A COMPARATIVE STUDY ON THE DETERMINANTS OF HIV INFECTION IN SWAZILAND AND ETHIOPIA

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558473

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DECLARATION

I, Vusie Lokotfwako declare that this research report is my own work. It is being submitted for the degree of Master of Science in Epidemiology in the field of Epidemiology and Biostatistics in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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ABSTRACT

Background

Despite the national and international efforts to combat HIV, sub-Saharan Africa continues to suffer the effects of the pandemic. In 2011 in sub-Saharan Africa there were 23.5 million people living with the virus and 1.8 million new infections. Swaziland, with a population of 1.1 million people, has equally shouldered the HIV burden as it has an adult prevalence of 26%, which is one of the highest in the world. State resources have been affected and the number of orphaned and vulnerable children continues to rise. Ethiopia on the other hand, has a population of 74 million people and is one of the poorest countries in the world. However, the adult HIV prevalence remains low at 1.5% and is lower than many sub-Saharan African countries. HIV prevalence in pregnant women attending antenatal clinic has declined by 82% between 2000 and 2010. The main mode of transmission in both countries is through heterosexual contacts.

Objective

The main objective of the study was to identify and compare the main differences in the determinants of HIV infection in Swaziland (2006) and Ethiopia (2005)

Materials and methods

The research was a secondary analysis of a cross-sectional survey from two demographic health surveys and studied the effect of the determinants on HIV infection. We constructed a conceptual framework based on the Mosley and Chen framework, and we grouped the variables into underlying and proximate factors. The outcome variable was HIV status and descriptive statistics as well as bivariate tests were carried out using Pearson's Chi-square and Fischer's exact tests for associations. Univariable and multivariable logistic regression were used to model the explanatory

variables against the outcome. Datasets from the two countries were then appended and propensity score matching was done using age, gender and wealth index. Further logistic regression analysis for the merged data was done for the proximate factors and the outcome. The conceptual framework based model was used to model direct and indirect determinants of HIV infection using a structural equation model.

Results

In Swaziland, a total of 4 584 females and 3 602 males were tested for HIV, and the adult prevalence was 26.20%. Females had a higher prevalence of 30.98% compared to their male counterparts who were at 19.51% ($p<0.0001$). In the multivariable regression analysis the result showed a greater than 3 times increased likelihood of contracting HIV for those who had more than 3 sexual partners in their lifetime, [AOR=3.14, 95% CI (2.55-3.87)]. Those with genital ulcers were above 2 times more likely to have HIV compared to those who did not, [AOR=2.15, 95% CI (1.71-2.71)]. Circumcision yielded almost 38% HIV protection in circumcised men compared to uncircumcised men, [AOR=0.62, 95% CI (0.45-0.85)].

In Ethiopia, a total of 5 942 females and 4 630 males aged 15-49 years were tested for HIV and the adult prevalence was 1.97%. Female prevalence was 2.39% compared to 1.43% for males ($p<0.0001$). In the multivariable regression analysis participants with high number of lifetime partners had almost 6 fold chance of being HIV infected compared to those who had one, [AOR=5.61, 95% CI (2.73-11.52)]. Individuals who had first sex at age 15-19 years were greater than 4 times more likely to have HIV compared to those who had never had sex, [AOR=4.20, 95% CI (1.90-9.32)]. Circumcision had HIV benefits as it yielded a 74% protection for the circumcised, [AOR=0.26, 95% CI (0.14-0.48)]. The inverse association between Moslems

religion and HIV was also observed in this study as they had a 67% HIV protection compared to Orthodox, [AOR=0.33, 95% CI (0.21-0.54)]. Living in Gambela region was associated with almost 4 times increased risk of HIV infection compared to Tigray, [AOR=4.11, 95% CI (2.07-8.17)].

Analysis using logistic regression and structural equation modelling adjusting for the country effect showed a protective effect for those staying in Ethiopia compared to those staying in Swaziland. The structural equation modelling confirmed findings from the earlier regression analysis as those with age at first sex below 15 years were 6.03 times more likely to get HIV, AOR=[AOR=6.03, 95% CI (5.40-10.07)]. Those with three or more sexual partners were 5.15 times more likely to get HIV infection compared to those with one partner [AOR=5.15, 95% CI (3.77-7.03)].

Conclusion and recommendation

This study was able to demonstrate the association between HIV acquisition and the determinants. Most importantly is the ability to clearly point out on the proximate factors in both countries which happen to be behavioural. The structural equation modelling added value as it was able to show the indirect factors and how they impact on HIV infection. This can be addressed through strengthening of behaviour change programs to reduce risky sexual behaviours. Programs aimed at delaying sexual debut and reduction of sexual partners should be strengthened in both countries. Male circumcision programs should be scaled up through social mobilisation and community involvement more especially in Swaziland.

DEDICATION

This research is dedicated to my family for their untiring support and prayer throughout my studies. Special thanks to my mother for her encouragement and moral support even when the journey seemed so impossible. This project would have not been successful without the encouragements from my friends who always motivated me to work harder despite the challenges. Lastly I dedicate this piece of work to my son (Nkosingivile Lokotfwako) and hope one day you will take it from here onwards to greater heights.

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
AOR	Adjusted Odds Ratio
ART	Antiretroviral Therapy
BSS	Behavioural Sentinel Surveillance
CSA	Central Statistics Agency
CSO	Central Statistics Office
DBS	Dried Blood Spot
DHS	Demographic and Health Survey
EDHS	Ethiopia Demographic and Health Survey
ELISA	Enzyme-Linked Immunosorbent Assay
GUD	Genital Ulcer Disease
HAPCO	HIV/AIDS Prevention and Control Office
HIV	Human Immunodeficiency Virus
LR	Likelihood Ratio
MC	Male Circumcision
MCP	Multiple Concurrent Partnerships
MICS	Multi Indicator Cluster Survey
MOH	Ministry of Health
NERCHA	National Emergency Response Council on HIV and AIDS
OR	Odds Ratio
PLHIV	People Living With HIV
PY	Person Years of Follow-up
RCT	Randomised Controlled Trial
SADC	Southern African Development Community
SDHS	Swaziland Demographic and Health Survey
SEM	Structural Equation Modelling
SES	Socio-Economic Status
SHIMS	Swaziland HIV Incidence Measurement Survey
SNNPR	Southern Nations Nationalities and Peoples Region
SSA	Sub-Saharan Africa
STI	Sexually Transmitted Infections
VCT	Voluntary Counselling and Testing

Definition of terms

Conceptual framework: It is a group of concepts used in research to outline possible courses of action or to present a preferred approach to an idea or though. It is a conceptual basis for many theories.

Confidence interval: It is a type of interval estimate of a population parameter and is used to indicate the reliability of an estimate.

Proximate determinants: These are factors that directly influence the risk of HIV infection and sometimes called intermediate variables.

Proxy measure: It is the method that does not measure the exposure or outcome of interest directly but measures a variable that is thought to be closely associated with it, usually when it is not possible to measure it directly.

Risky sexual behaviour: It is an action that promotes increased risk of a negative health outcome. They include having oral, vaginal or anal sexual contact without using a condom, having more than one sexual partner, changing sexual partners frequently and having sex below the age of 16 years.

STATA: It is a general purpose software package created in 1985 by Stata Corp. It is used by many business and academic institutions around the world. Most of its users work in research, especially in the fields of economics, sociology, political science, biomedicine and epidemiology. Its capabilities include data management, statistical analysis, graphics, simulations and custom programming.

Structural equation modelling: It is a statistical technique for testing and estimating causal relations using a combination of statistical data and qualitative causal assumptions. They allow both confirmatory and explanatory modelling hence suitable for both theory testing and theory development.

Underlying determinants: This are factors that are present but not obvious and they usually take precedence. They indirectly affect the risk of HIV infection.

Wealth index: It is a proxy measure of wealth of households which is based on household characteristics, ownership of assets (house ownership, source of drinking water, sanitation facility, electricity, floor material, roof material type etc.).

CHAPTER 1. INTRODUCTION AND BACKGROUND

1.1 Background

1.1.1 Burden of HIV and AIDS in sub-Saharan Africa

Africa has the highest burden of human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) infections in the world. Although only 11% of the world's population lives in Africa, about 69% of those living with HIV and AIDS are in Africa.(1) In 2011 globally there were 34 million [23.5 million in sub Saharan Africa (SSA)] people living with the disease and there were 2.5 million (1.8 million in SSA) new infections.(1) SSA accounted for 71% of adults and children's new infections in 2011 despite the numerous interventions.(1) It is estimated that 14.8 million children in SSA have fallen victim to HIV/AIDS, and as such have been orphaned.(2) Sub Saharan Africa remains the most affected region with HIV and AIDS in the world. In 2011, 58% of people living with HIV and AIDS were women,(2) and 1.2 million people died as a result of AIDS related illness.(1) In 2009, there were 11.1 million people living with HIV and AIDS (PLHIV) in the South African Development Community (SADC) region accounting for 34% of the number of PLHIV in the world, even though the region has a population of less than 4% of the global population.(2, 3)

Despite the access to antiretroviral treatment (ART) to date the HIV epidemic has claimed lives of more than 15 million Africans. It is estimated that about half the people in need of ART are not receiving it mainly due to cost implications in SSA. Some (SADC) countries which includes Botswana, Namibia, Zambia and Swaziland have reached universal access targets and South Africa has scaled up to reach 80% of people in need of ART.(2)

1.1.2 HIV Situation in Swaziland

Swaziland, like most sub-Saharan countries, continues to face the challenges imposed by the advance of HIV and AIDS. The country, with a population of 1.1 million (4) people, has the highest global HIV prevalence: the national prevalence (defined as those aged 2 years and above) stands at 19% while prevalence in the sexually active population (adult), defined as those aged 15-49 years, is 26%.(5) The pandemic is of concern not only because of the physical destruction it inflicts on individuals, but also because it undermines almost all aspects of human existence in Swaziland. Since the first case of HIV in the country was diagnosed in 1986, human resources have been depleted, state capacity to deliver services has been damaged, communities are under continuous stress, and the number of orphaned and vulnerable children continues to rise.(6)

The ART coverage at the end of 2011 was 79 099 which translates to an 85.1% of people in need of ART.(7) Results from incidence modelling suggest that in 2008, the major mode of transmission was heterosexual transmission which accounted for approximately 94% of new infections.(8) Key drivers of the epidemic have been noted to be gender inequalities, low and inconsistent condom use, intergenerational sex, low HIV testing and disclosure, high levels of stigma and discrimination, and multiple concurrent partnerships (MCPs).(6, 8) These are further exacerbated by high levels of poverty and unemployment, as well as food insecurity.(6)

1.1.3 HIV Situation in Ethiopia

With a population of 74 million people and an annual per capita income of less than US$100,(9, 10) Ethiopia is one of the world's poorest countries. It has an estimated 1.1 million people living with HIV and the third highest absolute number of people living with HIV in Africa.(10) The country statistics shows a low-level generalized epidemic which is driven by the most at risk groups and gender based violence accounts for some spread in certain groups.(11)

HIV prevalence among the adult population remains low in Ethiopia than many SSA countries. With the first HIV case seen in 1986, the adult HIV prevalence in 2010 was estimated to be 1.5%. Unlike in Swaziland where the HIV prevalence is high, in Ethiopia the prevalence is low at 1.9% and 1% for females and males respectively.(12) The HIV national prevalence for women attending antenatal care (ANC) in 2009 was 3%, with an urban and rural difference of 5.3% and 1.9% respectively.(13)

The ART coverage at the end of 2011 was 333 434 which is about 86% of people in need of ART.(14) As in Swaziland, the primary mode for HIV transmission in Ethiopia is heterosexual contact which account for 87% and 10% is acquired through vertical transmission from mother to child.(15) Young women are more vulnerable to infection than young man; urban women are three times as likely to be infected as urban men, although, in rural areas, the difference between genders is negligible. Populations at high risk for HIV infection include sex workers, police officers, members of the military, long distance drivers, cross border populations, MCPs and war affected people.(11, 16)

1.2 Problem Statement

Swaziland and Ethiopia share certain characteristics like the practice of polygamy, and cultural beliefs (although not entirely similar). However the incidence and prevalence of HIV are very different as comparative prevalence is shown in figure 1.1. In both countries, heterosexual sex remains the major mode of HIV transmission while gender inequality which favours men, poverty, unemployment and food insecurity drives the epidemic. However, Ethiopia has managed to reduce the prevalence notably among pregnant women attending ANC by 82% between 2000 and 2010.(17) The HIV prevalence among women attending ANC in Swaziland in 2000 was 34.6% while in Ethiopia in 2001 it was 14.3%. In 2010 the prevalence among women attending ANC in Swaziland was 42% while in Ethiopia in 2009 it was 5.3%.(13, 18) The overall incidence is showing decline by 25% from 2001 to 2009.(17) Understanding the major determinants of HIV infection in the two countries will be of great interest as Swaziland still battles with high incidence rate of 2.4/100 PY.(19)

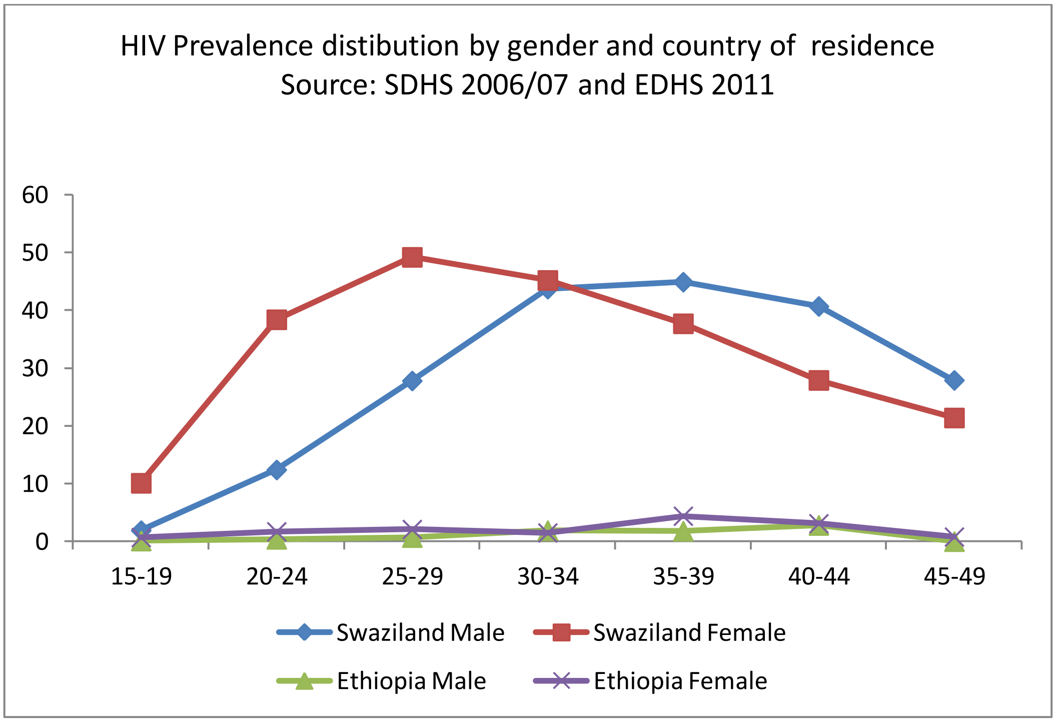


Figure 1.1: HIV Prevalence for Swaziland and Ethiopia in 2006/07 and 2011

Worth noting is that there has not been much research done in Swaziland to examine the determinants of HIV infection, and the few available used small sample size which are liable to small sample bias.(20) Analysis of this unrepresentative data leads to incorrect conclusions, and making it difficult to infer findings to the general population. For example, only one study was found, which used Demographic and Health Survey (DHS) data to examine the determinants of HIV infection in Swaziland. This study compared socio-economic determinants for Swaziland, Lesotho, Malawi and Zimbabwe. This study departs from the study quoted here in that it utilized nationally representative data sets from the DHS from both countries. Such data will be used for comparison purposes to determine the associated factors accounting for such high prevalence in Swaziland (26%),(5) which are different to that of Ethiopia. In view of limited resources and the fatal nature of HIV and AIDS, if not well managed, country policies and programmes should be driven by structured analysis as opposed to anecdotal evidence.(20)

1.3 Justification for the Study

The HIV prevalence in Swaziland is unprecedented and the highest in the world at 26% of all adults, (5) and has reduced life expectancy to 37 years. The prevalence in Ethiopia is generally low; however the trends are almost similar with females at an increased risk compared to males as seen in figure 1.1. Based on this data it is clear that the future economy of the countries is in doubt as the virus greatly affects the working ages. In its National Multisectoral Strategic Framework 2009-2014, Swaziland made an ambitious goal of reducing the HIV incidence rate from 3.2/100 PY to 2/100 PY by 2014.(6) Findings of this study will therefore contribute evidence to inform policy and planning in the Ministry of Health (MOH) as well as other sectors involved in HIV work on best practices that can contribute to the reduction of HIV incidence. The findings will also facilitate appropriate interventions in the two countries to address raised issues as we move towards evidence informed interventions.

1.4 Literature Review

1.4.1 Introduction

HIV prevalence and incidence vary considerably between different populations within a country and within a region. The variations are usually as a result of differences in demographic, socio-economic, behavioural and biological factors.(21) However, this does not disregard other possible factors, but highlights the role each has on the disease burden.

Determinants of HIV infection facilitate or delay the process of transmission, and at times, the progression of the disease. Research on the determinants of HIV infection is crucial for countries with high HIV prevalence for planning purposes.(20) The basis for such comparison analysis is to understand the determinants accounting for such differences in prevalence as Swaziland have the highest in contract to Ethiopia who have one of the lowest adult prevalence in sub-Saharan Africa.

1.4.2 HIV studies in sub-Saharan Africa

Studies have been done to find the association of the determinants and HIV infection in several countries in Africa. A study on MCPs in Zambia found that men were seven times more likely to have MCPs than women in the past year. However, men were much less likely to consider themselves at risk of HIV infection independent of condom use and HIV testing.(22) The study furthers states that men who had high knowledge of HIV and AIDS were associated with low likelihood of having multiple partners.(22) Based on this, one can assume increasing knowledge on HIV and delay of sexual activities until marriage can help reduce the infection rate, even though other factors needs to be considered. In another study informal settlements were associated with increased risk of HIV. The study was done in South African women living in informal settlements in Carletonville and they found that they had an increased risk of infection.(23)

1.4.3 HIV studies in Swaziland

In Swaziland the impact of the HIV epidemic have been greatly felt with over 72% of the MOH's annual budget absorbed by curative services as a result of ART and other health interventions.(24) Few studies have been done to identify determinants of HIV transmission, one of which was the first to use DHS data was a cross-sectional study and compared different countries done by Asiedu et al. They found that an adult was more likely to be HIV positive, if the person is female, lives in urban areas and is unmarried. (20) They also found that HIV infection was associated with socioeconomic status (SES) as poor households in Swaziland and the other countries had a higher probability of HIV infection, and this perhaps might explain the role of poverty in the pandemic.(20) However the impact is questionable as findings from a study done in SSA countries have contrasting findings. The findings suggest that there is a weak positive relationship between national wealth and HIV prevalence across the region where higher prevalence is seen in wealthier countries. (25)

Stigma and discrimination is still common in Swaziland, and in a qualitative study done to assess condom use in PLHIV, found that there are a lot of women who knew they were HIV positive: However because of fear of discrimination they suffer in silence, and as a result they engage in unprotected sex all the time and hence infecting their partners.(26) They fear negotiating condom use as they have to explain who taught them thus compromising their safety as there may be possibility of HIV re-infection. (26) PLHIV are victims of abuse, and a study done in Swaziland estimates that one in five HIV positive people have been targets for HIV related insults and 33.3% were gossiped for their HIV status.(27) This has impacted negatively to the people living with HIV as they feel dejected and hopeless. Even though the study interviewed 45 respondents, the findings may be true and may perhaps explain the role stigma plays in perpetuating the pandemic in the tiny kingdom.

MCPs are still driving the epidemic even though there has been a decline in the past years. A study done in Swaziland, found that MCPs are one of the major drivers of HIV transmission in Swaziland and entire SADC region. They linked five studies to measure the changes in MCPs pattern and found that between 2002 and 2008, MCPs declined from 61% to 49% in men, and for women it declined from 22% in 2002 to 18% in 2008.(28)

Mining has over the years been a major source of income for Swaziland and other countries as they migrated to South Africa to work in the mines. This has been found to increases the susceptibility to HIV for both the miner and the spouse in Swaziland and Lesotho. The study found that, being a miner aged 30-44 years increases the chance of being HIV positive by 15% and the likelihood in the spouse increases by 8%. The authors further states that this is exacerbated by the fact that miners and spouses are less likely to abstain, or be faithful and use condoms.(29) Internal migration is also a problem and due to the small size of the country people move easily between urban and rural areas thus transmitting the HIV virus across the country.(30)

1.4.4 HIV studies in Ethiopia

In Ethiopia women are at more risk of infection, and in 2010 in urban areas, women were 1.5 as likely to be infected as men (9.2 % and 6.2% respectively).(31) Physical abuse is common in the entire country and between 40% and 60% of women experience sexual and physical abuse thus increasing their vulnerability to HIV. Condom use during last sexual intercourse was higher in older women than younger women, and women with secondary education or higher than uneducated women; However there was lower likelihood of condom use amongst rich women compared to poor women and women with multiple concurrent partners compared to those with one partner .(31)

People with STIs are at higher risk of contracting HIV. A study by Mekonnen et al on blood donors and various population sub-groups, found that the overall HIV prevalence in patients at the STI clinic was 34.1%. This may be so because the people who get STIs are engaging in unprotected sex. Prevalence for males was 25.5% and 41.8 for females, and the difference between the sexes at the STI clinic was statistically significant.(32)

In recent years the number of manufacturing industries (factories) has escalated and has been associated with increasing HIV levels. This usually happens as workers get low income and try to supplement with transactional sex especially females. A study was done by Mekonnen et al to assess risk factors in factory workers in Ethiopia. The authors studied two sites where 1 679 individuals participated. The baseline prevalence of HIV in males was 9.4% and 12.4% for females. Risk factors for males were being Orthodox Christian, having had a higher number of sexual partners in the past five years and genital discharges in the past five years. Risk factors for women were low income, casual sex in the last year and being a victim of rape one or several times. (33)

It was hypothesised that the civil war between the Ethiopian and Eritrean armies between 1998 and 2000 would cause an increase in HIV prevalence.(34) HIV prevalence on army recruits 1999/2000 was 7.2% in urban and 3.8% in rural recruits and was below previous estimates.(35) There has been mixed evidence as the authors argue that the 76% increase in HIV prevalence among conscripts and soldiers, would have occurred among a similar cohort not in the army and also sexual violence was not common.(34) On the contrary voluntary counselling and testing (VCT) and ANC data were declining i.e. VCT from 61.9% in 1993-1998, 56.5% between 1999 and 2000 and 49.5% between 2001 and 2003. There was no conclusive evidence and authors attribute any HIV impact in Tigray to long term effects of changing social and economic situation.(34)

Male circumcision (MC) reduces HIV infection in males by up to 60%, and has been scaled up in the past five years. The prevalence of male circumcision in Ethiopia is 92% compared to 16% in Swaziland.(12, 19) In an analytical study done in Ethiopia, the authors observed that there are some regions that still resist the practice. This has led to regional differences in HIV prevalence with places of low circumcision, i.e. In Gambela 53% men were uncircumcised and 20.4% in the Southern Nations Nationalities and Peoples (SNNP) region and they both have high HIV prevalence. Therefore they suggest the high HIV prevalence in Gambela (5.9%) could be the risky sexual behaviour resulting from low levels of MC.(36)

1.4.5 The Conceptual Framework

This study was based on the Mosley and Chen analytical Framework of child survival developing countries developed in 1984.(37) This is a framework that incorporates social sciences in medical research. It postulates that there will be correlation between mortality and socio-economic characteristics to generate causal inference about mortality. Within this framework, Mosley and Chen have identified underlying (Socio-economic) factors. He further identified five proximate determinants namely: injury, maternal factors, personal illness control, nutrient deficiency and environmental contamination.(37) This framework further suggests that for mortality to occur it has to be an interplay between underlying and proximate determinants, as shown in figure 1.2 (37)

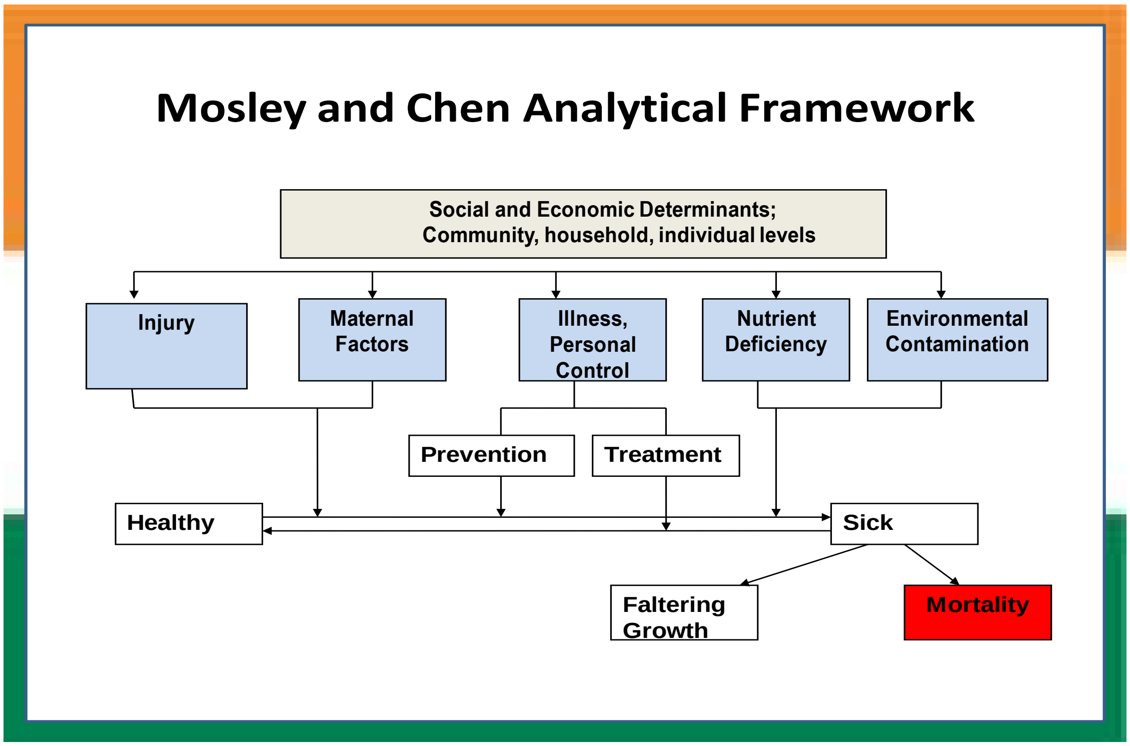


Figure 1.2: Mosley and Chen Analytical Framework of Child Survival

While the study does not attempt to measure child mortality in Swaziland and Ethiopia, it does attempt to measure the influence of underlying and proximate factors on HIV infection in the two countries. Therefore the conceptual framework was based on this and applied to this study, HIV infection (exposure) depends on three underlying determinants namely: demographic, socio-economic, and biological factors. These factors cannot directly cause individuals to contract HIV, but have to pass through the proximate determinant which is behavioural factors which in turn defines the outcome (HIV status). Although they do not directly cause the individual to get HIV, they predispose him or her to the infection. The vital role will be played by the behaviour of the individual on whether they contract the virus and this is a function of abstinence, faithfulness and condom use among many other factors as shown in figure 1.3.

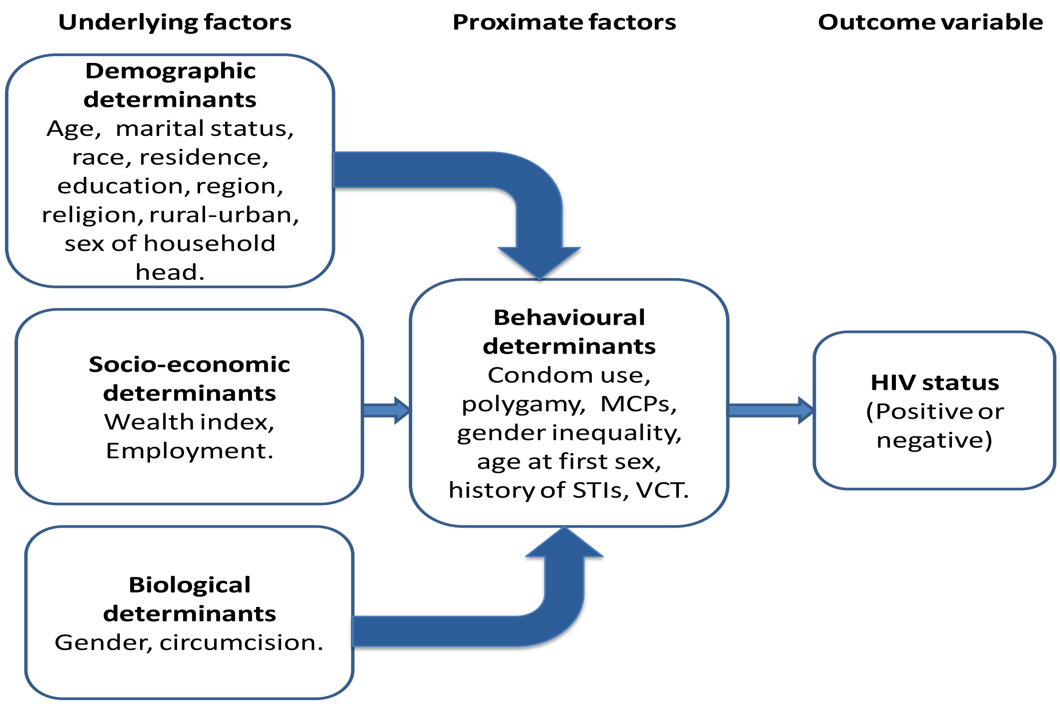


Figure 1.3: Conceptual Framework of the Study *(Adapted Mosley & Chen)*

1.5 Research Question

What are the main differences and similarities in the determinants of HIV infection in Swaziland and Ethiopia?

1.6 Aims and Objectives of the Study

1.6.1 Aim of the Study

The main aim of the study was to explore and compare the main determinants of HIV infection in Ethiopia and Swaziland in the years 2005 and 2006/07 respectively, and classify these into underlying and proximate determinants.

1.6.2 Study Objectives

- To identify and describe the main determinants of HIV infection among 15 – 49 years in Swaziland in 2006/07.
- To identify and describe the main determinants of HIV infection among 15 – 49 years in Ethiopia in 2005.
- To identify and compare the main differences in the determinants of HIV infection in 15 – 49 years in Swaziland (2006/07) and Ethiopia (2005).
- To explore and describe the relationship between underlying and proximate factors and HIV infection using the conceptual framework.

CHAPTER 2. METHODOLOGY

2.1 Introduction

This chapter presents the methodological approach of the whole research project and how statistical and epidemiological methods were used to enhance internal and external validity. Statistical methods of controlling for confounding and other factors were discussed. Propensity score matching and structural equation modelling (SEM) were introduced.

2.2 Description of Original Study

Demographic and health surveys have over the years become a useful source of data enriched with various indicators for health planning. Data on household health status was collected through questionnaires, and blood testing for HIV and anaemia were also done to eligible individuals. The Swaziland's demographic and health survey (SDHS) 2006/07 was the first of its kind in Swaziland, as it was a nationwide survey. It sampled a nationally representative sample of 4 843 households from 275 clusters (4 987 women aged 15-49 and 4156 men aged 15-49 years). The study was a cross-sectional survey and its main objective was to collect up to date information for policy makers, researchers and program managers that would be used in planning, monitoring and evaluation of population and health programmes. The study was commissioned by the Ministry of Health and implemented by the Central Statistics Office (CSO) and field work was carried out between July 2006 and March 2007.(5)

The Ethiopia demographic and health survey (EDHS) 2005 was the second of its kind in Ethiopia after EDHS 2000 and it was a nationwide survey and sampled a nationally representative sample of 14 500 households from 540 clusters (14 070 women aged 15-49 years and 6 033 men aged 15-59 years). The study was a cross-sectional survey and its main objective was to follow up on 2000 EDHS and provide updated estimates of demographic and health indicators. The EDHS was commissioned by the Ministry of Health and done by the Central Statistics Agency (CSA) from November 2004 to September 2005.(38)

2.3 Study Design

This was a secondary analysis of cross-sectional surveys of two demographic health survey data from Swaziland (2006/07) and Ethiopia (2005).

2.4 Inclusion Criteria

The study included both males and females aged 15-49 years, and only those with HIV results were eligible for the study.

2.5 Study Population

The study population was everyone aged 15–49 years interviewed in Swaziland Demographic Health Survey (SDHS) in 2006/07 and Ethiopia Demographic Health Survey (EDHS) in 2005 who also took the HIV test. Therefore, for the age group 15-49 years in both males and females, there were 8 185 in Swaziland and 10 572 in Ethiopia who tested for HIV.

2.6 Demographic Health Survey Sampling Procedure

The SDHS was a stratified, clustered sampling technique, and the Standard DHS policy that recommends 1 000 to 1 200 women per major domain was adopted. A total of 275 SDHS clusters (111 in the urban and 164 in the rural areas) were selected from a list of EAs defined by 1997 Swaziland Population and Housing Census. CSO staff conducted an exhaustive listing in each of the SDHS clusters in August and September 2005. From this list, systematic sample of 5 500 households was drawn and a sub sample of 2 750 was selected. All women and men aged 15-49 identified in these households were eligible for individual interview and participants were tested for HIV after consenting.(5)

The EDHS was a stratified, clustered and selected in two stages. A sample of 14 500 households from 540 clustered was selected. In the first stage 540 clustered (145 urban and 395 rural) were selected from the list of EAs from the 1994 Population and Housing Census Sample frame. In the second stage, a complete household listing was done by CSA staff in each cluster and it lasted for three months from November 2004 to January 2005. About 24 to 32 households from each cluster were systematically selected for participation in the study. Blood samples were collected for laboratory testing of HIV among men and women who consented.(38)

2.7 Data Analysis Plan

2.7.1 Explanatory Variables

Explanatory variables were grouped into four categories and as discussed below.

a) Demographic Factors

- Age: Participants eligible in the study were aged 15-49 years which was spaced at 5 year age band. This is the childbearing age group hence at more risk of contracting HIV.
- Marital status: This variable describes the kind of relationship one has with his or her spouse and the categories were never married, married, living together, not living together, widowed, and divorced.

- Rural urban differences: This was the type of place of residence for participants who were either urban or rural.
- Education: This was the highest level of education achieved by the participant and it was grouped as none, primary, secondary and higher.
- Religion: This was the denomination the participants were from which included among others: Traditional, Orthodox, Charismatic, Protestant, and Moslem.
- Region: This was the geographic location of the individuals which were four for Swaziland namely: Hhohho, Manzini, Lubombo and Shiselweni. There were eleven for Ethiopia namely; Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, SNNP, Gambela, Harari, Addis Ababa and Dire Dawa.
- Ethnicity: There were fifty-four ethnic groups and because of small numbers in most of them, only the main ones were maintained which are: Amara, Oromo, Tigraway, Gurarie, Somali, Affar and Sidamu, and the smaller groups were combined into the other races category. This variable was only relevant in Ethiopia as Swaziland only have one race which is the Swazis.
- Sex of the household head: This was the gender of household head which was either male or female.

b) Socio-Economic factors

- Wealth index was used as a proxy measures for SES. Wealth index was measured using a score matrix where household belongings were combined like access to safe water and sanitation, type of building material, radio, television, etc. This was weighted in a matrix score and came up with wealth indexes which ranges from poorest, poorer, middle, richer and richest.(39, 40)

- Another proxy measure for SES was occupation which included not working, professional technical, clerical, sales, agricultural employee and employer, skilled and unskilled manual.

c) Biological Factors

- Gender is a biological variable that the individual has no control over and a person can either be male or females and they have different susceptibility to various diseases.
- In that context male circumcision has been classified as a biological factor as it is only applicable to males.

d) Behavioural Factors

Unlike the other variables, the individual has control over them through behavioural practices and they play a major role in acquiring HIV infection.

- Condom use: This measures the extent to which an individual practices safe sex and it was measured by condom use at first sex, condom use at last sex, consistent condom use.
- Age at first sex: Age at sexual debut is perceived as a risk factor for HIV infection and was categorised to never, age below 15 years, 15-19 years and more than 20 years.
- Multiple sexual partners: This has been identified as one of the major drivers of HIV infection and it was measured by number of wives or partners and total number of lifetime partners.

- Domestic violence and condom negotiation: It was measured by perception on wife beating if she refuses sex and woman justified to negotiate condom use if she suspects husband has sexually transmitted infections (STIs).
- History of STIs: They are a good proxy measure of HIV and it was measured with variable had STI and had genital sores in the past year.
- Other behavioural variables were history of HIV testing within the past year and alcohol use during last sex, and these variables help in determining safety precautions taken by individuals.

2.7.2 Outcome Variable

The outcome variable was HIV status (binary), which is either positive or negative. Men and women interviewed voluntary consented for HIV testing. The DHS testing protocols involved collection of at least three blood spots from a finger prick on a special filter paper. Laboratory specialist's setup dried blood spot methodology (DBS) to test for HIV using two Enzyme-Linked Immunosorbent Assay (ELISA) test. HIV testing was done anonymously, and was linked to demographic characteristics using a unique bar code. Due to the anonymous nature of the testing, results could not be linked to individuals and as such it was not possible to provide HIV results information. Written and oral information on VCT were provided to the individuals where they could access such services for free.(5, 38)

2.8 Data Management

The data from the two countries was received in STATA format from Measures DHS International. The datasets "Males" and "Individual" (female) were appended and then merged to the HIV results using a unique identifier, which was made by a combination of certain key variables namely: cluster number, household number and respondent’s line number. Variables were renamed for ease of handling and this was done with the help of the codebook. Data was cleaned to remove outliers and inconsistent values. Missing data was excluded in the analysis, and individuals with no HIV results were also excluded as per the protocol. Data was then analyzed using STATA version 13 from STATA cooperation. (41)

2.9 Propensity Score Matching

Prior to analysis of the between country differences and similarities, data was matched using key demographic variables and socio-economic status. To adjust for the country effect, the datasets from the two countries were appended using the cluster number, household number and respondent’s line number and a country variable was generated. Out of a possible 18 758 observations, 15 161 were successfully matched and this is about 81% as seen in figure 2.1 and table 2.1. Propensity score matching was done using age, gender and wealth index, and this was to make sure that data is comparable and to control for confounding.

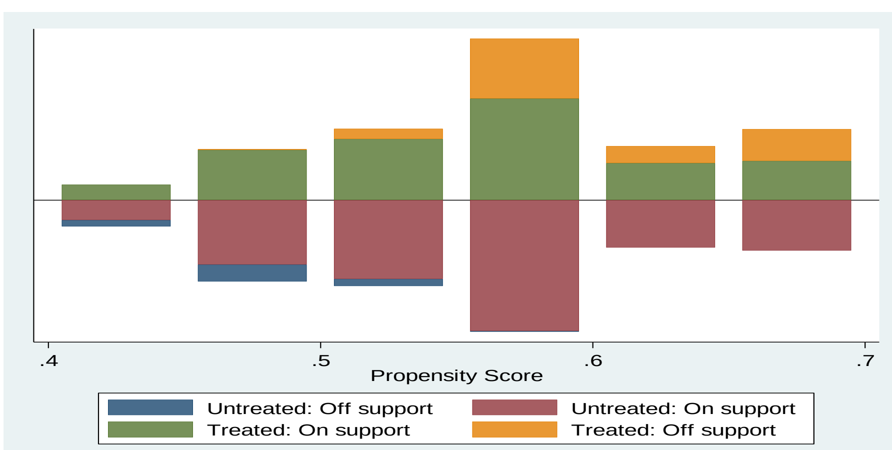


Figure 2.1: Propensity Score Output for Swaziland and Ethiopia Data

NB: **Swaziland:** The matched was the untreated on support which was 7 583 (maroon), unmatched was untreated off support which was 603 (navy blue). **Ethiopia:** The matched was the treated on support which was 7 578 (olive green) and the unmatched was the treated off support (orange) which was 2 994.

Table 2.1: Propensity Score Matching Report for Swaziland and Ethiopia Data

PS Match: Common Support	***Swaziland***	***Ethiopia***	***Total***
On support	7 583	7 578	15 161
Off Support	603	2 994	3 597
Total	8 186	10 572	18 758

2.10 Statistical Analysis Plan

2.10.1 Descriptive Statistics

The study populations were described using tables, frequencies and bar graphs because of the categorical nature of variables. The Pearson Chi-Square test was used for comparison of HIV results and categorical explanatory variables. The Fisher's exact test was used when the expected values in any of the cells was below 5.

2.10.2 Inferential Statistics

The use of sample weights has been recommended for consideration in analysis when using DHS data as it takes into account the differences in sample sizes through the use of sample weights. After running analysis using sampling weights (svy set) and also using the robust method, the results were similar to the traditional logistic regression method; hence the traditional logistic regression method was preferred for model building to be able to use LR testing method of model building. The final model reported in the results was based on the robust method because of its high precision and robust standard errors.

Since we had a binary outcome of either HIV negative or positive, then logistic regression was the best method of analysis. Univariable logistic regression analysis was done for all potential determinants and those significant at ≤ 0.25 were considered for multivariable analysis.(42) The variables that met the inclusion criteria at p-value ≤ 0.25 in univariable analysis were taken further to multivariable logistic regression analysis. Multivariable variable logistic regression analysis was used to determine factors associated with HIV infection among 15-49 years people in Swaziland and Ethiopia. The multiple variable model was built using the step-wise forward selection. The likelihood ratio (LR) test method was used to see if addition of a variable did improve the model and the Wald statistics were also considered.

The models were also checked for logistic regression diagnostics i.e. specification error, goodness of fit, multicollinearity and influential observations and there was no evidence of violation as seen in appendix 1 and 2. There were no significant changes in odds ratios after removing the effect of outliers. There was also no evidence of lack of fit of the models and the study used the 5% level of significance and p-value <0.05 was deemed significant. Tests for assumptions of all statistical tests were done before all parametric tests were performed. The model was tested for interaction of age and sex and there was no evidence interaction. To further control for any form of confounding, stratum odds ratios were reported.

A total of seven logistic models were developed during model building but because of limited space, only three were reported. Model 1 and 2 was modelling the underlying factors against the outcome variable which is HIV results for each country. Model 3 and 4 was modelling the proximate factors against the outcome variable again for each country. Model 5 and 6 were built using significant variables in the model (1 and 2) and (3 and 4) which were in turn modelled against the outcome for Swaziland and Ethiopia. Model 7 was done after propensity score matching in order to adjust for the country effect in the analysis. Proximate determinants were modelled against the outcome, controlling for the country effect. Proximate determinants play a crucial role on whether an individual will or will not contract HIV as they have a direct role and sometimes called the intermediate factors.

2.10.3 Structural Equation Modelling

The conceptual framework is a useful pictorial display of the relationship that exists between an exposure and outcome, and to quantify the associations we used a structural equation modelling. SEM is a systematic way of evaluating hypothesis involving pathways analysis against multivariable data.(43) Therefore it is used for testing and estimating causal relationships through statistical data and qualitative causal assumptions. Modelling in the SEM was based on variables that were significant in all regression analysis so as to quantify the relationship of the significant pathways. From the model 5 and 6 regression analysis education, urban-rural differences and religion were selected in the underlying determinants. These were variables which were significant in both countries' regression models.

In the proximate determinants, selection was based on variables most significant in model 7 after adjusting for the country effect. The most significant chosen variables were age at first sex, total number of lifetime partners and genital ulcers. In these variables only the most significant category was used in favour of the whole variable and that was done to determine the most significant factors impacting on HIV infection as we developed a basic SEM model. The model fit was assessed using the root mean square error of approximation (RMSEA) due to its sensitivity to the number of estimated model parameters and ability to handle large samples.(44) Studies show that a RMSEA below 0.8 shows evidence of good fit,(44) hence the RMSEA of 0.03 from our SEM model was good.

2.11 Ethical Consideration

The primary studies received ethical clearance from the Ministry of Health Research Ethics Committee in Swaziland and Ethiopia, and informed consent was obtained prior to data collection and HIV testing. The study title and protocol was approved by the Faculty of Health Sciences as shown in appendix 3. The study protocol of this secondary analysis was also presented to the University of Witwatersrand Human Research Ethics Committee. Ethical permission was granted prior to data analysis and the clearance certificate number is M120947, and a copy is attached in appendix 4. During data analysis, no personal identifiers were used and linking results to individuals was not possible.

CHAPTER 3. RESULTS

3.1 Introduction

In this chapter, results for determinants of HIV infection are presented from analysis of the study using DHS data from Swaziland and Ethiopia. Descriptive analyses are presented in a form of graphs and tables that report row percentages. Inferential analysis of the univariable and multivariable logistic regression models are presented but only multivariable results are discussed. These results are presented in four parts: Firstly the logistic regression model for Swaziland, and secondly the logistic regression model for Ethiopia. Thirdly the logistic regression model of the countries combined datasets after adjusting for country effect for proximate factors. Lastly, results from structural equation modelling for the combined datasets are also presented and interpreted.

3.2 Swaziland's Descriptive Analysis

The Swaziland demographic and health survey was conducted in 2006/7 and comprised of 15 144 participants. There were 4 987 females and 4 156 males aged 15-49 years and a total of 4 584 females and 3 602 males were tested for HIV. There were 69.42% HIV negative women, while 30.98% were HIV positive. There were 80.49% males who tested negative to HIV while 19.51% tested positive as seen in figure 3.1.

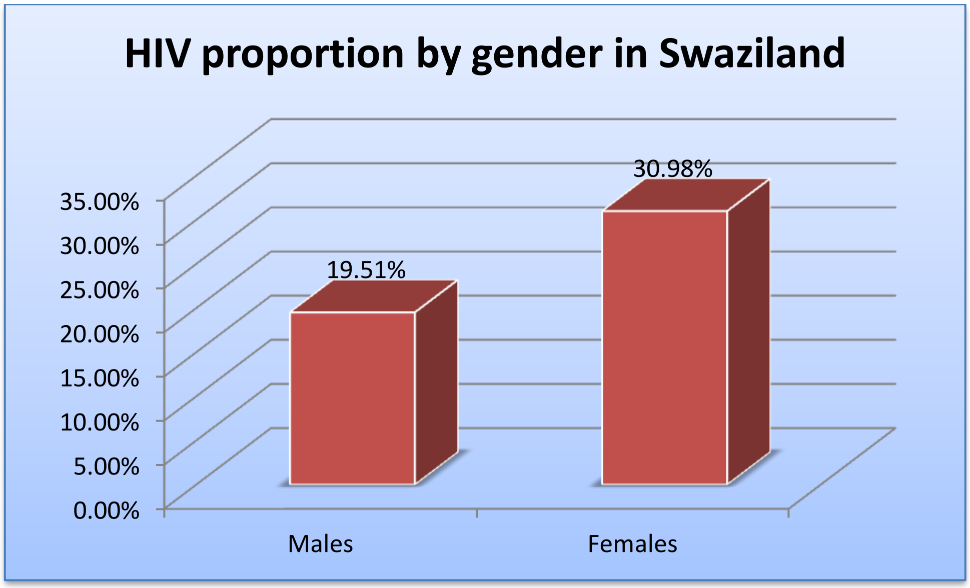


Figure 3.1: Bar Chart Showing Distribution of HIV Results by Gender in Swaziland

The HIV prevalence in Swaziland was generally high and this data shows a national adult HIV prevalence (15-49 years) of 26.20% with females at a higher rate of 30.98% compared to males who have 19.51% ($p<0.0001$). The widowed had the highest prevalence of 57.88% while the never married had the lowest with 17.50% ($p<0.0001$). Those aged 30-34 years had the highest HIV prevalence of 44.52%, while the 15-19 years had the least prevalence of 5.88%. Generally all education categories had a high prevalence and those with no education had the highest at 35.64%. Individuals with secondary education had the lowest prevalence of 24.26% ($p<0.0001$). There were no much regional differences in HIV prevalence. Hhohho region had the highest HIV prevalence of 28.86% compared to 23.32% for Shiselweni region ($p=0.0457$). Religion was significantly associated with HIV prevalence ($p=0.0073$), however there were no much differences among the various denominations. The prevalence was very high in urban areas at 31.64% compared to 24.00% for the rural areas ($p<0.0001$).

The non-working group had the least prevalence with 9.80% while clerical had the highest prevalence at 33.14% ($p<0.0001$). There was an association between age at circumcision and HIV prevalence as those circumcised below the age of 13 years had the least prevalence of 16.77%. Participants circumcised above 20 years of age had the highest HIV prevalence of 34.47% ($p=0.0212$). HIV prevalence was high amongst all categories of condom use. Those who did not use a condom at first sex had the highest prevalence of 26.58% while those who used a condoms had a prevalence of 20.63% ($p=0.0032$). Individuals who used a condoms during last sex had a prevalence of 37.19%, while those who did not use it had a prevalence of 31.02% ($p<0.0001$). Individuals who consistently use condoms had a prevalence of 35.29% compared to 40.04% for those who did not use a condom consistently ($p=0.0257$). There was a significant association between total number of lifetime partners and HIV prevalence. Those with 3, more than 3 and unknown number of partners had the highest proportion of people living with HIV at about 40% ($p<0.0001$). Those with no wife or partner had 30.91% of people living with HIV while those with concurrent sexual partners i.e. two or more partners had a prevalence of 45.45% ($p=0.0106$).

The prevalence was the same between those who perceived in favour of and against wife beating if she refuses sex at almost 25% ($p=0.0180$). Those who were for the idea that wife should negotiate condom use if she suspects husband has STIs had a prevalence of 25.97% while those who were against had a prevalence of 28.91% ($p=0.0096$). There was notable low prevalence for those who have never engaged at sex at 3.37% compared to those who had first sex at 15-19 years which was 33.62% ($p<0.0001$). Also notable was the high prevalence amongst those who had STIs within the past year with a prevalence of 53.23% while those who did not had a prevalence of 24.39% (p<0.0001). Those with genital ulcer in the past year had twice prevalence of 57.36% compared to 23.18% for those who did not have genital ulcers (p<0.0001).

Alcohol consumption was associated with HIV prevalence as it was high for those who were drunk the last time they had sex at 41.65% (p=0.0006). Those who had done an HIV test within the past year had a prevalence of 38.06% while those who did not, had a prevalence of 20.56% (p<0.0001). There was no association between sex of household head, wealth index and circumcision status and HIV prevalence as shown in table 3.1 and 3.2.

Table 3.1: Bivariate Analysis of Underlying factors by HIV Status for Swaziland and Ethiopia

	SWAZILAND		ETHIOPIA	
Variable	**HIV Positive Weighted %**	**P-value**	**HIV Positive Weighted %**	**P-value**
Gender				
Males	19.51	<0.0001†	1.43	<0.0001†
Females	30.98		2.39	
Marital status				
Never married	17.50	<0.0001†	0.28	<0.0001†
Married	29.24		1.30	
Living together	47.25		1.47	
Widowed	57.88		13.16	
Divorced	49.57		2.45	
Not living together	53.01		0.17	
Ethnicity				
Amara	***	***	1.91	0.1964
Oromo	***		0.40	
Tigraway	***		1.56	
Gurarie	***		0.72	
Somali	***		0.00	
Affar	***		0.41	
Sidamu	***		0.00	
Other	***		0.45	
Age group				
15-19	5.88	<0.0001†	0.13	<0.0001†
20-24	26.93		0.35	
25-29	39.69		0.69	
30-34	44.52		1.92	
35-39	40.41		1.76	

40-44	32.38		2.68	
45-49	23.97		0.01	
Highest education				
No education	35.64	<0.0001†	0.79	0.0055†
Primary	26.40		0.50	
secondary	24.26		2.08	
Higher	24.41		1.71	
Region				
Hhohho	28.86	0.0457†	***	***
Manzini	25.01		***	
Shiselweni	23.32		***	
Lubombo	26.25		***	
Tigray	***		1.53	0.0096
Affar	***		2.19	
Amhara	***		1.59	
Oromiya	***		0.44	
Somali	***		0.00	
Banish-Gumuz	***		0.00	
SNNP	***		0.40	
Gambela	***		6.57	
Harari	***		2.18	
Addis Ababa	***		3.01	
Dire Dawa	***		1.77	
Rural /Urban diff.				
Urban	31.64	<0.0001†	2.35	0.0003†
Rural	24.00		0.70	
Religion				
Charismatic	23.41	0.0073†	***	0.1242
Protestant	23.24		0.41	
Roman catholic	29.33		0	
Pentecostal	23.31		***	
Zionist	28.18		***	
Apostolic sect	26.57		***	
Orthodox	***		1.60	
Moslem	***		0.20	
Traditional	***		0	
None	26.41		***	
Other	19.05		0	
Gender of household head				
Male	26.34	0.4732	0.96	0.4745
Female	25.47		0.64	
Wealth index				
Poorest	26.52	0.7116	0.71	0.0027†
Poorer	26.78		0.32	
Middle	24.75		0.86	
Richer	26.74		0.40	
Richest	25.15		2.09	
Occupation				
Unskilled manual	21.85	<0.0001†	0.59	<0.0001†

Skilled manual	32.93		6.82	
Services	23.05		0.92	
Agric. Employee	29.77		0.72	
Agric. self-employ	25.45		***	
Sales	28.37		2.95	
Clerical	33.14		0.90	
Prof, tech, man.	23.97		1.83	
Not working	9.80		0	
Age at circumcision				
>13	16.77	0.0212†	***	***
13-19	28.09		***	
20+	34.47		***	
Circumcised				
No	19.32	0.3348	1.18	0.6571
Yes	21.79		0.90	

†P is significant at alpha level of 5%, *** Variable excludes in analysis or missing data, row percentage reported.

Table 3.2: Bivariate Analysis of Proximate by HIV Status for Swaziland and Ethiopia

	SWAZILAND		**ETHIOPIA**	
Variable	**HIV Positive Weighted %**	**P-value**	**HIV Positive Weighted %**	**P-value**
Condom use at first sex				
No	26.58	0.0032†	0.49	0.6829
Yes	20.63		0.12	
Condom use at last sex				
No	31.02	<0.0001†	1.28	0.7286
Yes	37.19		1.56	
Consistent condom use				
No	40.04	0.0257†	0.25	0.0381†
Yes	35.29		1.98	
Total life-time partners				
1	19.65	<0.0001†	1.79	<0.0001†
2	33.00		5.56	
3	40.22		4.78	
3+	40.05		12.61	
Unknown	38.49		8.33	
Number of concurrent sexual partners				
0	30.91	0.0106†	***	0.9262
1	34.10		1.30	
2	39.29		1.46	
2+	45.45		0	
Unknown	40.22		***	
Perception on wife beating if she refuse sex				
No	26.19	0.0180	1.25	0.0047†

Yes Don't know	24.89 17.46		0.08 0.00	
Wife justified to ask condom use if husband has STIs No Yes Don't know	 28.91 25.97 11.92	 0.0096	 0.29 1.32 0.01	 0.0001†
Age at first sex Never <15 15-19 20+	 3.37 31.79 33.62 32.79	 <0.0001†	 0.16 0.45 1.61 1.23	 0.0010†
Had STIs in last 12 months No Yes Don't know	 24.39 53.23	 <0.0001†	 0.92 0.00 0.00	 0.9420
Had genit. ulcer last 12 months No Yes Don't know	 23.18 57.36	 <0.0001†	 0.90 8.80 0.00	 0.0171†
Alcohol use at last sex No Yes	 32.82 41.65	 0.0006†	 1.11 3.59	 0.0118†
Ever tested for AIDS No Yes	 20.56 38.06	 <0.0001†	 0.87 2.38	 0.0439†

†P is significant at alpha level of 5%, ***Variable excludes in analysis or missing data, row percentage reported, Number of concurrent sexual partners is number of wives or partners.

3.3 Ethiopia's Descriptive Analysis

The Ethiopia demographic and health survey was conducted in 2005 and comprised of 20 103 participants. There were 14 070 females and 6 033 males aged 15-59 years. A total of 5,942 females and 4 630 males met the inclusion criteria. A total of 1.43% males were HIV positive and 2.39% females were HIV positive as shown in figure 3.2.

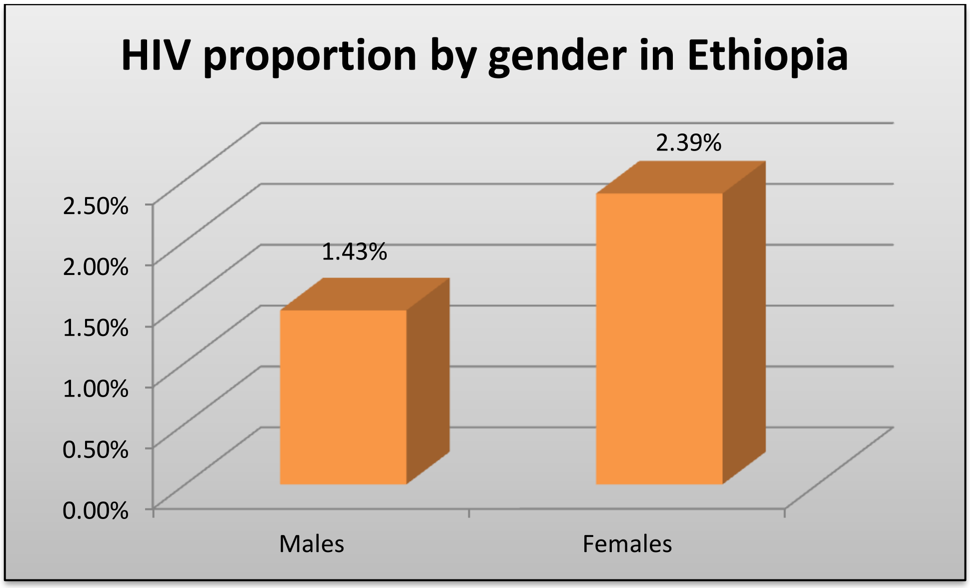


Figure 3.2: Bar Chart Showing Distribution of HIV Proportions by Gender in Ethiopia

The HIV prevalence in Ethiopia was generally low and the data shows an HIV prevalence of 1.97% with females at a rate of 2.39% compared to males who have 1.43% ($p<0.0001$). HIV prevalence was higher in widows at a rate of almost 13.16%, and the lowest was noted at approximately 0.17% for those not living together ($p<0.0001$). Age was associated with HIV prevalence as those aged 40-44 years had 2.68% prevalence while those aged 45-49 years had the lowest prevalence of 0.01% ($p<0.0001$).

Participants with secondary education had the highest prevalence of 2.08% and those with primary education had the lowest with 0.50% ($p=0.0055$). The Gambela region had the highest prevalence of 6.57% while the Somali and Banish-Gumuz had the lowest 0.00% ($p=0.0096$). There were rural urban differentials in HIV prevalence as those from the urban areas had a prevalence of 2.35% compared to the rural areas which only had 0.70% ($p=0.0003$). The richest wealth quintile had the highest prevalence of 2.09% and the poorer had the lowest prevalence at 0.32% ($p=0.0027$). The prevalence was zero for the non working and the skilled manual had the highest prevalence of 6.82% ($p<0.0001$). Those who used condoms consistently had a prevalence of 1.98% while those who did not use it had a prevalence of 0.25% ($p=0.0381$).

Participants who had 3 or more lifetime partners had the highest prevalence of 12.61% and those who had only one total lifetime partner had the lowest at 1.79% ($p<0.0001$). Those who perceived against the idea that wife beating is justified of she refuses sex had the highest prevalence at 1.25% compared to 0.00% for those who were not sure ($p=0.0047$). Participants who were for the idea that wife justified to negotiate condom use if she suspect husband has STIs had the highest prevalence of 1.32% compared to 0.01% for those who were not sure ($p<0.0001$).

Those who had never had sex had the lowest prevalence of 0.16% while those who had sexual debut at 15-19 years had a prevalence of 1.61% ($p=0.0010$). Those who had genital ulcer within the past year had a very high prevalence of 8.80% while those who did not have a genital ulcer had a prevalence of 0.90% ($p=0.0171$). Participants who had taken alcohol the last time they had sex had a prevalence of 3.59% and those who did not had a prevalence of 1.11% ($p=0.0118$). Those who had done an HIV test had a prevalence of 2.38% and those who did not test within the past year had a prevalence of 0.87% ($p=0.0439$). There was no association between ethnicity, gender of household head, religion, circumcision, condom use at first sex, condom use last sex, number of wives or partners and history of STIs in the past 12 months and HIV prevalence as seen in table 3.1 and 3.2.

3.4 Inferential Analysis in Swaziland and Ethiopia

In Swaziland, after running the bivariate analysis, there was evidence of association between the explanatory variables and HIV status. We then did logistic regression analysis to identify the determinants of HIV infection. Only multivariable logistic regression results after controlling for all other factors (holding other factors constant) were interpreted and discussed in text. In Ethiopia, condom use at first sex, and number of concurrent sexual partners (wives/partners) were the only variables not significant at univariable analysis, however they were taken to multivariable analysis as variables of interest. After running the multivariable logistic regression model, respondent's gender and total number of lifetime partners could not be run in the same model because of collinearity and as such two models were developed. Model 6 A with gender is presented in table 3.5 and 3.6 while model 6 B is shown in appendix 5. Only multivariable logistic regression results after controlling for all other factors (holding other factors constant) are discussed in text.

3.4.1 Underlying determinants analysis in Swaziland

Sex of household head, wealth index, and respondent circumcised were the only variables not significant at univariable analysis: however male circumcision and wealth index were taken to multivariable analysis with the significant variable as factors of interest as seen in table 3.3 and 3.4. The following HIV determinants were identified: Respondent's gender, marital status, age, level of education, type of place of residence and religion. Male circumcision also explains HIV transmission for males as seen in table 3.3 and 3.4.

Table 3.3: Univariable and Multivariable Analysis of Underlying Factors – Swaziland (n=8 186)

	Univariable Analysis			Multivariable Analysis		
Variable	**OR**	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Gender						
Males	1.00			1.00		
Females	1.88	1.70-2.09	<0.001	2.23	1.90-2.60	<0.001
Marital status						
Never married	1.00			1.00		
Married	1.98	1.76-2.23	<0.001†	0.99	0.82-1.18	0.873
Living together	4.05	3.42-4.79	<0.001†	1.66	1.34-2.06	<0.001†
Widowed	6.53	5.14-8.29	<0.001†	2.90	1.89-4.43	<0.001†
Divorced	4.23	2.33-7.68	<0.001†	1.85	0.76-4.49	0.175
Not living together	5.19	3.96-6.81	<0.001†	1.80	1.25-2.60	0.002†
Age group						
15-19	1.00			1.00		
20-24	5.89	4.81-7.20	<0.001†	2.54	1.92-3.36	<0.001†
25-29	10.08	8.20-12.39	<0.001†	3.25	2.42-4.37	<0.001†
30-34	12.37	9.99-15.31	<0.001†	4.03	2.95-5.49	<0.001†
35-39	10.49	8.40-13.10	<0.001†	3.24	2.33-4.51	<0.001†
40-44	7.86	6.20-9.97	<0.001†	2.32	1.63-3.30	<0.001†
45-49	5.32	4.12-6.85	<0.001†	1.53	1.05-2.23	0.028†
Highest education						
No education	1.00			1.00		
Primary	0.64	0.53-0.76	<0.001†	0.92	0.74-1.16	0.493
secondary	0.56	0.47-0.66	<0.001†	0.78	0.62-0.98	0.035†
Higher	0.55	0.43-0.70	<0.001†	0.48	0.35-0.66	<0.001†
Region						
Hhohho	1.00			1.00		
Manzini	0.86	0.75-0.98	0.029†	0.88	0.76-1.02	0.102
Shiselweni	0.85	0.73-0.98	0.027†	0.93	0.79-1.09	0.372
Lubombo	0.95	0.83-1.09	0.474	0.91	0.78-1.05	0.197
Rural /Urban diff.						
Urban	1.00			1.00		
Rural	0.69	0.62-0.76	<0.001†	0.82	0.72-0.94	0.005†
Religion						
Charismatic	1.00			1.00		
Protestant	1.00	0.84-1.19	0.996	1.02	0.81-1.29	0.853
Zionist	1.37	1.17-1.61	<0.001†	1.25	1.00-1.55	0.047†
None	1.24	1.01-1.52	0.038†	1.19	0.91-1.56	0.214
Other	1.19	0.99-1.43	0.059	1.08	0.85-1.37	0.528
Sex of household head						
Male	1.00			***		
Female	0.99	0.90-1.10	0.912	***	***	***
Wealth index						
Poorest	1.00			1.00		
Poorer	1.04	0.88-1.24	0.634	1.15	0.95-1.39	0.152
Middle	0.97	0.82-1.15	0.738	1.04	0.86-1.26	0.657
Richer	1.03	0.88-1.22	0.683	1.07	0.88-1.30	0.514

Richest	0.95	0.81-1.11	0.489	0.90	0.72-1.11	0.324
Occupation						
Unskilled manu.	1.00			1.00		
Skilled manual	2.08	1.24-3.48	0.006†	1.52	0.83-2.79	0.176
Services	1.24	0.72-2.13	0.443	1.30	0.68-2.47	0.432
Agric. Employee	1.62	0.89-2.94	0.115	1.75	0.85-3.57	0.126
Agr. self-employ	1.46	0.83-2.56	0.192	1.19	0.61-2.31	0.617
Sales	1.39	0.77-2.51	0.280	1.01	0.50-2.02	0.982
Clerical	2.15	1.06-4.37	0.035†	1.42	0.62-3.23	0.403
Prof, tech, man.	1.24	0.70-2.19	0.462	0.76	0.39-1.48	0.417
Not working	0.43	0.26-0.72	0.001†	1.41	0.75-2.64	0.288
Age at circumcision						
>13	1.00			1.00		
13-19	1.69	0.75-3.79	0.205	1.10	0.17-6.90	0.885
20+	2.40	1.24-4.68	0.010†	1.39	0.32-3.80	0.511
Circumcised						
Missing	1.00			1.00		
Yes	1.09	0.81-1.46	0.566	0.62	0.45-0.85	0.003†

OR=odds ratio, AOR=adjusted odds ratio, 95% CI=95% confidence interval, †P is significant at alpha level of 5%, ***Variable excluded in analysis or there is missing data.

The multivariable logistic regression analysis shows that females were almost 2 times more likely to be infected with HIV compared to males [AOR=2.23, 95% CI (1.90-2.60)]. Those who were widowed had the highest risk as they were about 3 times more likely to be infected with HIV compared to the never married group [AOR=2.90, 95% C(1.89-4.43)]. They were followed by couples not living together who were almost 2 times more likely to be HIV infected compared to those who were never married, [AOR=1.80, 95% CI (1.25-2.60)]. Couples living together were approximately 2 times more likely to be HIV infected compared to never married, [AOR= 1.66, 95% CI (1.34-2.06)].

Age was significantly associated with HIV infection at p-value <0.001 for all age categories from 15-49 years. There was an increase in chances of infection with increasing age group until 34 years and there after the risk decreases. Individuals aged 20-24 years were 2.54 times more likely to contract HIV compared to 15-19 years age group, [AOR=2.54, 95% CI (1.92-3.36)]. HIV prevalence was generally high for the age band 25-39 years. However the highest rate was noted on the 30-34 years who were almost 4 times more likely to be infected with HIV compared the 15-19 years, [AOR=4.03, 95% CI (2.95-5.49)].

There is generally a decrease in the likelihood of infection with increasing levels of education, and those with secondary schooling were 0.78 times less likely to be HIV infected compared to those with no education [OR=0.78,95% CI (0.62-0.98)]. Likewise those with higher education were almost 50% less likely to be infected compared to those with no education, [AOR=0.48, 95% CI (0.35-0.66)]. Living in the rural areas had a protective effect as they were 0.82 times less likely to be infected with HIV compared to those living in urban areas [AOR=0.82, 95% CI (0.72-0.94)]. There was no much association of HIV infection with religion except for those of Zionist religion, and they were almost 1.3 times more likely to be HIV infected compared to the Charismatic religion, [AOR=1.25, 95% CI (1.00-1.55)].

Though not included in the final model, at multivariable analysis male circumcision was significantly associated with HIV infection. After adjusting for marital status, age and level of education those who were circumcised were 0.62 times less likely to contract HIV compared to those who had missing information on circumcision, [AOR=0.62, 95% CI (0.45-0.85)].

3.4.2 Underlying determinants analysis in Ethiopia

The following determinants were identified in the model 6 A (model with gender) which was a better model. Respondent’s gender, marital status, age, level of education, region, religion, wife justified to ask husband to use condom if she suspects STIs and age at first sex. Male circumcision also explains HIV transmission for males as shown in table 3.5 and 3.6.

Table 3.4: Univariable and Multivariable Analysis of Underlying Factors – Ethiopia (n=10 572)

	Univariable Analysis			Multivariable Analysis		
Variable	**OR**	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Gender						
Males	1.00			1.00		
Females	1.69	1.26-2.27	<0.001†	1.57	1.10-2.25	0.014†
Marital status						
Never married	1.00			1.00		
Married	1.67	1.14-2.43	0.008†	1.06	0.60-1.87	0.850
Living together	9.10	4.53-18.30	<0.001†	4.43	1.93-10.18	<0.001†
Widowed	8.90	5.21-15.22	<0.001†	3.73	1.68-8.30	0.001†
Divorced	6.08	3.57-10.35	<0.001†	2.52	1.26-5.06	0.009†
Not living together	6.64	3.33-13.26	<0.001†	1.86	0.83-4.16	0.129
Ethnicity						
Amara	1.00			1.00		
Oromo	0.46	0.32-0.67	<0.001†	0.90	0.57-1.42	0.642
Tigraway	0.68	0.44-1.06	0.092	0.92	0.46-1.87	0.828
Gurarie	0.51	0.30-0.95	0.034†	0.53	0.27-1.05	0.067
Somali	0.06	0.01-0.46	0.006†	0.31	0.03-3.58	0.349
Affar	0.21	0.07-0.67	0.008†	0.62	0.13-2.90	0.546
Sidamu	1.00	***	***	***	***	***
Other	0.38	0.25-0.57	<0.001†	0.79	0.42-1.47	0.453
Age group						
15-19	1.00			1.00		
20-24	2.89	1.57-5.32	0.001†	1.46	0.75-2.82	0.265
25-29	4.88	2.74-8.70	<0.001†	2.37	1.28-4.41	0.006†
30-34	4.47	2.44-8.19	<0.001†	2.33	1.19-4.56	0.014†
35-39	5.43	2.98-9.89	<0.001†	2.88	1.48-5.61	0.002†
40-44	4.36	2.28-8.35	<0.001†	2.04	0.96-4.35	0.066
45-49	1.68	0.71-3.97	0.240	0.75	0.30-1.88	0.537
Highest education						
No education	1.00			1.00		
Primary	1.67	1.16-2.39	0.006†	1.58	1.03-2.43	0.037†
secondary	3.72	2.67-5.20	<0.001†	1.54	0.91-2.62	0.106
Higher	2.05	0.93-4.52	0.075	0.62	0.25-1.52	0.296
Region						
Tigray	1.00			1.00		
Affar	1.15	0.50-2.65	0.740	2.52	1.01-6.29	0.048†
Amhara	1.01	0.53-1.93	0.982	1.19	0.60-2.39	0.615
Oromiya	0.88	0.46-1.67	0.688	1.41	0.70-2.83	0.330
Somali	0.30	0.07-1.32	0.111	0.52	0.06-4.25	0.541
Banish-Gumuz	0.37	0.12-1.12	0.078	0.51	0.17-1.56	0.240
SNNP	0.18	0.07-0.50	0.001†	0.26	0.09-0.75	0.013†
Gambela	3.36	1.80-6.28	<0.001†	4.11	2.07-8.17	<0.001†
Harari	2.28	1.17-4.47	0.016†	1.31	0.59-2.89	0.505
Addis Ababa	3.28	1.84-5.84	<0.001†	1.33	0.67-2.67	0.417
Dire Dawa	2.27	1.11-4.63	0.024†	1.14	0.49-2.65	0.752
Rural/Urban diff.						

Urban	1.00			1.00		
Rural	0.18	0.13-0.24	<0.001†	0.28	0.17-0.45	<0.001†
Religion						
Orthodox	1.00			1.00		
Protestant	0.55	0.37-0.81	0.003†	0.86	0.57-1.31	0.494
Moslem	0.23	0.15-0.35	<0.001†	0.33	0.21-0.54	<0.001†
Other	1.00	***	***	***	***	***
Sex of household head						
Male	1.00			1.00		
Female	2.27	1.70-3.02	<0.001†	1.10	0.77-1.58	0.606
Wealth index						
Poorest	1.00			1.00		
Poorer	0.76	0.36-1.62	0.480	0.69	0.32-1.49	0.341
Middle	1.22	0.62-2.37	0.565	1.00	0.50-2.00	0.991
Richer	1.17	0.59-2.30	0.654	0.93	0.46-1.90	0.842
Richest	5.22	3.19-8.55	<0.001†	1.83	0.90-3.74	0.097
Occupation						
Unskilled manu.	1.00			1.00		
Skilled manual	2.66	0.73-9.70	0.139	2.70	0.64-11.40	0.176
Services	6.44	1.00-41.67	0.050	5.02	0.65-38.94	0.123
Agric. Employee	0.46	0.14-1.51	0.199	2.10	0.45-9.74	0.341
Sales	1.64	0.46-5.78	0.443	2.24	0.56-9.01	0.256
Clerical	4.03	0.39-41.75	0.243	1.25	0.07-23.04	0.879
Prof, tech, man.	2.45	0.62-9.67	0.200	2.69	0.52-13.79	0.236
Not working	1.00	***	***	1.00	***	***
Circumcised						
No	1.00			1.00		
Yes	0.35	0.19-0.65	0.001†	0.26	0.14-0.48	<0.001†

OR=odds ratio, AOR=adjusted odds ratio, 95% CI=95% confidence interval, †P is significant at alpha level of 5%, ***Variable excluded in analysis or there is missing data.

The multivariable logistic regression analysis shows that females were 1.57 times more likely to be infected with HIV compared to males [AOR=1.57, 95% CI (1.10-2.25)]. Those who were living together were 4.43 times more likely to be infected compared to those who were never married, [AOR=4.43), 95% CI (1.93-10.18)]. Participants who were widowed were almost 4 times more likely to be infected compared to never married, [AOR=3.73, 95% CI (1.68-8.30)]. Participants who were divorced were 2.52 times more likely to be infected compared to those who were never married, [(AOR=2.52, 95% CI (1.26-5.06)]. The 25-39 age groups had a higher chance of HIV infection compared to the 15-19 year old. Those aged 25-

29 and 30-34 years were almost 2 times more likely to get infected compared to the 15-19 years, [AOR=2.37, 95% CI (1.28-4.41)] and [AOR=2.33, 95% CI (1.19-4.56), respectively. Participants aged 35-39 years were almost 3 times more likely to get HIV infection compared to the 15-19 years age group. [(AOR=2.88, 95% CI (1.48-5.61)].

Individuals with primary education were almost 1.6 times more likely to be infected compared to those with no education, [AOR=1.58, 95% CI (1.03-2.43)]. Living in the rural areas was protective and as such participants were about 0.3 times less likely to be infected with HIV compared to those in urban areas, [AOR=0.28, 95% CI (0.17-0.45)]. There were regional differences in the determinants of transmission in Ethiopia. Participants from the Affar region were about 2.5 times more likely to get HIV compared to those in Tigray, [AOR=2.52, 95% CI (1.01-6.29)]. Individuals from Gambela were at a higher chance of contracting HIV as they were almost 4 times more likely compared to those from Tigray, [AOR=4.11, 95% CI (2.07-8.17)]. Living in the SNNP was protective as they were almost 0.3 times less likely to be infected with HIV compared to those from Tigray, [AOR=0.26, 95% CI (0.09-0.75)]. Belonging to the Moslem religion was very protective against HIV infection. Moslem religion were about 0.3 times less likely to be infected with HIV compared to Orthodox, [AOR=0.33, 95% CI (0.21-0.54)].

Though circumcision was not included in the final model, at multivariable analysis it was significantly associated with HIV infection. After adjusting for marital status, age and level of education, circumcised males had about 0.3 times reduced chance of getting HIV compared to those who were not circumcised, [AOR=0.26, 95% CI (0.14-0.48)].

3.4.3 Proximate determinants analysis in Swaziland

After running the multivariable logistic regression model, the following proximate HIV determinants were identified: Condom use during last sex, total number of lifetime partners, history of sexually transmitted disease in the past 12 months, history of genital ulcer in the past 12 months and testing for HIV within the past year.

Table 3.5: Univariable and Multivariable Analysis of Proximate Factors – Swaziland (n=5 210)

	Univariable Analysis			Multivariable Analysis		
Variable	**OR**	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Condom use at first sex						
No	1.00			1.00		
Yes	0.70	0.58-0.86	0.001†	0.90	0.72-1.13	0.358
Condom use at last sex						
No	1.00			1.00		
Yes	1.32	1.18-1.48	<0.001†	1.42	1.24-1.63	<0.001†
Consistent condom use						
No						
Yes	1.00			1.00		
	0.84	0.70-1.00	0.056	1.03	0.83-1.27	0.812
Total life-time partners						
1	1.00			1.00		
2	2.08	1.76-2.46	<0.001†	1.86	1.53-2.26	<0.001†
3	2.71	2.78-3.24	<0.001 †	2.41	1.95-2.99	<0.001†
3+	2.68	2.30-3.13	<0.001 †	3.14	2.55-3.87	<0.001†
Unknown	2.62	1.93-3.56	<0.001 †	3.35	2.30-4.88	<0.001†
Number of concurrent sexual partners						
0	1.00			1.00		
1	1.11	0.94-1.32	0.211	0.85	0.62-1.17	0.328
2	1.44	0.98-2.11	0.063	1.21	0.76-1.91	0.418
2+	1.86	0.96-3.59	0.065	1.64	0.76-3.56	0.209
Unknown	1.42	1.09-1.85	0.009†	1.14	0.85-1.53	0.386
Perception on wife beating if she refuse sex						
No	1.00			1.00		
Yes	0.97	0.75-1.27	0.834	1.13	0.79-1.60	0.510
Don’t know	0.63	0.44-0.90	0.011†	0.99	0.62-1.60	0.980
Wife justified to ask condom use if husb. has STIs						

No	1.00			1.00		
Yes	0.90	0.71-1.15	0.416	1.09	0.81-1.48	0.561
Don't know	0.43	0.23-0.82	0.010†	1.19	0.51-2.75	0.686
Age at first sex						
Never	1.00			1.00		
<15	13.94	10.59-18.36	<0.001†	0.83	0.67-1.01	0.059
15-19	14.69	11.34-19.03	<0.001†	0.96	0.82-1.12	0.577
20+	13.89	10.58-18.24	<0.001†	1.00	***	***
Had STIs in last 12 months						
No	1.00			1.00		
Yes	3.39	2.79-4.11	<0.001†	1.30	1.02-1.65	0.035
Had genit. ulcer last 12 months						
No	1.00			1.00		
Yes	4.29	3.55-5.18	<0.001†	2.15	1.71-2.71	<0.001†
Alcohol use at last sex						
No	1.00			1.00		
Yes	1.48	1.21-1.81	0.146	1.11	0.88-1.39	0.385
Ever tested for AIDS						
No	1.00			1.00		
Yes	2.27	2.05-2.52	<0.001†	1.26	1.10-1.44	0.001†

OR=odds ratio, AOR=adjusted odds ratio, 95% CI=95% confidence interval, †P is significant at alpha level of 5%, ***Variable excluded in analysis or there is missing data, Number of concurrent sexual partners is number of wives or partners.

Condom use during last sex in the past 12 months was significantly associated with HIV infection; although its use had no beneficial effects as it was not protective. Individuals who had used a condom in the past year were 1.42 times more likely to infected compared to those who reported not having used it, [AOR=1.42, 95% CI (1.24-1.63)].

The total number of lifetime partners was significantly associated with HIV infection, and there was an increasing trend of likelihood of infection with increasing number of partners. Those with 2 partners were almost 2 times more likely to be infected compared to those with one partner in their lifetime, [AOR=1.86, 95% CI (1.53-2.27)]. Individuals with 3 lifetime partners were over 2 times more likely to be infected compared to those with one partner, [AOR=2.41, 95% CI (1.95-2.99)]. Those with more than 3 lifetime partners had an increased chance of infection as they were about 3 times more likely to be infected compared to those with one lifetime partners, [AOR=3.14, 95% CI (2.55-3.87)]. Having many partners was also significantly associated with HIV infection as those with unknown number of lifetime partners were almost 3 times more likely to get infected compared to those who had one lifetime partners, [AOR=3.35, 95% CI (2.30-4.88)].

Having a history of sexually transmitted infection in the past year was associated with HIV infection as those who had an STI were 1.30 times more likely to get infected compared to those who did not have an STI, [AOR=1.30, 95% CI(1.02-1.65)]. Having a genital ulcer was a determinant of infection as those who had genital sores were almost 2 times more likely to get infection compared to those who did not have an ulcer within the past year, [AOR=2.15, 95% CI (1.71-2.71)]. Having done an HIV test within the past year was significantly associated with HIV infection; however it had no protective effect. Individuals who reported having taken an HIV test within the past 12 months were 1.26 times more likely to get infected compared to those who did not test, [AOR=1.26, 95% CI (1.10-1.44)].

3.4.4 Proximate determinants analysis in Swaziland

After running the multivariable logistic regression model, the following proximate HIV determinants were identified: Wife justified to negotiating condom use, age at first sex and total number of lifetime partners.

Table 3.6: Univariable and Multivariable Analysis of Proximate Factors – Ethiopia (n=10 128)

Variable	Univariable			Multivariable Analysis		
	OR	95% CI	P-value	AOR	95% CI	P-value
Condom use at first sex						
No	1.00			1.00		

Yes	1.27	0.44-3.63	0.660	0.84	0.22-3.25	0.803
Don't know	1.00	***	***	1.00	***	***
Condom use at last sex						
No	1.00			1.00		
Yes	3.89	2.36-6.41	<0.001†	0.98	0.51-1.89	0.976
Consistent condom use						
No	1.00			1.00		
Yes	4.07	2.40-6.92	<0.001†	1.81	0.81-4.06	0.151
Total life-time partners						
1	1.00			***	***	***
2	3.22	2.19-4.73	<0.001†	***	***	***
3	2.75	1.39-5.46	0.004†	***	***	***
3+	7.90	4.26-14.63	<0.001†	***	***	***
Unknown	4.98	0.63-39.16	0.127	***	***	***
Number of concurrent sexual partners						
0	1.00			1.00		
1	0.90	0.61-1.33	0.585	0.85	0.33-2.16	0.734
2	0.95	0.38-2.39	0.914	1.00	***	***
2+	1.16	0.16-8.54	0.886	1.89	0.25-14.44	0.542
Perception on wife beating if she refuse						
No	1.00			1.00		
Yes	0.43	0.30-0.62	<0.001†	0.86	0.52-1.41	0.549
Don't know	0.41	0.15-1.12	0.082	0.61	0.17-2.15	0.443
Wife justified to ask condom use if husb. has STIs						
No	1.00			1.00		
Yes	2.89	1.92-4.35	<0.001†	1.81	1.15-2.86	0.010†
Don't know	0.91	0.51-1.63	0.755	1.01	0.55-1.85	0.979
Age at first sex						
Never	1.00			1.00		
<15	6.68	3.60-12.38	<0.001†	4.20	1.90-9.32	<0.001†
15-19	7.29	3.97-13.41	<0.001†	4.98	2.30-10.80	<0.001†
20+	5.52	2.93-10.40	<0.001†	4.23	1.88-9.54	0.001†
Had STIs in last 12 months						
No	1.00			1.00		
Yes	2.56	0.62-10.69	0.196	1.96	0.35-11.04	0.446
Don't know	1.00	***	***	1.00	***	***
Had genit. ulcer last 12 months						
No	1.00			1.00		
Yes	5.58	2.19-14.21	<0.001†	1.45	0.38-5.61	0.588
Don't know	1.00	***	***	1.00	***	***

Alcohol use at last sex						
No	1.00			1.00		
Yes	2.01	1.22-3.33	0.006†	1.32	0.57-3.05	0.520
Ever tested for AIDS						
No	1.00			1.00		
Yes	2.53	1.73-3.68	<0.001†	0.68	0.38-1.22	0.193

OR=odds ratio, AOR=adjusted odds ratio, 95% CI=95% confidence interval, †P is significant at alpha level of 5%, ***Variable excluded in analysis or there is missing data, Number of concurrent sexual partners is number of wives or partners.

Wife justified to negotiating condom use with husband if she suspects STIs was significant, however it was not protective. Participants who were for the idea of negotiating were almost 2 times more likely to contract HIV compared to those who feel wives are not justified to negotiate condom use, [AOR=1.81, 95% CI (1.15-2.86)]. Age at first sex was significantly associated with HIV infection. Participants who had sexual debut at <15 years of age were almost 4 times more likely to be infected with HIV compared to those who never had sex, [AOR=4.20, 95% CI (1.90-9.32)]. Those who had first sex at age 15-19 had the highest chance as they were almost 5 times more likely to be infected compared to those who never had sex, [AOR=4.98, 95% CI(2.30-10.80)]. Those who had a sexual debut at age more than 20 years were about 4.2 times more likely to be infected compared to those who never had sex, [AOR=4.23, (1.88-9.54)].

A similar trend was observed in model 6 B (model with total number of lifetime partners). There was generally an increasing trend of likelihood with increasing number of sexual partners. Individuals with 2 partners in their lifetime were about 2.7 times more likely to get HIV compared to those who had one partner in their lifetime, [AOR=2.65, 95% CI (1.76-4.08)]. Individuals with 3 partners were almost 2 times more likely to get HIV compared to those with one partner in their lifetime, [AOR=2.30, 95% CI (1.03-5.14)]. Individuals with more than 3 lifetime partners in their lifetime had the highest odds as they were approximately 6 times more likely to be HIV positive compared those who had one partner in their lifetime, [AOR=5.61, 95% CI (2.73-11.52)] as seen in appendix 5.

3.5 Modelling the Combined Proximate Determinants of HIV Infection

Proximate determinants from combined data were modelled against the HIV results. Significant variables were age at first sex, total number of lifetime partners, condom use at first sex, condom use at last sex, perception on wife beating if she refuses sex, history of STIs, history of genital ulcers, alcohol use during last sex and ever tested for HIV. The results of the multivariable analysis after controlling for the other all factors (holding other factors constant) are as follows: Age at first sex was significantly associated with HIV infection and those who had sexual debut at less than 15 years were almost 13 times more likely to be HIV positive compared to those who never had sex [AOR=13.08, 95% CI (7.66-22.34)]. Participants who had sexual debut at age 15-19 years had the highest chance of getting HIV as they were nearly 14 times more likely to be HIV positive compared to those who never had sex, [AOR=14.30, 95% CI (8.47-24.13)]. The data suggests that there were no protective effect of delayed sexual debut as participants who had sexual debut at more than 20 years were approximately 13 times more likely to be infected compared to the never group, [AOR=12.81, 95% CI (7.56-21.68)] as seen in table 3.7.

Table 3.7: Analysis Adjusted for Country and other Proximate (Behavioural) Factors (n=15 048)

Variable	Odds Ratio Adjusted for Country			Odds Ratio Adjusted for Country and Behavioural Factors		
	AOR	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Age at first sex						
Never	1.00			1.00		

<15	13.01	9.89-17.12	<0.001†	13.08	7.66-22.34	<0.001†
15-19	14.05	10.84-18.20	<0.001†	14.30	8.47-24.13	<0.001†
20+	13.31	10.15-17.46	<0.001†	12.81	7.56-21.68	<0.001†
Missing	19.07	4.56-79.67	<0.001†	22.16	5.01-97.98	<0.001†
Ethiopia	0.07	0.06-0.08	<0.001†	***	***	***
Total life-time partners						
1	1.00			1.00		
2	2.28	1.94-2.67	<0.001†	1.99	1.68-2.34	<0.001†
3	2.92	2.45-3.47	<0.001†	2.31	1.93-2.77	<0.001†
4+	2.95	2.54-3.44	<0.001†	2.24	1.90-2.63	<0.001†
Unknown	2.78	2.04-3.79	<0.001†	2.20	1.60-3.03	<0.001†
Missing	0.29	0.24-0.36	<0.001†	1.22	0.90-1.67	0.905
Ethiopia	0.11	0.09-0.13	<0.001†	***	***	***
Number of concurrent sexual partners						
0	1.00			1.00		
1	1.17	1.00-1.35	0.054	0.89	0.74-1.07	0.213
2	1.50	1.05-2.14	0.026†	1.14	0.78-1.66	0.502
3+	1.87	0.99-3.53	0.054	1.35	0.69-2.63	0.383
Unknown	1.45	1.11-1.89	0.006†	1.25	0.95-1.66	0.112
Missing	0.73	0.64-0.83	<0.001†	1.21	1.03-1.43	0.024†
Ethiopia	0.05	0.04-0.06	<0.001†	***	***	***
Condom use at first sex						
No	1.00			1.00		
Yes	0.71	0.57-0.87	0.001†	0.69	0.56-0.86	0.001†
Don't know	1.00	***	***	1.00	***	***
Missing	1.01	0.88-1.16	0.873	1.40	1.21-1.63	<0.001†
Ethiopia	0.05	0.04-0.06	<0.001†	***	***	***
Condom use at last sex						
No	1.00			1.00		
Yes	1.41	1.26-1.59	<0.001†	1.44	1.27-1.63	0.001†
Missing	0.36	0.31-0.41	<0.001†	1.50	0.45-5.02	0.508
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Consistent condom use						
No	1.00			1.00		
Yes	0.97	0.82-1.16	0.767	0.94	0.78-1.14	0.549
Missing	0.51	0.44-0.59	<0.001†	1.49	0.97-2.28	0.068
Ethiopia	0.05	0.04-0.06	<0.001†	***	***	***
Perception on wife beating if she refuse						
No	1.00			1.00		
Yes	0.71	0.57-0.90	0.004†	0.77	0.60-0.98	0.036†
Don't know	0.55	0.39-0.80	0.001†	0.80	0.54-1.19	0.271
Missing	46.23	2.88-743.23	0.007†	83.07	3.26-2113.83	0.007†
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Wife justified to ask						

condom use if husb. has STIs						
No	1.00			1.00		
Yes	1.19	0.95-1.48	0.122	1.17	0.93-1.47	0.186
Don't know	0.52	0.34-0.81	0.003†	0.72	0.46-1.12	0.144
Missing	1.00	***	***	1.00	***	***
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Had STIs in last 12 months						
No	1.00			1.00		
Yes	3.28	2.70-4.00	<0.001†	1.34	1.05-1.70	<0.001†
Don't know	1.00	***	***	1.00	***	***
Missing	0.65	0.29-1.48	0.304	0.54	0.23-1.26	0.061
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Had genit. ulcer last 12 months						
No	1.00			1.00		
Yes	4.18	3.46-5.07	<0.001†	2.45	1.94-3.08	<0.001†
Don't know	1.00	***	***	1.00	***	***
Missing	1.36	1.17-1.59	<0.001†	0.70	0.48-1.02	0.061
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Alcohol use at last sex						
No	1.00			1.00		
Yes	1.52	1.25-1.85	<0.001†	1.32	1.08-1.62	0.008†
Missing	0.33	0.29-0.37	<0.001†	1.25	0.39-3.96	0.709
Ethiopia	0.05	0.04-0.06	<0.001†	***	***	***
Ever tested for AIDS						
No	1.00			1.00		
Yes	2.17	1.96-2.41	<0.001†	1.53	1.37-1.71	<0.001
Missing	1.16	0.75-1.81	0.497	1.25	0.79-2.00	0.341
Ethiopia	0.06	0.05-0.07	<0.001†	***	***	***
Ethiopia	***	***	***	0.11	0.09-0.15	<0.001†

AOR=adjusted odds ratio, 95% CI=95% confidence interval, - Variable excludes in analysis or missing data, †P is significant at alpha level of 5%, ***Variable excluded in analysis, NB: Missing information included in the analysis and the variable is called missing, Number of concurrent sexual partners is number of wives or partners.

Total number of lifetime partners was significantly associated with HIV infection and there was generally an increasing trend of HIV infection with increasing number of sexual partners. Individuals with 2 lifetime sexual partners were almost 2 times more likely to be infected with HIV compared to those with one, [AOR=1.99, 95% CI (1.68-2.34)]. Individuals with more than 3 lifetime partners were almost 2 times more likely to be infected with HIV compared to those with one, [AOR=2.24, 95% CI (1.90-2.63)]. Condom use at first sex was significant and had a 30% protection compared to those who did not use a condom, [AOR=0.69, 95% CI (0.56-0.86)]. On the contrary, condom use at last sex was significantly associated with HIV infection but had no protective effect as those who used a condom were about 1.44 times more likely to be HIV infected compared to those who did not use a condom, [AOR=1.44, 95% CI (1.27-1.63)]. Wife beating was associated with HIV infection as those who perceived that wives should be beaten if they refuse sex were 33% less likely to be infected with HIV compared to those who believed it was wrong, [AOR=0.77, 95% CI (0.60-0.98)].

Individuals with history of STIs in the past year were 1.34 times more likely to be HIV infected compared to those who did not have STIs, [AOR=1.34, 95% CI (1.05-1.70)]. Similarly individuals with history of genital ulcers in the past year were 2.45 times more likely to be infected with HIV compared to those who did not have an ulcer, [AOR=2.45, 95% CI (1.94-3.08)]. Alcohol use was significantly associated with HIV infection as those who had taken alcohol in their last sexual activity were 1.32 times more likely to be infected compared to those who never used alcohol during last sex, [AOR=1.32, 95% CI (1.08-1.62)]. Testing for HIV status was significantly associated with HIV infection, however it was not protective. Those who had tested for HIV in the last year were 1.53 times more likely to be infected compared to those who did not test, [AOR=1.53, 95% CI (1.37-1.71)]. Controlling for the country effect in multivariable analysis, the results suggest that there is an 89% protection from HIV infection in people living in Ethiopia compared to those living in Swaziland, AOR=0.11, 95% CI (0.09-0.15)].

3.6 Modelling the Determinant using the Structural Equation Modelling

Modelling in the SEM was based on variables that were significant in all regression analyses so as to quantify the relationship of the significant pathways as seen in figure 3.3 and table 3.8.

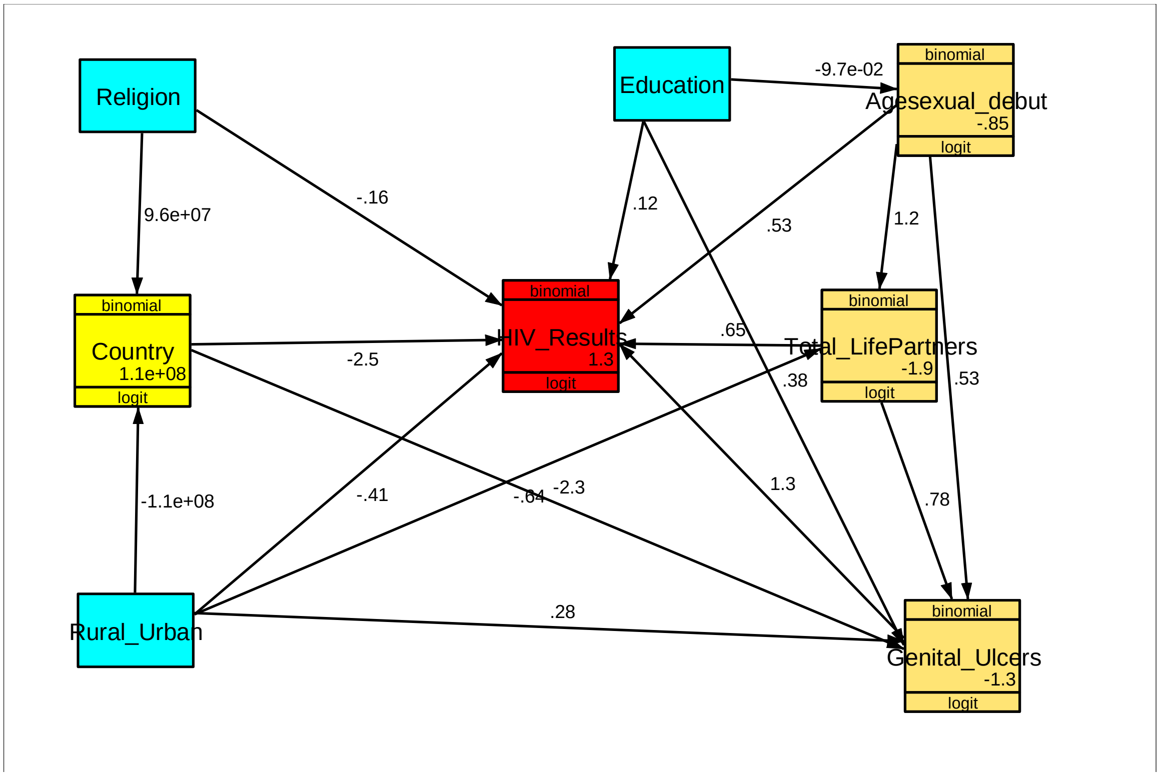


Figure 3.3: Effects of the Determinants on HIV Infection using SEM.

Table 3.8: Odds Ratios and Confidence Intervals for HIV determinants Estimated using SEM for Swaziland and Ethiopia Combined Data (n=15 154).

		Direct Effects		*Indirect Effects*		*Total Effects*	
Effect on HIV	**Effect of**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
	Country	0.08	0.07:0.10	0.06	0.03:0.11	0.14	0.002:0.019*
	Education	1.13	1.02:1.26	1.42	1.09:1.86	2.55	1.20:3.14
	Rural/Urban	0.67	0.60:0.74	0.93	0.70:1.25 NS	1.60	0.46:1.84
	Religion	0.85	0.75:0.97	0	0.00:0.00	0.85	0.75:0.97
	Age at first sex	1.71	1.54:1.89	4.32	3.20:5.83	6.03	5.40:10.07
	Total number of lifetime partners	1.92	1.71:2.15	2.68	2.00:3.59	4.60	3.77:7.03
	Genital ulcers	3.55	2.92:4.32			3.55	2.92:4.32
Country	Rural/Urban	0	***			0	***
	Religion	0	***			0	***
Age at first sex	Education	0.91	0.84:0.98			0.91	0.84:0.98
Total number of lifetime partners	Education			0.89	0.81:0.97	0.89	0.81:0.97
	Rural Urban	0.53	0.47:0.58			0.53	0.47:0.58
	Age at first sex	3.36	3.05:3.71			3.36	3.05:3.71
Genital ulcers	Country	0.10	0.07:0.15			0.10	0.07:0.15
	Education	1.46	1.21:1.76	0.95	0.91:0.99	2.41	1.14:2.68
	Rural/Urban	1.32	1.07:1.63	0.61	0.52:0.70	1.93	0.63:2.02NS
	Religion			0	0.00:0.00	0	0.00:0.00
	Age at first sex	1.70	1.41:2.05	2.57	2.00:3.30	4.27	3.26:5.87
	Total number of lifetime partners	2.18	1.79:2.65			2.18	1.79:2.65

NS: Not statistically significant at 5% significance level, *95% Confidence interval reported at 3 decimal places, ** Variable excluded in analysis, NB: 95% Confidence intervals reported at 3 decimal places because values are very small hence at 2 decimal level approximates zero, and interval not visible. Indirect effect computed as a product along the related pathway i.e. indirect effect of age at first ex and HIV (logit coefficient) is: (1.20 X 0.65) + (0.53X1.3) = **1.469** = AOR= **4.344.** Total effects were computed as the sum of direct and indirect effects.

The results from the SEM are expressed as logit regression coefficients, and for ease of analysis and consistency of reporting throughout the report they were converted to odds ratios as seen in table 3.8 and appendix 6. This was done by calculating the exponential of the coefficient. **For example:** the logit coefficient between genital ulcer and HIV infection in the direct route is 1.27. Hence; OR= $e^{1.27} = 3.55$. For more details of the mathematical conversion of the logit coefficients to odds ratios, please see appendix 7.

Results are reported adjusting for all endogenous and exogenous factors and holding all other factors constant. The SEM has advantages of being able to adjust for multiple factors and at the same time take into account multiple outcomes hence gives a refined estimate of odds ratios compared to those from multiple variable analyses. The results shows that age at first sex, high total number of lifetime partners and having a history of genital ulcers are moistly associated with contracting HIV in Swaziland and Ethiopia. Participants who had a history of genital ulcers were 3.55 times more likely to be HIV positive compared to those who did not have [AOR=3.55, 95% CI (2.92-4.32)].

Those who had 3 or more sexual partners in their lifetime were 1.92 times more likely to be HIV positive in the direct route compared to those who had one partner [AOR=1.92, 95% CI (1.71-2.15)]. The relationship is amplified and the odds ratio rises to 2.68 in the indirect route but the direction does not change, while in the total effects there is a big increase in the likelihood as it increases to 4.60, [AOR=4.60, 95% CI (3.77-7.03)].

The model suggest a similar trend for age at first sex, which means having a sexual debut at 15-19 years increases the chance of getting HIV by almost 6.03 [AOR=6.03, 95% CI (5.40-10.07)]. Just like age at first sex, the model predicts that there is an association between primary education and having HIV in total effects as individuals with primary education were 2.55 times more likely to be HIV positive compared to those with no education [AOR=2.55, 95% CI (1.20-3.14)].

We notice a protective effect of living in Ethiopia, rural areas, religion (Protestant) and HIV infection. The model predicts that in terms of chances of infection, being in Ethiopia decreases the chance by almost 86% in the total effects compared to Swaziland [AOR=0.14, 95% CI (0.002-0.019)]. The result shows that living in rural areas have about 33% protection from HIV infection in the direct effects. There was an attenuation of the likelihood of infection in the indirect effects; however it was not statistically significant. Protestant religion had about 15% HIV protection in direct effects [AOR=0.85, 95% CI (0.75-0.97)].

It is worth noting that having at least primary education has about 9% protective effect on age at first sex. If an individual has sexual debut at age 15-19 years they are 3.36 times more likely to have 3 or more total lifetime partners for both direct and total effects [AOR=3.36, 95% CI (3.05-3.71)]. The model also predicts that the having 3 or more total lifetime partners increases the chance of getting genital ulcers by almost 2.18. Participants who live in rural areas have an 47% reduced chance of having 3 or more lifetime partners, however they have a 32% increased risk of contracting genital ulcers in total effects [AOR=0.53, 95% CI (0.47-0.58)] and [AOR=1.32, 95% CI (1.07-1.63)] respectively.

CHAPTER 4. DISCUSSION

4.1 Introduction

This section discusses the determinants of HIV infection from the two countries in view of previous findings from other studies. Evidence on the determinants of HIV infection is well documented in both countries, however most studies done especially in Swaziland have been purely descriptive. This study explored the association between HIV infection and the various explanatory variables in the DHS for Swaziland and Ethiopia. The main aim of the study was to explore and compare the main determinants of HIV infection in Ethiopia and Swaziland in the years 2005 and 2006/07 respectively. There was no observed association between HIV infection and socio-economic factors in both countries. The study demonstrated that underlying (demographic, biological) and proximate (behavioural) factors were associated with HIV infection.

4.2 Determinants of HIV Infection in Swaziland and Ethiopia

In Swaziland, the study identified the following as the main determinants of HIV infection: Underlying factors: gender, marital status, age, education, urban-rural differences, religion, and male circumcision. Proximate factors were: condom use during last sex, total number of lifetime partners, history of STI, history of genital ulcers, and history of HIV test within the last year. In Ethiopia, the study found the following underlying factors: gender, marital status, age group, education, region, urban-rural differences, religion, and male circumcision. Proximate factors were: age at first sex, total number of lifetime partners, and wife justified to negotiate condom use.

4.2.1 Underlying Determinants Associated with HIV Infection in Swaziland

In our study gender was a significant factor for HIV infection and the finding that females are more likely to be infected has been found in many studies. There are many factors accounting for such making women vulnerable due to their biological susceptibility. In a cross-sectional study done in Swaziland and Botswana, they found that those women who had food shortage had an 80% increased odds of selling sex for money or food and 70% increased odds of engaging in unprotected sex.(45) This finding is also in line with studies done in sub-Saharan Africa, which found that gender disparities, sexual norms, lack of education and violence are social determinants that make females more susceptible to HIV infection.(46) The authors further states that in SSA females constitute 60% of those infected with HIV. (46)

Our study demonstrates that marital status is one of the determinants of HIV infection and this finding is in line with previous studies. In a study done in South Africa, they found that the HIV prevalence among married was 10.5% and 15.7% among the unmarried, but the risk of infection did not differ.(47) In our study, being married was not significantly associated with HIV infection. However, living together was significantly associated with HIV infection which was in line with finding from a study done in Rwanda and urban Zambia. They found that about 55.1% to 92.7% of new heterosexual HIV infection occurred within cohabiting relationships.(48) Our study identified widowhood as significantly associated with HIV infection just like in other studies. In a study conducted in rural western Kenya female widows were 7.5 times more likely to be HIV positive.(49) Amornkul et al (2009), alludes that to the fact that they may have been infected by their spouses who died of HIV/AIDS. (49)

We found that age was associated with HIV infection and the peak was seen between age 25 and 39 years. This result is in line with a finding of a study done in South Africa where HIV prevalence peaked among women aged 20-29 years (24.1%) and in men aged 30-39 years at 21.3% (50) probable because this is the childbearing ages. The study shows that HIV prevalence increases with age because prevalence indicates the lifetime risk. Hence it may also be driven by the fact that the older you are, the more lifetime partners which is also a risk factor for HIV infection. This result suggests that the most at risk groups are the childbearing ages hence the need to strengthen interventions targeting this group and save more lives.

Our finding of the inverse association between education and HIV prevalence is consistent with other findings. In a study done in Kilimanjaro (Tanzania), they found that in 2005 those with secondary or higher education had 0.4 reduced odds of getting HIV compared to those with less than 7 years of schooling. This contrasted an earlier finding in 1991 of increasing likelihood of getting HIV with increasing education. This adds the increasing evidence that educated people are more likely to use protection and less likely to engage in risky HIV behaviours. (51)

Just like several studies, we found the rural urban differences in patterns of HIV prevalence which seem to favour rural areas as low prevalence levels have been observed there. Asiedu et al (2012) found that the probability of infection is about 8% higher for urban residents than rural residents in Swaziland.(20) This may be due to differences in lifestyles and the in migration to urban areas in search of employment. Our study demonstrated religion as a determinant of HIV infection in line with other studies. An ecological study by Drain et al

(2006), found that increase in Christian population was associated with 1.32 fold increase in adult HIV prevalence in sub-Saharan African countries.(52) This could be partly explained by the lower levels of circumcision among Christians and the fact that some still resist use of condoms and other prevention strategies.

Medical male circumcision has been proved to help reduce HIV transmission and reduces the risk of cervical cancer. The finding from our study of yielding a 38% protection from HIV is in agreement with other studies. A randomised controlled trial (RCT) done in South Africa found a 60% protection from HIV in the circumcised group compared to those who were not circumcised.(53) With such result from an RCT which is a gold standard we have seen the scale up of male circumcision to complement condom use. Though not statistically significant in multivariable analysis in our study, there was increasing likelihood of infection with increasing age at circumcision in univariable analysis.

Whiteside et al (2003) highlight the importance of early circumcision before sexual debut.(54) Therefore, there is still need to improve the scale up of male circumcision to achieve the 144,688 target by 2013 set in the Swaziland male circumcision policy.(55) Evidence from Swaziland HIV Incidence Survey (SHIMS) shows that male circumcision has doubled since 2007 from 8% to 16% in 2011, hence the need to mobilize more males to circumcise.(19)

4.2.2 Underlying Determinants Associated with HIV Infection in Ethiopia

Females continue to be the most at risk gender group in HIV acquisition. Our results support findings from a study done in Ethiopian youth which found that out of school women had an excess HIV prevalence 60% compared to their male counterparts. This result is attributed to the cultural beliefs which give males authority and control in relationships especially over condom use.(56) Carpenter et al (1999) reported that within married women with HIV positive spouses the HIV incidence rate was twice than that of man. In the case where the spouse was HIV negative, the incidence in women was less than half compared to that of men.(57) Although this is the case it remains unclear where the discrepancy lies as one would expect an equally higher incidence among men. However the authors suggest that men are two times more likely to bring infections to the marriage due to extra marital affairs, and women remain victims due to sexual abuse, gender imbalance and biological plausibility.(57) Mishra et al (2007) reported that increasing wealth has been linked with increasing HIV prevalence in cohabiting couples. The wealthiest being two to seven times more likely to have HIV than the poorest.(58)

Age is a significant determinant for HIV infection in many countries in the world. Just like in our study, the EDHS 2011 found that the adult HIV prevalence is generally low at 1.5%. The prevalence amongst females aged 15-49 is 1.9% and 1.0% for males of the same age group. As in our study prevalence is highest among 35-39 years and is at 3.0%. The same EDHS 2011 states that to have a deeper understanding of the epidemic it is essential and recommended that an in depth analysis on data sources is done.(12)

Our study demonstrates an inverse association between education and HIV infection and such has been documented from other studies. In a systematic review by Hagrieves et al (2008), data from 1996 onwards suggest that there is lower risk of HIV infection amongst the most educated.(59) An increase in education makes individuals to be more independent and have the ability to decide what they want and increased ability to negotiate for safe sex.

Our study shows the regional differences which have also been found in previous studies in Ethiopia over the years. Just like in our study, Gambela has always had the highest prevalence of HIV in the entire country at 6.5%.(12) Possible reasons could be the high polygynous rate which is estimated at 27%.(12) It may also be due to the low levels of circumcision, and the higher magnitude of risky sexual behaviour.(36) However SNNP region has been seen to have a protective effect despite the low levels of circumcision. This therefore remains inconclusive and requires further investigation as SNNP region has a low HIV prevalence 0.9%(12) despite the high proportion of uncircumcised men at 20.4%. (36)

In a study on army recruits in Ethiopia urban recruits had HIV prevalence of 7.2% compared to 3.8% for rural recruits.(35) This finding of low rural prevalence is in line with our study; however there has been remarkable decrease in HIV incidence as ANC data reflect that urban prevalence have halved, declining from 11.5% in 2003 to 5.5% in 2009.(13)

We found that religion was significantly associated with HIV infection in Ethiopia and the Muslim had a 67% protection. In a systematic review by Grey (2004), he found that six out of seven studies indicated a negative relationship between HIV prevalence and Muslim. Of note though is that the only differing study which observed a positive association used a different method and used wards rather than individuals.(60) The Muslim faith is known for their strong discipline and the tradition of male circumcision which may possible explain the low HIV prevalence. Many studies have found that high number of sexual lifetime partners and alcohol consumption are associated with increased risk of HIV. The Muslim religion strongly discourages such practices, hence might also explain the negative correlation between HIV prevalence and Muslims.

In our study we demonstrated the protective effect of medical male circumcision on HIV infection. MC has been identified as one of the prevention strategies of combating HIV transmission independent of other factors. Studies have shown that it can reduce the transmission from female to male by 60%. Drain et al (2006), found that higher MC prevalence was associated with 8.94-fold decrease in the adult HIV prevalence in countries where the main cause is heterosexual transmission.(52) Not surprising in countries where main transmission is homosexual and injection drug use it MC was not significant.

4.2.3 Proximate Determinants Associated with HIV Infection in Swaziland

Consistent condom use is a good measure of condom use as it reduces the chance of infection optimally and provides protection; however in our study it was not significant, meaning it does not explain HIV infection. Condom use the last time had sex which is a good proxy measure for condom use was significant, however it was not protective. In line with this, Shisan et al (2008) found that those who had used a condom the last time they had sex were 1.61 times more likely to be HIV positive compared to those who did not use it.(47) This may be due to the fact that it measures the condom use based only on the last sexual encounter irrespective of previous exposures which may have been unsafe. Condom use during last sex is improving in Swaziland as in Multi Indicator Cluster Survey (MICS) 2010 showed that it improved to 73.1% for females and 71.0% for males when compared to SDHS 2006/07. (61)

Our study also identified total number of lifetime partners as a determinant for HIV infection and we see proportional relationship of increasing chance of infection with increasing number of partners. This finding is in keeping with Whiteside et al (2003), which highlights number of partners as one of the drivers of the pandemic. They further states that the situation is exacerbated by sexual mixing patterns. This happens as people from rural areas leave their partners and look for employment in town where they in turn have other partners, and more partners on vacation in and out of the country.(54) HIV incidence survey done in Swaziland shows that having multiple partners is a major risk factor for HIV infection. It shows that participants with 2 or more partners had an incidence rate of 9.6/100 PY, even though they only accounted for 3% of the study population. (19)

Numerous studies have outlined the relationship between sexually transmitted infections and HIV infection. If a person contracts STI he or she is at greater risk of contracting HIV as this is a sign of risky behaviour and not using protection. Korenromp et al (2005) estimates that STI intervention could reduce HIV prevalence drastically if well managed. It reduced it by 28% in Mwanza, 3% in Masaka and 10% in Rakai, hence the need to strengthen STI management in HIV prevention.(62) However the finding contrasts Chen et al (2007), in a systematic review where they found that lower risks of HIV infection was associated with history of STIs both in men and women. This could be explained by limited number of comparison studies which only had two studies from high prevalence setting which might have biased the results.(63)

Genital ulcer disease (GUD) was identified as a risk factor for heterosexual HIV transmission for both males and females in Africa. O Farrell (2001) states that the rate of infection in GUD is even higher than any other forms of STIs due to the direct contact caused by the disruption of mucous membrane, and also contributes about 68% of STIs. (64)

The concept of HIV testing and counselling was introduced as a preventive approach, however in Swaziland that is not the case as the levels of testing are very low.(65) The SDHS reports that 36% of women reported having tested for HIV and got results compared to 17% of men.(5) This could be the reason why those reporting having done the test were likely to be positive as it is not used as a preventive approach. Most of the time HIV testing is voluntary and on rare instances it is initiated by the health provider; however consent still has to be sought.

4.2.4 Proximate Determinants Associated with HIV Infection in Ethiopia

Age at first sex is a very important indicator in HIV prevention as it is believed that delaying the sexual debut is a key positive factor. In line with our findings, Pettifor et al (2004), found that early sexual debut for women is a risk factor and reported that women who engaged early in sexual activities had 1.3 times increased risk compared to women who delayed sexual debut. However the duration the woman is sexually active and the total number of partners seem to contribute immensely on the outcomes. (66)

Our finding on women inability to negotiate condom use has negative impact on the battle against HIV. This finding accord with Dunkle et al (2008), where they attribute it to the fact that cultural context supports men extramarital activities and prevents women from practicing HIV prevention in their relationships. (48) Pettifor et al (2004) states that women who reported forced sex were 5.77 times more likely to be inconsistent condom users.(67) It's also worth noting that women with early sexual debut have a very high risk of contracting HIV. They also report a high number of lifetime partners and usually do not complete high school education.(66) Furthermore the authors report that a majority of young women have no control on delaying first sex. They state that the situation is worsened by gender imbalance in Africa which makes them vulnerable to unwanted sex and limited control over condom use. (66)

The study found that an increase in total partners is associated with an increase in likelihood of HIV infection. Wealthier men tend to have more lifetime partners and hence more likely to have sex with non regular partners compared to poorer men.(58) Maybe this could explain why wealthier men have been reported to be more likely to use condoms.

4.3 Comparative Analysis

4.3.1 General Comparison

Swaziland is located in the Southern part of Africa and has a population of 1.2 million.(4) Ethiopia on the other hand is located on the horn of Africa with a population of 74 million people.(9) However despite the differences the countries have, they do have certain common characteristics. They are both low income and developing countries, and are located on in sub-Saharan Africa. All underlying determinant in both countries were similar except for region which was only significant in Ethiopia. Religion was significant in both countries i.e. Zionist in Swaziland which was associated with increased risk and Muslims in Ethiopia which was very protective.

Proximate determinants unique in Swaziland were condom use during the last sex, history of STIs, history of genital ulcers, and history of HIV testing within the past year. Condom use in Swaziland is very low especially among married couples and long term partners.(6) This provides an opportunity for infection as partners are involved in other love affairs. The rate of intergenerational sex is very high in Swaziland. About 7% of young women who engaged in high risk sex had sex with man 10 years and older than them, and 10% of women had first sex with sexual partners aged ten years and older than them.(5) This minimises the women's ability to negotiate condom use putting their lives at risk of contracting STIs and HIV.(68) Consistent and correct condom use reduces the risk of contracting STIs and genital ulcers. The ministry of health through Sexual Reproductive Health program educates and distribute condoms to the entire country. In 2010, the average monthly consumption was 700,000 male condoms and 18,000 female condoms.(69) While the distribution may be adequate, usage is still a problem, as low and inconsistent condom use is still one of the drivers of the epidemic.

Proximate determinants unique in Ethiopia were; age at first sex and wife justified to negotiate condom use if she suspects husband has STIs. Women start sexual activities at about 4.5 years earlier than men at a median age of 16.6 years and men start at a median age of 21.2 years.(12) The median age at first marriage is 16.5 years for women and 23.2 years for males, and the average age at first birth is 19.2 years for women.(12) This predisposes the women to risky sexual behaviours at a tender age. This has an effect on the gender imbalance as they have limited powers in terms of negotiating condom use and other family planning commodity usage.

4.3.2 Country Effect Comparison

Generally the logistic regression model for proximate factors predicts that living in Ethiopia has an 89% protection compared to being in Swaziland. The analysis from SEM gives a more refined analysis and predicts that living in Ethiopia has an 86% protection against HIV infection compared to living in Swaziland and more SEM results are discussed in the next session. A lot of factors account for the differences and one of which is the dominance of the Muslims in Ethiopia who constitutes about 45% of the population and has a set disciplined practices.

4.4 Structural Equation Modelling for the Determinants of HIV Infection

This study analyzes the determinants of HIV infection using a conceptual framework developed from the Mosley and Chen.(37) The framework clearly identified having age at first sex and having history of genital ulcers within the past year and having three or more sexual partners as main determinants in the framework. The framework classifies such as the proximate factors, and worth noting is that they are behavioural factors. Genital ulcers may not always be an STI and has been found to have an increase risk of HIV in many studies; hence our findings are in line with many studies. Just like in our study and previous studies, in a study by Rottingen et al (2001) they found that there was an increased risk of HIV acquisition among people with genital ulcers as they had a 2.7 times more risk compared to those with no ulcers.(70)

The study is also in line with Paz-Baile et al (2010), where they found that men with a deep ulcers were 3 times more likely to be HIV positive compared to those with no ulcers.(71) Our finding of increased risk of HIV infection with increasing number of sexual partners supports the findings by Chen et al (2007) in a systematic review, where they found that men reporting three or more partners were 3.15 times more likely to be HIV positive.(63) The contribution of indirect effects like age at first sex highlights the key challenges in addressing HIV issues.

4.5 Possible Limitations

The limitations of this study are discussed in three parts namely; data, bias, and study design. **Data**: The study utilised secondary data analysis which makes it difficult for the researcher to have all the variables which might better establish the associations. Secondly, the fact that Swaziland has not done a second DHS, the study used EDHS 2005 so as to match the SDHS 2006; hence we view that as a limitation because some of the findings may have been overtaken by events. It was also not possible to examine the contribution of some variables which have been highlighted by literature as driving the epidemic i.e. Stigma and discrimination of HIV positive people, migration and mining as well as the effect of war on HIV in Ethiopia workers etc would have been more informative.

Bias and confounding: In as much as the demographic health surveillance data has a bigger sample and represents the entire population, it has various limitations. This includes recall and reporting bias, as the data is based on self reported responses and longer periods of up to a year which compromises data quality. Consistent condom use was not significant which could probable be a result measurement error arising from differential misreporting. However; efforts to control for confounding was done through propensity score matching and reporting of stratum odds ratios from multiple regression analysis.

Study design: The cross-sectional survey design of our study does not allow for investigation of temporality and observance of participants prior to getting infected. Infection may have preceded the sexual and behavioural practice thus biasing the associations and as such temporality cannot be established. During the course of the study, sometimes it was very difficult to find country level studies hence more discussions were based from studies done in South Africa and other SSA countries.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The high burden of HIV/AIDS continues to impact on the health of many nations in SSA. This is as a result of both limited resources to implement adequate interventions and lack of behaviour change in the communities. Both Ethiopia and Swaziland have suffered and shouldered the consequences of HIV. Based on the findings of this study it comes out clearly that the proximate factors need to be addressed in a more vigorous approach. The protective effect seen on Ethiopia in comparison to Swaziland should be interpreted with caution. This result does not imply that HIV is not a major concern in Ethiopia they have one of the highest numbers of people living with HIV. On the other hand Swaziland can learn something from Ethiopia including the best practice from the Muslim religion which has been seen to be effective in most Islam countries. This study adds the evidence of associated risky sexual behaviours and HIV acquisition hence the need to strengthen behaviour change programs.

5.2 Recommendations to Swaziland

The Government of Swaziland declared HIV/AIDS as a disaster in the year 1999 and has since embarked on various activities to curb the spread of HIV. Among others includes the establishment of the National Emergency Response Council on HIV/AIDS (NERCHA) in 2001 and stakeholders have been engaged since then; however the output has not been equally significant as the prevalence of 19%(5) and incidence of 2.4%(19) remain high. In light of that the researcher proposes the following recommendations based on the study findings:

- Health information messaging aimed at the youth should be intensified and also increase youth friendly services.

- Pursue and scale up efforts of promoting and delivering male circumcision services, and also harmonise circumcision intervention with condom use promotion.
- Increase access to condoms to all sexually active people and strategies should be employed to promote consistent use.
- The Muslim religion shows a protective effect on HIV, and Swazis can adopt best practices which have proven to be effective over the years.

5.3 Recommendations to Ethiopia

The Government of the Federal Democratic Republic of Ethiopia declared HIV as a Public health emergency in 2002 and since then various strategies have been implemented. They include the establishment of HIV/AIDS Prevention and Control Office (HAPCO) in the year 2002. In view of that the researcher proposes the following recommendation:

- Development of health interventions strategies targeting the youth to delay sexual debut.
- Further investigations of improving HIV interventions in Gambela regions and scale up male circumcision.
- Strengthen programs aimed at empowering women to negotiate condom use and other health interventions

5.4 Overall Recommendations

The study was able to identify overlapping issues in both countries. The SEM singled out genital ulcers, total number of lifetime partners and age at first sex as major determinants of HIV infection. There is a therefore an urgent need for policy makers to develop interventions to impact on them. While it is important to target the direct routes, policy makers should also focus on the indirect routes to HIV infection. Intervention programs aimed at curbing indirect routes of HIV infection should be given priority and accelerated. This can be done by strengthening behaviour change programs. This is true as the decline in HIV incidence and prevalence in Uganda has been attributed to sexual behaviour change by promoting faithfulness and multiple partner reduction.(72) There is a need to embark on focused groups on certain issues which perpetuates the pandemic. Programs targeting men should be intensified to scale up VCT uptake by men as results show low coverage. Widows and elderly are usually a neglected cohort and have the highest prevalence; hence the need to implement prevention programs targeting them. Urban programs should be strengthened as evidence show urban dominance in prevalence.

There is need to address social determinants of health and also a need to intensify social and behaviour change communication strategies. Qualitative studies to understand and address risky sexual behaviour are needed. Such studies can help understand the underlying reasons accounting for the regional differences despite almost similar determinants. Government should lobby for resource to support prevention and intervention strategies in order to scale up and sustain ART. Lastly, various associations when analysing proximate determinants in combined data were explained by missing data hence the need to improve data quality in terms of accuracy and completeness.

REFERENCES

1. UNAIDS, WHO and UNICEF. *UNAIDS report on the Global AIDS epidemic*. Geneva; 2012. Avaialable at: http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2012/gr2012/20121120_UNAIDS_Global_Report_2012_en.pdf [Accessed 25 February 2013].
2. International HIV and AIDS Charity. *The impact of HIV and AIDS in Africa 2012.* Available at: http://www.avert.org/aids-impact-africa.htm [Accessed 25 February 2013].
3. USAID. *HIV/AIDS Health profile, Sub-Saharan Africa 2012.* Available at: http://transition.usaid.gov/our_work/global_health/aids/Countries/africa/hiv_summary_africa.pdf [Accessed 18 February 2013].
4. Central Statistics Office, Swaziland. *National census and household survey report*. Mbabane; 2007. Available at: http://www.docstoc.com/docs/50665858/Swaziland-2007-population-housing-census [Accessed 10 May 2012].
5. Central Statistics Office, Swaziland and Macro International Inc. *Swaziland* d*emographic and health survey 2006/07.* Mbabane; 2008. Available at: http://measuredhs.com/pubs/pdf/FR202/FR202.pdf [Accessed 05 February 2013].
6. National Emergency Council on HIV and AIDS, Swaziland. *The National multi-sectoral strategic framework for HIV and AIDS 2009-2014.* Mbabane; 2009. Available at: http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---ilo_aids/documents/legaldocument/wcms_174723.pdf [Accessed 04 March 2013].
7. Ministry of Health : Strategic Information Department, Swaziland. *ART Programme annual report-2011.* Mbabane; 2012 Available at: http://www.gov.sz/images/art_annualreport%202011.pdf [Accessed 12 February 2013].
8. Mngadi S, Fraser N, Mkhatshwa H, Lapidos T, Khumalo T, Tsela S et al. (eds). *HIV prevention response and modes of transmission analysis.* National Emergency Council on HIV and AIDS. Mbabane; 2009. Available at: http://www.k4health.org/sites/default/files/Swazi%20HIV%20Prevention%20Report.NERCHA%202009.pdf [Accessed 23 January 2013].

9. Population Census Commission, Federal Democratic Republic of Ethiopia. S*ummary and statistics report of the 2007 population and housing Census, population size by age and sex.* Addiss Ababa; 2008. Available at: http://www.csa.gov.et/pdf/Cen2007_firstdraft.pdf [Accessed 22 January 2013].
10. African Services Committee. *Improving the health and the self sufficiency of the African community.* Available at: http://www.africanservices.org/index.php/African-Services-in-Ethiopia/Background-HIV/AIDS-in-Ethiopia [Accessed 10 December 2012].
11. USAID Ethioipa. *HIV/AIDS health profile 2012.* Available at: http://transition.usaid.gov/our_work/global_health/aids/Countries/africa/ethiopia.pdf [Accessed 26 February 2013].
12. **A** Central Statistical Agency (Ethiopia) and Macro International Inc. *Ethiopia demographic and health survey-2011.* Addis Ababa; 2012. Available at: http://measuredhs.com/pubs/pdf/FR255/FR255.pdf [Accessed 19 February 2013].
13. Federal Ministry of Health (Ethiopia), Ethiopia Health and Research Institute (EHRI). *Report on the 2009 round antenatal care sentinel HIV surveillance in Ethiopia.* Addis Ababa; 2011. Available at: http://www.ehnri.gov.et/newsletter/ANC%202009_Final_Report.pdf [Accessed 10 January 2013].
14. Federal Ministry of Health, Ethiopia: Ethiopia HIV/AIDS Prevention and Control Office. *Country progress report on HIV/AIDS response, 2012.* Addis Ababa; 2012. Available at: http://www.unaids.org/en/dataanalysis/knowyourresponse/countryprogressreports/2012countries/GAP%20Report%202012.pdf [Accessed 16 January 2013].
15. Federal Ministry of Health, Ethiopia: Ethiopia HIV/AIDS Prevention and Control Office. *Strategic plan II for intensifying multisectoral HIV and AIDS response in Ethiopia 2010/11-2014/15.* Addis Ababa; 2010. Available at: http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---ilo_aids/documents/legaldocument/wcms_175221.pdf [Accessed 10 March 2013].
16. Getnet M and Melesse T. (eds). *The Drivers of HIV/AIDS epidemic and response in Ethiopia.* Federal Ministry of Health Federal HIV/AIDS Prevention and Control Office.

Addis Ababa; 2008. Available at: http://ethiopia.unfpa.org/drive/DeskReview.pdf [Accessed 06 December 2012].

17. UNAIDS, WHO and UNICEF. Global HIV/AIDS Response: *Epidemic update and health sector progress towards universal access. Progress Report-2011.* Geneva; 2011. Available at: http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/20111130_UA_Report_en.pdf [Accessed 27 November 2012].
18. Ministry of Health (Swaziland). *12th Round National HIV Sentinel Surveillance in Pregnant Women attending Antenatal Care in Swaziland.* Mbabane, 2011. [Unpublished].
19. Ministry of Health (Swaziland), ICAP and Columbia University. *Swaziland HIV incidence measurement survey (SHIMS).* Mbabane; 2012. Available at: http://icap.columbia.edu/news-events/detail/swaziland-hiv-incidence-results-announced-at-aids-2012 [Accessed 11 February 2013].
20. Asiedu C, Asiedu E, Owusu F. The socio-economic determinants of HIV/AIDS infection rates in Lesotho, Malawi, Swaziland and Zimbabwe. *Development Policy Review.* 2012;30(3):305-26.
21. Johnson L and Budlender D. *HIV risk factors: A review of the demographic, socio-economic, biomedical and behavioural determinants of HIV prevalence in South Africa.* Centre for Actuarial Research, University of Cape Town. Care Monograph No.8. Cape Town; 2002. Available at: https://www.commerce.uct.ac.za/Research_Units/CARE/Monographs/Monographs/mono08.pdf [Accessed 20 August 2012].
22. Do M, Meekers D. Multiple sex partners and perceived risk of HIV infection in Zambia: Attitudinal determinants and gender differences. *AIDS Care-Psychological and Socio-Medical Aspects of AIDS/HIV.* 2009;21(10):1211-21.
23. Wojcicki JM. Socioeconomic status as a risk factor for HIV infection in women in East, Central and southern Africa: A systematic review. *Journal of Biosocial Science.* 2005;37(1):1-36.

24. Ministry of Health and Social Welfare (Swaziland). *National health policy*. Mbabane. 2007. Available at: http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---ilo_aids/documents/legaldocument/wcms_174726.pdf [Accessed 23 January 2013].
25. Gillespie S, Kadiyala S, Greener R. Is poverty or wealth driving HIV transmission? *AIDS*. 2007;21:S5-S16.
26. Zamberia AM. Sexual activity and condom use among people living with HIV in Swaziland. *Ajar-African Journal of AIDS Research*. 2009;8(1):69-81.
27. Root R. Situating experiences of HIV-related stigma in Swaziland. *Global Public Health*. 2010;5(5):523-38.
28. Cockcroft A, Andersson N, Ho-Foster A, Marokoane N, Mziyako B. What happened to multiple sexual partnerships in Swaziland? Analysis of five linked national surveys between 2002 and 2008. *AIDS Care-Psychological and Socio-Medical Aspects of AIDS/HIV*. 2010;22(8):955-60.
29. Corno L, de Walque D. Mines, migration and HIV/AIDS in Southern Africa. *Journal of African Economics*. 2012;21(3):465-98.
30. Feirman S. Men's susceptibility to HIV in Swaziland. *Culture, Health & Sexuality*. 2012;14(7):723-35.
31. Ethiopean Society of Population Studies. *Factor fuelling the prevalence and contributing for regional variations: Findings from EDHS 2005, Indepth analysis of the Ethiopean Demographic and Health Survey 2005.* Addis Ababa; 2008. Available at: http://ethiopia.unfpa.org/drive/HIV.pdf [Accessed 12 february 2013].
32. S Sentjens R, Sisay Y, Vrielink H, Kebede D, Ader HJ, Leckie G, et al. Prevalence of and risk factors for HIV infection in blood donors and various population subgroups in Ethiopia. *Epidemiology and Infection*. 2002;128(2):221-8.
33. Mekonnen Y, Sanders E, Messele T, Wolday D, Dorigo-Zestma W, Schaap A, et al. Prevalence and incidence of, and risk factors for, HIV-1 infection among factory workers in Ethiopia, 1997-2001. *Journal of Health Population and Nutrition*. 2005;23(4):358-68.
34. Berhe T, Gemechu H, Alex DW. War and HIV prevalence. *African Security Studies*. 2005;14(3):107-14.

35. Abebe Y, Schaap A, Mamo G, Negussie A, Darimo B, Wolday D. HIV prevalence in 72 000 urban and rural male army recruits, Ethiopia. *AIDS.* 2003;17(12):1835-40.
36. The World Bank, Ethiopia HIV/AIDS Prevention and Control Office and Global HIV/AIDS Monitoring and Evaluation Team. *HIV/AIDS in Ethiopia: An Epidemiological Synthesis.* Washington DC; 2008. Available: http://siteresources.worldbank.org/INTHIVAIDS/Resources/375798-1103037153392/EthiopiaSynthesisFinal.pdf [Accessed 26 June 2012].
37. Mosley W and Chen L. An analytical framework for the study of child survival in developing Countries. *Population and Development.* 1984(Review. 10.):25-45.
38. Central Statistical Agency (Ethiopia) and Macro International Inc. *Ethiopia demographic and health survey.* Addis Ababa; 2006. Available at: http://www.measuredhs.com/pubs/pdf/FR179/FR179[23June2011].pdf [Accessed 06 December 2012].
39. Vyas S, Kumaranayake L. Constructing socio-economic status indices: How to use principal components analysis. *Health Policy and Planning.* 2006;21(6):459-68.
40. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: An application to educational enrollments in States of India*. *Demography.* 2001;38(1):115-32.
41. Institute for Digital Research and Education: UCLA Academic Technology. *Statistical Computing Seminars: Logistic Regression with Stata Stata* [Online]. Available at: http://www.ats.ucla.edu/stat/stata/seminars/stata_logistic/default.htm [Accessed 22 October 2012].
42. Bursac Z, Gauss CH, Williams DK, Hosmer D, editors. A purposeful selection of variables macro for logistic regression. *BioMed Central.* 2007; 3(17).
43. Grace JB. Structural equation modeling for observational studies. *The Journal of Wildlife Management.* 2008;72(1):14-22.
44. Hooper D, Coughlan J, Mullen M. Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research methods.* 2008;6(1):53-60.

45. Weiser SD, Leiter K, Bangsberg DR, Butler LM, Percy-de Korte F, Hlanze Z, et al. Food insufficiency is associated with high-risk sexual behavior among women in Botswana and Swaziland. *PLoS Medicine.* 2007;4(10):e260.
46. Quinn TC, Overbaugh J. HIV/AIDS in women: An expanding epidemic. *Science Signalling.* 2005;308(5728):1582.
47. Shisana O, Zungu-Dirwayi N, Toefy Y, Simbayi L, Malik S, Zuma K. Marital status and risk of HIV infection in South Africa. *South African Medical Journal.* 2004;94(7):537-43.
48. Dunkle KL, Stephenson R, Karita E, Chomba E, Kayitenkore K, Vwalika C, et al. New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: An analysis of survey and clinical data. *Lancet.* 2008;371(9631):2183-91.
49. Amornkul PN, Vandenhoudt H, Nasokho P, Odhiambo F, Mwaengo D, Hightower A, et al. HIV prevalence and associated risk factors among individuals aged 13-34 years in rural Western Kenya. *PLoS One.* 2009;4(7).
50. Connolly C, Colvin M, Shisana O, Stoker D. Epidemiology of HIV in South Africa-results of a national, community-based survey. *South African Medical Journal.* 2008;94(9):776.
51. Mmbaga EJ, Leyna GH, Mnyika KS, Hussain A and Klepp KI. Education attainment and the risk of HIV-1 infections in rural Kilimanjaro Region of Tanzania, 1991-2005: A reversed association. *Sexually Transmitted Diseases.* 2007;34(12):947-53.
52. Drain PK, Halperin DT, Hughes JP, Klausner JD, Bailey RC. Male circumcision, religion, and infectious diseases: An ecologic analysis of 118 developing countries. *BioMed Central Infectious Diseases.* 2006;6(1):172.
53. Auvert B, Taljaard D, Lagarde E, Sobngwi-Tambekou J, Sitta R, Puren A. Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: The ANRS 1265 Trial. *PLoS Medicine.* 2005;2(11):e298.
54. Whiteside A, Hickey A, Ngcobo N, Tomlinson J. *What is driving the HIV/AIDS epidemic in Swaziland, and what more can we do about it?* Natinal Emergency Response Council on HIV/AIDS. Mbabane; 2003. Available at:

http://fr.allafrica.com/download/resource/main/main/idatcs/00010555:08b98d36e5efddab4f9b5ccd922bf055.pdf [Accessed 27 January 2013].

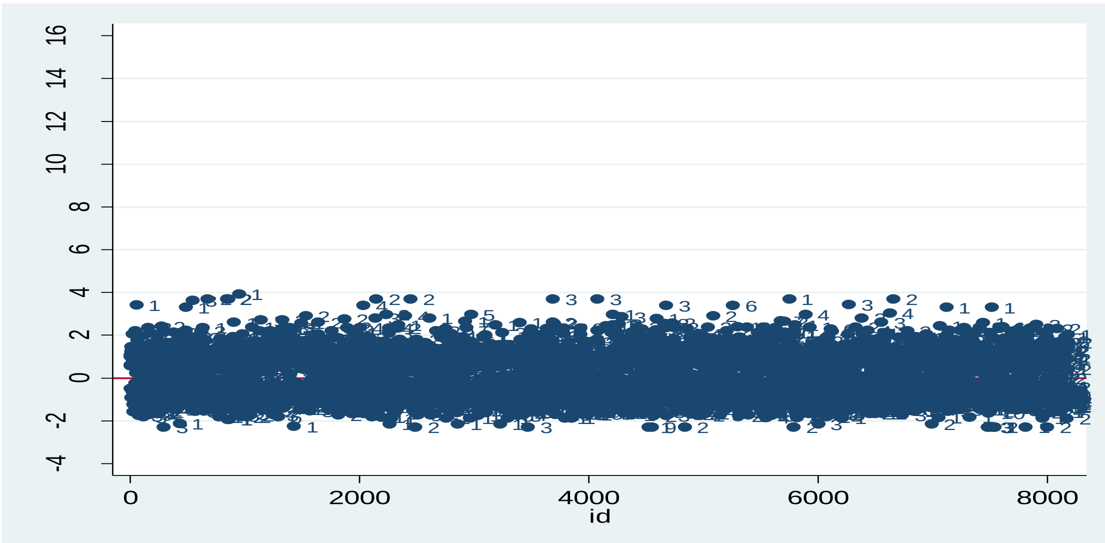
55. Ministry of Health (Swaziland), CDC, USAID and PEPFAR. *Strategy and implementation plan for scaling up safe male circumcision for HIV prevention in Swaziland: 2009-2013.* Mbabane; 2009. Available: http://www.c-hubonline.org/sites/default/files/resources/main/MC%20Communication%20Strategy%202009-2013_Sept%202009.pdf [Accessed 14 January 2013].
56. Taffa N, Sundby J, Holm-Hansen C, Bjune G. HIV prevalence and socio-cultural contexts of sexuality among youth in Addis Ababa, Ethiopia. *Ethiopian Journal of Health Development.* 2004;16(2):139-45.
57. Carpenter LM, Kamali A, Ruberantwari A, Malamba SS, Whitworth JAG. Rates of HIV-1 transmission within marriage in rural Uganda in relation to the HIV sero-status of the partners. *AIDS*. 1999;13(9):1083-9.
58. Mishra V, Bignami-Van Assche S, Greener R, Vaessen M, Hong R, Ghys PD, et al. HIV infection does not disproportionately affect the poorer in sub-Saharan Africa. *AIDS.* 2007;21:S17-S28.
59. Hargreaves JR, Bonell CP, Boler T, Boccia D, Birdthistle I, Fletcher A, et al. Systematic review exploring time trends in the association between educational attainment and risk of HIV infection in sub-Saharan Africa. *AIDS.* 2008;22(3):403-14.
60. Gray PB. HIV and Islam: Is HIV prevalence lower among Muslims? *Social Science and Medicine.* 2004;58(9):1751-6.
61. Ministry of Health (Swaziland), UNICEF, UNFPA, NERCHA and Joint United Nations Programme on HIV/AIDS. *Swaziland multi cluster indicator survey final report. 2010.* Mbabane; 2011. Available at: http://reliefweb.int/sites/reliefweb.int/files/resources/MICS4_Swaziland_FinalReport_2010_Eng.pdf [Accessed 14 January 2013].
62. Korenromp E, White R, Orroth K, Bakker R, Kamali A, Serwadda D, et al. Determinants of the impact of sexually transmitted infection treatment on prevention of HIV infection:

A synthesis of evidence from the Mwanza, Rakai, and Masaka intervention trials. *Journal of Infectious Diseases.* 2005;191(Supplement 1):S168-S78.

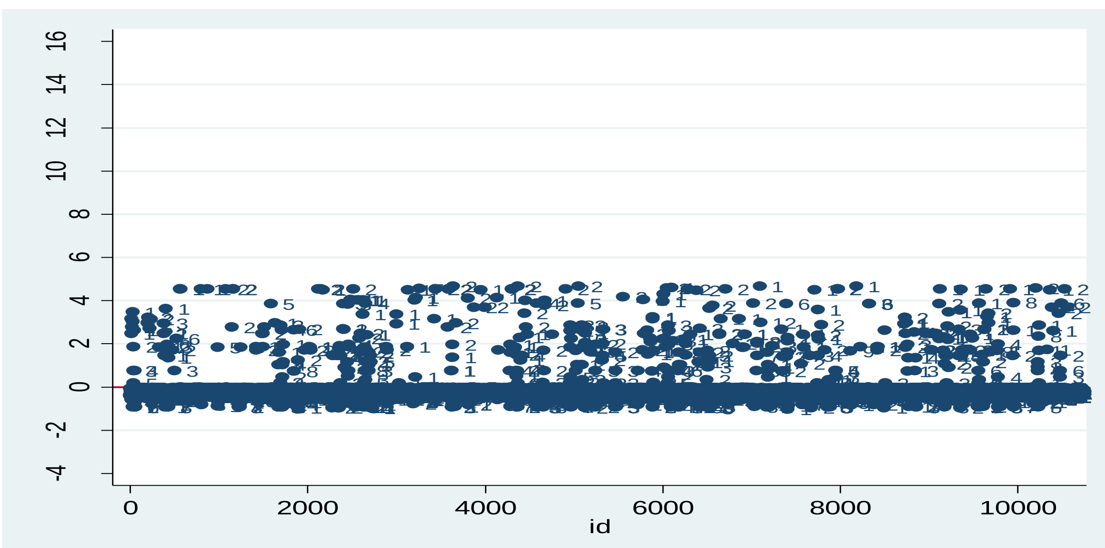
63. Chen L, Jha P, Stirling B, Sgaier SK, Daid T, Kaul R, et al. Sexual risk factors for HIV infection in early and advanced HIV epidemics in sub-Saharan Africa: Systematic overview of 68 epidemiological studies. *PLoS One*. 2007;2(10):e1001.
64. O Farrell N. Targeted interventions required against genital ulcers in African countries worst affected by HIV infection. *Bulletin-World Health Organization.* 2001;79(6):569-77.
65. Cassell MM, Surdo A. Testing the limits of case finding for HIV prevention. *The Lancet Infectious Diseases.* 2007;7(7):491-5.
66. Pettifor AE, van der Straten A, Dunbar MS, Shiboski SC, Padian NS. Early age of first sex: A risk factor for HIV infection among women in Zimbabwe. *AIDS.* 2004;18(10):1435-42.
67. Pettifor AE, Measham DM, Rees HV, Padian NS. Sexual power and HIV risk, South Africa. *Emerging Infectious Diseases.* 2004;10(11):1996-2004.
68. Cockcroft A, Kunda JL, Kgakole L, Masisi M, Laetsang D, Ho-Foster A, et al. Community views of inter-generational sex: Findings from focus groups in Botswana, Namibia and Swaziland. *Psychology, Health and Medicine.* 2010;15(5):507-14.
69. Ministry of Health (Swaziland) UNFPA, USAID, NERCHA and WHO. *The national condom strategy: 2010-2015.* Mbabane, 2010. [Unpublished].
70. Røttingen JA, Cameron DW, Garnett GP. A systematic review of the epidemiologic interactions between classic sexually transmitted diseases and HIV: How much really is known? *Sexually Transmitted Diseases.* 2001;28(10):579-97.
71. Paz-Bailey G, Sternberg M, Puren AJ, Steele L, Lewis DA. Determinants of HIV type 1 shedding from genital ulcers among men in South Africa. *Clinical Infectious Diseases.* 2010;50(7):1060-7.
72. Green EC, Halperin DT, Nantulya V, Hogle JA. Uganda's HIV prevention success: The role of sexual behavior change and the national response. *AIDS and Behavior.* 2006;10(4):335-46.

APPENDICES

Appendix 1: Graphical Presentation of Residuals (Swaziland)



Appendix 2: Graphical Presentation of Residuals (Ethiopia)



Appendix 3: Approval of Title by University of Witwatersrand, Faculty of Health Sciences

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Swaziland

Dear Mr Lokothwayo

Master of Science in Epidemiology in the field of Biostatistics and Epidemiology: Approval of Title

We have pleasure in advising that your proposal entitled "*A comparative study on the determinants of HIV infection in Swaziland and Ethiopia*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 4: Ethics Clearance Certificate from the University of Witwatersrand Human Research Ethics Committee (Medical)

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mr Vusi Lokothwayo

CLEARANCE CERTIFICATE	**M120947**
PROJECT	A Comparative Study on the Determinants of HIV Infection in Swaziland and Ethiopa
INVESTIGATORS	Mr Vusi Lokothwayo.
DEPARTMENT	School of Public Health
DATE CONSIDERED	28/09/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 28/09/2012 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Mr E Musenge

DECLARATION OF INVESTIGATOR(S)

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

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix 5: Model 6 B-Multivariable Logistic Regression Analysis of Underlying and Proximate Determinants of HIV Transmission in Ethiopia (n=4318)

Variable	AOR	95% CI	P-value
Marital status			
Never married	1.00		
Married	0.73	0.37-1.42	0.353
Living together	3.39	1.21-8.51	0.020†
Widowed	2.35	1.05-5.24	0.037†
Divorced	1.39	0.63-3.07	0.408
Not living together	1.18	0.48-2.91	0.717
Highest education			
No education	1.00		
Primary	1.63	0.93-2.85	0.086
secondary	1.71	0.93-3.15	0.086
Higher	0.44	0.09-2.14	0.310
Rural/Urban diff.			
Urban	1.00		
Rural	0.23	0.12-0.42	<0.001†
Region			
Tigray	1.00		
Affar	2.49	0.66-9.36	0.178
Amhara	0.94	0.37-2.37	0.896
Oromiya	2.57	1.04-6.35	0.040†
Somali	1.04	0.11-9.40	0.974
Banish-Gumuz	0.78	0.22-2.73	0.694
SNNP	0.12	0.01-1.04	0.055
Gambela	3.75	1.41-9.96	0.008†
Harari	1.37	0.47-4.01	0.568
Addis Ababa	1.63	0.62-4.29	0.326
Dire Dawa	0.90	0.30-2.70	0.857
Religion			
Orthodox	1.00		
Protestant	0.76	0.40-1.43	0.391
Moslem	0.46	0.26-0.82	0.009†
Other	1	***	***
Total life-time partners			
1	1.00		
2	2.65	1.72-4.08	<0.001†
3	2.30	1.03-5.14	0.042†
3+	5.61	2.73-11.52	<0.001†
Unknown	2.63	0.21-32.31	0.451
Wife justified to ask condom use if husb. has STIs			
No	1.00		
Yes	1.85	1.03-3.33	0.039†
Don't know	1.13	0.56-2.30	0.732

AOR=adjusted odds ratio, 95% CI=95% confidence interval, *** Variable excludes in analysis or missing data, †P is significant at alpha level of 5%.

Appendix 6: Coefficients and Confidence Interval HIV Determinants Estimated using SEM for Swaziland and Ethiopia Combined Data (n=15 154).

		DIRECT EFFECTS		INDIRECT EFFECTS		TOTAL EFFECTS	
Effect of	**On**	**Coefficient**	**95% CI**	**Coefficient**	**95% CI**	**Coefficient**	**95% CI**
HIV	Country	-2.528889	-2.707548:-2.350231	-2.864243	-3.502667:-2.22582	-5.393132	-6.049435:-4.736831
	Education	0.1227321	0.0151902:0.230274	0.3508756	0.081691:0.6200603	0.4736077	0.1850824:0.762133
	Rural/Urban	-0.4070391	-0.5144584:-0.2996197	-0.0690758	-0.3598748:0.2217232 NS	-0.4761149	-0.7825019:-0.1697279
	Religion	-0.1639648	-0.2923612:-0.0355684	-5.19e+08	-5.82e+08: -4.56e+08	-5.190e+08	-5.82e+08:-4.56e+08
	Age at first sex	0.53464	0.432452:0.636828	1.463666	1.16381:1.763521	1.998306	1.686868:2.309743
	Total number of lifetime partners	0.6521963	0.5377918:0.7666008	0.9866092	0.694368:1.27885	1.6388055	1.327631:1.94998
	Genital ulcers	1.266484	1.070249:1.46272			1.266484	1.070249:1.46272
Country	Rural/Urban	-1.05e+08	***			-1.05e+08	***
	Religion	9.63e+07	***			9.63e+07	***
Age at first sex	Education	-0.0968209	-0.1722949:-0.021347			-0.0968209	-0.1722949:-0.021347
Total number of lifetime partners	Education			-0.1174224	-0.2094397:-0.025405	-0.1174224	-0.2094397: -0.025405
	Rural Urban	-0.6439429	-0.7445436:-0.5433423			-0.6439429	-0.7445436: -0.5433423
	Age at first sex	1.212779	1.115413:1.310144			1.212779	1.115413:1.310144
Genital ulcers	Country	-2.26157	-2.623943:-1.899198			-2.26157	-2.623943:-1.899198
	Education	0.3783879	0.1906801:0.5660957	-0.0514266	-0.0954836:-0.0073697	0.3269613	0.1349975:0.518925
	Rural/Urban	0.2770673	0.0659436:0.488191	-0.5016406	-0.6505676:-0.3527137	-0.2245733	-0.469216:0.0200692NS
	Religion			-2.18e+08	-2.53e+08:-1.83e+08	-2.18e+08	-2.53e+08:-1.83e+08
	Age at first sex	0.5311521	0.3424063:0.7198979	0.9447717	0.6944939:1.195049	1.4759238	1.182151:1.769697
	Total number of lifetime partners	0.7790141	0.582352:0.9756762			0.7790141	0.582352:0.9756762
Coefficients reported are logit regression coefficients, NS: Not statistically significant at 5% significance level.							

Appendix 7: Formulae for Odds Ratio Calculation and Conversion of logit coefficients

Odds Ratio Calculation

The study utilized odds ratios which is the odds of an event occurring in one group to the odds of it occurring in another group (the other group usually termed the reference group).

$$OR = \frac{\text{odds of event occurring in one group}}{\text{odds of event occurring in another group}}$$

$$P1/1 - (P1\ /\ P2)/1 - P2$$

$$((P1/1 - P1))/((P2/P0)/1 - P2)$$

$$e\text{^}(\beta 0 + \beta 1xi/1+) = 1 + e\text{^}\beta 0 + \beta 1x1 \div/e\text{^}\beta 0\ \ + \beta 1xi/1 + e\text{^}\beta 0 + \beta 1xi$$

Converting the logit coefficient to an odds ratio

The structural equation modeling model reported the logit coefficients and we converted them to odds ratios for consistency in our reporting as follows:

Step 1. Logit P(x_1)= $\beta_0 + \beta_1\ x_\mathrm{i}$

Step 2. Log[$\frac{\mathrm{P}(x1)}{1-\mathrm{P}(x1)}$] $=\ \beta_0 + \beta_1\ x_\mathrm{i}$

Step 3. Log[$\frac{P(xi)}{1-P(xi)}$] $= e^{\beta 0+\beta 1\ x1\ldots\beta nxn}$

Where: x_i= number of covariates in the fitted model

β_0= intercept of the fitted model

β_i= fitted model parameters