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UNIVERSITY OF THE WITWATERSRAND
FACULTY OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

RESEARCH REPORT

TITLE:

Migration patterns in rural KwaZulu Natal, and the association with adult HIV infection

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Research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements for the Degree of Master of Science in Medicine in the field of Population Based Field Epidemiology.

Supervisors

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Johannesburg, South Africa 2011

Declaration

I, Charfudin N. J. Sacoor 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 at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature: Charfudin Sacoor

Full Name: Charfudin Nicos Jussub Sacoor

05 day of Aril 2011

Dedication

I would like to dedicate this report to my family, especially my father, **Jussub Sacoor** for having been a pillar, a guide and inspiration in my life and for all the love and support that he gave me while alive. May *Allah* give him *Jannat*.

Abstract

Background

Assessing HIV incidence over time in a rural population, largely characterized by high levels of migration and poverty is important to understand the dynamics of the spread of HIV infection. Understanding patterns of HIV infection is a key to defining the appropriate strategies for prevention of the disease especially in areas where information on HIV incidence is scarce, such as in Africa and South Africa in particular.

Objectives and methods

The main objective of this study is to measure the association between migration history and newly acquired HIV infection by sex. The specific objectives are to: (i) quantify median distance of migration by members of the cohort during the period of observation; (ii) measure the association between migration status and acquisition of HIV infection among males and females study participants.

The current analysis is based on secondary data collected at the Africa Centre Demographic Surveillance System (DSS) in South Africa. Women aged 15-49 years and men aged 15-54 years were enrolled in the study and tested for HIV between 2003/5 and 2008. A Weibull survival model was used to determine the probability of HIV infection, subject to migration and possible confounders.

Results

For external migration, the median of external in-migration distance was 53.9 km, with a lower quartile of 27 km and upper quartile of 204 km while the median of external out-migration distance was 104.7 km, with a lower quartile of 52 km and upper quartile of 204 km. The total migration rate among males is 8.8 and for females the rate is 8.2 per 100 person-years (PYO). The majority of external migrants moved to Durban, which appeared to be the most important origin and destination

for most migrants. Of the 9300 individuals enrolled in this study, 699 sero-converted. The HIV incidence rate among non-migrants males was 2.0/100 PYO (95% CI, 1.7 – 2.3) and for non-migrants females was 4.1/100 PYO (95% CI, 3.8 – 4.5) while the HIV incidence rates among migrants were higher for females in all categories: 2.0/100 PYO (95% CI, 1.3- 3.1) among internal migrants, 3.8/100 PYO (95% CI, 1.7- 8.5) for external in-migrant and among external out-migrants the HIV incidence rate was 3.2/100 PYO (95% CI, 2.3 – 4.5). For both genders, except internal migration showed a significant risk of HIV acquisition, other types of migration showed no significant association with HIV acquisition. Among other predictors, males who were in the age group 25-29 had the highest hazard of 3.75 times increased risk of HIV acquisition compared to the age group 15-19 [HR = 3.75, 95% CI (2.30 – 6.32), P < 0.001]. Females aged 20-24 years had 43% increased risk of HIV acquisition compared to the those aged 15-19 years [HR = 1.43, 95% CI (1.13 – 1.79), P = 0.002]. For marital status, females who had never been married and not engaged had 71% increased risk of HIV acquisition compared to those who were married, [HR = 1.71, 95% CI (1.09 – 2.68), P = 0.019]. Females with conjugal partners who were always resident and females with conjugal partners who were partial resident had a reduced risk of HIV acquisition of 41% [HR = 0.59, 95% CI (0.36 – 0.95), P = 0.031] and 38% [HR = 0.62, 95% CI (0.40 – 0.96), P = 0.034] respectively.

Conclusion

Rates of migration vary by age and gender in this cohort of repeat-testers of HIV. Younger individuals migrated more often and the majority of migrants moved to urban centres close to the study area. In terms of HIV incidence, for all covariates, females had higher rates of HIV acquisition than males. External migration does not appear to increase HIV acquisition for this cohort of repeat-testers of HIV, and those who internally migrated had a reduced risk of HIV acquisition. Based on these findings, public health efforts aimed at controlling the spread of HIV infection in this cohort should target at socio-economic condition, sexual behaviour and empowering of women in particular.

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Definitions of terms

- 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).

- Migration – Migration is an event that occurs when an individual or household moves from one homestead to another.

- An external in-migrant is a household member who lived outside of the study area and subsequently moved into the surveillance area during the period of observation.

- An external out-migrant is defined as a person who was resident in the surveillance area who subsequently moved out of the surveillance during the period of observation.

- An internal migrant refers to movement of resident individuals from one bounded structure to another within the *DSS* area during the period of observation.

- A non-migrant is classified as an individual not exposed to the above types of migration.

- Bounded structures – is a building, or a group of buildings, on land belonging to a single person or organisation, and used for one main purpose. So, bounded structures can be homesteads and facilities.

- 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.

- Sero-conversion- The change from HIV-negative to HIV-positive status.

- HIV Incidence rate - the probability of sero-conversion among the study participant expressed per 100 person years of observation.

- Survival function- function of time that starts with population 100% well at particular time and provides the percentage of the population still well at later time (Last, 2001).

- Weibull regression- Is a regression model used when the dependent variable is duration of observation and allows the hazard rate to increase or decrease monotonically with respect to elapsed time, (Imai et al, 2007).

Abbreviations and Acronyms

ACDIS - Africa Centre's Demographic Information Systems

AIDS - Acquired Immune Deficiency Syndrome

C.I. – Confidence Interval

DSA – Demographic Surveillance Area

DSS - Demographic Surveillance System

ELISA – Enzyme linked immunosorbent Assay

GIS – Geographical Information System

GPS – Geographic Position System

HIV - Human Immune-deficiency Virus

HR – Hazard Ratio

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

IOM - International Organization for Migration

KZN – KwaZulu-Natal

PCA – Principal Component Analysis

PYO – Persons Year Observation

SES – Socio Economic Status

STIs - Sexual Transmitted Infections

SARS - Severe Acute Respiratory Syndrome

SPFS - Self Perception of Financial Status

TLC - Transitional Local Council

UNAIDS - The Joint United Nations Programme on HIV/AIDS

UNDP – United Nations Development Programme

WHO - World Health Organization

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CHAPTER ONE: LITERATURE REVIEW

1.1 Introduction

Migratory movements are largely associated with dissemination of diseases in many parts of the World. Epidemiological information regarding the dissemination of certain types of diseases likes Sexually Transmitted Infections (STIs), Severe Acute Respiratory Syndrome (SARS) and Tuberculosis (TB) around the world is associated with migration (Collinson et al, 2006a). Quinn (1994) for example, has pointed to international migration from civil wars, tourism, business purpose, and drug trade and also the individual's movement from rural to urban with subsequent return migration as largely responsible for dissemination of HIV.

HIV/AIDS is the most significant cause of morbidity and mortality among adult people in sub-Saharan Africa. UNAIDS (2008) pointed out that the Sub-Saharan African region alone accounts for almost a third (32%) of all new HIV infections and AIDS-related deaths globally. In countries like Botswana, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe the national adult HIV prevalence exceeded 15% in 2005.

UNAIDS (2008) has classified South Africa as the country with the largest number of infections in the world (5.5 million), with 18.3% of adults (15–49 years) living with HIV in 2006. It is estimated that about 1.8 million people have died since the epidemic began in South Africa. However, the distribution of HIV/AIDS in this country is not homogenous. The epidemic varies considerably between provinces and districts. For example, data from 2006 showed that HIV prevalence among pregnant women was highest in the KwaZulu- Natal province (39%), and lowest in the Northern Cape (15%), (UNAIDS, 2008).

Few HIV incidence studies were conducted in South Africa. Among those available in the literature, the results show high incidence rates in South African population, especially among women and younger adult people (Shisana et al 2005; Hargreaves et al, 2007; Bärnighausen et al, 2008).

In KwaZulu-Natal for example, where the data of this study was collected, the incidence rate was estimated at about 3.8 among females and 2.3 among males per 100 person years observated between 2003 and 2005, (Bärnighausen et al, 2008).

1.2 Migration in Africa and South Africa

About two billion people are on the move each year and hundreds of millions move within their own countries (UNESCO/UNAIDS, 2000). The phenomenon of migration in sub-Saharan Africa where 5.4 million out of 35 million of migrants are officially recognized refugees is caused by many different factors (Quinn, 1994). According to Mbirimtengerenj (2007) migration and other social problem like sexual trade, polygamy and teenage marriages are a consequence of poverty in the Sub Saharan region. The socio-economic contrast between urban and rural areas, work and/or political repression, social and economic reasons and natural disasters stimulate movement of people in many African countries (UNDP, 2007 & Kahn et al, 2003).

According to Lurie et al (2003) the historical demand of labour migration in South Africa was associated with the discovery of gold in the Witwatersrand area in 1886. Since that time, South Africa have received migrant men from countries like Mozambique, Malawi, Botswana, Swaziland, Zimbabwe and Zambia who come to seek work in the gold mines as well as platinum and diamond mines. The phenomenon persists until today, even within South Africa where labour migrants, mostly men, move from rural areas to South Africa's mining and industrial centres, (Collinson et al, 2006b). According to Lurie et al (2003) the official estimated number of migrants to South Africa from neighbouring countries is about 2.5 million, with many more undocumented.

In the Africa Centre demographic surveillance area, the number of resident people has declined over time, highlighting the importance of migration to the population dynamics of the study area. For example, the in-migration rate between the year 2000 to 2005 in this area changed from 1.81 to 9.09

for females and 1.78 to 8.52 for males whereas the out-migration rate, changed from 0.91 to 9.76 for females and 0.79 to 11.04 for males, (Muhwava & Nyirenda, 2007).

1.3 Migration and HIV/AIDS

Historically, human migration is recognized as the main source of transmission and spread of epidemics in a population and geographic areas (Collinson et al, 2006a; Mmbaga et al, 2008). Migration is largely associated with many public health problems, notably HIV, (Jochelson 1991; Crush, 2006; Lurie et al, 2003; Mbirimtengerenji, 2007; Quinn, 1994). Despite its negative impact on health, migration offers many important socio economic benefits, and the majority of migrants view migration as an opportunity to satisfy many of their life aspirations, (Mbirimtengerenji, 2007). People migrate in search of better socio economic conditions as a result of disequilibrium between rural and urban areas. As a result, migration has led to many problems such as over-population and crowding in cities, lack of employment, inadequate infrastructure, increased crime rates, prostitution and public health problems.

Studies conducted in different parts of Africa and South Africa showed a strong association between migration and HIV status among migrants in the mine industry. For example the prevalence of HIV among labour migrants from Malawi to South Africa increased from 3.8% in 1986 to 21% in 1989 (Jochelson, 1991).

Urbanization in sub-Saharan Africa, between 1960 and 1980, caused by rural migration was responsible for the spread of HIV-1 to large population centres. In West African countries, migration was also responsible of the spread of endemic HIV-2 (Quinn, 1994). According to UNAIDS (2008) about 67% of the total people living with HIV/AIDS are resident in sub-Saharan Africa. This region also contributed with 75% of HIV/AIDS related death around the world.

Migration is correlated with both high risk sexual behaviour and HIV infection (Mundandi, 2006; Welz et al, 2007), but the mobility varies by gender and the direction of movement, **(**Brockerhoff & Biddlecom, 1999; Zuma et al, 2003). For instance, according to Brockerhoff & Biddlecom (1999) urban to rural migrants (circular migration) are more likely to practice high-risk sex than non migrants already living in the rural area. Similar results have indicated that migrants report more sexual risk behaviours and promiscuity than non migrants which could have led to the high HIV incidence rates (Zuma et al 2003; Lurie et al 2003; Hu et al 2006).

Prevalence mapping for HIV/AIDS in Tanzania shows that the regions with the highest prevalence are characterised by good transportation networks. Long distance truck drivers are thought to be one of the most common sources of HIV transmission through their contact with sex workers and other mobile populations, (Msisha et al, 2008). Similarly, in KwaZulu Natal (KZN), HIV prevalence among truck drivers was 56%, representing a significant high level of risk among this population (Ramjee & Gouws, 2001).

Several studies have shown an association between migration and HIV/AIDS in South Africa, (Quinn, 1994; Brockerhoff & Biddlecom, 1999; Zuma et al, 2003; Lurie et al, 2007). Research has shown that many labour migrants living alone in urban centres in comparatively poor conditions, and relatively far from their home communities or families, are at an increased risk of infection with HIV since the pandemic began, (Clark et al, 2007).

In terms of age, sexually active young people in urban centres of developing countries clearly play a role in the dissemination of HIV and other infectious diseases (Quinn, 1994). Rehle et al (2007) find that among youth aged 15–24, females years are estimated to account for about 90% of recent HIV infections.

One study carried out in South Africa, shows that migration is often coupled with an increase in sexual risky behaviour, placing migrant communities at greater risk. The migrant labour system has created a market for prostitution in mining towns and has established geographic networks of relationships within and between urban and rural communities (Quinn, 1994).

There is some evidence that the prevalence of HIV is highest in short distance migration due to frequent contact between partners soon after the initial infection when viral loads are highest (Brockerhoff & Biddlecom, 1999). Males tend to be more mobile than women, and typically migrate further away and for longer period. This fact increase the probability of male's migrants to seek for others sexually partners, increasing their risk of HIV infection (Lurie et al, 1997).

Kahn et al (2003) observed that female temporary migration in South Africa is steadily rising with an average of one in five adult women temporarily migrating in 2000. Zuma et al, (2003) show that migrant women are significantly more likely to have two or more lifetime partners compared with non-migrant women. Moreover migrant women are more likely than non-migrant women to report having had sexual contact with a person other than a regular partner in the last year. This has contributed to the increase in the risk of HIV infection in migrant women (46.0%, $p=0.011$) as compared to non-migrant women (34.7%, $p=0.011$).

Men leave their houses to find jobs in urban areas and they often have various sexual partners which eventually lead to an increased risk for HIV infection. When they return home, they infect their spouses and/or other sexual partners. Males who are unable to send money home or lack an opportunity to return home may invite their wives to come and collect it at their work places, exposing these females to high risk of infection by their husbands or partners (Lurie et al, 1997).

A study conducted among educators in South Africa showed a relationship between mobility and HIV infection. Educators who upon completion of their studies moved without their families to the place of work were shown to have a higher HIV prevalence (23.5%; 95% CI: 21.4-25.8) when compared with those educators who stayed in the same areas after completing their studies (18.9%; 95% CI: 17.3-20.6), (Zungu-Dirwayi et al, 2007).

According to Zuma et al (2003), circular migration between rural and urban areas is common in South Africa and is known to increase the risk of HIV infection among women whose partners are migrants. He finds that being a further being a migrant, younger, married, drinking alcohol and having other STIs such syphilis and gonorrhoea are all significant predictors of HIV infection. On the other hand Zuma finds that education is not predictive of HIV infection.

In KwaZulu- Natal migration appears to be an independent risk factor for HIV infection among men, where in the Hlabisa district of KwaZulu- Natal province, HIV prevalence among males' residents (12.7%) and males' migrants (25.9%) are significantly different. Migration is very high in the district, with 62% of adult men spent spending the majority of nights away from their household, (Lurie et al, 2003).

1.4 HIV incidence in Africa and South Africa

HIV incidence studies using prospective population-based cohort data are scarce in Africa and in South Africa in particular. However those that have been done consistently show very high HIV incidence.

Analysis of HIV incidence in Uganda using a rural population cohort of 14449 HIV negative individuals at a first HIV test from 1989 to 2005 showed gender difference in terms of HIV incidence rate, (Shafer et al, 2008). The South African National HIV incidence showed an HIV infection rate of 2.7% among a population of 16000 study respondents aged 2 and over. Females had a HIV incidence of 3.6% compared to 1.5% for males, (Shisana et al 2005). Among adult participants, HIV incidence was 6.3% for females and 2.4% for males, (Shisana et al 2005). Analysis on risk factors for acquisition of HIV in a prospective population-based cohort study in KZN showed that the crude HIV incidence rate per 100 person-years in women was 3.8 and in men was 2.3, (Bärnighausen et al, 2008).

A further study conducted in Uganda using three groups of sexually active women (pregnant, lactating and non-pregnant/non-lactating) showed that pregnant women in the age group 15-19 years had a higher risk of HIV infection compared with women of other age groups (20-29 and >30) and also had a higher risk when compared to lactating women (Gray et al, 2005). The South African national HIV incidence survey of 2005 showed that among adult participants (15-49 years) the incidence of HIV was 4.4%, with the highest being 7.1% for those aged 25-34 years, (Shisana et al, 2005). Bärnighausen et al (2008) found that men aged 30-34 and women aged 25-29 years are at very high risk of acquiring HIV with 10.7/100 PYO; 95% CI (6.7-14.8) and 12.5/100 PYO; 95% CI (10.14.9) respectively. Higher HIV incidence was found in older ages groups in comparison to younger age groups.

Bärnighausen et al (2008), revealed that unmarried individuals having a partner had a higher probability of HIV acquisition [11.2/100 PYO; 95% CI (9.6-12.9)] meaning that both single and married people are at lower risk in this area. According to Gray et al, (2005) the results revealed that never married pregnant women had the highest risk ratio for HIV acquisition compared with married women.

The distribution of incidence of HIV in South Africa varies by provinces. HIV incidence was highest in Mpumalanga province (4.2%) following by KwaZulu-Natal (3.8%), with the lowest incidence rate found in the Northern Cape, (0.5%), (Shisana et al, 2005).

1.5 Research question

South Africa is one of the countries with the highest rates of HIV infection in the world. The use of prospective population-based cohort helps to measure and understand the dynamics of HIV infection and enables the identification of risk factors associated with HIV infection. This study aims to determine if migration is a risk factor of adult HIV acquisition in rural KwaZulu-Natal, South Africa.

1.6 Hypotheses

This study presents three hypotheses:

- The risk of acquiring HIV is higher among migrants in comparison to non-migrants in rural KwaZulu-Natal.
- Having a partner as a migrant confers a higher risk of HIV infection in comparison with having a partner who is a non-migrant.

1.7 Study aim

To describe and to quantify types of migration in a rural KwaZulu Natal population and to measure the association between migration history and HIV infection.

1.8 Objectives

Main objective

The main objective of this study is to measure the association between males and females migration history and newly acquired HIV infection.

Specific objectives

1. To quantify median distances migrated by members of the cohort during the period of observation.

2. To measure the association between migration status and acquisition of HIV infection among the study participants, both males and females.

3. To measure the association between partners' status and acquisition of HIV infection among males and females study participants.

CHAPTER TWO: METHODOLOGY

2.1 Study area

The Africa Centre Demographic Information System (ACDIS) covers approximately 438 km² and it is located near the Mtubatuba in the Umkhanyakude district of KwaZulu-Natal (Tanser et al, 2008). The area encompasses Hlabisa Municipality and Inyala/Mtuba Transitional Local Council (TLC), and includes the township of KwaMsane and Indlovu (figure 1, appendix 1).

Geographically the Africa Centre Demographic Surveillance Area (DSA) is marked by large perennial rivers, nature reserves, forestry areas, and commercial farmland, (Muhwava & Nyirenda, 2007). The total population in ACDIS was 85,957 in 2006 distributed among approximately 11,000 households with an average size of 7.9 members. Among these, 56,791 were residents and 29,166 were non residents (33%), (Muhwava & Nyirenda, 2007).

The majority of the population is Zulu-speaking, and is mainly located in rural settlements and in the informal peri-urban and urban township settlements. The bounded structures are located in three principal areas: (i) rural with a population density below 400km², (ii) peri-urban with a population density over 400 people/km² and (iii) urban area covering the population of KwaMsane Municipality. The population density varies in rural and urban areas from 20 to 3000 people/km² (Tanser et al, 2008). The female population is about 52.6% (45,192) while the male population is about 47.4% (40,764).

The ACDIS collects longitudinal demographic data (for example: mortality, fertility and migration), morbidity and physical structure data (for example: homesteads, schools). This information is updated every six months and all individuals registered in every household within the surveillance area have a

permanent identification number that allows follow-up and avoid duplication. Accurate rates are given by dividing the number of events by the number of person-years of observation.

2.2 Data source

The study was based on data sources as described in detail below.

2.2.1 HIV Surveillance data collection

The data of HIV Surveillance used in this report come from five annual data collection rounds of data collection. The first round (Round-1) occurred between December 2003 and February 2005 and the last round occurred between January and December 2008. HIV surveillance includes both residents and non-residents based on the following inclusion criteria: For Residents, it includes males and females aged 15 and above, with a residency episode when last seen. For Non-residents, the selection process uses a stratified sampling procedure to obtain a representative sample of 12.5% of all non-residents aged 15-49 for females and 15-54 for males respectively.

For residents (i.e those with an individual residence episode when last seen), their eligibility list come from the demography surveillance data for the previous rounds. However, at the time of visit some participants included in the eligibility become ineligible basically because they were dead or had out migrated. There were also those individuals who were alive and not out migrated but not contacted and those who refused to participate in the HIV surveillance as well those who refused to be tested.

After written informed consent was obtained field workers collected finger-prick dried blood spot samples in accordance with UNAIDS/WHO guidelines for HIV testing. HIV serology status was determined by antibody testing with a broad based HIV-1/HIV-2enzyme-linked immunosorbent assay (Vironostika, Organon Teknika,Boxtel, Netherlands) followed by a confirmatory enzyme-linked immunosorbent assay (GAC-ELISA, Abbott, Abbott Park, IL). Possible outcomes for the HIV test were: positive, negative, indeterminate, not applicable and null, (Welz & Herbst, 2008 and Tanser et al, 2008). The dataset included only those individuals who consented at list for two HIV tests.

Among the total study participants 48,8% had two HIV tests, 29,4% had three HIV tests, 15,3% had four HIV tests and 6.5% of participants had five HIV tests.

Information obtained from the Africa Centre website shows that percentage for those who refused to HIV test varied during the study period. In the first round (2003/5) the percentage of refusal was 38%, in the second round 44%, in the third round 45%, in the fourth round 45% and in the last round (2008) was 55%. The main reason for refusal is that many participants think or already know their HIV status. Information on refusals' characteristics is scarce in the available literature, thus it is very difficult to predict the impact of refusals in this study. Analysis conducted by Bärnighausen et al (2007) in this area among individuals who consented to the first HIV test and refused or were not contacted in the second HIV test showed no significant differences in terms of their socio-demographic characteristics. For this secondary analysis, the Information about those individuals who were not contacted or refused to HIV test was not provided. This issue can bias the result of the study in this community especially if those individuals not contacted or refused to be tested are engaged in short term circular migration or engaged in high sexual risk behaviour. Previous studies at the Africa Centre have shown that women who refuse to be tested usually do so because they already know their HIV status, (Barnighausen et al, 2007). It happens more with older than younger women who are more likely to have had a test by virtue of them being older. The sample may this represent a younger more susceptible age group, which should be borne in mind when interpreting the findings.

2.2.2 Migration data collection

The migration database describes an individual's and household's movements and links all individual and household residency start and end events. The migration data are collected twice a year during the process of data update (rounds) using a dedicated questionnaire. Essentially this database stores information about the date of the event, origin, destination and reason for migration.

2.2.3 Bounded structure data collection

Bounded structures are physical units directly observed in the field that can be represented by a point in a geographical information system (GIS). The geographical coordinates (latitude and longitude) for every bounded structure were recorded using geographical position system (GPS). In the bounded structures database, most of the records are homesteads i.e. residential but others can be schools, clinics, shops and churches.

2.2.4 Member status observation data collection

Member status observation data refers to the set of basic information collected from every DSA member at each round. Essentially it includes data about the identification of the bounded structure, household membership, membership type, presence or absence of the individuals in the bounded structure in the previous night or over the previous days, marital status, partnership and other additional demographic characteristics.

2.2.5 Household and Individuals socio economic status data collection

The household database includes every household with a current residency in a bounded structure. Data collection on household assets and living conditions began in 2001 and collects details on water source, type of latrine, electricity, type of cooking fuel and household ownership of a car, bed, refrigerator among others.

In addition, information on socio economic status, such as level of education, type of employment and receipt of government grants is collected. Household and individual Socio-Economic Status surveys are conducted once a year.

2.3 Study Design

The study design is a prospective population-based cohort study using data from a population-based HIV cohort nested within the Africa Centre DSS. The study compared the risk of HIV infection among males and females who had always been resident and those who were exposed to at least one type of migration.

2.4 Study Population

The study population included all adult members of the Africa Centre DSA site during the period 2003/5 to 2008.

2.5 Study sample

The study sample comprised of all adult individuals both males and females who were observed to be HIV negative at one point in time and who had had at least another HIV test any time of the study period. Beginning with the first HIV survey carried out in 2003/5, a total of 5,806 HIV negative people were eligible for inclusion in the study. They were followed-up to December 2008. Because it was an open cohort all eligible in-migrants were included in the study resulting in total of 9,300 adult individuals enrolled in the study at the end of the follow-up time.

Eligibility:

Inclusion criteria:

Adults (15-54 years males and 15-45 females) members of the DSA between 2003/5-2008 who were observed to be HIV negative at the time of study entry and who had had at least another HIV test any

time of the study period (699 sero-converters). To be included in the analysis the participants needed to have at least two HIV tests at different points of the study period of which the first had to be negative. The sero-conversion time was estimated as the midpoint between the last negative HIV test and the first positive HIV test irrespective of the participant having undergone HIV testing regularly during the annually HIV survey or not.

Exclusion criteria:

- Non- registered individuals
- Males who were younger than 15 years and older than 54 years and females who were younger than 15 years and older than 49 years.
- Individuals whose result of HIV test was Positive/indeterminate, missing and not applicable or null at the study entry point.
- Individuals who were migrated after sero-conversion point.

2.6 Study variables

a) Exposure assessment:

The main exposure variable is type of migration categorized as (i) internal migration, (ii) external in-migration (iii) external out-migration. The risk of HIV infection was compared between migrants and non-migrants among males and females. The migration exposure information was collected prospectively from the date of the first negative test. For those individuals who sero-converted changes in migration status occurred before mid-time between last negative and first positive HIV test.

The exposure period was defined as the duration between the first HIV test until the end of follow-up time for those who did not sero-converted and the midpoint between the last negative HIV test and the first positive HIV test for those who did sero-convert.

The analysis was based taking into account 3 types of migration exposure; (i) External in-migration: a single migration episode per individual for those individuals who had only one external in-migration episode and become fulltime resident in DSA; (ii) Internal migration: for those individuals who had changed the residence within to DSA, and finally (iii) External out-migration for those individuals who had migrated out to DSA and then returned as resident to DSA. The definition of external out-migrants in this study can be related to the concept of circular migration in which individuals from rural areas migrated temporarily to urban areas and then return to their rural villages.

(i) Origin and destination of migration

The origin of external in-migration was established using the central geographical coordinates of the political and administrative areas of South Africa and foreign countries. For all external in-migration, the coordinates of Africa DSA (central point) were assumed as their destination. Inversely for all external out-migration we assumed their origin as Africa Centre DSA coordinates and their destination was the specific geographical coordinates of the places that they migrated to. The categorization of the origin and the destination for moves outside of DSA was based on the ACDIS code book.

(ii) Distance of migration

The migration distance was computed using *MapInfo Professional* version 9.5 (Geographic Information System, GIS) software. Distance is calculated by subtracting the geographical coordinates (Latitude and Longitude) of the destination from the coordinates of the origins, expressed in kilometres. The origin, destination and distance of migration are presented in histograms.

(iii) Migration rates

The migration rates were estimated using the confidence interval of a single proportion using Wilson procedure (VassarStatcs[1]). The rates were calculated as gross migration rate as well for each type of migration (internal migration, external in-migration and external out-migration) the age specific migration rates were computed by dividing the total number of migration events for each age group by the population at risk in this age interval per 100 PYO. Migration rates are presented in graphs.

b) Outcome variable:

The outcome variable in this study is acquisition of HIV infection. This variable was computed using HIV surveillance data.

c) Other explanatory variables:

(i) Age and Gender

Age was used in the analyses as categorical data with eight age groups of five year intervals (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 and 50-54). For individuals aged 15-49 years the data indicated is for both gender and the last age group (50-54) describe data only for males. In addition 9 categories of age groups of five years intervals were generated for partners.

(ii) Education

The variable Education represents the highest school level attended per individual and was classified according to the following categories: 1- Never went to school, 2- Less than 1 year, 3- Completed lower primary school, 4- Completed primary school, 5- Completed secondary school and tertiary, 6-

[1] http://faculty.vassar.edu/lowry/prop1.html

Other (incomplete information, refusals) and 7- Unknown. It is important to note that few people with secondary school have a university degree as well.

(iii) Employment

Employment was classified according to the following categories: 1- Employed full time, 2- Employed part time, 3- Not employed and 4- Other (incomplete information and don't know). The form used to collect this information do not explain the meaning of full time or part time employed and during the data collection process the residents are invited to answer if they are employed as full time, part time or not employed. Other codes for this question are: not applicable and don't know.

(iv) Socio-Economic Status (SES)

Socio-economic status (SES) was estimated using principal components analysis (PCA) in STATA package version 10 on household assets collected in the household socio economic survey. These assets are for example a car, cattle, bed, bicycle, radio, refrigerator, etc. For interpretation, the socioeconomic index were divided into 5 SES quintiles with the lowest SES quintile (Q1) representing the poorest individuals and the highest quintile (Q5) representing the least poor. The proportion of individuals distributed into each quintile was: Q1 (poorest) = 20.00%, Q2 (poorer) = 20.00%, Q3 (poor) =20.00%, Q4 (poor) =20.08% and Q5 (least poor) = 19.91%. Those individuals without household data on SES where categorized as Unknown SES.

Table 1 shows the mean, standard deviation and factor score or weight, of 10 selected variables out of 27 variables used in the index. The negative factor score, such as electric hotplate are associated with lower SES. The remaining 26 variables in the component analysis were associated with higher level of socio-economic status. In table 1 we can see that individuals living in household with bed nets and car have an index of 0.17 and 0.15 respectively.

Table 1: Factor scores of selected variables after the PCA

Variable	Observation	Mean	Std. Dev.	Factor Score
Bed net	8929	0.953	0.212	0.172
Bicycle	8929	0.905	0.293	0.095
Car	8929	0.864	0.343	0.151
Cattle	8929	0.698	0.459	0.078
Electric Hotplate	8929	0.711	0.453	-0.104
Fridge	8929	0.438	0.496	0.042
Kombi/Lorry/Tractor	8929	0.966	0.180	0.093
Radio	8929	0.196	0.397	0.111
Telephone	8929	0.955	0.207	0.139
TV	8929	0.563	0.496	0.049

Among the 27 components used in PCA analysis, we find that the variance in the first factor is explained by those households with bed nets (15.9%) while the variance in second factor is explained by those households with bed (8.1%). Bicycle, block maker, car and cattle were following factor with higher variance with 5.6%, 4.4%, 4.0% and 3.8% respectively. Besides the fact that the first two factors have a higher variance, these two factors probably do not reflect the wealth status of the study participant. This situation shows for example one of the limitations of this technique.

Figure 2.1 shows the first 4 *eiginvalues* from the correlation matrix. These first four *eiginvalues* explain 34.0% of the total variability in 27 components used to generate the index.

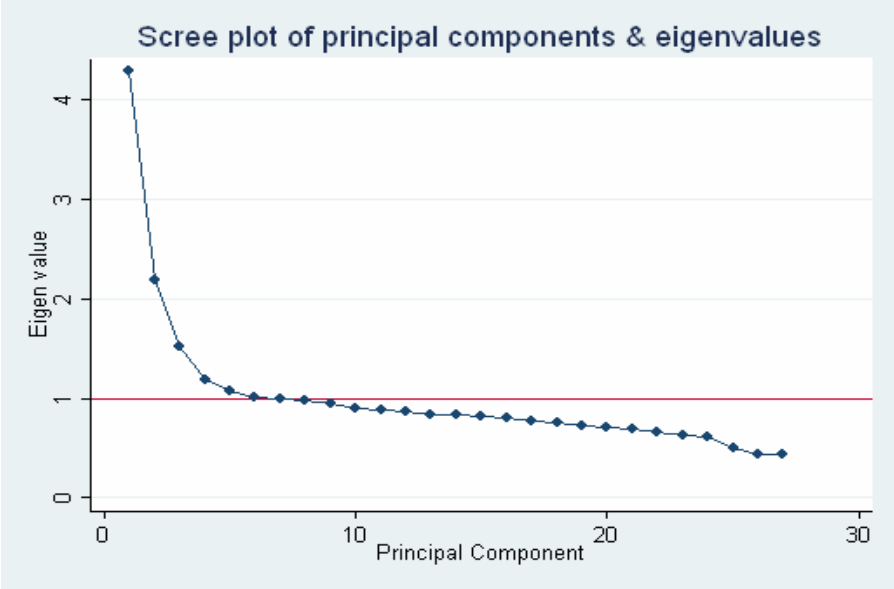

Figure 2: Scree plot of principal components and eigen values

(v) Marital status

Marital status is categorized into 5 types: 1- Married, 2-Widowed/Divorced/Separated, 3- Never been married and not engaged, 4- Never married but engaged, 5-Other (incomplete information/refusal).

(vi) Partners' status

The variable partners' status was collected among those individuals engaged in sexual relationship with someone that was possible to draw their linkage. Among the partners of the study participants was collected information of their residence status (always resident, partial resident and non resident). The variable partners' status was classified according to the following categories: 1- Not engaged, 2- Engaged with always resident partners, 3- Engaged with partial resident partners and 4- Engaged with non resident partners.

2.7 Data extraction, cleaning and management

Data extraction was based on attributes and events associated with bounded structures, households and individuals as well their relationships to each other, including longitudinal dynamics of socio-demographic events which describe for example migration, household assets, socio economic status, etc. All the records stored in the relational data base were extracted and merged for each individual with inclusion criteria using SQL. The linkages between different tables were established using individual permanent identification number as well the bounded structure permanent identification number. The study variables like individual's socio economic status, education, employment and marital status was generated at midpoint between the last negative HIV test and first positive HIV test for those who sero-converted. For those who remained negative, these socio-economic variables were generated at midpoint between the follow-up times. Then, the table with the study variable was

exported to STATA 10 format where the data was cleaned, managed and analysed. Duplicate records generated during the extraction process were dropped.

2.8 Data analysis

The main guiding principle of the analysis in this report was to investigate whether types of migration are associated with newly acquired HIV infection and to determine the contribution of the potential confounders' risk factors on HIV acquisition. All analysis was computed at 95% confidence interval with a two sided 0.05 value denoting statistical significance.

2.8.1. Descriptive statistics (frequencies)

All descriptive statistics are shown both for males and females. Results are presented as counts and percentages. Missing values were excluded from the analysis.

2.8.2. HIV incidence rate

HIV incidence was measured as the number of newly sero-converted in a given time interval divided by the population at risk using Kaplan-Meier (K-M) survival estimates. Incidence rates were expressed per 100 person years. The average follow-up time was 2.4 years. Maximum follow-up time was 5.4 years. Subjects not contacted during the surveys or those who refused to take other HIV test were followed-up until last HIV survey (2008) and treated as missing or excluded. HIV incidence was assumed to be linearly associated with the risk factors. The HIV incidence rate by migration status and other exposure variables such as age, marital status, education and other covariates was calculated. Results on HIV incidence are presented in tables.

2.8.3. Hazard rate estimation

A Weibull regression model was used to compute HIV acquisition rates based on a coefficient p-value less than 0.05. The hazards rates were computed both for males and females using primarily univariate models and subsequently multivariate models. Since the precise time of sero-conversion is unknown, observation time (i.e. follow-up time) was calculated assuming that the individuals sero-converted at the middle of the interval between the last negative and first positive HIV tests. A Weibull regression model was chosen after Cox Proportional hazard showed not be applicable for this analysis because the violation of assumption of constant hazards due to the distribution of the data. Weibull regression model (parametric model) was used because the model minimizes the assumption of constant hazards and allows the hazard rate to increase or decrease monotonically with respect to exposure time. In the multivariate analysis, the shape parameter *p* for males in the model was 1.13; 95% CI (0.98 – 1.30) while among females, the shape parameter *p* in model was 1.11; 95% CI (1.03 – 1.19).

2.9 Ethical Considerations

Ethical approval to conduct this study was obtained from the Human Research Ethics Committee of University of the Witwatersrand (see appendix 2). All eligible participant in the HIV survey received detailed verbal and written pre-test information before being asked to sign the written informed consent. Ethical clearance for the primary data collection by Africa Centre Demographic and Information System (ACDIS) was obtained from the University of KwaZulu Natal, (see appendix 3). A data user agreement between the student and the Africa Centre for Health and Population studies was obtained before this secondary analysis started (see appendix 4).

CHAPTER THREE: RESULTS

This study investigates the association between migration patterns and adult HIV infection. Results are presented in four sections. Section one presents demographic profile of the study sample both for males and females, section two details the measurement and description of migration patterns, the third section presents results on HIV incidence rates and the final section investigates the relationship between migration history and HIV sero-conversion.

3.1 Socio-demographic profile of the study sample

This study enrolled a total of 9,300 adult individuals (15-54 years) from the HIV survey between 2003/5 to 2008. Table 2 shows the socio-demographic characteristics of the study participants, both males and females. The chi square test for gender distribution among type of migration and SES shows no statistically significant and the remained variables showed a statistically significant from the p-values. Of the study participants, 3845 (41.3%) were males and 5455 (58.7%) were females. A total of 3,219 (83.7%) individuals were non-migrants males while 4617 (84.6%) were non-migrants females for each gender distribution. About 875 individuals migrated internally, of whom 315 (8.2%) were males and 477 (7.2%) were females. Regarding external migration, 266 (6.9%) males and 388 (7.1%) females migrated out of the study area whilst about 45 males (1.2%) and 56 females (1.0%) migrated into the study area.

The majority of the participants were concentrated between the ages 15-19 years. In this age group there were 2,140 (55.7%) males and 2,418 (44.3%) females respectively.

More than half of the total population had completed secondary school education 5,875 (63.2%). About 40 (0.4%) of the participants had less than 1 year of education and 608(6.5%) never went to school.

Among 3,219 male participants, 63.4% had completed secondary education, 18 (0.5%) had less than one year of education and 200 (5.2%) never went to school.

Of the total 5,455 female participants, 63.0% had completed secondary education, 22 (0.4%) had less than one year of education and 408 (7.5%) never went to school.

The data reveals that 70 (1.8%) males were full time employees, 2,321 (60.4%) with part-time employment and 295 (7.7%) were unemployed. Among female participants, 89 (1.6%) were full time employees, 3,582 (65.7%) with part-time employment and 491 (9.0%) were unemployed.

The socio economic status (SES) was more or less uniformly distributed in the 5 quintiles except for the unknown category.

Regarding males, 298 (7.8%) were married, 20 (0.5%) were categorized as widowed, divorced or separated, 3,098 (80.6%) were never married and not engaged, and 100 (2.6%) were never married but engaged. Among females, 927 (17.0%) were married, 243 (4.5%) were categorized as widowed, divorced or separated, 3,633 (66.6%) were never married and not engaged and 266 (4.9%) were never married but engaged.

Of the total male participants, 362 (9.4%) were engaged to partners who were always resident in the study area, 209 (5.4%) were engaged to partners who were partial resident and lastly 36 (0.9%) were engaged to non-resident partners in the study area. Regarding females, 553 (10.1%) were engaged to partners who were always resident in the study area, 603 (11.1%) were engaged to partners who were partially resident and lastly 396 (7.2%) were engaged to non-resident partners in the study area.

Figure 3 shows the reasons of migration among the study participant. The most important reason of migration for both genders was accommodation, 22.9% for males and 29.4% for females, followed by employment with 9.3% among males and 13.0 among females. Conjugal relationship was the less important reason of migration among the study participants.

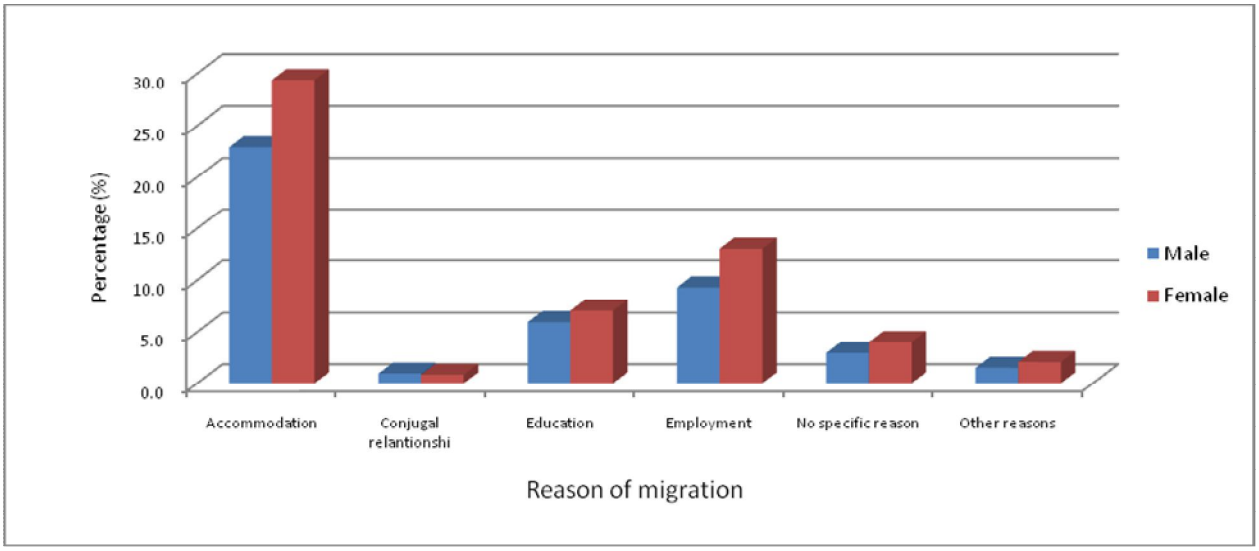

Figure 3: Distribution of reasons of migration among study participants

Table 2: Socio-demographic characteristics of the study sample

Exposure Variables	Gender				P value	Total	
	Males		Females				
	N	%	N	%	(chi square)	N	%
Migration type							
Non-Migrant	3219	83.7%	4617	84.6%		7836	84.3%
Internal Migrant	315	8.2%	394	7.2%	0.313	709	7.6%
External In-migrant	45	1.2%	56	1.0%		101	1.1%
External Out-Migrant	266	6.9%	388	7.1%		654	7.0%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
Age Groups							
15-19	2140	55.7%	2418	44.3%		4558	49.0%
20-24	620	16.1%	782	14.3%		1402	15.1%
25-29	240	6.2%	344	6.3%		584	6.3%
30-34	154	4.0%	337	6.2%	<0.000	491	5.3%
35-39	160	4.2%	438	8.0%		598	6.4%
40-44	170	4.4%	543	10.0%		713	7.7%
45-54	361	9.4%	593	10.9%		954	10.3%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
Education							
1-Never went to school	200	5.2%	408	7.5%		608	6.5%
2-Less than 1 year	18	0.5%	22	0.4%		40	0.4%
3-Lower primary school	121	3.1%	228	4.2%		349	3.8%
4-Primary school	661	17.2%	800	14.7%	<0.000	1461	15.7%
5-Secondary school	2437	63.4%	3438	63.0%		5875	63.2%
6-Other	291	7.6%	388	7.1%		679	7.3%
7-Unknown	117	3.0%	171	3.1%		288	3.1%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
Employment							
1-Employed full time	70	1.8%	89	1.6%		159	1.7%
2-Employed part time	2321	60.4%	3582	65.7%		5903	63.5%
3-Not employed	295	7.7%	491	9.0%	<0.000	786	8.5%
4-Other	93	2.4%	121	2.2%		214	2.3%
5-Unknown	1066	27.7%	1172	21.5%		2238	24.1%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
SES							
1-Poorest	740	19.2%	1001	18.4%		1741	18.7%
2-Poorer	693	18.0%	1017	18.6%		1710	18.4%
3-Poor	717	18.6%	1009	18.5%		1726	18.6%
3-Less Poor	695	18.1%	1044	19.1%	0.704	1739	18.7%
5-Least Poor	709	18.4%	1007	18.5%		1716	18.5%
6-Unknown	291	7.6%	377	6.9%		668	7.2%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
Marital status							
1-Married	298	7.8%	927	17.0%		1225	13.2%
2-Widowed/divorced /Separated.	20	0.5%	243	4.5%		263	2.8%
3-Never married & not engaged.	3098	80.6%	3633	66.6%	<0.000	6731	72.4%
4-Never married but engaged	100	2.6%	266	4.9%		366	3.9%
5-Other	329	8.6%	386	7.1%		715	7.7%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**
Partners status							
1-Not engaged	3238	84.2%	3904	71.6%		7142	76.8%
2- Engaged with Always resident partners	362	9.4%	553	10.1%		915	9.8%
3- Engaged with partial resident partners	209	5.4%	603	11.1%	<0.000	812	8.7%
4- Engaged with non-resident partners	36	0.9%	395	7.2%		431	4.6%
Total	**3845**	**100.0%**	**5455**	**100.0%**		**9300**	**100.0%**

3.2 Migration distances by origin and destination

In this section, the results (frequencies) of place of origin or place of destination where the individuals moved to or from using Africa Centre DSA as point of reference are presented. For those participants who in-migrated the origin is somewhere outside of DSA and end point is the DSA. In terms of out-migration the origin is Africa Centre DSA and the destination is somewhere outside of DSA.

3.2.1 Individuals external in-migration

Figure 4 shows a distribution of the frequency of external in-migration. The median of the external in-migration distance is 53.9 km, with a lower quartile of 27 km and upper quartile of 204 km. Durban with a distance of 203.8 km was the origin with highest frequency (27) followed by Empangeni (20) and Gauteng (11) with 53.9 km and 472.4 km respectively.

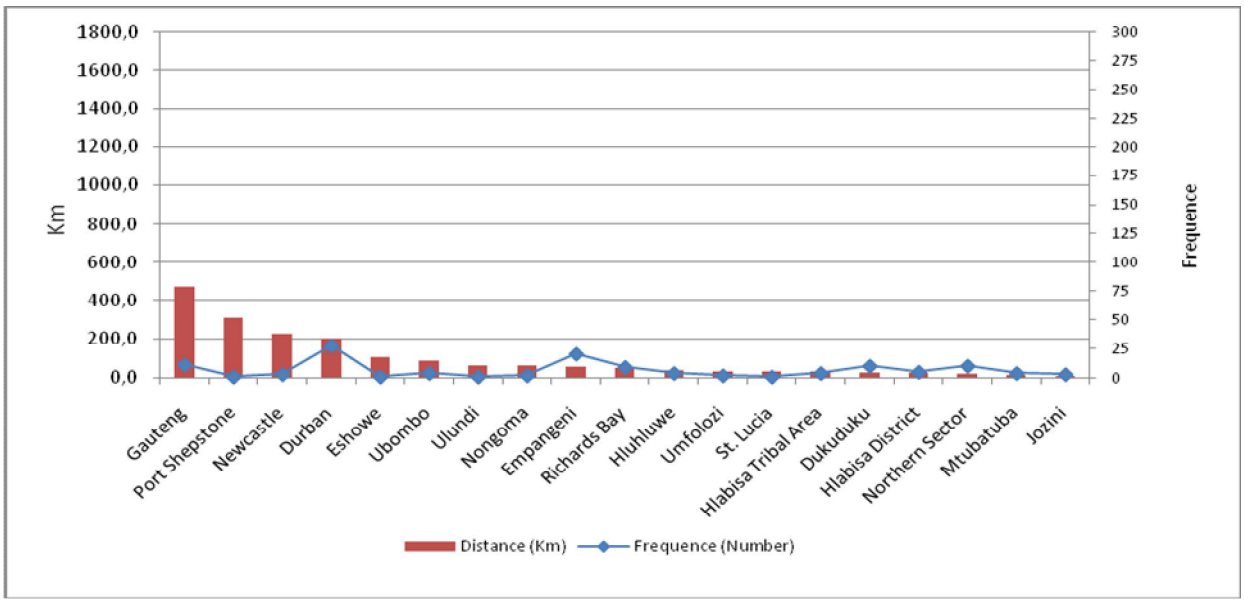

Figure 4: Frequency of individuals external in-migration distance

3.2.2 Individuals external out-migration

Figure 5 below shows the distribution of frequency of external out-migration and the distance migrated by the study participant. The median of the external out-migration distance is 104.7 km, with a lower quartile of 52 km and a upper quartile of 204km**.** In terms of external out-migration destination, we can see that the highest frequency (266) is concentrated in Durban (203.8km), followed by Empangeni (53.4km) and Gauteng (472.4 km).

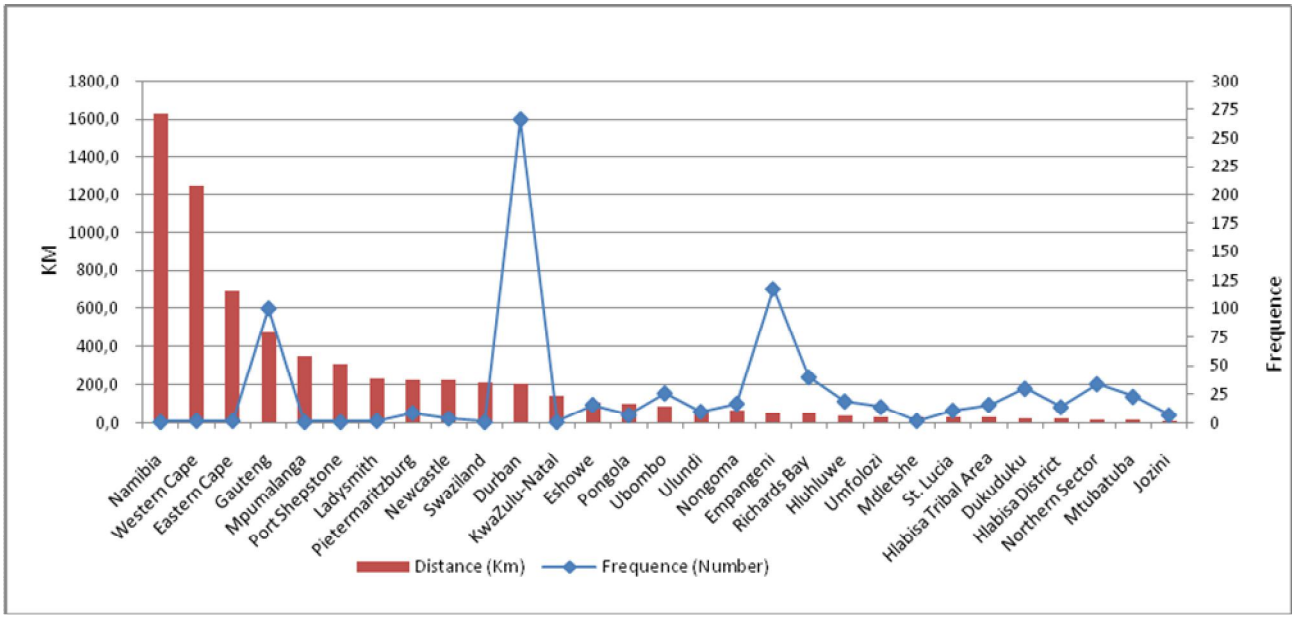

Figure 5: Frequency of individuals external out-migration distance

3.3 Sex and age specific migration rates

Migration rates were computed using the total number of migration episodes for each individual. The rates were calculated by gender for each specific age interval presented as gross migration rates as well for each type of migration. Globally, males migrate more as a result of higher rate of external out migration. The total migration rate among males is 8.8 and for females the rate is 8.2.

Figure 6 shows the gross migration rates by age groups and gender. Migration rates for both males and females in all age groups, excepting in age groups 30-34 and 45-49 did not differ significantly as

indicated by the overlapping confidence bands above. For both gender, the highest migration rate (approximately 16%) occur in age group 20-24. Also is important to not that females have higher rates than males in the younger age groups (15-19 and 20-24).

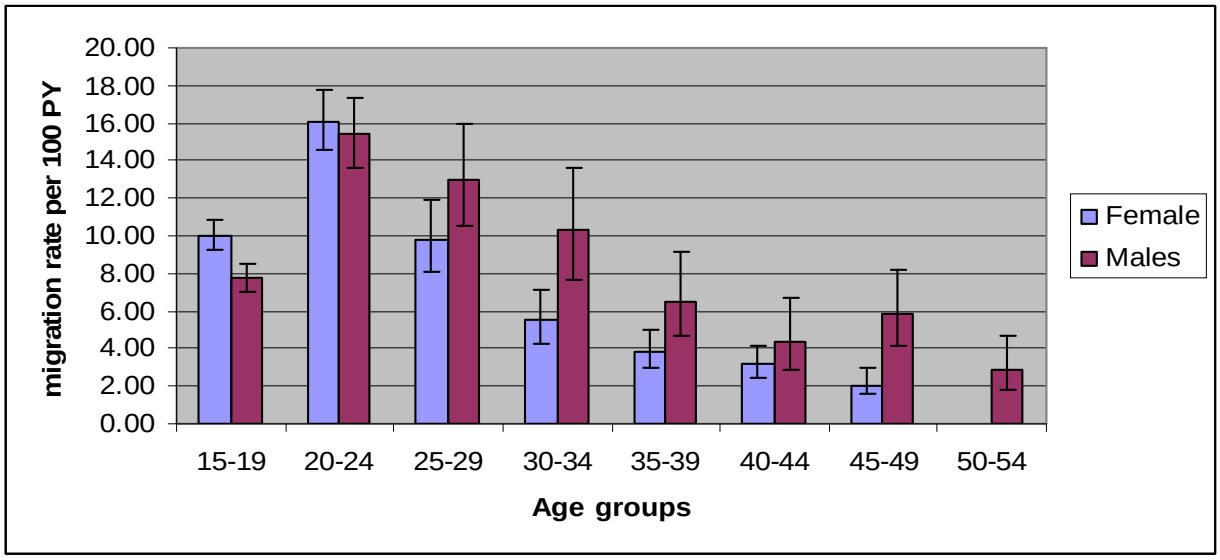

Figure 6: Gross migration rates among study participants during 2004 to 2008

Figure 7 shows migration rates by age groups and gender for the internal migrants. Migration rates for both males and females in all age groups did not differ significantly as indicated by the overlapping confidence bands above.

Migration rates of females in age group 15-19 differed significantly from the migration rates for the age groups 20-24, 40-44 and 45-49. The migration rate for females in age group 20-24 was significantly different from the migration rates in age groups 35-39, 40-44 and 45-49.

Migration rates of males in the age group 15-19 differed significantly from those in the age group 50-54. Similarly the migration rate of males in the age group 20-24 differed only significantly from those in the age group 50-54.

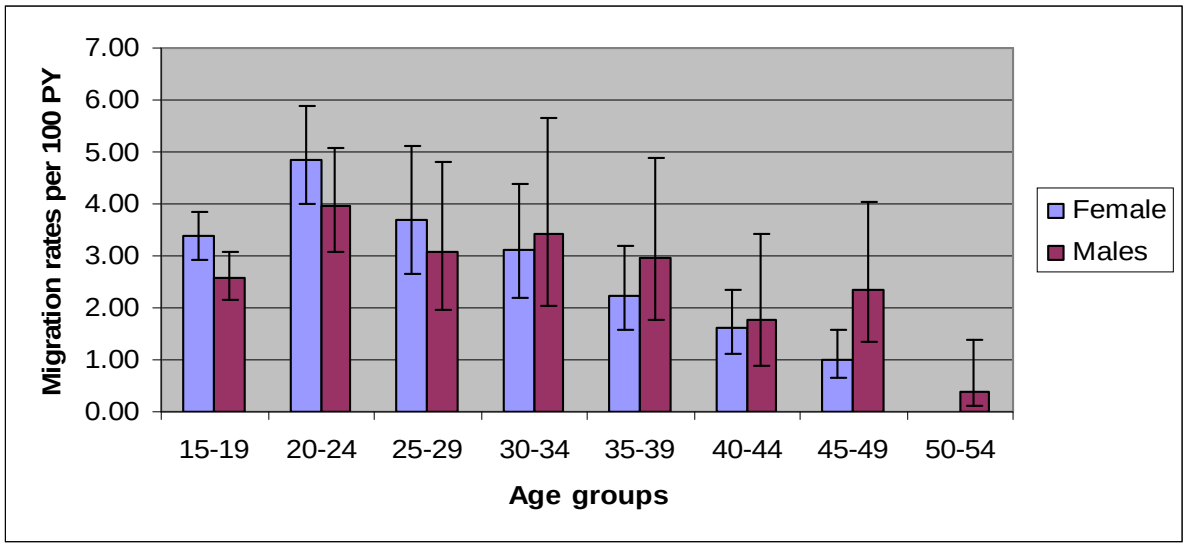

Figure 7: Internal migration rates among study participants during 2004 to 2008

Figure 8 shows migration rates of external in-migrants by sex and age group. There was no significant difference in migration rates between males and females in all the age groups. However there was a significant difference in migration rates for females in the age group 15-19, 20-24, 25-29 and 35-40. The migration rate for males in the age group 15-19 was significantly different from the migration rates in the age groups 20-24 and 25-29.The migration rates for the other age groups were not significantly different from each other.

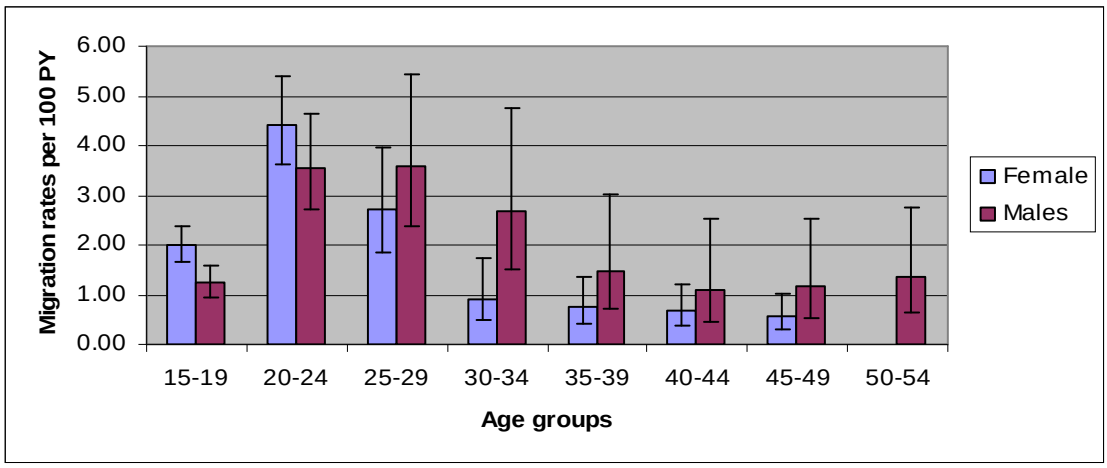

Figure 8: External in-migration rate among study participants during 2004 to 2008

Figure 9 shows migration rates by age groups and gender for the External out-migrants. In the age group 15-19 there was no significant difference in migration rates between males and females. This was also true for the age groups 20-24, 25-29, 35-39 and 40-44.The age groups 30-34 and 45-49 showed significant difference in migration rates between males and females.

Comparisons between females in different age categories reveal that there was a significant difference in migration rate between females in age group 15-19 and those in age group 20-24, 30-34, 35-39, 40-44 and 45-49. Males in the age group 15-19 showed significant difference in migration rate from males in the age groups 20-24, 40-45 and 50-54.The migration rate for males in the age group 20-24 differed significantly from males in the age groups 35-40, 40-45, 45-49, and 50-54.

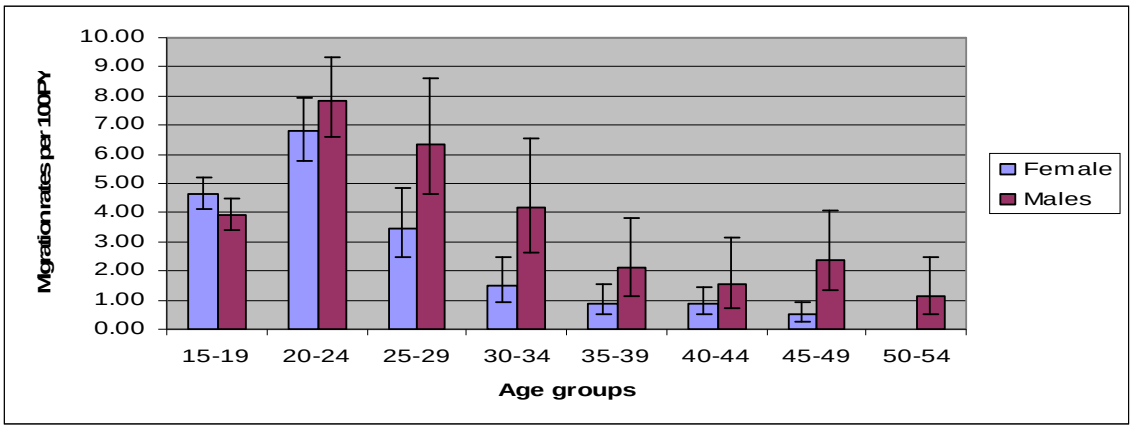

Figure 9: External out-migration rate among study participants during 2004 to 2008

3.4 HIV incidence rate

9,300 individuals enrolled in this study, contributed for a total of 22,695.5 person-years at risk (PYO) of which, 8951.5 and 13743.9 males and females person years respectively. Globally 699 individuals became sero-positive during the study. Table 3 shows HIV incidence rate per 100 PYO by gender. The crude incidence rate per 100 person-years was 3.1/100 PYO 95% CI (2.9-3.3). HIV incidence for women aged 15-49 years was about two times higher [3.9/100 PYO; 95% CI (3.6-4.3)] than in men aged 15-54 years [1.8/100 PYO; 95% CI (1.6-2.1)].

Females had higher incidence rates than males in all the migration categories. Female's non-migrants had an incidence rate of 4.1; 95% CI (3.8 – 4.5) while the male non-migrants had an incident rate of 2.0; 95% CI (1.7 – 2.3). In terms of migration, female exposed to external in-migration had an incidence rate of 3.8; 95% CI (1.7 – 8.5) while the male exposed to external out-migration had an incident rate of 1.2; 95% CI (0.6 – 2.3). This represented the highest rates for both males and females among types of migration.

The age group 25-29 years had the highest incidence rate for males [IR =4.8; 95% CI (3.3 – 7.0)] while the age group 20-24 years had the highest incidence rate for females [IR = 7.5; 95% CI (6.3 – 8.9)].

In the education category the highest incidence rate was recorded among females who completed secondary education [4.6/100 PYO; 95% CI (4.1 - 5.0)]. For males, the highest incidence rate was recorded among those who have less than one year of education [2.3/100 PYO; 95% CI (0.3 – 3.9)].

For employment category, comparing males and females, the HIV incidence was highest for those females who were employed part time and those males who were employed full time. The incidence rates were 4.1/100 PYO; 95% CI (3.7 - 4.5) and 3.3/100 PYO; 95% CI (1.4-8.0) respectively.

According to the SES quintiles the poor category among females and poorer category among males had higher incidence rates compared to those participants in the other SES quintiles in the respective gender. The HIV incidence rates were 4.0/100 PYO 95% CI (3.3-4.9) for females in poor category and 2.3/100 PYO 95% CI (1.7-3.3) for males in poorer category respectively.

In the marital status category, females who were never married and not engaged had the highest HIV incidence of 4.9/100 PYO 95% CI (4.5 – 5.4) while those females married had the lowest incidence rate of 1.4/100 PYO 95% CI (1.0-1.9). Among males, those males who were widowed/divorced or separated had the highest HIV incidence at 4.2/100 PYO 95% CI (1.1 – 16.9) and the lowest incidence rate at 1.0/100 PYO 95% CI (0.5-2.0) among those who were married.

In the partners status category, males who were engaged with non-resident partners had the highest HIV incidence of 4.2/100 PYO; 95% CI (1.3-13.0). Similar to males, the highest HIV incidence rates among females occurred in those who were engaged with non-resident partners [2.4/100 PYO; 95% CI (1.6 – 3.4)].

Table 3: HIV incidence rates for males and females

Exposure Variables	Males			Females		
	PYO	Sero-converters	IR (95%CI)	PYO	Sero-converters	IR (95%CI)
Migration type						
Non-Migrant	7311.1	145	2.0 (1.7 - 2.3)	11472.7	476	4.1 (3.8 - 4.5)
Internal Migrant	835.8	8	1.0 (0.5 – 1.9)	1086.9	22	2.0 (1.3 – 3.1)
External In-migrant	118.9	1	0.8 (0.1 – 6.0)	156.8	6	3.8 (1.7 – 8.5)
External Out-Migrant	685.7	8	1.2 (0.6 – 2.3)	1027.5	33	3.2 (2.3 – 4.5)
Age Groups						
15-19	4778.4	41	0.9 (0.6 - 1.2)	5382.0	248	4.6 (4.1 - 5.2)
20-24	1382.4	52	3.8 (2.9 - 4.9)	1805.5	135	7.5 (6.3 – 8.9)
25-29	543.5	26	4.8 (3.3 - 7.0)	861.4	47	5.5 (4.1 - 7.3)
30-34	377.0	9	2.4 (1.2 - 4.6)	942.6	24	2.5 (1.7 – 3.8)
35-39	447.9	12	2.7 (1.5 - 4.7)	1271.9	33	2.6 (1.8 - 3.6)
40-44	433.4	9	2.1 (1.1 - 4.0)	1668.7	28	1.7 (1.2 - 2.4)
45-54	988.9	13	1.3 (0.8 - 2.3)	1811.8	22	1.2 (0.8 – 1.8)
Education						
1-Never went to school	545.4	12	2.2 (1.2 – 3.9)	1240.6	23	1.9 (1.2 – 2.8)
2-Less than 1 year	42.6	1	2.3 (0.3 - 16.7)	62.9	1	1.6 (0.2 - 11.3)
3-Lower primary school	319.6	6	1.9 (0.8 - 4.2)	736.6	10	1.4 (0.7 - 2.5)
4-Primary school	1429.4	29	2.0 (1.4 – 2.9)	2177.1	66	3.0 (2.4 - 3.9)
5-Secondary school	5830.4	93	1.6 (1.3 - 2.0)	8351.4	381	4.6 (4.1 - 5.0)
6-Other	627.7	17	2.7(1.7 – 4.4)	951.2	41	4.3 (3.2 - 5.9)
Employment						
1-Employed full time	150.6	5	3.3 (1.4 – 8.0)	189.7	5	2.6 (1.1 - 6.3)
2-Employed part time	6050.7	144	2.4 (2.0 – 2.8)	10182.7	418	4.1 (3.7 - 4.5)
3-Not employed	662.8	6	0.9 (0.4 – 2.0)	1027.2	31	3.0 (2.1 - 4.3)
4-Other	118.4	1	0.8 (0.1 - 6.0)	157.2	3	1.9 (0.6 - 5.9)
SES						
1-Poorest	1607.6	20	1.2 (0.8 - 1.9)	2376.3	89	3.7 (3.0 - 4.6)
2-Poorer	1624.4	38	2.3 (1.7 - 3.2)	2535.2	99	3.9 (3.2 - 4.8)
3-Poor	1644.7	30	1.8 (1.3 - 2.6)	2555.3	103	4.0 (3.3 – 4.9)
3-Less Poor	1596.3	24	1.5 (1.0 - 2.2)	2674.4	89	3.3 (2.7 - 4.1)
5-Least Poor	1675.8	25	1.5 (1.0 - 2.2)	2618.6	90	3.4 (2.8 - 4.2)
Marital status						
1-Married	806.0	8	1.0 (0.5 - 2.0)	2868.6	39	1.4 (1.0 – 1.9)
2-Widowed/divorced /Separated.	47.2	2	4.2 (1.1 - 16.9)	745.2	16	2.1 (1.3 - 3.5)
3-Never married & not engaged.	7399.8	144	1.9 (1.7 - 2.3)	8857.7	437	4.9 (4.5 - 5.4)
4-Never married but engaged	244.5	6	2.5 (1.1 - 5.5)	738.4	24	3.3 (2.2 - 4.8)
5-Other	454.1	2	0.4 (0.1 - 1.8)	534.0	21	3.9 (2.6 - 6.0)
Partners status						
Not engaged	7315.4	135	1.8 (1.6 - 2.2)	9068.9	453	5.0 (4.6 – 5.5)
Engaged with Always resident partners	922.3	14	1.5 (0.9 - 2.6)	1584.2	26	1.6 (1.1 – 2.4)

Engaged with partial resident partners	642.0	10	1.6 (0.8 – 2.9)	1948.1	31	1.6 (1.1 -2.3)
Engaged with non-resident partners	71.8	3	4.2 (1.3 – 13.0)	1142.7	27	2.4 (1.6 - 3.4)
Total	**8951.5**	**162**	**1.8 (1.6 - 2.1)**	**13743.9**	**537**	**3.9 (3.6 - 4.3)**

3.5 Univariate analysis of factors associated with HIV acquisition among males

Table 4 shows univariate and multivariate models for males. In a univariate regression model, among all types of migration, males exposed to internal migration had a significant association with HIV infection. Other categories of migration showed no statistically significant association with HIV infection. Males exposed to internal migration had a 53% significant reduced risk of HIV acquisition [HR = 0.47, P = 0.039, 95% CI (0.23 – 0.96)] as compared to non-migrants.

The age group 25-29 years had the significant highest risk of HIV acquisition which was 5.56 times higher compared to the age group 15-19 [HR = 5.56; P < 0.000, 95% CI (3.40 - 9.09)]. There was no association between the age group 45-54 and HIV acquisition. Besides age group 45-54 years, other age groups had a significant increased risk of HIV acquisition.

All categories of education did not show any association with HIV acquisition among males.

Males not employed part time had a 73% statistically significant reduced risk of HIV acquisition compared to those employed full time [HR = 0.27, P = 0.031, 95% CI (0.08 – 0.89)]. The other category of employment showed no significant association with HIV acquisition.

Males in the Poorer category had a significant increased risk of 109% of HIV acquisition compared to those in the poorest category, [HR = 2.09, P = 0.007, 95% CI (1.23 - 3.55)].

All categories of partner's residence status did not show any association with HIV acquisition among males.

3.6 Multivariate analysis of factors associated with HIV acquisition among males

In the multivariate model the hazard ratios of the majority of covariates was attenuated. Internal migrants males had a 56% significant reduced risk of HIV acquisition [HR = 0.44, P = 0.027, 95% CI (0.22 – 0.91)] as compared to non-migrants males.

In the age groups category, males who were in the age group 25-29 years had the highest increased risk of HIV acquisition, which was 275% higher compared to the age group 15-19 [HR = 3.75, P < 0.000, 95% CI(2.30– 6.32)] and was statistically significant. The age groups 20-24 years and 35-39 had also a significant increased risk of HIV acquisition.

Males who were in the poorer category of SES had 83% increased risk of HIV acquisition compared to those poorest category, [HR = 1.83, P = 0.031, 95% CI (1.05 - 3.16)] and this was statistically significant. The remaining categories of all covariates showed no significant association with HIV acquisition in the multivariate model.

In the marital status category, males who were widowed, divorced or separated had borderline significant increased risk of HIV acquisition which was 4.87 times higher compared to those who were married [HR = 4.87; P < 0.052, 95% CI (0.98 – 24.11)]

Table 4. HIV Hazard rates for males

Exposure Variables	Hazard ratios for males					
	Unadjusted HR			Adjusted HR		
	HR	95%CI	P-value	HR	95%CI	P-value
Migration type						
Non-Migrant	1			1		
Internal Migrant	0.47	(0.23- 0.96)	0.039	0.44	(0.22- 0.91)	0.027
External In-migrant	0.41	(0.06- 2.97)	0.382	0.41	(0.06- 3.00)	0.383
External Out-Migrant	0.58	(0.28- 1.19)	0.132	0.57	(0.27- 1.17)	0.125
Age Groups						
15-19	1			1		
20-24	4.38	(2.91- 6.60)	0.000	2.81	(1.82- 4.33)	0.000
25-29	5.56	(3.40- 9.09)	0.000	3.75	(2.30- 6.32)	0.000
30-34	2.75	(1.33- 5.65)	0.006	2.04	(0.93- 4.44)	0.072
35-39	3.03	(1.59- 5.78)	0.001	2.17	(1.02- 4.59)	0.043
40-44	2.37	(1.15- 4.88)	0.019	1.81	(0.78- 4.22)	0.168
45-54	1.49	(0.80- 2.78)	0.209	1.28	(0.56- 2.90)	0.555
Education						
1-Never went to school	1			1		
2-Less than 1 year	1.09	(0.14- 8.39)	0.933	0.76	(0.10- 5.91)	0.790
3-Lower primary school	0.86	(0.32- 2.29)	0.763	0.71	(0.26- 1.93)	0.507
4-Primary school	0.95	(0.48- 1.87)	0.887	0.92	(0.45- 1.89)	0.819
5-Secondary school	0.74	(0.40- 1.35)	0.326	0.60	(0.30- 1.21)	0.151
6-Other	1.28	(0.61- 2.68)	0.513	0.97	(0.44- 2.19)	0.935
Employment						
1-Employed full time	1			1		
2-Employed part time	0.70	(0.29- 1.72)	0.441	0.77	(0.31- 1.92)	0.576
3-Not employed	0.27	(0.08- 0.89)	0.031	0.33	(0.10- 1.11)	0.074
4-Other	0.26	(0.03- 2.28)	0.226	0.14	(0.01- 1.57)	0.112
SES						
1-Poorest	1			1		
2-Poorer	2.09	(1.23- 3.55)	0.007	1.83	(1.05- 3.16)	0.031
3-Poor	1.65	(0.95- 2.87)	0.075	1.38	(0.78- 2.46)	0.271
3-Less Poor	1.34	(0.75- 2.38)	0.324	0.99	(0.54- 1.83)	0.985
5-Least Poor	1.47	(0.84 - 2.58)	0.179	0.94	(0.50- 1.74)	0.836
Marital status						
1-Married	1			1		
2-Widowed/divorced /Separated.	4.34	(0.92- 20.43)	0.063	4.87	(0.98- 24.11)	0.052
3-Never married & not engaged.	1.99	(0.97- 4.05)	0.058	1.98	(0.84- 4.69)	0.120
4-Never married but engaged	2.49	(0.86- 7.19)	0.090	1.75	(0.58- 5.24)	0.320
5-Other	0.48	(0.10- 2.29)	0.362	2.38	(0.41- 13.51)	0.332
Partners status						
Not engaged	1			1		
Engaged with Always resident partners	0.81	(0.47- 1.40)	0.453	0.73	(0.33- 1.29)	0.388
Engaged with partial resident partners	0.81	(0.43- 1.54)	0.525	0.73	(0.40- 1.44)	0.404
Engaged with non-resident partners	2.32	(0.74- 7.27)	0.150	1.94	(0.68- 5.71)	0.288

3.7 Univariate analysis of factors associated with HIV acquisition among females

Table 5 shows hazard rates for females. In the migration type category, the univariate model shows that internal migration had a 52% reduced risk of HIV acquisition [HR = 0.48, P = 0.001, 95% CI (0.32 – 0.74)] compared to non-migrants. Other types of migration infection showed no significant association with HIV acquisition. Regarding age groups, females who were in the age group 20-24 years had the significant highest risk of HIV acquisition which was 1.61 times higher compared to the age group 15-19 years [HR = 1.61; P < 0.000, 95% CI (1.31- 1.99)] while females in the age group 45-49 years had the significant lowest risk of HIV acquisition which was 0.26 times lower compared to the age group 15-19 years [HR = 0.26, P < 0.000, 95% CI (0.16 – 0.40).

Females who completed primary school education had a 64% statistically significant increased risk of HIV acquisition compared to those who had no education [HR = 1.64, P = 0.040, 95% CI (1.02 – 2.64)]. Females who completed secondary education had 150% statistically significant increased risk of HIV acquisition compared to those who had no education [HR = 2.50, P < 0.000, 95% CI (1.64 – 3.80)].

In the marital status category, females who had never married and not engaged had the significant highest risk of HIV acquisition which was 3.69 times higher compared to those who were married [HR = 3.69; P < 0.000, 95% CI (2.66 – 5.12)].

Regarding partners' residence status, females engaged with partners who were partial resident had the lowest risk of HIV acquisition which was 0.31 lower times compared to females who were not engaged [HR = 0.31, P < 0.000, 95% CI (0.21 – 0.45) and this was statistically significant. Other categories of partner's residence status showed a significant reduced risk of HIV acquisition.

3.8 Multivariate analysis of factors associated with HIV acquisition among females

In the multivariate model the hazard ratios some of the covariates were attenuated and others exaggerated. Similarly to univariate model, in the multivariate model only internal migration was significantly associated to HIV infection. Female internal migration showed a reduced risk of 50% [HR = 0.50, P < 0.002, 95% CI (0.33 – 0.77)] as compared to those females who were non-migrants.

Regarding the age groups categories, females who were in the age group 20-24years had a significant increased risk of HIV acquisition of 43% compared to the age group 15-19 years [HR = 1.43, P < 0.002, 95% CI (1.13 – 1.79)], while age group 45-49 had a significant reduced risk of 66% compared to the age group 15-19 [HR = 0.34, P < 0.000, 95% CI (0.19 – 0.58)].

Regarding the marital status, females who had never married and not engaged had 1.71 times higher risk compared to those who were married [HR = 1.71, P = 0.019, 95% CI (1.09 – 2.68)].

In the partner's residence status category, females engaged with partners who were always resident had significant lowest risk of HIV acquisition which was 0.59 times lower compared to those who were not engaged [HR = 0.59, P < 0.019, 95% CI (0.35 – 0.91).

Table 5: HIV Hazard rates for females

Exposure Variables	Hazard ratios for females					
	Unadjusted HR			Adjusted HR		
	HR	95%CI	P-value	HR	95%CI	P-value
Migration type						
Non-Migrant	1			1		
Internal Migrant	0.48	(0.32 -0.74)	0.001	0.50	(0.33 -0.77)	0.002
External In-migrant	0.92	(0.41- 2.05)	0.834	1.05	(0.47- 2.36)	0.903
External Out-Migrant	0.77	(0.54- 1.10)	0.151	0.80	(0.56- 1.15)	0.233
Age Groups						
15-19	1			1		
20-24	1.61	(1.31 – 1.99)	0.000	1.43	(1.13- 1.79)	0.002
25-29	1.17	(0.86- 1.60)	0.323	1.13	(0.81- 1.59)	0.472
30-34	0.54	(0.36- 0.82)	0.004	0.66	(0.41- 1.06)	0.085
35-39	0.55	(0.38- 0.79)	0.001	0.68	(0.43- 1.07)	0.094
40-44	0.35	(0.23- 0.52)	0.000	0.44	(0.27- 0.72)	0.001
45-49	0.26	(0.16- 0.40)	0.000	0.34	(0.19- 0.58)	0.000
Education						
1-Never went to school	1			1		
2-Less than 1 year	0.86	(0.11- 6.36)	0.882	0.56	(0.07- 4.15)	0.568
3-Lower primary school	0.73	(0.35- 1.53)	0.405	0.66	(0.31- 1.39)	0.272
4-Primary school	1.64	(1.02- 2.64)	0.040	1.11	(0.68- 1.83)	0.674
5-Secondary school	2.50	(1.64- 3.80)	0.000	0.88	(0.54- 1.44)	0.618
6-Other	2.36	(1.41- 3.93)	0.001	1.28	(0.75- 2.20)	0.369
Employment						
1-Employed full time	1			1		
2-Employed part time	1.54	(0.64- 3.71)	0.339	1.23	(0.51- 3.00)	0.644
3-Not employed	1.15	(0.44- 2.95)	0.777	0.79	(0.30- 2.05)	0.629
4-Other	0.74	(0.18- 3.10)	0.680	0.13	(0.02- 0.60)	0.009
SES						
1-Poorest	1			1		
2-Poorer	1.04	(0.78- 1.38)	0.790	1.02	(0.76- 1.36)	0.904
3-Poor	1.07	(0.81- 1.42)	0.627	1.02	(0.77- 1.36)	0.884
3-Less Poor	0.88	(0.66- 1.19)	0.417	0.84	(0.63- 1.14)	0.266
5-Least Poor	1.81	(0.68 - 1.22)	0.545	0.84	(0.62- 1.14)	0.261
Marital status						
1-Married	1			1		
2-Widowed/divorced /Separated.	1.58	(0.88- 2.83)	0.124	1.57	(0.81- 3.02)	0.178
3-Never married & not engaged.	3.69	(2.66- 5.12)	0.000	1.71	(1.09- 2.68)	0.019
4-Never married but engaged	2.41	(1.45- 4.00)	0.001	1.59	(0.93- 2.71)	0.089
5-Other	3.10	(1.82- 5.29)	0.000	1.95	(1.01- 3.78)	0.047
Partners status						
Not engaged	1			1		
Engaged with Always resident partners	0.32	(0.22- 0.48)	0.000	0.59	(0.36- 0.95)	0.031
Engaged with partial resident partners	0.31	(0.21- 0.45)	0.000	0.62	(0.40- 0.96)	0.034
Engaged with non-resident partners	0.46	(0.31- 0.68)	0.000	0.83	(0.51- 1.35)	0.460

CHAPTER FOUR: DISCUSSION

This is the first longitudinal population based cohort study in this community to investigate the relationship between migration patterns and HIV infection in adults. The study illustrates that the origins for the external in-migrants are concentrated in Durban, Empangeni, Gauteng and Richards Bay. These same areas are the destinations of the external out-migrants. Females have higher infection rates than males in the categories of covariates considered. Some categories such as age, internal migration, employment, SES and marital status were found to be predictors of newly acquired HIV infection in adults among males while internal migration, age, marital status and partners' residence status are covariates associated to females HIV infection.

4.1 Patterns of migration and HIV Incidence

The relevance of this study is that we managed to show that migration occurs for both men and women and that both sexes are at high risk of HIV infection. A considerably high rate of migration of both men and women was revealed in this study which is in agreement with other studies conducted in this area (Zuma et al 2003; Muhwava & Nyirenda, 2007; Camlin, 2008). Globally, males migrate more than women. However, women have slightly higher migrations than man, especially in terms of internal migration and external in-migration. This is in agreement with a study that was recently done in the same community by Camlin (2008) and findings in rural Mpumalanga reported by Collinson (2009) which reveals increased patterns on female migration. Increased women migration was also reported by International Organization of Migration-IOM (2007) which identified the reason for rural to urban migrations as a mechanism among women to achieve economic and social independence. Fewer marriages rates and changes in household decisions and composition are other reasons

identified by Posel (2003) to explain the female migration in South Africa. Generally, women appear to move more often closer to home and more likely return to their rural homesteads. This is supported by the fact that the majority of migrants moved to Durban which is about two hour drive from the study area. This appeared to be the furthest destination for most migrants. The other major destinations of migrants were Richards Bay and Empangeni which are about 30 minutes drive from the study site.

The data presented here do provide support for the proposition that a 'feminization of internal migration' has taken place in South Africa (Camlin, 2008). It is a likely consequence of the processes of rapid urbanization and globalization that occur in Southern Africa today and is likely to be both a cause and a consequence of contemporary transformations in gender.

Among all types of migrations, individuals in the age group 20-24 years have the highest migration rates. This is in consistent with a study that was done by Muhwava & Nyirenda, (2007) in the same community as well as with study findings on migration patterns in rural Mpumalanga since the onset of democracy, (Collinson, 2009).

Women had higher HIV incidence than men in all categories of migration. The incidence rate for females was more than double that of men indicating that HIV is a major public health problem among women of reproductive age in KwaZulu-Natal. This is consistent with previous studies done in the same area, **(**Tanser et al, 2008; Bärnighausen et al, 2008). Similar findings in KwaZulu Natal province were described at South African National level by Shisana et al (2005). Higher HIV incidence in women than men in this study may be attributed to a power imbalance, access to resources and in decision-making authority between men and women in South Africa as pointed out by (Abdool Karim & Abdool Karim, 2005). Anatomical and physiological characteristics of women can be another important factor to explain the gender difference on HIV infection among the study participants, (Johnson & Budlender, 2002). Furthermore, untreated sexually transmitted infections

may increase the biological susceptibility of women to acquire HIV infection (Fleming & Wasserheit, 1999; Abdool Karim & Abdool Karim, 2005). Especially in this study, HIV incidence is greater for women in the age groups 15-19 years and 20-24 years as compared to men in these age groups. This result is in agreement with findings by Rehle et al, (2007) and Collinson, (2009) and can be attributed to earlier sexual debut for women than that for men. It is likely that these infections occur immediately after sexual debut (Glyn et al, 2001). Further, because women tend to have older partners both at sexual debut and later on, they may be at higher risk for HIV infection because they might be exposed to previously infected partners (Gregson et al 2002**;** Mocumbi, & Amaral, 2006**;** Msuya et al, 2006; Hargreaves et al 2007, Johnson & Budlender, 2002). According to Shisana (2009), poverty is the reason why young females seek older partners. This practice is based on material gains.

In the destination place, migrant women are strongly associated with HIV infection as consequence of poor education, access to formal labour market, poor and vulnerable working conditions as sex work. Female migrants working in farming settings have been known to exchange sex for food, jobs and accommodation (IOM, 2007). Incidence rates were lower in married individuals irrespective of their sex compared with other categories of marital status. A protective effect of marriage on HIV infection was also found among women in Tanzania (Kapiga et al, 1998).

4.2 Factors associated with HIV infection in adults

4.2.1 Migration

About 18.2% of the study participants migrated during the study period. This highlights the importance of migration in disease spread in rural areas as they constitute a large proportion of the village population. All categories of external migration in this study both for males and females were not associated with HIV Infection while internal migration showed a significant reduced risk of HIV infection. In terms of external migration, similar result was found by Hargreaves, (2007) and Lumfwa, (2007) in Limpopo Province, South Africa where the socio-demographic characteristics of

this area seem to be similar to those of KwaZulu-Natal. Several studies have recognized that migration per se is a non-direct risk factor of HIV infection but the migrant's behaviour or the migrant's socio-economic condition is the direct factor for HIV infection (Deering et al, 2008; Hugo, 2005; Brockerhoff & Biddlecom, 1999)**.** Migration can be a risk factor not simply because men return home to infect their rural partners. In the other way rural women of both partners of migrant and non migrants are likely to become infected from outside their primary relationships. Women with absent partners are more likely to have additional sexual partners and as a result have an increased risk of becoming HIV infected, (Serwadda et al 1995). Several studies pointed migration as a mechanism where people infected in urban areas transmit the virus to their partners in the rural when they return home. Inversely, the virus can be transmitted when migrants infected in urban areas invite their partners living in rural areas to come to their work places for temporary visit or to collect money (Johnson & Budlender, 2002; Lurie et al, 1997).

The majority of external migrants in this community are engaged in urban environments in Durban, Empangeni and Gauteng. This may contribute to increased alcohol consumption and engaging in commercial transactional sex. Drinking alcohol may facilitate contact with commercial sex workers in bars and increase the desire to have multiple sexual partners and unprotected casual sex (Simbayi et al 2004; Hendershot et al 2007; Kongnyuy & Winysonge 2007).

4.2.2 Age

In the adjusted model, age among males showed a significant increased risk of HIV infection in the younger age as well in age group 35-39 years. However, among females, age was positively significant associated to HIV acquisition in the group 20-24. In the last to age group categories age had a reduced effect on HIV acquisition. This particular situation at age 20-24 where females get infected in early age differs to the result reported by two different studies which showed higher risk of HIV infection among females aged 24 years and above in Tanzania and females aged 25-29 years in

Kenya (Mmbaga, 2007; Johnson, 2006). Differently to the distribution of the risk in the age groups of this study, where the younger people are at greater risk, one study conducted in Tanzania showed that the higher risk factor for HIV infection was higher to those individuals who were older than 30 years, particularly for those females aged 30-39 years and those males aged 30 years and above, (Landman et al, 2008). Comparing the distribution of HIV incidence for age categories, in general females had higher rate than males. However, in both adjusted and unadjusted models, is evident that males are at greater risk than females of acquisition of HIV infection meaning that probably in this rural settlement the HIV is transmitted from males to females in all age groups.

4.2.3 Education

Categories of Education among males did not show any significant association with HIV infection. This result is in disagreement with findings reported by Hargreaves (2007) where males who attended and completed secondary school had significant odds to be infected. Although, a cross sectional study conducted in Carletonville shows that level of education was not associated to HIV infection (Zuma et al, 2003). In contrast, among females, there were a significant association between education and HIV infection in the unadjusted model, especially for those who completed primary school and secondary school. Similar result was found at the beginning of pandemic in Rakai, rural Uganda in the 1990s where the most educated people were associated with higher HIV infection. However, since the middle of the 1990s education starts to have an important benefit, lowering HIV infection (Smith et al, 1999; Bloom et al, 2002; Hargreaves, 2007). In some recent studies there were found education as protective factor for HIV Infection (Walque, 2003; Michelo et al, 2006; Bärnighausen et al, 2008; Jukes et al, 2008).

4.2.4 Employment

Males employed part time had a significant reduced risk of HIV infection compared to those employed full time in the unadjusted model. This illustrates that employment status play an important role on HIV infection, particularly among males where the risk of infection was positively associated to the depreciation of the employment category. This finding is in disagreement to the results reported by Williams et al (2000) who find out that males with full time employment in Carletonville, South Africa were at great risk of HIV infection. However, after adjusting for potential confounders, employment showed no significant association with HIV infection.

4.2.5 Socio-economic status

Males in the poorer category of socio-economic status are the only ones who had a significant risk of HIV infection both in univariate and multivariate analysis. Other categories among males and all categories among females do not show significant association with HIV infection. This result on males showing a significant increased risk in the lower category of socio-economic status is in disagreement with one incidence study conducted in Limpopo province, South Africa where the result among males showed a protective effect of poor SES, (Hargreaves et al, 2007). Other inconsistence with this finding is related to a study conducted in Kenya where the better wealth condition was positively associated to HIV infection, (Johnson, 2006).

4.2.6 Marital status

The capacity of marital status to protect or not protect individuals has been reported in several studies involving HIV and other diseases, (Kaplan & Kronick, 2006). Currently unmarried and not engaged and currently unmarried but engaged females have significant higher risk of HIV infection in the unadjusted model. After adjusting for confounders only females who were unmarried and not

engaged had a significant higher risk of HIV infection as compared to married females. This finding is in agreement to one survey conducted in Carletonville, South Africa where individuals who had non-spousal relationship had an increased risk of HIV infection, (Williams et al, 2000). Married individuals have been reported to have no or fewer extramarital partners as compared to those who are single, (Lurie et al, 2003). Being married also increases the likelihood that intimacy needs are being met, which may protect against seeking multiple partners.

Among males, those individuals who were widowed, divorced or separated were borderline significant associated to HIV infection. This finding is in agreement with a study carried out in the same area (Bärnighausen et al, 2008).

4.2.7 Partners residence status

In this study, females engaged with partners who were always resident and partners who were partially resident showed a significant reduced risk of HIV infection. However, comparing these two categories of partner's residence status which were significant, females engaged with always resident partners had a protection of 41% and those females engaged partial resident partners had a protection of 38%. Many studies have found that lengthy separation of spouses or partners and detachment from the socio-cultural constraints of home is associated with risk- taking among migrants, (Anarfi et al, 2000; Brokerhoff & Biddlecom, 1999**;** Yang, 2004). This may be responsible for the lower protection observed among females engaged with partial resident partner. Another study in South Africa indicated that risk behaviours are more important in shaping migrants HIV risk than exposure to different transmission intensity, (Coffee et al, 2004).

Research may be needed to better understand the complex social and sexual lives of rural women, especially in relation to the migration status of their partners. Understanding these dynamics could

help to promote the development of new approaches for HIV prevention among rural women. Social control is stronger in the villages and it appears to reduce the risk of HIV infection among non-migrants, (Barnett & Whiteside, 2002).

4.3 Implication of the results

The high incidence of HIV among women emphasizes the urgent need for interventions aimed at combating the spread of HIV among women in general and migrant women in particular. Such interventions should address social and economic factors promoting the spread of HIV. Population based strategies for treating STDs, which have been shown to reduce HIV incidence, are essential, (Grosskurth et al, 1995).

The nature of existing rural- urban migration in South Africa and other developing countries requires an integrated approach of ongoing interventions at both ends of the migration spectrum (Lurie et al, 1997). Interventions such as those described by Williams et al (2000) should cover not only the migration destinations but also the rural areas and other places from where the migrants originate. There is also a need for educational and empowerment programmes that will promote condom use among women. In the long run steps must be taken to address the social and economic pressures that migrant women face. Just as the HIV epidemic in the United States has become a disease of women and of racial and ethnic minorities (UNAIDS, 2006), so the epidemic in Africa may also concentrate among the socially vulnerable. There is a strong case for the wider testing and implementation of structural interventions that address the ‘upstream’ determinants of HIV infection (Blakenship et al, 2000).

4.4 Limitations

Interpretation of the results of this study should be considered in the light of a number of limitations. Firstly, the study sample does not include all eligible individual among the study population. The sample represents about 1/3 of the eligible individuals and the majority (about 1/2) of individuals who consented to HIV test was in age group 15-19 years. Higher HIV test's refusal rate in the other age groups (probably more exposed to migration and sexual risk behaviour) can bias the results of study.

Secondly, collecting information on migration in the place of origin (rural area) where usually we find deficit of migrants can bias in terms of number of migrants, eligible individuals for HIV test and individuals at risk, thus because migration tend to be selective. Linked to migrants, the reasons given for migration were speculative and further studies including in-depth interviews are needed to understand those reasons as well as other qualitative experiences of in-migration. This information may prove useful in the design of interventions.

Thirdly, the date of sero-conversion was assumed as the midpoint between the last negative and first positive HIV test. Thus, it is impossible to identify when and where the individuals were infected.

Fourthly, the number of conjugal partners exposed to migration in this study was very few because data for casual partners was not collected.

Fifthly, the analysis of this study was based on type of migration (first single event) and issues such frequency of migration and multi-movers were not taken in account.

Sixthly, external validity is a critical issue when data from a selected rural community are extrapolated to the whole rural population. The socio-economic characteristics of this area (for example, forest plantations, livestock and agricultural activities) make this area unique, limiting the generalization of these results to the whole rural population in the country.

4.5 Conclusion

Migration in the study area varies by type, gender, and age. The most predominant type is internal migration followed closely by external out-migration. Among all types of migration, in this cohort of repeat-testers of HIV, males migrate more, but women have also a considerable higher migration rates and this fact reveals the emerging changes of patterns of migration where females start to engage in this phenomenon which was a tradition only for males in South Africa. Younger individuals migrated more often and the majority of migrants moved to urban centres close to the study area. Migration rates peaked among individuals aged 20-24 years and probably as a result this age group appears to have the highest HIV incidence rate.

The effect of gender in this study is very important in terms of HIV incidence. The incidence is 217% higher in women than in men in this cohort of repeat-testers of HIV. The external in-migrants and the external out-migrants had a higher incidence of HIV than the non migrants and internal migrant, both for males and females. External migration does not appear to increase HIV acquisition for this cohort of repeat-testers of HIV, and those who internally migrated had a reduced risk of HIV acquisition. External in-migration and external out-migration per se appeared to be non significant independent risk factor of HIV acquisition. Socio-economic conditions, probably attitudes and practices among young adults seem to be the principal factor both among migrants and non migrant for HIV acquisition, especially among females. Thus, public health efforts to control the spread of HIV infection in this rural population should be aimed especially at women. Moreover, prevention programs should target young people, especially women, empowering them to delay sexual debut, to avoid risky sexual behaviour and to improve their negotiating skills especially regarding the use of condom in this cohort.

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Appendixes

Appendix 1. Map of the geographically location of Africa Centre study area

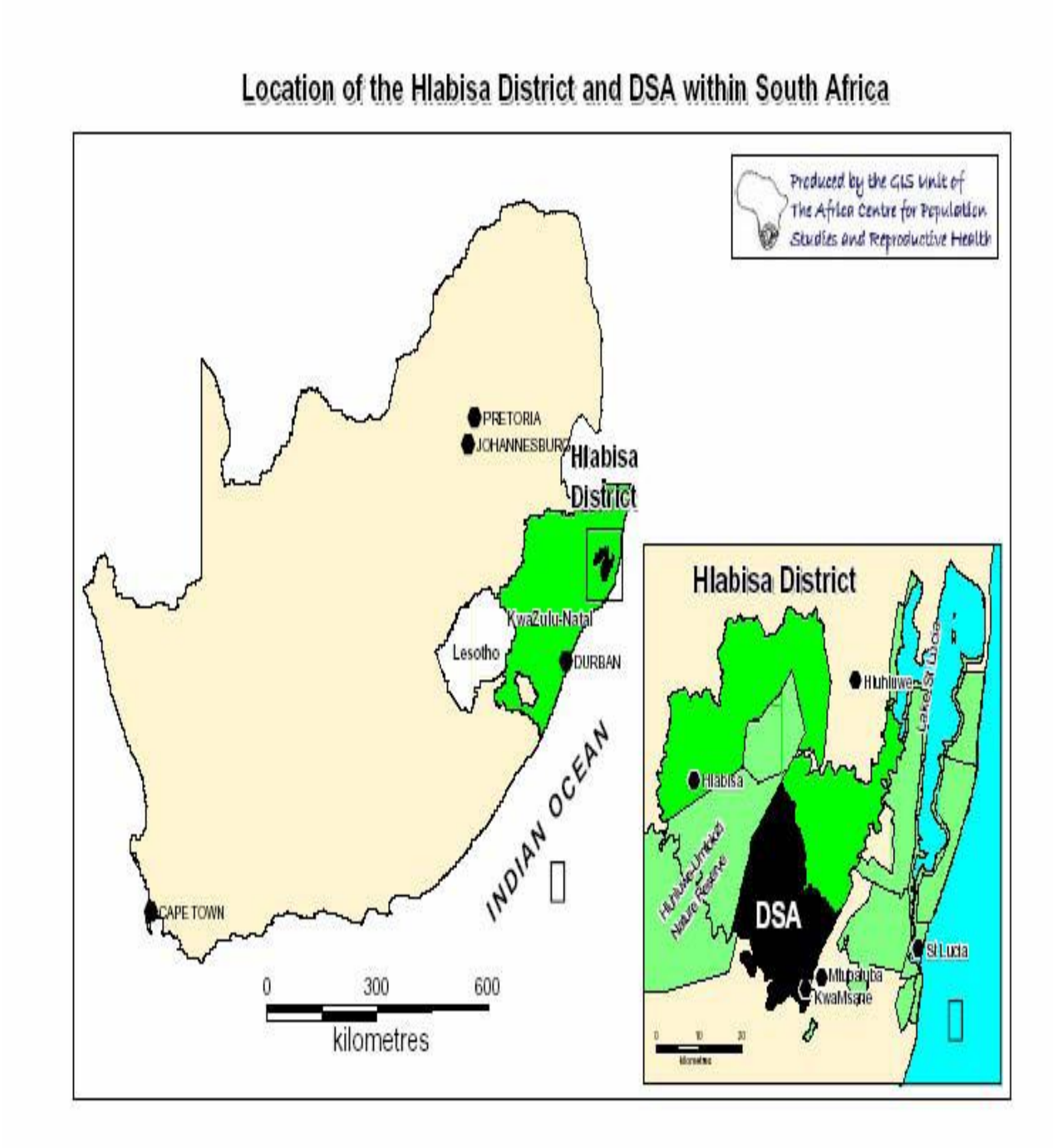


Figure 1: Map of the geographically location of Africa Centre study area (Source: Africa Centre).

Appendix 2. Human research Ethics Clearance Certificate from WITS

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Sacoor

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M081149**
PROJECT	Migration Patterns in Rural Kwa-Zulu Natal, and the Association with Adult HIV Infection
INVESTIGATORS	Mr CNJ Sacoor
DEPARTMENT	School of Public Health
DATE CONSIDERED	08.11.28
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 08.11.26 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr F Tanser

DECLARATION OF INVESTIGATOR(S)

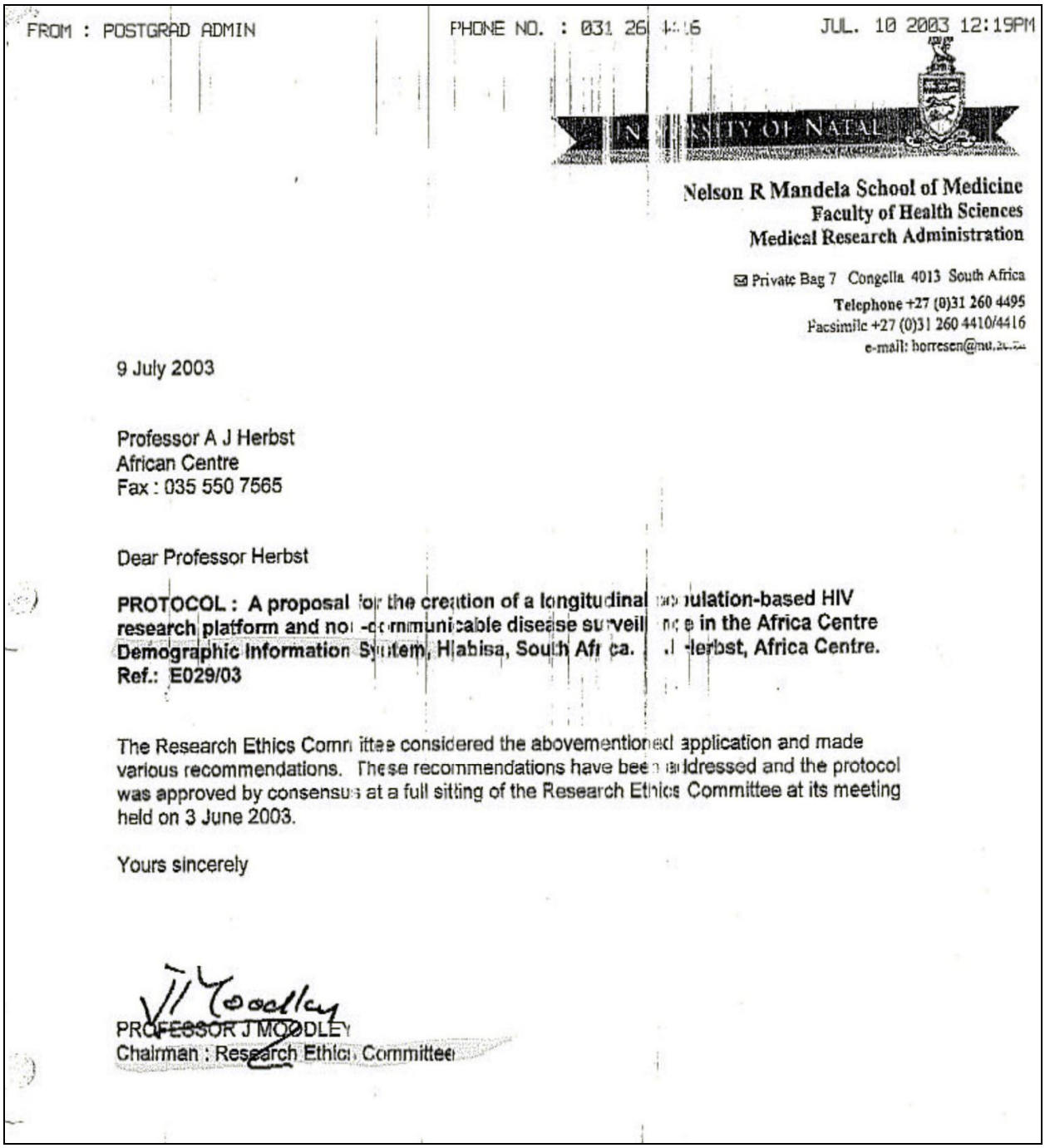
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. 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...

Chanduu Sacoor
17/12/2008

Appendix 3. Ethics Clearance Certificate of primary data collection.

A



FROM : POSTGRAD ADMIN PHONE NO. : 031 26 [illegible]6 JUL. 10 2003 12:19PM

UNIVERSITY OF NATAL

Nelson R Mandela School of Medicine
Faculty of Health Sciences
Medical Research Administration

Private Bag 7 Congella 4013 South Africa
Telephone +27 (0)31 260 4495
Facsimile +27 (0)31 260 4410/4416
e-mail: horresen@nu.ac.za

9 July 2003

Professor A J Herbst
African Centre
Fax : 035 550 7565

Dear Professor Herbst

PROTOCOL : A proposal for the creation of a longitudinal population-based HIV research platform and non-communicable disease surveillance in the Africa Centre Demographic Information System, Hlabisa, South Africa. A Herbst, Africa Centre.
Ref.: E029/03

The Research Ethics Committee considered the abovementioned application and made various recommendations. These recommendations have been addressed and the protocol was approved by consensus at a full sitting of the Research Ethics Committee at its meeting held on 3 June 2003.

Yours sincerely

PROFESSOR J MOODLEY
Chairman : Research Ethics Committee

UNIVERSITY OF
KWAZULU-NATAL

Research Office
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Nelson R Mandela School of Medicine
Private Bag 7, Congella 4013
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15 October 2007

RECERTIFICATION APPLICATION APPROVAL NOTICE

Name & Address of PI:	Professor A J Herbst Africa Centre Fax: 035 550 7565
Protocol:	PROTOCOL: A proposal for the creation of a longitudinal population-based HIV research platform and non-communicable disease surveillance in the Africa Centre Demographic Information System, Hlabisa, South Africa. A J Herbst, Africa Centre.
Reference Number:	E029/03
Approved:	15 October 2007
Expiration of Ethical Approval:	15 October 2008

I wish to advise you that your application dated **14 September 2007** for the above protocol (including the documents listed below) has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

1. BioMeasures Questionnaire (English)
2. Men's General Health Questionnaire (English)
3. Women's General Health Questionnaire (English)
4. Informed Consent Form, Version 3.0 (English)
5. Informed Consent Form, Version 3.0 (Zulu)

If any modifications or adverse effects occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received a BREC approval letter for the change.

A full sitting of the Committee will be advised of this decision at a meeting to be held on **13 November 2007.**

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator

B

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02 February 2007

Dr K Herbst
Africa Centre
Nelson R Mandela School of Medicine
University of KwaZulu-Natal

Dear Dr Herbst

PROTOCOL: HIV sero-surveillance in the over 50's. Dr K Herbst, Africa Centre. Ref: E122/06

The Biomedical Research Ethics Committee considered the abovementioned application and the protocol was approved at its meeting held on 07 November 2006 pending appropriate responses to queries raised. Your responses dated 21 December 2006 and 12 January 2007 to queries raised on 24 November 2006 has been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as at **02 February 2007.**

The following documents have been approved:

Letter of approval from the CAB dated 05 December 2006
Protocol Version 21 December 2006
Informed Consent Form Version 1.1 dated 5 December 2006
Zulu Informed Consent Version 1.0 dated February 2006
Men and Women Questionnaires Version 1 dated 13 September 2006
Men and Women Zulu Questionnaires Version 1 dated February 2006
Certification of translation dated 12 January 2007

This approval is valid for one year from **02 February 2007.** To ensure continuous approval, an application for recertification should be submitted a couple of months before the expiry date. In addition, when consent is a requirement, the consent process will need to be repeated annually.

I take this opportunity to wish you everything of the best with your study. Please send the Biomedical Research Ethics Committee a copy of your report once completed.

Yours sincerely

DR J MOODLEY
Chair: Biomedical Research Ethics Committee

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26 November 2007

Dr K Herbst
Africa Centre
Nelson R Mandela School of Medicine
University of KwaZulu-Natal

Dear Dr Herbst

RECERTIFICATION APPLICATION APPROVAL NOTICE

PROTOCOL: HIV sero-surveillance in the over 50's. Dr K Herbst, Africa Centre.

Reference Number:	E122/06
Approved:	02 February 2008
Expiration of Ethical Approval:	02 February 2009

Your letter dated 09 November 2007 in response to queries raised on 15 October 2007 regarding your application for recertification dated 20 September 2007 has been noted by a sub-committee of the Biomedical Research Ethics Committee.

I wish to advise you that your application for Recertification dated **20 September 2007** for the above protocol has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above. The approval includes the English and Zulu Informed Consents version 4.0.

If any modifications or adverse effects occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received a BREC approval letter for the change.

The approval will be ratified by a full sitting of the Committee at a meeting to be held on **12 February 2008.**

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator

C

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29 November 2007

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

Dear Dr Herbst

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

Your application for recertification received on 21 November 2007 has been noted by a sub-committee of the Biomedical Research Ethics Committee.

As there is verbal consent for analysis you are requested to please submit an amendment in addition to this submission.

Please also note that according to our records, full approval for the above study was given on 06 September 2000, and where the PI was G C Solarsh.

Please indicate whether this has since changed, and if so, a letter from the PI has to be submitted.

Yours sincerely

Suraiya Buccas
Biomedical Research Ethics Administrator

AcDIS

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13 February 2008

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

PROTOCOL AMENDMENT RATIFICATION

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

Dear Dr Herbst

Further to our letter to you dated 20 December 2007, this letter serves to notify you that at a full sitting of the Biomedical Research Ethics Committee Meeting held on **12 February 2008**, the Committee RATIFIED the sub-committee's decision to approve the Protocol Amendment with change in PI and submission of 2003 Progress Report.

Yours sincerely

SURAIYA BUCCAS
Ethics Research Administrator
SB/pn

Appendix 4: Data use agreement between the student and the ACDIS

AFRICA CENTRE
FOR HEALTH AND POPULATION STUDIES

Africa Centre Demographic Information System (ACDIS)

Data Use Agreement

It is hereby agreed with : **Charfudin Nicos Jussub Sacoor** (The "Data User")
Of **University of Witwatersrand as student** (Affiliation) on 30/10/2008 (year)
that s/he will have access to the following ACDIS dataset(s) :

1. Demographic database
2. Migration database
3. Serosurveillance database
4. Household database

The following conditions will apply:

1. The Data User will neither release nor permit others to release the files or data therein to any person (including media and subcontractors) except with the written approval of the ACDIS Project Leader;
2. The Data User will neither use nor permit others to use the data in any way other than listed in the original application (Analysis Plan) for access to the dataset;
3. The Data User will ensure that the data are kept in a secured environment and that only authorized users have access to the data.
4. Every publication or report based on the data must carry an acknowledgement of the form:
   This Analysis is based on data collected by the Africa Centre Demographic Information System
5. The Data User will not release or permit others to release any data that identifies persons, directly or indirectly;
6. Once the dataset has served its indicated purpose it must be disposed of;

All datasets remain the property of the Africa Centre and the Africa Centre reserves the right to request the return of any datasets should any of the above conditions be violated;

The following documents **must** accompany this agreement:

1. A short description of the intended purpose and method of analysis of the data (Analysis Plan)
2. A list of the names and organizational affiliations of all those who will engage in this analysis. In the case of students, a statement by their supervisor that they will ensure that the student abides by these conditions.
3. A description of the means by which the Data User will restrict access to confidential Africa Centre data.

Signed:

Charfudin Sacoor
Data User — Date: 30/10/2008.

Marie Louise Newell
Prof Marie-Louise Newell (Director) — Date: .....

pp. [signature]
Dr A J Herbst — Date: 31/11/2008
(ACDIS Project Leader)

A short description of the intended purpose and method of analysis of the data (Analysis Plan)

IN COLLABORATION WITH THE UNIVERSITY OF KWAZULU-NATAL AND THE SOUTH AFRICAN MEDICAL RESEARCH COUNCIL

Postal: PO Box 198, Mtubatuba 3935, South Africa **Physical:** Africa Centre, R618 en route to Hlabisa, Somkhele
Tel: +27 (0)35 550 7500 Fax +27 (0)35 550 7565 E-mail: info@africacentre.ac.za
Website: www.africacentre.ac.za

C:\Users\chanijusa\Desktop\ACDIS_Data_Use_Agreement[1].doc