2007
- Individuals turning 65 years and still under observation
- When the individual is no longer a member of any household under surveillance
- When the individual dies

Other rules for extracting data

- Where information is collected at household level then we will take information from the household where the person is co-resident with the household. This applies to individuals' information on marital status, partnership Pattern name, education and employment.
- If information on the first half of 2002 is unavailable then information collected in the last half of 2001 should be used for the selected individual. If both are unavailable then the information is treated as missing
- Duplicate records will be minimized by choosing household level observations only where individual is co-resident with the household.
- **Datasets namely Individual, Household assets and HIV Deaths to be provided separately**

Summary of variables used:

Variables required for selected individuals (Period of observation 2002-2007)

- Adult mortality due to HIV/AIDS (CODE B24,B20, B20.8,A15,A17,A18,A18.3,A19,A49.0 for those aged 20-64 years in the period 2002-2007 as revealed by verbal autopsy.
- Education data collected in 2001.If an individual does not have education data for 2001 then education data for 2003 should be used.
- Employment data collected in 2001.If an individual does not have employment data for 2001then employment data for 2003 should be used.
- Marital status data collected in the first half of 2002.For individuals missing marital status in the first half of 2002 then the data on marital status collected in the last half of 2001 should be used.
- PartnershipsPatternName data collected in first half of 2002. For individuals missing Partnerships data in the first half of 2002 then the data on partnerships collected in the last half of 2001 should be used.
- Household socioeconomic data collected in 2001.Data for 2003 will be used for households missing socioeconomic data in 2001.
- DateOfBirth and Sex

DATASET 1: INDIVIDUAL DATASET VARIABLE LIST

(a) Criteria for inclusion

- All individuals resident on Jan 1 2002 aged 20 and less or equal to 64 years.

(b) Unit of analysis

- One row per individual

VARIABLE NAME	DESCRIPTION	NOTES
IIntId	Individual internal Id	Resident on 1 Jan,2002 aged 20 and less or equal to 64 years
Sex	Male or female	
DateOfBirth	Date an individual was born	
EndOfObservation	The date of death if individual died between 1 Jan.,2002 and 31 Dec.,2007 or last date on which this individual was still under surveillance	Period of observation is Jan.1,2002 to Dec.31,2007
HHIntID	Id of the household	Household to which the individual is a member and co-resident with on 1 Jan., 2002.
LastObservationType	Event type(3 letter code)of individual end event	
PartnershipPattern	Current Partnership pattern	The Partnership pattern observed during the first half of 2002 as closely as possible to1Jan.,2002,otherwise the observation in second half of 2001 as closely as possible to 1 Jan.,2002
PartnershipPatternName	Name/label associated with codes in previous variable	
MaritalStatus	Marital Status at date of Visit	The marital status observed during the first half of 2002 as closely as possible to 1Jan. 2002, otherwise the observation in second half of 2001 as closely as possible to 1 Jan., 2002.
MaritalStatusName	Name/label associated with codes in previous variable	
EducationLevel	Highest education grade completed?	The Education level observed during 2001 as closely as possible to1Jan.,2002,otherwise the observation in 2003 as closely as possible to 1 Jan.,2002

EducationLevelName	Label associated with previous variable	
IsEmployed	Is currently employed or earning money or goods by selling, farm work, or helping in a family business	The Employment status observed during 2001 as closely as possible to1Jan.,2002,otherwise the observation in 2003 as closely as possible to 1 Jan.,2002
IsEmployedName	Label associated with previous variable	

DATASET 2: HOUSEHOLD ASSETS

In formation collected for the co-resident households of all individuals in Dataset 1 collected during HSE 2001. If information is not available in 2001 then from HSE 2003/4.

I have indicated how the same variables were coded in 2001 and 2003. I have left out new variables collected in 2003 since most of my household data come from 2001.

(a) Criteria for inclusion

- All households resident on January 1,2002

(b) Unit of analysis

- One record per household

VARIABLE NAME	DESCRIPTION	NOTES
HHIntId	Id of household	
ToiletType	What kind of toilet does the household use?	To be linked to HHIntID in dataset 1
ToiletTypeName	Label associated with previous variable	
IsElectrified	Is this household connected to an electricity supply? (ESKOM only)	
IsHouseOwnedByMember	Is the owner of this BS a member of this household	
RoofMaterial	material used for the roof of the main building	
RoofMaterialName	Label associated with previous variable	
WallMaterial	material used for the walls	

	of the main building	
WallMaterialName	Label associated with previous variable	
DrinkWaterSource	the most often used source of drinking water in this household	
DrinkWaterSourceName	Label associated with previous variable	
S06v01r/BIC	Number of Bicycles owned	Variable name2001/variable name 2003
S06v01q/BLM	Number of Block Makers owned	Variable name2001/variable name 2003
S06v01s/CAR	Number of Cars/bakkies owned	Variable name2001/variable name 2003
S06v01i/ECO	Number of Electric heaters owned	Variable name2001/variable name 2003
S06v01b/EHP	Number of Electric hot plate owned	Variable name2001/variable name 2003
S06v01f/EKT	Number of Electric kettles owned	Variable name2001/variable name 2003
S06v01e/FGH/FRG	Number of Fridge Freezers owned or fridges owned	Variable name2001/variable name 2003
S06v01d/GCK	Number of Gas cooker owned	Variable name2001/variable name 2003
S06v01z/HSF	Number of Other farm tools (spades, hoes) owned	Variable name2001/variable name 2003
S06v01u/KLT	Number of Lorries/transporters owned	Variable name2001/variable name 2003
S06v01a/PMC	Number of Primuscooker/Sikeni owned	Variable name2001/variable name 2003
S06v01j/RAD	Number of Radios owned	Variable name2001/variable name 2003
S06v01w/SOF/TBC	Number of Household Furnishings owned	Variable name2001/variable name 2003
S06v01p/SWM	Number of Sewing Machines owned	Variable name2001/variable name 2003
S06v01aa/TLL	Number of Telephone - landline owned	Variable name2001/variable name 2003
S06v01ab/TMB	Number of Telephone - mobile owned	Variable name2001/variable name 2003
S06v01m/TVS	Number of Televisions owned	Variable name2001/variable name 2003
S06v01n/VCR	Number of VCRs owned	Variable name2001/variable name 2003
S06v01y/WBR	Number of Wheelbarrows owned	Variable name2001/variable name 2003

Livestock/CTL	Does HH keep any livestock for self, profit, or both?	Variable name2001/variable name 2003
S03v02cw	Is wood a main or secondary fuel for cooking	
S03v02ce	Is electricity a main or secondary fuel for cooking	
S03v02cp	Is paraffin a main or secondary fuel for cooking	
IsLandOwnedByMember	Do you own or rent the majority of land you use for crops	
Crops	Does household grow any crops for self, profit or both	
FRG	Fridge in good working order	

DATASET 3: DEATHS DATASET

(a) Criteria for inclusion

- Only underlying cause of death for HIV/AIDS and TB that occurred among the selected resident individuals in the period 2002-2007.

(b) Unit of analysis

- One row per death

VARIABLE NAME	DESCRIPTION	NOTES
IIntId	Internal Id of individual	
Underlying cause of death	ICD-10 Code	Only codes related to HIV/AIDS &TB deaths ('B24','B20','B20.0','B20.8','A15','A17','A18','A18.3','A19','M49.0')

APPENDIX 3

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)
HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Anguko

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080985**
PROJECT	Effect of Marital Status and Educational Level on HIV Mortality in Adults in Rural KwaZulu Natal, South Africa
INVESTIGATORS	A Anguko
DEPARTMENT	School of Public Health
DATE CONSIDERED	08.09.26

DECISION OF THE COMMITTEE*

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

DATE **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

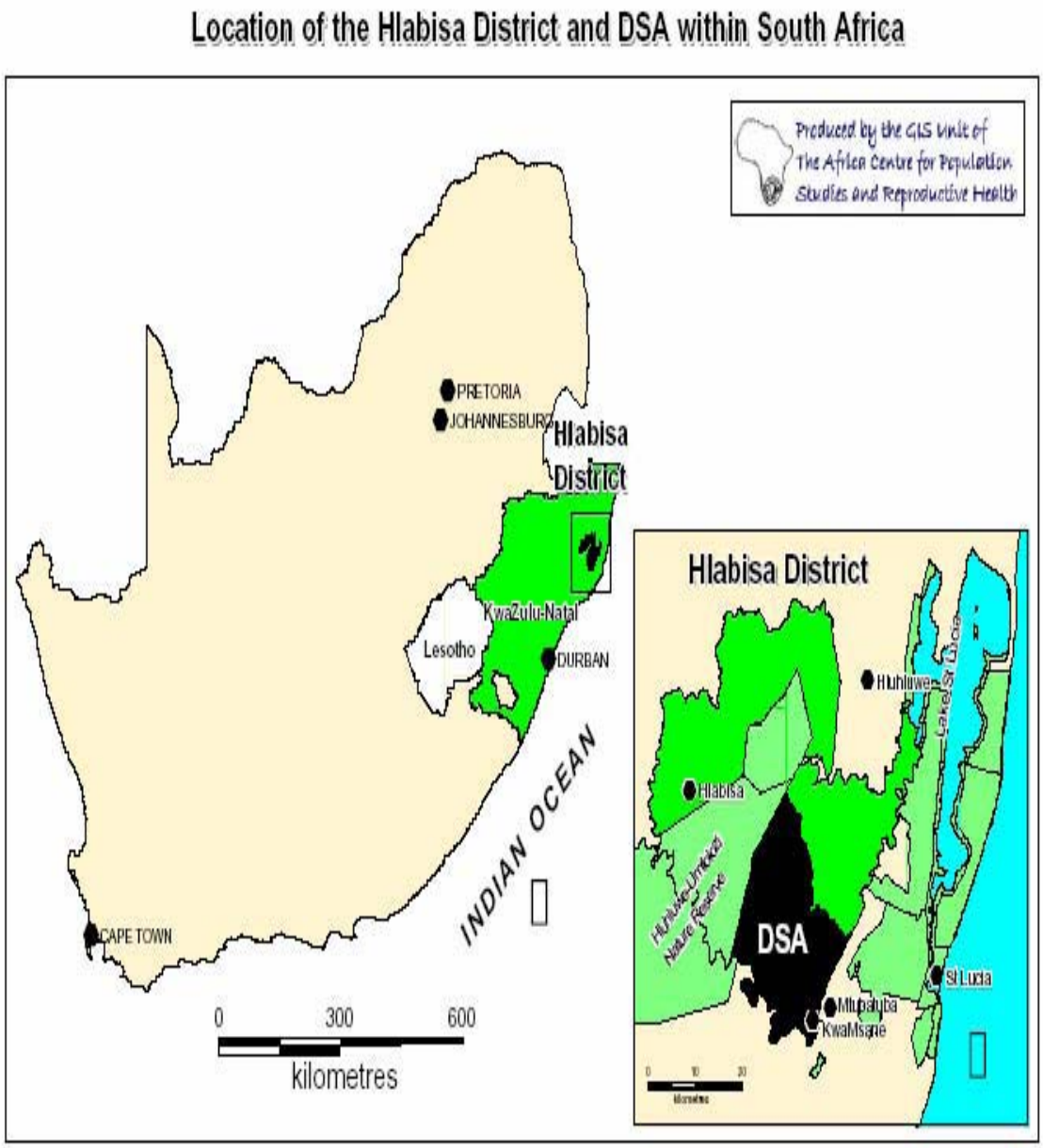
cc: Supervisor · Prof S Tollman

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 4


Location of the Hlabisa District and DSA within South Africa
Produced by the GIS Unit of
The African Centre for Population
Studies and Reproductive Health
PRETORIA
JOHANNESBURG
Hlabisa
District
KwaZulu-Natal
Lesotho
DURBAN
INDIAN OCEAN
CAPE TOWN
0
300
600
kilometres
Hlabisa District
Hluhluwe
Lake St Lucia
Hlabisa
Hluhluwe-Umfolozi
Nature Reserve
DSA
St Lucia
Mtubatuba
KwaMsane

APPENDIX 5

UNIVERSITY OF
KWAZULU-NATAL

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za
Website: http://research.ukzn.ac.za/ResearchEthics11415.aspx

11 February 2009

Dr K Herbst
Africa Centre for Health & Population Studies
Nelson R Mandela School of Medicine
University of KwaZulu-Natal
kherbst@africacentre.ac.za

PROTOCOL: A socio-demographic platform for population-based reproductive health research in a rural health district of KwaZulu-Natal. Dr A J Herbst. Ref: E009/00

PROTOCOL RECERTIFICATION RATIFICATION

Further to our letter to you dated 22 December 2008, this letter serves to notify you that at a full sitting of the Biomedical Research Ethics Committee Meeting held on **09 February 2009**, the Committee RATIFIED the sub-committee's decision to approve the Recertification of the above protocol dated 05 November 2008.

Yours sincerely

Ramnarain

Ms D Ramnarain
Senior Administrator: Biomedical Research Ethics

UNIVERSITY OF NATAL

FACULTY OF MEDICINE

MEMORANDUM

TO:	FROM:
Professor GC Solarsh Paediatrics & Child Health Faculty of Medicine	Mrs Anita Walker Postgraduate Administration Faculty of Medicine

6 September 2000

PROTOCOL: A socio-demographic platform for population-based reproductive health research in a rural health district of KwaZulu-Natal. GC Solarsh. Paediatrics. Ref E009/00

Thank you for submitting the Zulu translation of section E9 – information given to subjects. Full ethical approval is granted as of this day.

Anita Walker

Anita Walker
Postgraduate Administration
Aw/ethics/solarsh.1S