



# **THE RELATIONSHIP BETWEEN HOUSEHOLD WEALTH AND HIV PREVALENCE IN ETHIOPIA**

by

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# Dissertation abstract

Epidemiologic research shows that socioeconomic status influences different health outcomes including HIV/AIDS. Although poverty (low socioeconomic status (SES)) and HIV prevalence are correlated at the global level, the association between SES and HIV prevalence is rather mixed in sub-Saharan Africa.

Differences in findings could be attributed to context and thus context specific evidence is needed to develop interventions that could have greater impact in those settings. However there are few studies that investigate the association between SES and HIV prevalence in Ethiopia.

In 2011, the Central Statistics Agency (CSA) in collaboration with Federal Ministry of Health and ORC-MACRO collected a broad range of demographic, socioeconomic and health data on a representative sample of the population of Ethiopia. This included information on HIV status, demographic and socioeconomic variables (age, gender, religion, marital status, place of residence, household wealth, education, occupation and others) and behavioural risk factors.

The present study took advantage of this dataset to describe the relationships between SES and demographic factors and HIV prevalence in the Ethiopian adult population, and to explore the relationship between household wealth and HIV prevalence.

Part A of this dissertation (Protocol) describes the characteristics of the Ethiopian Demographic and Health Survey (EDHS2011) dataset, gives details on the sampling and data collection in the original study, and delineates the methodology of the secondary analysis.

Part B (Literature review) illustrates the main findings of the conflicting epidemiological literature on the socioeconomic determinants of HIV/AIDS in sub-Saharan Africa and presents a summary of the major studies on wealth, education and place of residence as risk factors for HIV prevalence.

Part C (Article) presents the methodological details, results, and possible interpretations of the analyses carried out on the EDHS2011 dataset.

The estimated prevalence of HIV in the Ethiopian population aged between 15 to 49 years was 1.47% (95% CI: 1.25% to 1.68%). The analysis showed that household wealth and education were the main socioeconomic status determinants and were independently associated with

higher HIV prevalence in Ethiopia, though having education beyond high school was protective against HIV.

Data also suggested that living in urban areas, religion and age were the main demographic determinants of HIV prevalence in Ethiopia. Behavioural factors, especially having multiple sexual partners and condom use in the last 12 months were more prevalent both among HIV positive individuals and among more educated and relatively wealthier individuals. It is possible that these factors could be involved in the causal pathway between household wealth and HIV prevalence. The results confirm the pattern of association between education and HIV prevalence in sub-Saharan African countries undergoing epidemiological transition. Those with higher educational attainment had lower HIV prevalence compared to those with no education as the epidemic matured. The evidence generated in this study can be used to develop and update prevention strategies in order to target areas which have higher HIV prevalence.

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I would like to thank my sponsors Ministry of Health and Central Statistics Agency of Ethiopia for the opportunity to use the Demographic and Health Survey 2011 datasets.

# Declaration

I, Meseret Yenehun (YNHMES001), hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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# Acronyms and abbreviations

<b>AIDS</b>	Acquired Immunodeficiency Syndrome
<b>CI</b>	Confidence Interval
<b>CSA</b>	Central Statistics Agency
<b>EA</b>	Enumeration Area
<b>EDHS</b>	Ethiopian Demographic and Health Survey
<b>EHNRI</b>	Ethiopian Health and Nutrition Research Institute
<b>GDP</b>	Gross Domestic Product
<b>HAPCO</b>	HIV/AIDS Prevention and Control Office
<b>HIV</b>	Human Immunodeficiency Virus
<b>HSV-2</b>	Herpes Simplex Virus-2
<b>LRM</b>	Logistic Regression Model
<b>OR</b>	Odds Ratio
<b>PCA</b>	Principal components analysis
<b>PHC</b>	Population and Housing Census
<b>PPP</b>	Purchasing Power Parity
<b>SERC</b>	Scientific and Ethical Review Committee
<b>SERO</b>	Scientific and Ethical Review Office
<b>SES</b>	Socioeconomic Status
<b>SSA</b>	Sub-Saharan Africa
<b>STD</b>	Sexually Transmitted Disease
<b>STI</b>	Sexually Transmitted Infection
<b>UCT</b>	University of Cape Town
<b>USA</b>	United States of America
<b>USD</b>	United States Dollar

<b>VCT</b>	Voluntary counseling and testing
<b>WDI</b>	World Development Indicator

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# Part A: Protocol

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# Executive Summary

Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) is a major public health problem in the world, particularly in Sub-Saharan Africa. There are several risk factors which increase an individual's risk of HIV infection. Socioeconomic status of an individual is considered an important determinant of HIV infection. Socioeconomic status is a broad and multidimensional construct which can only be measured by means of proxy measures such as wealth, level of education and occupation. Different epidemiological studies have reported conflicting findings on the association between socioeconomic status and HIV seroprevalence in various contexts. This indicates that there is a need to generate context specific evidence in order to support the development and implementation of appropriate interventions.

To date, there is not enough evidence on this issue in the Ethiopian context. Therefore the main purpose of this study is to generate context specific evidence which can be used in the development of strategies and interventions to prevent HIV transmission in Ethiopia. The study will include detailed analysis of secondary data on HIV serostatus, socioeconomic variables (which include household wealth status, educational attainment and occupation) and demographic characteristics collected during the 2011 Ethiopian Demographic and Health Survey (EDHS 2011) which included a cross sectional sample of 33,293 participants (17,385 women and 15,908 men) representative of the Ethiopian population. According to the EDHS 2011 there was a clear trend that HIV prevalence increases with increasing household wealth among men and women. Therefore household wealth will be assessed as the main exposure variable for HIV seroprevalence in this study.

Logistic Regression Models (LRM) will be used to analyse the data and test the hypothesis that after controlling for demographic characteristics and other socio-economic factors, differences in household wealth status partly explain the observed differences in HIV seroprevalence among different population groups in Ethiopia.

# 1 Introduction

## 1.1 Literature review

Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) is one of the major public health problems in the world, particularly in Sub-Saharan Africa (SSA) where approximately two-thirds of the HIV/AIDS burden occurs. There were an estimated 34 million people living with HIV worldwide in 2010, 23.5 million of whom were from SSA (1). Ethiopia, one of the Sub-Saharan countries, contributes a significant burden of the HIV epidemic (1). Recent reports show that by 2011 approximately 1.2 million people were living with HIV/AIDS in Ethiopia, which is about 5% of the total burden in SSA (2). However the prevalence remains lower than in many other SSA countries. HIV prevalence is 1.9% among women aged 15-49 and 1% among men aged 15-59(3). For women, HIV prevalence increases with age to a peak of 3.7% at age 30-34. For men, HIV prevalence increases from 0% at age 15-19 to 3% at age 35-39 and drops thereafter. The overall estimates show that HIV prevalence is higher for women than for men in most age groups (3).

HIV is transmitted through contact of body fluids between HIV infected persons, mainly through sexual contact. Besides these biological causes of HIV/AIDS, there are downstream and upstream factors which determine individual and community susceptibility to HIV/AIDS. Among the upstream factors, SES and demographic factors are the major determinants of health outcomes including HIV/AIDS (4).

The term socioeconomic status (SES) is a broad and multidimensional construct which is used to describe both economic and social circumstances and is difficult to measure directly (5,6). Measures of SES are highly context specific as they may have different meanings in different social groups. Thus when selecting and interpreting SES measures, the context of plausible explanatory pathways in which socioeconomic factors may influence health should be considered carefully (6). Braveman et al have recommended that “researchers should select socioeconomic factors systematically, considering whether economic resources, education, occupation, socioeconomic factors earlier in life, and neighborhood socioeconomic conditions at any life stage could plausibly be relevant to the particular health outcome and population of interest”(6). Among those factors, education, income (or wealth) and occupation are mainly used as proxy measurements of SES of individuals or communities (5). For instance

occupation is commonly used as a proxy for SES in Europe, while income or education is more commonly used in the United States (6). Background and early or late life experiences may determine SES. Equally, SES itself is likely to affect behaviour throughout life. Family background may, in part, determine inherited wealth and attendance at school, whilst educational attainment and later life choices will affect earning capacity and will likely affect lifestyle, including sexual, marital and health seeking behaviours. There are thus many pathways through which an individual's SES may be associated with the risk of infection with HIV (5).

Numerous studies have explored the relationship between SES and the risk of HIV infection (7) (8-10). In the early stages of the HIV epidemic, prevalent HIV infection was more likely among individuals who were more mobile, had greater education or were from more wealthy households (11). In contrast, in the later stages of the epidemic when the epidemic matures, it is argued that because of increased access to information about safer sexual behaviour, people with higher SES tend to adopt safer sexual behaviours and thus reduce their chance of HIV infection (11). It is also hypothesized that low SES or poverty increase an individual's biological susceptibility to HIV infection as is the case with other infectious diseases through malnutrition, parasitosis or lack of access to health care among the poor. These factors can undermine the immune system which in turn increases the probability of infection with other untreated sexually transmitted infectious diseases (12). In addition, poverty may result in a lack of education and illiteracy and these factors limit access to information about HIV risks and prevention. Furthermore, poverty can drive people to migration, and commercial or transactional sex work, all of which increase the risk of HIV infection (12).

A range of operational research studies have been conducted to investigate the association between SES and HIV infection and inform the development of appropriate interventions. The following section summarizes current epidemiologic evidence on the relationship between SES and HIV status. Despite the strong positive correlation between HIV prevalence and poverty at the global level (13)(14)(15), studies investigating the association between HIV prevalence and individual-level SES have shown conflicting findings ranging from no association to strong positive or negative associations. These studies from different contexts have utilized different measures as proxies for SES including food insufficiency, wealth, education, etc. A cross-sectional population survey in Botswana and Swaziland showed that food insufficiency was associated with inconsistent condom use with a non-primary partner, sex exchange, intergenerational sexual relationships, and lack of control in sexual relationships. These associations persisted after controlling for respondent characteristics

including income and education, HIV knowledge, and alcohol use (16). Among men, however, food insufficiency was highly associated with risky sexual behaviour only. In this context, then, food insufficiency, which can be used as an indicator for poverty or low SES, may be an important risk factor for increased sexual risk-taking behaviour among women, thus increasing their risk of HIV infection (16). However, having higher SES (as measured by higher wealth) was positively associated with HIV positive serostatus among both men and women in Kenya, and the wealthiest women were 2.6 times more likely than the poorest women to be HIV positive (17). This evidence was also supported by a study conducted in eight countries which found that wealth was positively associated with HIV seroprevalence though this finding was not statistically significant (11).

Recently published studies from four countries in Sub-Saharan Africa reported different results for the relationships between components of SES and HIV seroprevalence. Asiedu et al analyzed two major components of SES, education and wealth, and found a negative effect of education on HIV infection for an average adult in Zimbabwe, Swaziland and Lesotho (12). An extra year of schooling to the average (8 years in Swaziland and Zimbabwe) was associated with a 0.5% decrease in the probability of infection for Zimbabwe and a 1.5% decrease for Swaziland. In contrast, the estimated marginal effect of education on HIV infection for an average adult was positive in Malawi as an extra year of schooling to the average schooling of five years was associated with a 0.5% increase in the probability of infection (7). In addition, the analysis of the effect of wealth on HIV seroprevalence also differed among these countries. For an average adult, there was no significant association between wealth and HIV status in Lesotho and Zimbabwe; but wealth was positively correlated with HIV status in Malawi, and negatively correlated in Swaziland (7). For Malawi, a one unit increase in wealth was associated with a 0.6% increase in the probability of being HIV-positive, whereas for Swaziland, a 1 unit increase was associated with a 0.2% decrease in infection rate (7).

Associations between socioeconomic determinants and HIV transmission have also been investigated in prospective cohort studies. A population based open cohort study in Zimbabwe reported that people in the highest wealth tercile had the lowest HIV prevalence compared with those at the lowest wealth tercile at the end of 3 years follow up, implying that wealth was negatively associated with HIV seroprevalence (18). Another prospective study of 1,967 subjects in Limpopo province, South Africa, reported no significant association between socioeconomic determinants and HIV seroconversion among men. HIV seroconversion was lower among more educated women than those with no education but there was no association between wealth and HIV seroconversion among women (19).

It is hypothesized that lack of education and illiteracy affect people's ability to process and access information on HIV prevention (12). A follow up study in Masaka, Uganda, during the early stages of the HIV epidemic, found no association between schooling and HIV infection for both men and women older than 17 years of age (20). But during the later stages of the epidemic, in 1999-2000, the study reported a significant association between higher educational attainment and lower HIV prevalence among 19-28 years old women after adjusting for other variables. This suggests that those who had higher educational attainment may have accessed and used information about HIV prevention and reduced their risk of contracting HIV/AIDS. The study has also shown that condom use increased during the study period, predominantly among more educated individuals (20), suggesting that in the later stages of the epidemic, education may have a protective effect against HIV infection.

Evidence from the Cape Area Panel Study (2002-2005) shows that risky behaviours for HIV infection are associated with poverty (low SES): sexual debut was earlier and having multiple sexual partners more likely in poor households, especially those which had experienced an economic shock (11)(21). Not only does individual or household economic status predict risky sexual behaviour, but contextual factors do too. Community poverty rates predicted earlier sexual debut for girls and boys, and higher rates of unprotected sex for boys (11)(21). A longitudinal study on 3,325 adults in KwaZulu-Natal reported that one additional year of education reduced the hazard of acquiring HIV by 7% after controlling for other risk factors, indicating the protective effect of education. However, those belonging to a household that fell into the middle 40% of relative wealth had a 72% higher hazard of HIV acquisition than members of the poorest households, and per capita household expenditure did not significantly affect HIV incidence (8).

As discussed above, epidemiological studies have shown that various measures of SES are associated with HIV seroprevalence. Conflicting findings suggest that these associations may be highly context-specific. There are few studies that have investigated the association between SES and HIV infection in the Ethiopian context. A systematic review on the effect of educational attainment on HIV-1 infection in developing countries included a paper that reported a protective effect of increased general schooling among sugar estate residents in Ethiopia (22). Another study which examined the association between educational attainment and HIV status among HIV voluntary counseling and testing (VCT) clients reported a protective effect of education. Those who reportedly have more than secondary level education are 58% (males) and 66% (females) less likely to be HIV-positive than VCT clients with no education (23). However, secondary analysis of EDHS 2005 has shown that education was

positively associated with HIV prevalence: educated participants were more likely to be HIV positive than non-educated, although these effects were not statistically significant after controlling other variables. This analysis also reported that women living in the wealthiest 20% of households were over six times more likely to be HIV positive than women living in the poorest 20% of households, but this effect was not statistically significant. Also, there was no significant adjusted association between household wealth status and HIV prevalence among men (24). Since there is limited research on the impact of socioeconomic factors on the prevalence of HIV in Ethiopia, there is a need to generate more evidence that can help to develop strategies and interventions to better prevent and control HIV/ADS. According to the EDHS 2011, there was a clear trend that HIV prevalence increases with increasing household wealth among men and women with those in the highest wealth quintile having the highest prevalence of 3.9%. Therefore this study will be conducted using household wealth as the main exposure variable for HIV seroprevalence.

## **1.2 Problem**

There is a large and conflicting body of evidence regarding the associations between SES and HIV seroprevalence, suggesting that these associations are highly context specific. Key indicators of SES that have been researched related with HIV prevalence include education, wealth and occupation. It is often assumed that HIV risk is associated with low SES, particularly in the realm of public health and intervention research. To date there has been little research on these issues in Ethiopia. A scientific, epidemiological examination of the relationship between HIV prevalence and household wealth is necessary to investigate this assumption and inform the development of appropriate strategies to effectively prevent and control HIV/AIDS (4).

## **1.3 Purpose of the study**

The aim of this study is to utilize a large national dataset to generate context-specific evidence on association between household wealth status and HIV seroprevalence in Ethiopia. The study will also assess whether demographic and other SES factors act as confounders. The dataset is part of the Ethiopian Demographic & Health Survey (EDHS) 2011 which anonymously links HIV testing results with demographic, socioeconomic, and behavioural characteristics of survey respondents.

## 2 Objectives and Hypotheses

### 2.1 Main Objective

- To investigate the association between household wealth status and prevalent HIV infection in Ethiopia using the nationally representative Demographic and Health Survey (EDHS 2011) data.

### 2.2 Secondary objectives

- To describe HIV seroprevalence by demographic variables such as sex, age, marital status, place of residence, etc
- To investigate possible confounding variables in the association between household wealth status and HIV seroprevalence in Ethiopia.
- To interpret and discuss the results of the analyses in light of recent studies on SES and HIV/AIDS seroprevalence.

### 2.3 Hypothesis

The main hypothesis of this study is that wealth affects prevalent HIV infection and that differences in household wealth status partially explain observed differences in prevalent HIV infection among different population groups in Ethiopia.

## 3 Methods

### 3.1 Definition of terms

Table 1 Definition of terms used in the protocol

Terms	Definition
Socioeconomic status	Socioeconomic status is a classification indicating the close relationship between a person's social status and his/her financial standing.
Household wealth index	The wealth index is a composite measure of a household's cumulative living standard. The wealth index is calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used

	for housing construction; and types of water access and sanitation facilities.
Demographic variable	A varying characteristic that is a vital or social statistic of an individual, sample group, or population, for example, age, sex, socioeconomic status, racial origin, education.
Proxy measure	Method of determining certain outcomes using calculable quantities or values when you do not have the ability to measure the exact value.
Confounding variable	A confounding variable is related to the independent variable (exposure, wealth index in this study), but in order it to be an actual confounder it has to also be an independent risk factor for the outcome (HIV prevalence) and not an intermediate on the causal pathway.
Exposure variable	The "independent variable" that represents the inputs or risk factors that can be used in analysis. In this study, the exposure of interest is 'household wealth'.
Outcome variable	The "dependent variable" represents the output or effect that can be used in analysis. In this study, the exposure of interest is 'prevalent HIV infection'.
Sampling weight	Adjustment factors applied to each case in tabulations to adjust for differences in probability of selection and interview between cases in a sample, either due to design or happenstance.
Household	All persons living under one roof or occupying a separate housing unit, having either direct access to the outside (or to a public area) or a separate cooking facility. Where the members of a household are related by blood or law, they constitute a family. According EDHS 2011, the household size is 4.6 people.

### 3.2 Study Design

The study will use nationally representative population-based cross-sectional study datasets that were collected as part of the Demographic and Health Survey in 2011. Information on HIV testing was collected as part of EDHS 2011 and it will be used in this study with other

datasets on participant and household characteristics. There is no need to collect additional data.

### **3.3 Sample size**

All adults who gave consent and were interviewed and tested for the EDHS 2011 will be included in this analysis. In the EDHS 2011, a sample of 17,817 households was selected as nationally representative of all 9 regional states and 2 city administrations. In the selected households, 17,385 eligible women and 15,908 eligible men were identified for individual interviews. Overall, 86% of all EDHS respondents who were eligible for testing were interviewed and consented to HIV testing. Four percent of respondents were interviewed but refused to be tested for HIV and did not provide blood samples. Coverage rates for HIV testing were 89% for women and 82% for men. Hence a total of 28,532 participants were included in the analysis who gave consent to be tested and have information on household wealth status.

### **3.4 Sampling frame**

The source population for this study is the Ethiopian population eligible for HIV testing. The sampling frame used for 2011 EDHS was the Population and Housing Census (PHC) conducted in 2007 provided by the Central Statistical Agency (CSA, 2008). CSA has an electronic file consisting of 81,654 Enumeration Areas (EA) created for the 2007 census in 10 of its 11 geographic regions. An EA is a geographic area consisting of a convenient number of dwelling units which served as the counting units for the census. The frame file contains information about the location, the type of residence, and the number of residential households. A sketch map is available to delimitate the geographic boundaries of the EAs. Due to access difficulties, the Somali region used a different methodology and hence the sampling frame is in a different file and format. Due to security concerns in the Somali region, 2011 EDHS was conducted in six of nine zones in the Somali region: Shinile, Jijiga, Liben, Afer, Gode and Warder. The sampling frame for the 2011 EDHS consists of a total of 85,057 EAs. Ethiopia is divided into 11 geographical regions. Among the 85,057 EAs, 17,548 (21%) are in urban areas and 67,509 (79%) are in rural areas. The average size of EA is 169 households in an urban EA and 180 households in a rural EA, with an overall average of 178 households per EA.

### **3.5 Sample design and implementation**

The 2011 EDHS used a stratified sample selected in two stages from the Population and Housing Census (PHC) frame. Stratification was achieved by separating each region into

urban and rural areas. The Somali region was split into two parts: the first consisting of the initial three zones, and the second part comprising the three zones that were added later. In total, 23 sampling strata have been created because Addis Ababa region is entirely urban. The sample points were selected independently in each sampling stratum, by a two-stage selection process.

In the first stage, 624 EAs were selected with a probability proportional to the EA size and with independent selection in each sampling stratum. Because of the length of time since the 2007 PHC, a household listing operation was carried out in all selected EAs before the start of fieldwork. A team of listers visited each of the 624 selected EAs. The team drew a detailed sketch map of the EA and recorded in the household listing forms all households in the EA, their address, and the name of the head of the household. The list of the households from this listing served as the sampling frame for the selection of households in the second stage. In the second stage, a fixed number of 30 households were selected for each EA. Among the 624 selected EAs, 187 are in urban areas and 437 are in rural areas. Of all the selected 18,720 households, 5,610 are in urban areas and 13,110 are in rural areas.

The regional household distribution ranges from less than 1% in Harari to 36% in Oromiya. Therefore, a proportional allocation provides the best precision for national level indicators, but not for regional level indicators. Regions with very small populations such as Gambela, Harari and Dire Dawa would be allocated a very small sample size. It is estimated that a minimum number of 800 women 15-49 is needed to have reliable estimates for most of the EDHS indicators by region. However, because of the low vaccination coverage in Affar and Somali, and the low fertility rates in Gambela, Harari, Addis Ababa and Dire Dawa, it was decided to increase the number of individual women interviews to about 1,300 per region. As a result, the final sample allocation reflected a power allocation that is between the proportional allocation and the equal size allocation. In order for the survey precision in urban areas to be comparable with that in rural areas, urban areas were slightly over sampled.

The cluster and household allocation by region and residence are a function of the average number of women 15-49 per household and of the household and individual response rates (obtained from EDHS 2005). According to EDHS 2005, the average number of women 15-49 per household was 1.28 in urban areas and 1 in rural areas. The average number of men 15-49 per household was 1.05 in urban areas and 0.94 in rural areas. The household response rates are 97% in urban areas and 99% in rural areas. The eligible woman response rates were 94% in urban areas and 96% in rural areas, and the eligible man response rates were 84% in urban areas and 91% in rural areas.

### 3.6 Study population

All participants who were part of the survey i.e. women 15-49 years and men 15-59 years of age for whom HIV testing was done and had information on the main exposure (household wealth) will be included in this analysis.

### 3.7 Variables

All variables that were measured and reported on characteristics of respondents and HIV serostatus will be included. There will be no need to conduct additional measurement for this analysis. The variables that will be included in this analysis are listed below.

**Table 2 Variables that will be used for data analysis**

Name	Type	Description	unit	Possible value	
<b>Demographic Variables</b>					
Religion	Religion	Categorical	-	Orthodox, catholic, Muslim, protestant, traditional, other	
Marital status	Current marital status	Categorical	-	Never in union Married Living with partner Widowed Divorced No longer living together/separated	
Age	Respondent's current age	Continuous	Years	15-49 for women and 15-59 for men	
Residence	Type of place of residence	Binary	-	Urban, Rural	
Region	Region	Categorical	-	All 11 regions of Ethiopia	
<b>Exposure variable</b>					
Wealth Index	Household wealth index	Categorical	-	Poorest, poorer, middle richer, richest	
<b>Outcome Variable</b>					
HIV result	Blood test result	Nominal	Binary	-	Negative, positive
<b>Possible Confounding Variables</b>					
Condom use	Condom use during last sex with most recent partner	Binary	-	Yes, no	
	Used condom every time had sex with most recent partner in past 12 months	Binary	-	Yes, no	
STI	Had any STI in last 12 months	Nominal	-	Yes, no, don't know	
Sexual Partners	Number of sex partners, excluding spouse, in last 12 months	Count	Number	0-95, don't know	
	Total lifetime number of sex partners	Count	Number	0-95+, don't know	

Education	Education in single years	Continuous	Year	0-19
	Educational attainment	Categorical	-	No education, incomplete primary, complete primary, incomplete secondary, complete secondary, higher
	Highest educational level	Categorical	-	No education, primary, secondary, higher
	Highest year of education	Count	Years	1-8
Literacy	Literacy	Categorical	-	cannot read at all, able to read only parts of sentence, able to read whole sentence, no card with required language, blind/visually impaired
Occupation	Respondent's occupation(grouped)	Categorical	-	Not working Professional/technical/managerial Clerical Sales Agricultural-employee Services Skilled manual Unskilled manual Other

### 3.8 Data analysis

The main aim of this study is to explore whether there is an association between prevalent HIV infection and household wealth. In situations where household income and expenditure data are not available and reliable, household wealth is often considered a good measure of socioeconomic status in developing countries to distinguish wealth layers within a population (26). The household wealth index is constructed from household assets using principal component analysis (PCA). One of the limitations of PCA is its arbitrariness meaning that the choice of the number of components and the variables to include is not well defined (27). Despite limitations, wealth index is widely used as measure of economic status in many developing countries (28). Thus the wealth index will be used as an independent variable in this analysis and its effect on HIV prevalence will be analysed and interpreted.

Analysis will be performed using different statistical methods which are suitable for analysis of survey data. There are three types of weights in the DHS data namely household, individual (women and men) and HIV weights. These were used to adjust for differential probabilities of selection within households, differential non-response and residual discrepancies between the

sample and the population on a profile of census demographic and geographic variables (29). Since individual weights were calculated using household weight and individual response rate, individual weights from the HIV sample will be mainly used in all data analyses. Simple descriptive statistics will be used to explore the demographic and socioeconomic characteristics of participants. Means will be computed for continuous and proportions will be computed for categorical variables. In order to explore the relationship between demographic and socioeconomic variables and HIV status and to compare those who did and did not consent using these variables, chi-square statistics will be used. Odds ratios (ORs) and confidence intervals (CI) of HIV status by demographic and socioeconomic variables will be generated using those who consented and tested for HIV and were HIV negative as a reference group (30). Logistic regression models (LRMs) will be used to describe the crude and adjusted association between household wealth index and HIV status taking into account the effect of demographic (gender, age, marital status, place of residence, etc) and other socioeconomic variables (education and occupation). Sensitivity analysis will be conducted to compare those who gave consent and tested for HIV and those who were not tested in terms of demographics and socioeconomic characteristics.

## 4 Ethics

This study uses data from an existing EDHS 2011 raw dataset. The previous study had ethical approval from the Ethiopian Health and Nutrition Research Institute (EHNRI) Scientific and Ethical Review Office (SERO) and Scientific and Ethical Review Committee (SERC). A copy of the approval letter is appended in Appendix C.

The rights and autonomy of study participants were respected through the process of obtaining informed consent before any interview or HIV testing was conducted. Participation in the survey was entirely voluntary. Consent forms for household and individual interviews are appended in appendix A. The dataset that will be used for the analyses does not have names or other identifying markers and it cannot be linked back to the subjects from whom data was originally collected, thus ensuring confidentiality. All the questionnaires and data from the participants are owned by Central Statistics Agency (CSA) of Ethiopia. Although there was no direct benefit for participation in the EDHS 2011, the objective of the survey was to provide up-to-date information about knowledge and attitudes toward HIV/AIDS and other sexually transmitted infections (STIs) and estimates of prevalence.

This study is an analysis of anonymised secondary data. There is thus no risk to the rights or autonomy of the patients. The results of this study could potentially benefit the source populations as it could inform the design of interventions to reduce the impact of SES on seroprevalence. The findings of this analysis will be available publicly in the Health Science library of the University of Cape Town, and sent for publication in a peer-reviewed scientific journal in the field of public health in line with the Helsinki Declaration that the results of scientific research, especially when human subjects are involved, though indirectly, should be available publicly.

## **5 Resources**

### **5.1 Budget**

There is no budget required to conduct this analysis as there is no direct cost, other than the author's time commitment. The dataset has already been collected and is available for research purposes based on formal request.

### **5.2 Available resources**

Access to bibliographic references and software for statistical analysis, as well as scientific supervision and support are provided by the University of Cape Town (UCT), as part of the Master of Public Health degree of which this study constitutes the final dissertation.

## **6 Dissemination of Results**

The results of the proposed study will be disseminated to various stakeholders such as the Federal Ministry of Health of Ethiopia, public health officials, HIV/AIDS Prevention and Control Office (HAPCO) of Ethiopia and regional and district health offices. In addition, the results will be published in peer-reviewed scientific journals in the field of public health to disseminate the results to a wider scientific audience. The results of the analysis will also be presented in international conferences.

## **7 References**

(1) Global H. AIDS response: epidemic update and health sector progress towards universal access: progress report 2011. Geneva, UNAIDS 2011.

- (2) USAID-Ethiopia. HIV/AIDS Health Profile. HIV/AIDS 2012.
- (3) Central Statistics Agency and ORC Macro. Ethiopia Demographic and Health Survey 2011. Addis Ababa and Calverton 2012:253-265.
- (4) Wojcicki JM. Socioeconomic status as a risk factor for HIV infection in women in East, Central and Southern Africa: a systematic review. *J Biosoc Sci* 2005;37(1):1-36.
- (5) Hargreaves JR, Morison LA, Chege J, Rutenburg N, Kahindo M, Weiss HA, et al. Socioeconomic status and risk of HIV infection in an urban population in Kenya. *Tropical Medicine & International Health* 2002;7(9):793-802.
- (6) Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research. *JAMA: the journal of the American Medical Association* 2005;294(22):2879-2888.
- (7) 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):305-326.
- (8) Bärnighausen T, Hosegood V, Timaeus IM, Newell M. The socioeconomic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa. *AIDS* 2007;21(Suppl 7):S29.
- (9) Hargreaves JR, Morison LA, Chege J, Rutenburg N, Kahindo M, Weiss HA, et al. Socioeconomic status and risk of HIV infection in an urban population in Kenya. *Tropical Medicine & International Health* 2002;7(9):793-802.
- (10) Luke N. Economic status, informal exchange, and sexual risk in Kisumu, Kenya. *Economic Development and Cultural Change* 2008;56(2):375-396.
- (11) Gillespie S, Kadiyala S, Greener R. Is poverty or wealth driving HIV transmission? *AIDS* 2007;21:S5-S16.
- (12) Fenton L. Preventing HIV/AIDS through poverty reduction: the only sustainable solution? *The Lancet* 2004;364(9440):1186-1187.

- (13) Bloom DE, Sevilla J. Health, wealth, AIDS and poverty. : AUSAID; 2001.
- (14) 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.
- (15) Piot P, Bartos M, Ghys PD, Walker N, Schwartlander B. The global impact of HIV/AIDS. *Nature* 2001;410(6831):968-973.
- (16) 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.
- (17) Johnson K, Way A. Risk factors for HIV infection in a national adult population: evidence from the 2003 Kenya Demographic and Health Survey. *JAIDS J Acquired Immune Defic Syndromes* 2006;42(5):627-636.
- (18) Lopman B, Lewis J, Nyamukapa C, Mushati P, Chandiwana S, Gregson S. HIV incidence and poverty in Manicaland, Zimbabwe: is HIV becoming a disease of the poor? *AIDS* 2007;21(Suppl 7):S57.
- (19) Hargreaves JR, Bonell CP, Morison LA, Kim JC, Phetla G, Porter JD, et al. Explaining continued high HIV prevalence in South Africa: socioeconomic factors, HIV incidence and sexual behaviour change among a rural cohort, 2001-2004. *AIDS* 2007;21:S39-S48.
- (20) Walque D, Nakiyingi-Miiró JS, Busingye J, Whitworth JA. Changing association between schooling levels and HIV-1 infection over 11 years in a rural population cohort in south-west Uganda. *Tropical Medicine & International Health* 2005;10(10):993-1001.
- (21) Dinkelman T, Lam D, Leibbrandt M. Household and community income, economic shocks and risky sexual behavior of young adults: evidence from the Cape Area Panel Study 2002 and 2005. *AIDS* 2007;21(Suppl 7):S49.
- (22) Hargreaves JR, Glynn JR. Educational attainment and HIV-1 infection in developing countries: a systematic review. *Tropical Medicine & International Health* 2002;7(6):489-498.

- (23) Bradley H, Bedada A, Brahmabhatt H, Kidanu A, Gillespie D, Tsui A. Educational attainment and HIV status among Ethiopian voluntary counseling and testing clients. *AIDS and Behavior* 2007;11(5):736-742.
- (24) Rathavuth Hong, Vinod Mishra, and Pav Govindasamy. Factors Associated with Prevalent HIV Infections among Ethiopian Adults: Further Analysis of the 2005 Ethiopia Demographic and Health Survey Calverton, Maryland, USA: Macro International Inc 2008:18-20.
- (25) Rutstein SO, Johnson K. The DHS wealth index (DHS comparative Reports No. 6). Calverton: ORC Macro 2004.
- (26) Houweling TA, Kunst AE, Mackenbach JP. Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter? *International Journal for Equity in Health* 2003;2(1):8.
- (27) Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan* 2006;21(6):459-468.
- (28) Houweling TA, Ronsmans C, Campbell OM, Kunst AE. Huge poor-rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries. *Bull World Health Organ* 2007;85(10):745-754.
- (29) Stein DJ, Seedat S, Herman A, Moomal H, Heeringa SG, Kessler RC, et al. Lifetime prevalence of psychiatric disorders in South Africa. *The British Journal of Psychiatry* 2008;192(2):112-117.
- (30) Grimsrud A, Stein DJ, Seedat S, Williams D, Myer L. The association between hypertension and depression and anxiety disorders: results from a nationally-representative sample of South African adults. *PLoS one* 2009;4(5):e5552.

## **Part B: Literature Review**

University of Cape Town

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# 1 Objective

The main aim of the study is to investigate the association between household wealth and HIV prevalence in Ethiopia. The objective of the literature review is to explore the literature on socioeconomic status (SES) and HIV prevalence in different contexts, with a particular focus on household wealth, and to identify gaps for further research. The literature review is also aimed to identify the methodological differences between studies that assess the association of household wealth status and HIV prevalence and attempt to explain different findings.

## 2 Literature search strategy

The University of Cape Town Health Sciences Library was used to search for relevant literature. Databases and sources included Academic Search Premier, Africa-Wide: NiPAD, Africa-Wide information, African Journals Online (AJOL), African Studies Journals, Cochrane Library, EBSCO databases, PubMed, Google Scholar, ScienceDirect, SCOPUS, SpringerLink, EBSCOhost Web, CINAHL, ERIC, ERIC via EBSCO, Family and society studies worldwide, Health Source: Nursing/Academic Edition, MEDLINE, Oxford Journals and Public Health Reports. The following keywords were used: socioeconomic status, wealth, household wealth, education, occupation, income, proxy measures of SES, health, HIV/AIDS, and risk factors for HIV/AIDS. The search included research work written in English and published between 1990 and 2013. Published papers, journal articles, academic abstracts and reports were reviewed. The search terms were adapted to fit each database.

## 3 Literature summary and interpretation

### 3.1 Introduction and background

The Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) is one of the major public health problems in the world, particularly in Sub-Saharan Africa (SSA) where approximately two-thirds of the HIV/AIDS burden occurs. There were an estimated 34 million people living with HIV worldwide in 2010, 23.5 million of whom were from SSA (1).

Recent reports show that by 2011 approximately 1.2 million people were living with HIV/AIDS in Ethiopia, about 5% of the total burden in SSA (2). However HIV prevalence remains lower than in many other SSA countries. HIV prevalence is 1.9% among women aged 15-49 and 1% among men aged 15-59 years (3). For women, HIV prevalence increases with age to a peak of 3.7% at age 30-34 years. For men, HIV prevalence increases from 0% at age 15-19 years to 3% at age 35-39 years and drops thereafter. In most age groups, HIV prevalence is higher for women than for men (3).

Ethiopia is one of the low-income SSA countries where 30% of the people are living below the poverty line (4). Though there has been rapid urbanization in recent years, only 17% of people live in urban areas, defined as a locality with 2000 or more inhabitants(5). Ethiopia's economy is based on agriculture, which accounts for 46% of GDP and 85% of total employment. The GDP-per capita income (PPP) was \$1110 in 2011 (4). Although the recent EDHS report shows that 88% of the urban population and only 5% of the population living in rural areas are in the highest wealth quintile, the Gini coefficient for wealth was 29.8 in 2011, suggesting a comparatively fair distribution of wealth(6). However, the majority of the Ethiopian population lives in rural areas and fall into the lower wealth quintiles.

The population of Ethiopia is young with median age of approximately 17 years (5). About 61% of women and 60% of men are under age 30 years. By religious affiliation, Orthodox is the predominant religion. According to the 2007 census report, 44% were Orthodox, 34% Muslim, 19% Protestant, 3% traditional, 1% Catholic and 1% other (5). By marital status, 62% of women and 54% of men were married or living together, and 27% of women and 44% of men had never married. Women were more likely than men to be divorced, separated, or widowed (11% versus 3%) (3).

The coverage of education is very low in Ethiopia, with females even less educated than males. 52% of females and 38% of males have never attended school. 39% of females and 49% of males have only primary level of education. Only 3% of females and 5% of males have attended secondary education, and an additional 3% of females and 5% of males have completed secondary or higher education. By occupation, 46% of working women 15-49 years and 74% of working men 15-59 years were in agriculture, 33% of women and 10% of men were working in sales and services and 13% of employed women and 7% of employed men worked in skilled manual labour(3).

In this review, we consider SES measures education and wealth as main exposures and HIV status as outcome. The outcome (HIV status) is described using different terms depending on the study design. Cross-sectional studies frequently use HIV prevalence, odds of being HIV positive, odds of HIV infection and HIV status whereas follow up studies use HIV incidence or seroconversion. In order to be as inclusive as possible, these outcomes have been included in the literature review.

### **3.2 Socioeconomic status and measurement**

SES influences a wide range of health and health-related outcomes across diverse populations and settings (7). It is a multidimensional construct, which is used to describe both economic and social circumstances (8,9). As measures of SES are highly context specific and may have different meanings in different social groups, SES is difficult to measure directly. Consequently, studies may provide inconsistent results (10). Thus when selecting and interpreting SES measures, the context of plausible explanatory pathways in which socioeconomic factors may influence health should be considered carefully (9). Braveman et al. have recommended that “researchers should select socioeconomic factors systematically, considering whether economic resources, education, occupation, socioeconomic factors earlier in life, and neighborhood socioeconomic conditions at any life stage could plausibly be relevant to the particular health outcome and population of interest”(9). Among those factors, education, income/wealth and occupation are mainly used as proxy measurements of individual- or community-level SES, depending on the context (8,11). For instance occupation is commonly used as a proxy for SES in Europe, while income or education is more commonly used in the United States of America (9). However considering only these indicators of SES could provide an incomplete view of socioeconomic inequalities in health (11). Hence including other measures such as area-level indicators of SES could provide additional information on the influence of neighborhood and life-course SES on the distribution of disease. This could also help identify specific mechanisms explaining the development and maintenance of health inequalities (11). Background and early or late life experiences may determine SES. Equally, SES itself is likely to affect behaviour throughout life. Family background may, in part, determine inherited wealth and attendance at school, whilst educational attainment and later life choices will affect earning capacity and will likely affect lifestyle, including sexual, marital and health seeking behaviours. There are thus many pathways through which an individual’s SES may be associated with the risk of infection with HIV (8).

### **3.3 Wealth index**

The wealth index is used as a measure of inequalities in household characteristics, in the use of health and other services, and in health outcomes (12). It is used as an indicator of the level of wealth that is consistent with expenditure and income measures (13). Many economists in low- and middle-income countries prefer expenditure information and income information is mainly used in high-income countries (14). In situations where household income and expenditure data are not available and reliable in developing countries, household wealth is often considered a good measure of SES to distinguish wealth layers within a population (15). The index is constructed using data on ownership of durable assets and agricultural land, housing characteristics, access to services and presence of domestic servants (14,16) using principal component analysis (PCA). The wealth index is considered a proxy for consumption expenditure, as asset ownership is likely to be based at least partially on economic status, and household assets are unlikely to change in response to short-term economic shocks. Thus wealth index could be considered a measure of long-term economic status similar to consumption expenditure (14).

As a measure of SES, wealth has several advantages. It represents a more permanent status than does either income or consumption. Wealth is more easily measured (generally requiring only a single respondent) than consumption expenditures or income (16). In addition wealth is more strongly linked to social class. As it is a measure of assets, it indicates the ability to meet emergencies or to absorb economic shock. However, there are also several limitations of using wealth: i) there are multiple factors which contribute to the wealth index calculation, ii) there is a higher rate of error as reporting household assets may be sensitive for the individuals involved (10) and iii) the choice of the number of components and the variables to include is not well defined (17). Despite these limitations, wealth index is widely used as a measure of SES in many developing countries (18).

### **3.4 Socioeconomic status as a risk factor for HIV transmission**

HIV transmission in Africa and other parts of the developing world has been attributed to different factors. These include behavioural, biological, socioeconomic, cultural and political factors, which are interrelated (19). For instance, family SES may determine inherited wealth and attendance at school, whilst educational attainment and later life choices will affect earning capacity and will likely affect lifestyle, including sexual, marital and health seeking behaviours (8). Thus SES may influence health status at individual and community levels. Disproportionately high numbers of people living with HIV/AIDS live in poorer countries,

indicating a strong correlation between lower SES (poverty) and higher HIV prevalence in the world (20). Despite this strong positive correlation at the global level, studies investigating the association between HIV prevalence or HIV incidence and individual-level SES have shown conflicting findings ranging from no association to strong positive or negative associations. Since the beginning of the HIV pandemic, different studies have been conducted to investigate the influence of SES on HIV transmission using different proxies for SES in various settings. Studies which investigated wealth, education, and place of residence as proxies for SES as a predictor of HIV infection and risk factors of HIV infection are discussed below (Table 1) as these measures are better predictors of HIV status and risky behaviours, and have been most researched as proxies of SES in developing countries.

#### **3.4.1 Association between wealth and HIV status**

In SSA, countries with higher national wealth have a higher prevalence of HIV. This may be due to an association between economic inequality and HIV prevalence where countries with greater inequality (e.g. South Africa) have higher prevalence than countries with lower levels of inequality (e.g. Ethiopia) (21). However studies within countries have found conflicting relationships between individual wealth status and HIV status.

Most studies focused on relative wealth rather than absolute wealth to explain differences in HIV prevalence or incidence in different groups of society (16). A total of 14 observational studies were included in this review: eleven cross-sectional studies, three cohort studies and one longitudinal analysis of cross-sectional data. Four cross-sectional studies conducted in a single country reported higher HIV prevalence with increasing levels of wealth (22-25), and one study reported the reverse (26). Six studies that used demographic and health survey (DHS) datasets from different countries reported mixed results across countries (27-32). Mishra et al(27) reported that HIV prevalence rose with increasing wealth in eight SSA countries whereas Fortson reported a mixed result: a positive association in Tanzania and Burkina Faso, a negative association in Ghana and no association in Cameroon and Kenya (28). Another study in four African countries using large DHS datasets also reported a mixed result: no association in Lesotho and Zimbabwe, a positive association in Malawi and a negative association in Swaziland (31). Pooled analysis of DHS data from 13 African countries reported a positive association between wealth and HIV prevalence among women, but no association among men (29). Another study, which analysed DHS data from 20 SSA countries, reported similar findings, namely higher HIV prevalence in middle or richer households than

in poorer ones(30). However, a different analysis using the same datasets and comparing urban poor/non-poor and rural poor/non-poor reported that wealth was protective against HIV prevalence in urban areas and the opposite in rural areas (32).

Although a number of cross-sectional studies investigated the association between household wealth and HIV prevalence, few follow up or longitudinal studies have been conducted. Four cohort and longitudinal studies were included in this review. Of these, two studies reported no association (33,34), one reported a positive association between wealth and HIV incidence (35) and one study reported a negative association among men and no association among women (36).

Comparisons across studies are difficult, due to the heterogeneity of the samples, the variety of designs and adjustment techniques, differences in demographic characteristics of participants in the studies such as age, gender (some studies consider only women, only men and sometimes both) and the use of different measurements for wealth and SES. Although the findings are sometimes conflicting, a number of themes emerge.

The first is that follow up studies were more likely to report either a null or a negative association between wealth status and being HIV-positive than the nationally representative, large cross-sectional DHS studies from different countries and some of the individual studies. Cross-sectional studies are snapshots at a single point in time and hence are affected by prevalence bias as they include prevalent cases. Individuals from highest wealth households are therefore more likely to survive longer than the lowest wealth household and are more likely to be present in the population and included in the survey. This could increase the HIV prevalence rates among the highest wealth individuals and these studies may be more likely to report positive associations (37). However, follow up studies consider incident cases and/ or track changes over time which helps to investigate the dynamic relationship between wealth status and changes in risk of HIV infection (21).

Second, there was a slightly stronger wealth-gradient in HIV prevalence among women than men. Mishra et al. reported that the positive association between wealth status and HIV prevalence tended to be stronger for women in most of the countries (27). A nationally representative DHS dataset from Kenya also reported a stronger positive wealth gradient among women than men. The adjusted odds ratios (aOR) when comparing second, middle,

fourth and highest with the lowest quintile were 1.4, 1.9, 2.5 and 2.6 among women (increasing HIV prevalence with increasing wealth) and 1.8, 1.2, 2.5 and 2.3 among men (no significant increase in HIV prevalence with increase in wealth), respectively (22), though the 95% confidence interval (CI) may overlap. This suggests that women in the highest wealth quintile could have been disproportionately more vulnerable to HIV infection than men in this quintile (27).

Third, some studies that investigated the effect of wealth on HIV incidence did not control for possible mediating/behavioural risk factors (28,34-36), whereas others took these into account(22,23,27,33). Behavioural factors such as condom use, number of sexual partners and other mediating factors of HIV infection are a function of SES and demographic variables of interest. Adjusting for confounding variables is important to assess the true association between an exposure and an outcome. However, including mediating variables/behavioural factors may lead to 'overadjusting' and masking of the true associations between SES measures and HIV status (38). A systematic review on educational attainment and HIV-1 infection among developing countries reported that six overadjusted analyses on datasets from Africa and Haiti removed the apparent effect of education on the risk of HIV infection seen in univariate analyses (39). Thus overadjusting for behavioral/potential mediating factors may also have the same effect on the association between wealth and other SES measures and HIV status as these measures may lead to change in behavioral characteristics of individuals.

Lastly, after listing the studies chronologically by study date, there was no clear temporal trend in the association between wealth status and HIV status. Some hypothesized that the association between wealth and HIV may depend on the stage of the epidemic in different settings. They suggested that in the early stage of the epidemic wealthier people might be more affected and as the epidemic matures, poorer individuals may be more affected (21,39,40). However the most recent large, nationally representative DHS studies in Africa in countries with widespread HIV transmission; indicated that the wealthiest were at highest odds of HIV infection.

**Table 3 Summary of studies on the association between wealth and prevalent HIV infection**

<b>1. WEALTH</b>				
<b>Study Country Sample</b>	<b>Adjustments</b>	<b>Associated with HIV infection</b>	<b>Study design</b>	<b>Key findings</b>
Seeley et al 1994(26) Uganda 9950	Age, sex, age-sex interaction, wealth-sex interaction	Negatively	Cross-sectional	Male and female heads of the poorest households were most likely to be HIV positive
Kirunga et al 1997(33) Rakai, Uganda 1784	Age, sex, sex partners in past year, condom use, partner's occupation risk, place residence, education, partner's travel	Null	population-based longitudinal HIV cohort study	Wealth was not positively associated with HIV prevalence
Johnson et al 2006(22) Kenya 3273 women 2941 men	Age, gender (stratified analysis), region, marital status, sexual debut, religion, number of partners, alcohol use, education, urban	Positively	Cross-sectional survey, Kenya DHS 2003	Increased wealth was positively related to odds of HIV: the wealthiest women were 2.6 times more likely than the poorest women to be HIV positive (P=0.009)
Mishra et al 2007(27)	Age, community wealth, education,	Positively	Cross-sectional nationally	In all eight countries, wealthier men and women tend to have a higher prevalence of HIV than poorer individuals.

Kenya (6001) Tanzania (10747) Uganda (16906) Malawi(5150) Lesotho(5043) Cameroon(9900) Ghana(9142) Burkina Faso(2157)	place of residence, condom use, male circumcision, sexual risk taking, gender (stratifying factor)		representative DHS data from 2003 to 2007	The positive association between wealth status and HIV is considerably diminished when a number of underlying factors and some of the behavioural and biological pathways are taken into account
Lopman et al 2007(36) Zimbabwe 5507	Mobility Gender (stratifying factor) Education	Negatively for men, null for women	Longitudinal study: a large population based cohort study for 3 years	HIV incidence was associated with poverty among young men between 1998 and 2003, no such trend among women. Largest decrease in HIV prevalence among the top third wealth tercile.
Hargreaves et al 2007(34) Limpopo South Africa 1967	Age, marital status, migrancy status, educational attainment, gender (stratifying factor)	Null	Cohort study between 2001-2004	No association
Bärnighausen et al 2007(35) KwaZulu-Natal, South Africa 3325	Age Sex Migration status Partnership status Place of residence	Positively	A longitudinal HIV surveillance and a linked demographic surveillance in a poor rural community	Members of households that fell into the middle 40% of relative wealth had a 72% higher hazard of HIV acquisition than members of the 40% poorest households (P=0.012). However, per capita household expenditure did not significantly affect HIV incidence (P=0.669).

Rathavuth et al 2008(23) Ethiopia 3037 men 4358 women	Age, gender (stratifying factor), marital status and others, education, occupation, place of residence	Positively- for women Null-for men	Cross-sectional survey (EDHS 2005)	Household wealth was positively associated to risk for HIV among women: women living in the wealthiest 20 percent of the households were about 7 times more likely to be HIV positive than those in the poorest households (aOR= 6.60; 95% CI=0.90-48.54). Not associated among men (aOR=0.81; 95% CI=0.16-4.20)
Fortson 2008(28) Burkina Faso(7530) Cameroon(10195) Ghana(11554) Kenya(6188) Tanzania(10743)	Age, gender, sector of residence, region of residence	Mixed across countries: null in Cameroon and Kenya, positively in Tanzania and Burkina Faso and negatively in Ghana	Nationally representative DHS data: Cross-sectional	Estimates of the wealth gradient in HIV vary substantially across countries and are sensitive to the choice of measure of wealth
Msisha et al 2008(24) Tanzania 7515	Age, religion, place of residence, marital status, gender (stratifying factor), occupation, education	Positively	Cross sectional, large nationally representative HIV indicator survey 2003-2004	Individuals in the highest quintile of standard of living (wealth) had increased odds ratio (OR) of being HIV-positive (male: aOR=2.38, 95% CI=1.17-4.82; female: aOR= 3.74; 95% CI 2.16–6.49).
Mermin et al 2008(25) Uganda 21359	Sex, age, region, number of sex partners, history of STDs, history of HSV-2 infection, circumcision	Positively	Cross-sectional	Those with highest wealth index were 1.5 time more likely to be HIV positive compared to the lowest (aOR=1.5; 95%CI=0.8-2.7). However there was no significant difference between lowest and the middle wealth quintiles (aOR=1.1; 95%CI=0.7-1.9).
Babalola et al 2011(29) 13 African countries age 15-19 years	Circumcision status, number of sex partners, condom use, education, marital	Positively	Pooled analysis of DHS data: cross-sectional	Wealth and HIV status was associated for women, but not for men.

	status, gender (stratifying factor), place of residence			
Magadi et al 2011(30) 20 countries of SSA	Age, religion, gender (stratifying factor), circumcision, media exposure, HIV/AIDS exposure, marital status, education, urban residence, age at first sex, contextual factors-region and country	Positively	Demographic and Health Surveys conducted during 2003-2008: Cross-sectional	Overall, HIV prevalence was higher among those the middle or richer households.
Asiedu et al 2012 (31) Lesotho (6272) Malawi (7018) Swaziland (9527) Zimbabwe (15874)	Gender, place of residence, marital status, age, education	Mixed	Nationally representative DHS data: Cross-sectional	Wealth: no association for Lesotho and Zimbabwe, positively in Malawi and negatively in Swaziland.
Magadi 2012(32) 20 countries of SSA	Age, gender, religion, sex of household head, non-condom use with non-spousal partner, multiple sex partners, marital status, age at first sex, education	Negatively in urban Positively in rural	Demographic and Health Surveys conducted during 2003-2008: cross-sectional	The urban poor in SSA have significantly higher odds of HIV infection than their urban non-poor counterparts, despite poverty being associated with a significantly lower risk among rural residents. The urban-poor have on average 14% higher odds of being HIV positive compared to their non-poor counterparts and rural poor have 16% lower odds of HIV prevalence.

### 3.4.2 Association between education and HIV status

Education is one of the most widely used proxy measures of SES and can be used to predict health independently of income/wealth (21). The ability to process and access information is one of the mechanisms through which education may affect HIV status. Access to HIV prevention strategies and messages may increase condom use, which may reduce the risk of HIV (39). However, this effect may be offset by having multiple sexual partners among the more educated group of the population (41), which has also been highly cited as one of the main risk factors for higher HIV prevalence among wealthier individuals (21,27).

Different studies have reported conflicting results on the effect of education. Thirteen cross-sectional studies and five cohort studies and longitudinal studies assessed the association between education and/or school attendance and HIV infection. Of the cross-sectional studies, eight studies used data from a single country whereas the rest used datasets from many countries. Of the eight single-country cross-sectional studies, four studies reported a higher levels of education were associated with lower odds prevalent HIV infection, two studies reported a negative association and two studies reported no association. Five multi-country studies reported mixed findings on the association between education and HIV prevalence. DHS datasets from five countries reported an increase in the odds of HIV infection in four countries (Cameroon, Kenya, Tanzania and Ghana) and no association in Burkina Faso (28). However, the same dataset analysed by De Walque et al (41) reported that education was not associated with HIV status. DHS datasets from four countries were also analysed by Asiedu et al (31) and reported mixed findings across countries: a positive association in Malawi, a negative association in Zimbabwe and Swaziland and no association in Lesotho. Magadi et al (30) also analysed DHS datasets from 20 SSA countries and reported that women with primary-level education were at highest odds of being HIV positive compared to women with no education. A pooled analysis of DHS datasets of 20 SSA countries suggested that the relationship between education and HIV status differed by place of residence: higher levels of education were associated with lower odds of prevalent HIV infection in urban areas, but higher levels of education were associated with higher odds of prevalent HIV infection in rural areas (32). Of five prospective studies, one reported higher levels of education were associated with higher risk of HIV infection (33), three reported higher levels of education were associated with lower risk of HIV infection (35,42,43) and one study reported higher levels of education were associated with lower risk of HIV infection among women and no association among men (34).

Despite methodological and contextual differences between studies, some general conclusions can be drawn. Earlier studies that reported increased HIV prevalence at higher levels of education indicated that this might be because educated individuals practice riskier behaviours than individuals with less education (44). Similarly, wealthier individuals are more likely to report more sexual partners than poorer individuals (27,36). Wealth and education may have an effect on one another: having a wealthy family may determine school attendance and being educated may affect earning capacity (8), and wealthier individuals are more likely to be more educated (27) and may share some common characteristics such as risky sexual behaviours.

A large number of studies found the highest HIV prevalence among people with primary level of education compared to people with no education (22, 32). For instance, Jonson et al(22) reported the highest prevalence among women with primary education after taking into account other variables. Though those with secondary and higher education had higher odds of being HIV positive, the odds were not significantly different from those with no education. Another study using large DHS datasets from 20 SSA countries also found that highest odds of HIV infection among women who had primary level of education (32). A nationally representative cross-sectional study in South Africa among 11,904 young women also reported that those who had not completed high school were more likely to be infected with HIV than those that completed high school (45). This suggests that HIV prevalence may be highest among people with primary level of education.

It is possible that education has a temporal effect on HIV prevalence. Different studies have found that during the early stage of the epidemic where knowledge about HIV prevention was low, increased schooling was either not associated with HIV infection or was associated with increased risk of HIV infection (40). A systematic review including 36 studies from SSA countries suggested either no association or the highest risk among the most educated in studies prior to 1996. From 1996 onwards studies reported a negative association (40). Other studies from 2004 onwards also reflect a shift towards a reduced relative risk of HIV infection among more educated individuals as the epidemic matured (39,40,58). A systematic review found a more consistent decrease in HIV prevalence among highly educated groups than less educated groups, among whom prevalence sometimes rose while population prevalence was falling (40). A study in Zambia also found a significant reduction in risk of HIV infection in groups with higher than lower education from 1995 to 2003(42).

Finally, education may have a different impact on HIV prevalence in urban and rural areas. If education is protective in urban areas, this may indicate the maturity of HIV epidemic in most urban areas of SSA, while a positive association in rural areas may reflect an earlier stage in the epidemic. A recent analysis of large, nationally representative DHS datasets from 20 SSA countries reported that those with at least secondary level of education had 25% lower odds of HIV infection than individuals with no education among urban non-poor and the reverse among urban poor (32). This suggests that education may be protective among the urban wealthy but not the urban poor. Smith et al (44) reported that HIV prevalence increased with education in rural villages but not in main centres and trading villages.

**Table 4 Summary of studies on the association between education and HIV status**

<b>1. EDUCATION/SCHOOL ATTENDANCE</b>				
<b>Study</b>	<b>Adjustments</b>	<b>Associated with</b>	<b>Study design</b>	<b>Key findings</b>
<b>Country</b>		<b>HIV infection</b>		
<b>Sample</b>				
Dallabetta et al 1993(48) Malawi 6600	Age, current STD, more than one sexual partner, history of STD	Positively	Cross-sectional	Those with greater than 8 years of schooling were 2 times more likely to be HIV positive (aOR=2.23; 95%CI=1.93-2.56).
Kirunga et al 1997(33) Rakai, Uganda 1784	Age, sex, sex partners in past year, condom use, partner's travel, place of residence, occupation, wealth	Positively	population-based cohort study	Level of education was positively associated with HIV status. Those with secondary and plus educational level were 3 times higher risk of HIV infection compared to those with no education (aOR=2.88; P=0.008)

Smith et al 1999(44) Rural Uganda 1397 men 1705 women	Demographic and behavioural variables	Positively	cross-sectional analysis of a population-based cohort	Educational attainment is a significant predictor of HIV risk in rural Uganda, in part because of risk behaviours and other characteristics among better educated individuals
Abebe et al 2003(49) Ethiopia 72000	Age, region, marital status, occupation, religion	Positively	Cross-sectional study	(Higher) level of education in rural recruits was associated with HIV infection. Those with grade 7-12 were 2 times higher odds of HIV infection compared to no education (aOR=1.8; 95%CI=1.5–2.0).
De Walque et al 2005(43) Masaka, Uganda	Age, gender, marital status, wealth	Negatively after follow up	Population-based cohort between 1989/1990 and 1999/2000,	At the beginning of follow up, educational attainment was associated with higher risk of HIV before adjusting for age. However, educational attainment was associated with less risk of HIV at the end of follow up.
Johnson et al 2006(22) Kenya 3273 women 2941 men	Age, gender (stratified analysis), region, marital status, sexual debut, religion, number of partners, alcohol use,	Positively	Cross-sectional survey, Kenya DHS 2003	Those with primary education are nearly twice as likely to be HIV-positive as those with no education for women; although the odds for being HIV-positive are higher for the secondary and higher education categories, they are not significantly different than those for people with no

	place of residence, wealth			education. However, there was a positive-education in HIV prevalence among men.
Michelo et al 2006(42) Zambia 2989 (1995) 3506 (1999) 4442 (2003)	Age, gender (stratifying factor), place of residence (stratifying factor)	Negatively	Longitudinal analysis of cross-sectional surveys	There was a universal shift towards reduced risk of HIV infection in groups with higher than lower education in both sexes among urban young in men and in women. A similar pattern was observed in rural young men but was less prominent and not statistically significant in rural women
Hargreaves et al 2007(34) Rural SA 916 Men 1003 Women	Age and other confounders, gender (stratifying factor)	Negatively	Cross-sectional survey of unmarried young adults	Attending school was associated with lower-risk sexual behaviours and, among young men, lower HIV prevalence. Secondary school attendance may influence the structure of sexual networks and reduce HIV risk.
Bärnighausen et al 2007(35) KwaZulu-Natal, South Africa 3325	Age, sex, migration status, partnership status, place of residence	Negatively	A longitudinal HIV surveillance and a linked demographic surveillance in a poor rural community	Educational attainment significantly reduces the hazard of becoming infected with HIV in a poor rural community in South Africa.

Hargreaves et al 2007(50) Limpopo, South Africa 1967	Age, marital status, household wealth, migration status, gender(stratifying factor)	Null for men Negatively for women	A cohort study conducted between 2001 and 2004	During the follow up, HIV incidence was not associated with SES among men, but among women infections occurred fastest among the least educated. HIV sero- conversion was lower among more educated women than with no education.
Rathavuth et al 2008(23) Ethiopia 3037 men 4358 women	Age, gender (stratifying factor), marital status and others, occupation, wealth, place of residence	Null	Cross-sectional survey (ED HS 2005)	Increasing education was also associated with HIV prevalence, but not statistically significant.
Msisha et al 2008(24) Tanzania 7515	Age, religion, place of residence, marital status, gender (stratifying factor), standard of living, occupation	Null	Cross sectional, large nationally representative HIV indicator survey 2003- 2004	No marked association was found between increasing education and HIV seroprevalence for men and women.
Pettifor et al 2008(45)	Age, age difference between partners, self-	Negatively	A nationally representative	Young women who had not completed high school were more likely to be infected with HIV compared with those

South Africa 11904 women	reported, vaginal discharge, ever being pregnant, age of coital debut, estimated HIV prevalence of their partner		household survey of sexual behaviour and HIV testing in 2003	that had completed high school (aOR=3.75; 95% CI= 1.34–10.46)
Fortson 2008 (28) Burkina Faso(7530) Cameroon(10195) Ghana(11554) Kenya(6188) Tanzania(10743)	Age, sex, sector of residence, region of residence	Mixed across countries  Positive – Cameroon, Ghana, Kenya, Tanzania; Null- Burkina Faso	Nationally representative DHS data: cross-sectional	Positive education gradient in HIV infection, showing that, up to very high levels of education, better-educated respondents are more likely to be HIV-positive. Adults with six years of schooling are as much as 50% more likely to be infected with HIV than those with no schooling.
De Walque 2009(41) Burkina Faso, Cameroon, Ghana, Kenya, Tanzania	Age, region, ethnicity, earth floor (wealth)	Null	Nationally representative DHS data: cross-sectional	Education is not positively associated with HIV status, but is a predictor of other risk and protective factors.
Magadi et al 2011(30)	Age, religion, circumcision, media	Positively for primary level	Demographic and Health Surveys	Across countries in sub-Saharan Africa, the

20 countries of SSA	exposure, HIV/AIDS exposure, marital status, age at first sex, wealth, place of residence	education and null for secondary and more compared to no education.	conducted during 2003-2008.	Highest risk of being HIV positive is observed among women who have primary-level education compared to those with no education
Magadi 2012(32) 20 countries of SSA	Age, gender, religion, sex of household head, condom use with non-spousal partner, multiple sex partners, marital status  Age at first sex	Negatively in urban non-poor and positively in urban-poor	Demographic and Health Surveys conducted during 2003-2008.	Among the urban poor, those with at least secondary level education have on average a 25% higher odds of being HIV positive than their counterparts of similar characteristics with no formal education (aOR=1.25, 95%CI=1.05-1.48), while among the urban non-poor, the odds are on average 25% lower (aOR=0.75, 95%CI=0.61-0.92).
Asiedu et al 2012(31) Lesotho (6272) Malawi (7018) Swaziland (9527) Zimbabwe (15874)	Gender, place of residence, marital status, age, wealth	Mixed	Nationally representative DHS data: cross-sectional	Estimated marginal effect of education for an average adult was negatively associated with HIV prevalence for Zimbabwe and Swaziland and positively in Malawi and no association in Lesotho.

### **3.4.3 Place of residence: urban-rural differences in HIV status**

Place of residence was identified as a major determinant of HIV transmission in all of the studies reviewed. People living in urban areas were at increased risk of HIV infection compared to their rural counterparts in cross-sectional and longitudinal studies as well as in demographic and health surveys. In 20 SSA countries, living in rural areas was associated with far lower odds of HIV prevalence than in urban areas (30). Urban HIV prevalence rates in Ethiopia were almost seven times the rural estimates (4.2% in urban areas and 0.6% in rural areas) (3). A study using a large, nationally representative DHS dataset from Ethiopia also found 60% lower adjusted odds of HIV infection among rural women than urban women (23).

Different mechanisms are suggested to explain the increased HIV prevalence in urban compared with rural areas. A study in Kenya suggested that the high prevalence in urban areas was due to the dense population. Individuals living in urban areas may engage in many sexual networks, in turn increasing their risk of being infected (46). The urban poor were more likely than their rural counterparts to have an early sexual debut and a greater incidence of multiple sexual partnerships, which may increase their risk of HIV infection (46). Reasons for engaging in risky sexual behavior may include high unemployment, unstable wages and financial insecurity (46). Individuals with similar lifestyles including sexual practices are likely to associate with one another and membership in a large sociometric risk network has been identified in other cities as a predictor of serostatus and future risk for HIV infection (47).

**Table 5 Summary of studies on the association between HIV prevalence and place of residence**

<b>PLACE OF RESIDENCE (Urban versus Rural)</b>				
<b>Study Country Sample</b>	<b>Adjustments</b>	<b>Associated with HIV infection</b>	<b>Study design</b>	<b>Key findings</b>
Kirunga et al 1997(33) Rakai, Uganda 1784	Age, sex, sex partners in past year, condom use, partner's travel, education, wealth, occupation	Positively	population-based longitudinal HIV cohort study	Urban residence was positively associated with HIV status. Staying in trading centre and trading village increases the odds of HIV infection compared to staying in rural village (p=0.019).
Johnson et al 2006(22) Kenya 3273 women 2941 men	Age, gender (stratifying factor), region, marital status, sexual debut, religion, number of partners, alcohol use	Positively, but marginally insignificant	Cross-sectional survey, Kenya DHS 2003	Rural residence did not exert a protective effect on the risk of contracting HIV among women, and did so only weakly among men.
Dodoo et al 2006(46) Kenya-women Pooled data from 3 DHS (1989, 1993,1998)	Wealth	Positively	Quantitative cross-sectional and qualitative surveys.	The urban poor are significantly more likely than their rural counterparts to have an early sexual debut and a greater incidence of multiple sexual partnerships. Hence living in urban areas may be a factor for HIV infection.
Bärnighausen et al 2007(35) KwaZulu-Natal, South Africa 3325	Age, sex, migration status, partnership status	Positively	A longitudinal study	Urban residence was associated with a 65% increase in the hazard of HIV sero-conversion (p = 0.012).

Rathavuth et al 2008(23) Ethiopia 3037 men 4358 women	Age, gender (stratifying factor), marital status, education, occupation, wealth and others	Positively for women	Cross-sectional survey (EDHS 2005)	The adjusted odds of HIV infection among rural women were lower than the odds of HIV infection among urban women (aOR=0.40; 95%CI=0.14-1.13), but not among rural men (aOR=0.93; 95%CI=0.20-4.30).
Mermin et al 2008(25) Uganda 21359	Sex, age, wealth region, number of sex partners, history of STDs, history of HSV-2 infection, circumcision	Positively	Cross-sectional	Those who reside in urban areas were 1.6 times more likely to be HIV positive compared to the rural residents (aOR=1.6; 95%CI=1.0-2.5).
Magadi 2011(30) 20 countries of SSA	Age, Religion Circumcision Media exposure HIV/AIDS exposure Marital status Age at first sex Education Wealth	Positively	Demographic and Health Surveys conducted during 2003-2008.	Individuals living in rural areas have 34% less odds of HIV prevalence compared to urban residents (aOR=0.66; 95%CI=0.59-0.73)
Asiedu et al 2012(31) Lesotho (6272) Malawi (7018) Swaziland (9527) Zimbabwe (15874)	Gender Place of residence Marital status Age Wealth Education	Positively	Nationally representative DHS data	Respondents who live in urban areas have a higher likelihood of infection than those who reside in rural areas.

## 4 Conclusion and gaps for future research

The studies reviewed suggest that SES measures such as education, wealth (or income), and place of residence may impact on HIV prevalence. Generally, the evidence on associations between wealth, education and HIV status was mixed and sometimes conflicting. At the global level, an inverse relationship between SES and HIV prevalence has been well established. In contrast, in SSA the associations vary across countries, populations and gender, and the reasons of this heterogeneity are largely unknown. It is likely that such studies are context-specific as no universal relationship emerges from the studies reviewed. In contrast, being resident in an urban area was strongly associated with increased HIV prevalence and risky sexual practices in all studies

The relationship between SES and HIV is dynamic and may change over time. In this context, producing timely evidence and tracking changes over time could play a vital role in informing national HIV prevention programs. Contextual factors (unmeasured variables) may modify the effect of SES measures on HIV prevalence in any given society. Hence generating context-specific evidence plays an important role in the development of effective interventions.

Most importantly, in order to prevent the spread of HIV in SSA, epidemiological research aimed at the identification of upstream and downstream determinants of HIV prevalence has relevance from a public health perspective. However, this kind of research is extremely scarce in low-resource settings, and there is a need to generate more evidence.

## 5 References

- (1) Global H. AIDS response: epidemic update and health sector progress towards universal access: progress report 2011. Geneva, UNAIDS 2011.
- (2) USAID-Ethiopia. HIV/AIDS Health Profile. HIV/AIDS 2012.
- (3) Central Statistics Agency and ORC Macro. Ethiopia Demographic and Health Survey 2011. Addis Ababa and Calverton 2012:253-265.
- (4) World Bank. International Economics Dept. Development Data Group. World development indicators. : World Bank; 1978.
- (5) Federal Democratic Republic of Ethiopia Population Census Commission. Summary and statistical report of the 2007 population and housing census–population size by age and sex. Addis Ababa, December 2008.
- (6) World Bank. Development Data Group. World Development Indicators 2012. : World Bank-free PDF; 2012.
- (7) Pollack CE, Chideya S, Cubbin C, Williams B, Dekker M, Braveman P. Should health studies measure wealth?: A systematic review. *Am J Prev Med* 2007;33(3):250-264.
- (8) Hargreaves JR, Morison LA, Chege J, Rutenburg N, Kahindo M, Weiss HA, et al. Socioeconomic status and risk of HIV infection in an urban population in Kenya. *Tropical Medicine & International Health* 2002;7(9):793-802.
- (9) Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research. *JAMA: the journal of the American Medical Association* 2005;294(22):2879-2888.
- (10) Shavers VL. Measurement of socioeconomic status in health disparities research. *J Natl Med Assoc* 2007;99(9):1013.

- (11) Galobardes B, Lynch J, Smith GD. Measuring socioeconomic position in health research. *Br Med Bull* 2007;81(1):21-37.
- (12) Poverty, health inequality, and its health and demographic effects. Annual Meeting of the Population Association of America, Los Angeles, California; 2000.
- (13) Rutstein S. Wealth versus expenditure: Comparison between the DHS wealth index and household expenditures in four departments of Guatemala. Calverton, Maryland: ORC Macro 1999.
- (14) Howe LD, Hargreaves JR, Gabrysch S, Huttly SR. Is the wealth index a proxy for consumption expenditure? A systematic review. *J Epidemiol Community Health* 2009;63(11):871-877.
- (15) Houweling TA, Kunst AE, Mackenbach JP. Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter? *International Journal for Equity in Health* 2003;2(1):8.
- (16) Rutstein SO, Johnson K. The DHS wealth index (DHS comparative Reports No. 6). Calverton: ORC Macro 2004.
- (17) Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan* 2006;21(6):459-468.
- (18) Houweling TA, Ronsmans C, Campbell OM, Kunst AE. Huge poor-rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries. *Bull World Health Organ* 2007;85(10):745-754.
- (19) Kloos H, Mariam DH, Lindtjorn B. The AIDS epidemic in a low-income country: Ethiopia. *Human Ecology Review* 2007;14(1):39.
- (20) Fenton L. Preventing HIV/AIDS through poverty reduction: the only sustainable solution? *The Lancet* 2004;364(9440):1186-1187.
- (21) Gillespie S, Kadiyala S, Greener R. Is poverty or wealth driving HIV transmission? *AIDS* 2007;21:S5-S16.

- (22) Johnson K, Way A. Risk factors for HIV infection in a national adult population: evidence from the 2003 Kenya Demographic and Health Survey. *JAIDS J Acquired Immune Defic Syndromes* 2006;42(5):627-636.
- (23) Rathavuth Hong, Vinod Mishra, Pav Govindasamy and Macro International Inc. Calverton, Maryland, USA. Factors associated with prevalent HIV infection among ethiopian adults: further analysis of the 2005 Ethiopian Demographic and Health Survey. 2008.
- (24) Msisha WM, Kapiga SH, Earls F, Subramanian S. Socioeconomic status and HIV seroprevalence in Tanzania: a counterintuitive relationship. *Int J Epidemiol* 2008;37(6):1297-1303.
- (25) Mermin J, Musinguzi J, Opio A, Kirungi W, Ekwaru JP, Hladik W, et al. Risk factors for recent HIV infection in Uganda. *JAMA: The Journal of the American Medical Association* 2008;300(5):540-549.
- (26) Seeley JA, Malamba SS, Nunn AJ, Mulder DW, Kengeya-Kayondo JF, Barton TG. Socioeconomic Status, Gender, and Risk of HIV-1 Infection in a Rural Community in South West Uganda. *Med Anthropol Q* 1994;8(1):78-89.
- (27) 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.
- (28) Fortson JG. The gradient in sub-Saharan Africa: socioeconomic status and HIV/AIDS. *Demography* 2008;45(2):303-322.
- (29) Babalola S. Factors associated with HIV infection among sexually experienced adolescents in Africa: a pooled data analysis. *African Journal of AIDS Research* 2011;10(4):403-414.
- (30) Magadi M, Desta M. A multilevel analysis of the determinants and cross-national variations of HIV seropositivity in sub-Saharan Africa: evidence from the DHS. *Health Place* 2011;17(5):1067-1083.

- (31) 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):305-326.
- (32) Magadi MA. The Disproportionate High Risk of HIV Infection Among the Urban Poor in Sub-Saharan Africa. *AIDS and Behavior* 2013:1-10.
- (33) Kirunga CT, Ntozi JP. Socio-economic determinants of HIV serostatus: a study of Rakai District, Uganda. *Health Transition Review* 1997:175-188.
- (34) Hargreaves JR, Bonell CP, Morison LA, Kim JC, Phetla G, Porter JD, et al. Explaining continued high HIV prevalence in South Africa: socioeconomic factors, HIV incidence and sexual behaviour change among a rural cohort, 2001-2004. *AIDS* 2007;21:S39-S48.
- (35) Bärnighausen T, Hosegood V, Timaeus IM, Newell M. The socioeconomic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa. *AIDS* 2007;21(Suppl 7):S29.
- (36) Lopman B, Lewis J, Nyamukapa C, Mushati P, Chandiwana S, Gregson S. HIV incidence and poverty in Manicaland, Zimbabwe: is HIV becoming a disease of the poor? *AIDS* 2007;21(Suppl 7):S57.
- (37) Gillespie S. Poverty, Food Insecurity, HIV Vulnerability and the Impacts of AIDS in sub-Saharan Africa. *IDS Bulletin* 2008;39(5):10-18.
- (38) Beegle K, De Walque D. Demographic and socioeconomic patterns of HIV/AIDS prevalence in Africa. *World Bank Policy Research Working Paper Series*, Vol 2009.
- (39) Hargreaves JR, Glynn JR. Educational attainment and HIV-1 infection in developing countries: a systematic review. *Tropical Medicine & International Health* 2002;7(6):489-498.
- (40) 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):403-414.
- (41) De Walque D. Does education affect HIV status? Evidence from five African countries. *The World Bank Economic Review* 2009;23(2):209-233.

- (42) Michelo C, Sandøy IF, Fylkesnes K. Marked HIV prevalence declines in higher educated young people: evidence from population-based surveys (1995-2003) in Zambia. *AIDS* 2006;20(7):1031-1038.
- (43) Walque D, Nakiyingi-Miuro JS, Busingye J, Whitworth JA. Changing association between schooling levels and HIV-1 infection over 11 years in a rural population cohort in south-west Uganda. *Tropical Medicine & International Health* 2005;10(10):993-1001.
- (44) Smith J, Nalagoda F, Wawer MJ, Serwadda D, Sewankambo N, Konde-Lule J, et al. Education attainment as a predictor of HIV risk in rural Uganda: results from a population-based study. *Int J STD AIDS* 1999;10(7):452-459.
- (45) Pettifor AE, Levandowski BA, MacPhail C, Padian NS, Cohen MS, Rees HV. Keep them in school: the importance of education as a protective factor against HIV infection among young South African women. *Int J Epidemiol* 2008;37(6):1266-1273.
- (46) Dodoo F, Zulu EM, Ezech AC. Urban–rural differences in the socioeconomic deprivation–Sexual behavior link in Kenya. *Soc Sci Med* 2007;64(5):1019-1031.
- (47) Maas B, Fairbairn N, Kerr T, Li K, Montaner JS, Wood E. Neighborhood and HIV infection among IDU: place of residence independently predicts HIV infection among a cohort of injection drug users. *Health Place* 2007;13(2):432-439.
- (48) Dallabetta GA, Miotti PG, Chipangwi JD, Saah AJ, Liomba G, Odaka N, et al. High socioeconomic status is a risk factor for human immunodeficiency virus type 1 (HIV-1) infection but not for sexually transmitted diseases in women in Malawi: implications for HIV-1 control. *J Infect Dis* 1993;167(1):36-42.
- (49) 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):1835-1840.
- (50) Hargreaves J, Morison L, Kim J, Bonell C, Porter J, Watts C, et al. The association between school attendance, HIV infection and sexual behaviour among young people in rural South Africa. *J Epidemiol Community Health* 2008;62(2):113-119.

## **PART C: Article<sup>†</sup>**

<sup>†</sup>The manuscript meets the requirements set out in the Instructions for Authors of Tropical Medicine and International Health (TMIH) Journal. For readability purposes, figures and tables are inserted in the text rather than appended as required by the Journal, and spacing and justification match the other parts of the dissertation. Moreover, references are made to supplementary material in the appendices instead of to the online supplement allowed by the Publisher.

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# 1 Introduction

Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) remains one of the major public health problems worldwide. Globally 34 million people were living with HIV/AIDS in 2011, of which 69% were from sub-Saharan Africa (SSA)(1). Compared with other SSA countries, Ethiopia has a relatively low HIV prevalence with a national estimate of 1.5% in 2011 (2). With an estimated total population of 91.73 million, approximately 1.2 million people were living with HIV/AIDS in Ethiopia, which is about 5% of the total burden in SSA (2).

Socioeconomic status (SES) influences many health outcomes. Compared with those with higher SES, countries and individuals with lower SES have higher morbidity and mortality from many health conditions such as malnutrition, malaria and sexually transmitted infections (STIs)(3). This correlation also holds for HIV/AIDS at the global level. Wealthier countries tend to have higher HIV prevalence within SSA, but the evidence on SES and HIV prevalence is conflicting at the individual level (4). This may be partly due to the fact that SES is complex and difficult to compare across countries, particularly as different measures are used in different studies. Two of the most common SES measures, wealth/income and education, have been found to be major determinants of HIV prevalence in SSA. For example, in numerous large Demographic and Health Surveys (DHSs) from several countries across SSA, HIV prevalence increased with household wealth (3,5,6). In contrast, studies on the effect of education on HIV prevalence have produced mixed results ranging from a positive association (an increase in HIV prevalence with increasing education)(7,8) to no association (6,9) or an inverse association. (10-12). Finally, numerous studies in SSA have reported a higher HIV prevalence in urban than in rural areas (13-15).

Ethiopia is a low-income country. Thirty nine percent of its population live below the national poverty line (under 1.25USD a day)(16). The population is young: approximately 65% are below the age of 15 years and the median age of the total population is 17 years. Generally the level of education and employment is low (17).The Ethiopia Demographic and Health Survey (EDHS) 2011 reported that only 39% of women and 49% of men completed primary school, and 52% of women and 38% of did not attend school (17). The country's economy depends mainly on agriculture and over 80% of the people live in rural areas. The wealth distribution is relatively even with a Gini coefficient of 30%. In recent years urbanization has been rapid. Despite the presence of these determinants of HIV prevalence, few studies have investigated

the influence of such factors on HIV prevalence in Ethiopia, probably due to the low HIV prevalence and limited resources.

There is, however, a need to generate epidemiologic evidence on the impact of SES on HIV prevalence in specific country settings. Such studies would inform strategies for successful prevention and control of HIV/ADS. This study investigated the association between household wealth and HIV prevalence among adults (15-49 years old) in Ethiopia. The hypothesis was that household wealth was positively associated with HIV prevalence after taking into account other SES and demographic variables.

## **2 Methods**

### **2.1 Study Population**

The study used nationally representative population-based cross-sectional study data collected as part of the 2011 EDHS. A total of 17,817 households were selected (17). The response rate was 98% with 16,702 households participating. Ninety-five percent of eligible women and 89% of eligible men participated. Overall, 86% of all who were eligible for HIV testing were interviewed and consented to HIV testing (89% for women and 82% for men). A total of 28,532 adults aged 15-49 years who consented, were interviewed, tested for HIV and had data on household wealth, were included in this analysis. Men aged 50-59 years were excluded from the analysis for the purpose of comparing men with women as data collected during the survey were only on women age 15-49 years. Of these, 15,517 were women and 13,015 were men.

### **2.2 HIV Testing procedure**

The testing algorithm included testing all blood samples on the first ELISA assay test, the Vironostika® HIV Uni-Form II Plus O (Biomerieux). All positives were subjected to a second ELISA, the Murex HIV Ag/Ab Combination. If the first and second tests were discordant, a third confirmatory test, the HIV 2.2 western blot (DiaSorin), was conducted to resolve the discordance. When the western blot results were indeterminate, the sample result was recorded as indeterminate.

### **2.3 Potential confounders (demographic and socioeconomic variables)**

Demographic variables included in the analysis were age, gender, place of residence, religion and marital status. Socioeconomic variables included were educational level, literacy,

occupation and household wealth. Of the five variables that were used to measure education, education level only was included in the modeling as all these variables had the same correlation with the outcome. Educational level is classified in to four categories in Ethiopia: none, primary, secondary and higher education. Primary education indicates schooling from grades 1-8 and secondary from grades 9-12. Higher education indicates educational level from diploma to doctor of philosophy; which is provided by post-secondary institutions such as colleges, universities, polytechnics, etc. The other socioeconomic status (SES) variable, occupation, was excluded because of very strong collinearity with urban/rural residence.

#### **2.4 Household wealth**

The DHS data did not include information on income or expenditure, but information on several items that measure household ownership of consumer durables was collected. These included ownership of a television and a bicycle; material used for housing construction; and the availability of material amenities such as electricity, source of drinking water and type of toilet facility, which were generally correlated with household wealth status. Household wealth assets are an indication of the ability to meet emergencies or to absorb economic shock (18). Household wealth has been used in many DHSs and other country level surveys to indicate inequalities in household characteristics, in the use of health and other services, and in health outcomes (19). A household level wealth index has been constructed using household asset data via a principal components analysis (PCA) (17).

#### **2.5 Potential confounding and mediating factors**

Potential confounders of the association between wealth and HIV infection that were taken into account were age, gender, place of residence, religion, marital status and educational level (Figure 1).

Mediating factors are either protective or risk factors that lie in the causal pathway between an exposure and an outcome (Figure 1) (3). Potential mediating factors in this study included condom use during last sex with most recent partner in the last 12 months, history of sexually transmitted infections in the last 12 months, number of recent sexual partners in the last 12 months and during the respondent's lifetime and circumcision status (men only).

#### **2.6 Data analysis**

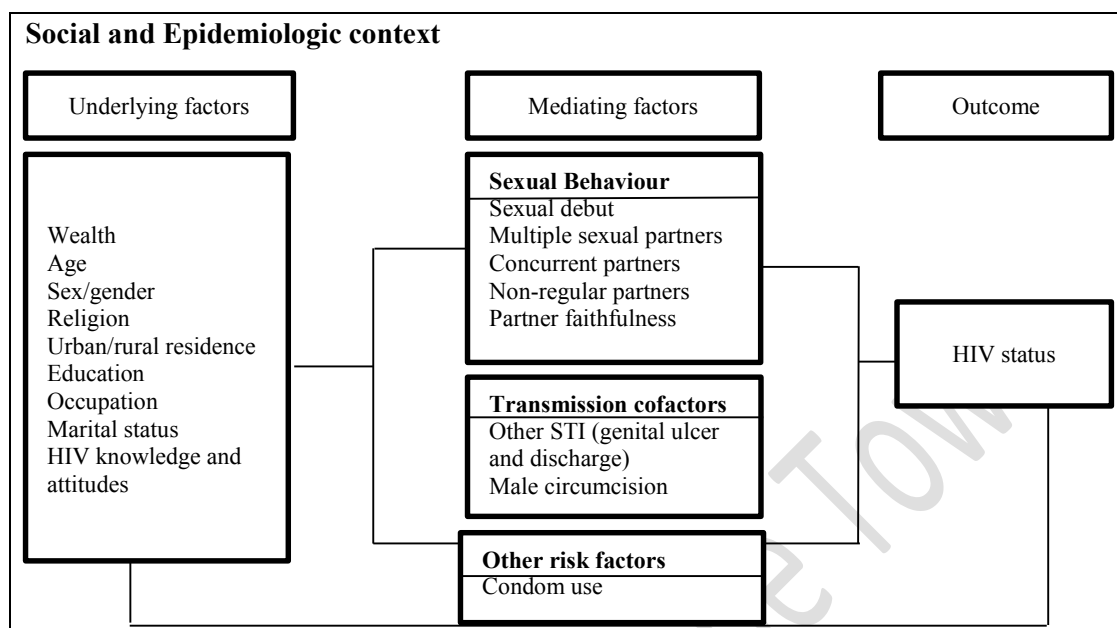
Data were analysed using Stata Version 12.0 (Stata Corporation, College Station, USA). All analyses accounted for the complex survey design based on individual-level weights that incorporated sample selection, non-response and post-stratification factors. The household

weight for a particular household is the inverse of its household selection probability multiplied by the inverse of the household response rate of its household response rate group. The individual weight of a respondent's case is the household weight multiplied by the inverse of the individual response rate of her individual response rate group. The final sampling weights (both household and individual weights) were normalized in order to give the total number of unweighted cases equal to the total number of weighted cases at the national level.

The normalized weights are relative weights which are valid for estimating means, proportions and ratios, but not valid for estimating population totals and for pooled data. The sampling weights for HIV testing were calculated in a similar way, but the normalization of the individual sampling weights was different compared to the individual survey weights. The HIV testing weights were normalized for women and men together at the national level, so that the HIV prevalence calculated for all adults (women and men) are valid. Individual weights were used to compare those who did and did not consent for HIV testing. HIV weights were used for the rest of the analysis to produce nationally representative results.

The associations between different factors and HIV prevalence were examined using descriptive, univariate and multivariate statistical analyses. Descriptive statistics were generated for categorical variables (proportions) and continuous variables (means). Confounding factors were stratified by HIV status and household wealth status, and mediating factors stratified by HIV status. Differences in categorical variables by HIV status were assessed using Pearson's chi-square statistic. For continuous variables, means were compared using the two-sample t-test by HIV status and the chi-square test for trend among the categories of the household wealth index. Logistic regression models were developed to assess crude and adjusted associations between household wealth and HIV status, using HIV-negative individuals as the comparison group. Odds ratios and 95% confidence intervals (CIs) were calculated. The final model included all confounding factors to minimize known confounding of the association between household wealth and HIV prevalence.

**Figure 1 Association between wealth status and HIV prevalence: a conceptual framework (adapted from Mishra et al (3))**



Seven percent of the EDHS respondents did not consent to be tested for HIV. Table 2A describes the characteristics of respondents who were tested versus those who were not. Those who were from better off households, males, and had less education were less likely to have been tested. To adjust for differential probabilities of selection within households, differential non-response and residual discrepancies between the sample and the population on a profile of census demographic and geographic variables, sampling weights were used during all analyses.

Potential mediating factors were not included in the models as they were considered to lie in the causal pathway between household wealth and HIV status since adjusting for mediators removes the indirect effect and we could not estimate the total effect of wealth on HIV status. As the aim of mediation analysis is to identify the total effect of wealth on HIV status which is the effect of wealth that acts through a given set of mediators of interest (indirect effect) and the effect of the exposure unexplained by those same mediators (direct effect). As the objective of the study was to describe the unadjusted and adjusted effect household wealth and other confounders on HIV prevalence, formal mediation analysis was not conducted.

A simple analysis was done to compare those who consented for HIV testing with the total DHS sample and stratified analysis to assess gender-specific associations between household wealth and HIV status.

The study was approved by the University of Cape Town, Faculty of Health Sciences Human Research Ethics Committee (HREC REF: 298/2013).

### 3 Results

A total of 28 532 participants were eligible for inclusion, of which 540 (2%) participants tested HIV positive (Table 1). The HIV prevalence in the population aged 15-49 years was 1.47% (95% confidence interval (CI): 1.25%; 1.68%), sample weighting was considered. The mean age of the sample was 29 years (95% CI 28-29). Participants were predominantly 15-39 years old, female and living in rural areas. Eighty-five percent of participants had no education, or had only attended primary school. Unemployment was high (25%) and agriculture was the most common form of employment. Household wealth was fairly evenly distributed in the total and HIV negative population, but three-quarter (68%) of the HIV positives fell into highest wealth quintiles when stratified by HIV status.

Comparison of those who did and did not have HIV test shows that those who are tested and not tested for HIV were similar in respect of most of the variables except for (a) a higher proportion of people in the highest wealth quintile among those not tested (46%) than tested for HIV (24%) and (b) a lower proportion from rural areas (57%) among those not tested than those tested for HIV (78%) (Table 2A). Those who were excluded thus differed in wealth and urban/rural status from those who were included. We were thus unable to compare them with regard to the outcome (HIV status). These may have led to differential or non-differential selection bias with an unpredictable effect on true measure of association.

**Table 1 Confounding factors (demographic and socioeconomic status variables) stratified by HIV status**

Baseline characteristics	Total (%) (n=28 532)	HIV positive (%) (n=540)	HIV negative (%) (n=27 992)	P-Value	
Age: mean(yrs)	29.0	33.5	29.0	<0.0001	
Age Categories(yrs)				<0.0001	
	15-19	23.9	2.0	24.2	
	20-24	18.0	7.1	18.1	
	25-29	18.5	25.8	18.4	
	30-34	12.1	20.7	11.9	
	35-39	12.3	25.3	12.1	
	40-44	8.1	11.0	8.0	
	45-49	7.3	8.1	7.2	
Gender				<0.0001	
	Female	51.5	66.9	51.3	
	Male	48.5	33.1	48.7	

Place of Residence						
	Urban	23.0	66.8	22.3	<0.0001	
	Rural	77.0	33.2	77.7		
Religion						
	Orthodox	48.1	73.0	47.7	<0.0001	
	Catholic	1.0	1.6	1.0		
	Protestant	20.6	11.2	20.7		
	Muslim	28.3	12.6	28.6		
	Traditional	0.7	0.0	0.7		
	Other	1.3	1.6	1.2		
Marital Status						
	Never in union	32.9	8.0	33.2	<0.0001	
	Married	57.1	51.1	57.2		
	Living with partner	3.2	7.6	3.1		
	Widowed	1.8	15.2	1.6		
	Divorced	3.6	10.7	3.5		
	Separated	1.4	7.5	1.3		
Education: Categorical						
	None	42.0	31.2	42.1	<0.0001	
	Primary	44.6	46.6	44.6		
	Secondary	8.0	17.0	7.9		
	Higher	5.4	5.3	5.4		
Occupation						
	Not working	24.9	21.4	25.0	<0.0001	
	Professional	2.8	3.8	2.7		
	Clerical	1.2	2.3	1.2		
	Sales	13.6	24.7	13.4		
	Agricultural-employee	48.1	15.0	48.6		
	Services	1.1	4.2	1.1		
	Skilled manual	7.2	26.9	6.9		
	Unskilled manual	1.2	1.6	1.2		
	Other	0.0	0.0	0.0		
Household Wealth Index						
	lowest	17.4	4.1	17.6		<0.0001
	second	18.6	5.4	18.8		
	Middle	19.0	8.8	19.2		
	Fourth	20.2	13.9	20.3		
	Highest	24.8	68.0	24.2		

There were significant differences in potential confounding factors by HIV status (Table 1). Compared with HIV-negative participants, HIV-positive individuals were older (mean age 34 vs. 29 years), more likely to be female (67% vs. 51%), living in urban areas (67% vs. 22%), widowed (15% vs. 2%) and in the highest wealth quintile (68% vs 24%). A higher proportion of people living with HIV had completed secondary school (17% vs 8%) and were working in

sales or skilled manual work than HIV-negative respondents. When household wealth among people living with HIV was stratified by place of residence, nearly 100% of all HIV+ individuals in the urban areas were in the fourth or highest quintile of wealth.

Table 2 presents potential mediating factors by HIV status. Overall, 60% had never previously tested for HIV. Almost no respondents reported having used condoms or experiencing symptoms of an STI/genital ulcer/discharge over the past year. Compared with HIV-negative individuals, HIV-positive individuals were more likely to have ever tested for HIV (75% vs 39%) and report an STI or symptoms in the last year. They also had a higher mean number of sex partners in the past year (1.1 vs 0.1) and total number of sexual partners (6.7 vs. 2.4). The prevalence of male circumcision is high in Ethiopia (92%) and did not differ by HIV status.

Table 3 presents the description of confounding factors stratified by household wealth index. Of those with the highest household wealth, 82% lived in urban areas whereas 98% of those with the lowest household wealth lived in rural areas. Sixteen percent of the wealthiest individuals compared with 64% of those in the lowest quintile had no education. Religion and marital status were also correlated with the wealth index; 60% of wealthiest individuals compared with 42% of those in the lowest quintile followed the Orthodox religion and 44% and 43% of the wealthiest compared to 24% and 65% of those in the lowest quintile were never in a union or were married respectively.

A dose response association between household wealth and HIV prevalence was observed (Table 4). HIV prevalence increased with wealth particularly among the highest quintile. Those in the wealthiest households were 12 times as likely to be HIV positive as those in the poorest households (OR=12.2; 95% CI=7.12-21.0). Demographic variables including age, gender, place of residence and marital status were associated with HIV status in univariate analysis. There was a trend towards increasing prevalence with increasing age: those 35-39 years were 25 times as likely to be HIV positive as those aged 15-19 years old (Table 4). Men were half as likely to be HIV positive as women (OR=0.52, 95% CI=0.38-0.71). Those in rural areas were 0.14 times as likely to be HIV positive as those in urban areas (OR=0.14; 95% CI=0.11-0.19).

**Table 2 Potential mediating factors stratified by HIV status**

Mediating factors		Total (%) (N=28 532)	HIV positive (%) (N=540)	HIV negative (%) (N=28 532)	P-values
Condom use at last intercourse	Yes	3.9	21.4	3.6	<0.0001
	No	96.1	78.6	96.4	
STI in last 12 months	Yes	0.6	3.4	0.6	<0.0001
	No	99.4	96.6	99.4	
Genital ulcer in last 12 months	Yes	0.8	3.9	0.7	<0.0001
	No	99.2	96.1	99.3	
Genital discharge in last 12 months	Yes	1.5	3.2	1.5	<0.0001
	No	98.5	96.8	98.5	
number of sex partners, excluding spouse, in the last 12 months : mean		0.1	1.1	0.1	0.0002
Total lifetime sex partners: mean		2.5	6.7	2.4	<0.0001
Respondent circumcised (men only)	Yes	92.3	92.8	92.3	0.8770
	No	7.7	7.2	7.7	
Age at first cohabitation: mean(yrs)		19.0	19.4	18.9	0.0384

Protestants, Muslims or traditional religious followers were less likely to be HIV positive than Orthodox followers. Those in any union had higher odds of being HIV-positive than those never in a union. Widowed participants had the highest odds of being HIV positive and were 38 times as likely to be HIV positive as those who had never been in union (OR=38.33; 95% CI=22.65-64.85). Those who completed secondary school were 2.9 times as likely to be HIV positive as those with no education, whereas those with higher education did not have a significantly higher HIV prevalence than the reference group.

After adjusting for confounding variables, the associations between household wealth and HIV prevalence were similar, but attenuated in the highest quintile. Those households which fell in the highest quintile were 5 times as likely to be HIV positive as those from the lowest quintile (aOR=4.9 CI=2.35-10.15). Associations of HIV with older age, urban residence, religion and higher education all persisted but were reduced. Higher education became a protective factor compared to none education.

In stratified analysis by gender, associations between higher household wealth and HIV prevalence persisted (Table 1A).

**Table 3 Demographic and socioeconomic variables stratified by wealth index**

Baseline characteristics-	Household wealth Index (%)						P-value*
	Total	Lowest	Second	Middle	Fourth	Highest	
Age: mean(yrs)	29.0	29.89	29.51	29.43	28.55	27.87	<0.0001
Age categories(yrs)							
15-19	23.93	23.01	22.51	23.52	26.61	23.77	<0.001
20-24	17.89	14.61	17.29	16.98	17.31	21.7	
25-29	18.55	17.44	19.04	18.31	18.56	19.12	
30-34	12.05	12.48	11.33	12.17	11.23	12.85	
35-39	12.15	13.0	13.01	12.79	11.53	10.95	
40-44	8.12	9.29	8.99	8.30	7.89	6.71	
45-49	7.32	10.16	7.83	7.94	6.86	4.90	
Gender							
Female	53.93	55.95	53.64	52.44	52.12	55.30	0.01
Male	46.07	44.05	46.36	47.56	47.88	44.70	
Place of residence							
Urban	23.01	2.27	1.05	1.04	8.00	82.27	<0.0001
Rural	76.99	97.73	98.95	98.96	92.00	17.73	
Religion							
Orthodox	48.05	42.01	45.34	46.19	42.51	60.14	<0.0001
Catholic	1.04	1.11	0.59	1.17	1.19	1.10	
Protestant	20.52	20.41	20.78	20.87	23.89	17.43	
Muslim	28.43	32.18	30.81	29.91	31.22	20.69	
Traditional	0.75	1.93	0.84	0.58	0.52	0.18	
Other	1.21	2.36	1.65	1.29	0.67	0.46	
Marital Status							
Never in union	32.90	24.34	27.03	28.71	36.16	43.71	<0.0001
Married	56.76	64.99	63.40	62.16	55.31	43.25	
Living with partner	3.24	2.98	3.10	2.91	1.78	4.94	
Widowed	1.94	2.42	1.92	1.62	1.79	1.97	
Divorced	3.73	4.11	3.41	3.68	3.78	3.7	
Separated	1.43	1.16	1.14	0.92	1.17	2.43	
Education							
None	42.42	63.97	55.64	51.00	37.02	15.53	<0.0001
Primary	43.99	34.54	42.02	45.30	53.73	43.22	
Secondary	7.99	1.32	2.04	2.89	7.16	21.53	
Higher	5.60	0.17	0.30	0.81	2.09	19.72	

Occupation								
	Not working	25.95	25.99	24.44	24.52	24.00	29.71	<0.0001
	Professional	2.83	0.33	0.31	0.32	1.31	9.57	
	Clerical	1.26	0.0076	0.13	0.081	0.16	4.75	
	Sales	13.69	7.84	8.04	9.85	15.05	23.75	
	Agricultural-employee	46.79	61.23	62.8	60.59	51.64	10.52	
	Services	1.16	0.24	0.12	0.095	0.48	3.91	
	Skilled manual	7.09	3.84	3.89	4.26	6.26	14.53	
	Unskilled manual	1.21	0.48	0.25	0.28	1.10	3.24	
	Other	0.009	0.044	0.00	0	0	0.0049	

**Table 4 Univariate and multivariate models of associations between participant characteristics and HIV status**

Baseline characteristics		Crude OR (95% CI)	Model I* OR (95% CI)
Wealth index			
	Lowest	1.00(ref)	1.00 (ref)
	Second	1.24 (0.58-2.65)	1.25 (0.58-2.70)
	Middle	1.99 (0.99-3.98)	2.02 (1.00-4.07)
	Fourth	2.96 (1.55-5.67)	2.75 (1.40-5.39)
	Highest	12.23(7.12-21.00)	4.90 (2.35-10.15)
Age categories			
	15-19	1.00 (ref)	1.00 (ref)
	20-24	4.71 (2.18-10.18)	3.62 (1.62-8.06)
	25-29	16.78 (8.23-34.20)	11.08 (5.41-22.72)
	30-34	20.72 (10.13-42.41)	11.77 (5.49-25.24)
	35-39	25.02 (12.25-51.12)	15.58 (7.13-34.08)
	40-44	16.45 (7.91-34.13)	10.07 (4.56-22.23)
	45-49	13.33 (6.18-28.77)	6.87 (2.95-15.99)
Gender			
	Female	1.00 (ref)	1.00 (ref)
	Male	0.52 (0.38-0.71)	0.69 (0.48-1.00)
Place of Residence			
	Urban	1.00 (ref)	1.00 (ref)
	Rural	0.14 (0.11-0.19)	0.43 (0.24-0.74)
Religion			
	Orthodox	1.00 (ref)	1.00 (ref)
	Catholic	1.03 (0.32-3.31)	0.94 (0.33-2.69)
	Protestant	0.35 (0.23-0.55)	0.46 (0.29-0.73)
	Muslim	0.29 (0.19-0.43)	0.42 (0.27-0.63)
	Traditional	0.01 (0.001-0.07)	0.02 (0.002-0.14)
	Other	0.86 (0.25-2.93)	0.66 (0.10-4.26)

Marital Status			
	Never in union	1.00 (ref)	1.00 (ref)
	Married	3.70 (2.48-5.52)	2.09 (1.31-3.34)
	Living with partner	10.12 (4.96-20.65)	3.57 (1.74-7.31)
	Widowed	38.33 (22.65-64.85)	18.17 (9.56-34.53)
	Divorced	12.54 (7.36-21.36)	4.71 (2.59-8.55)
	No longer living together	23.46 (12.82-42.92)	6.04 (2.94-12.42)
Educational level			
	None	1.00 (ref)	1.00 (ref)
	Primary	1.42 (1.01-1.98)	1.63 (1.11-2.38)
	Secondary	2.90 (1.81-4.64)	1.86 (1.07-3.26)
	Higher	1.32 (0.80-2.17)	0.56 (0.30-1.02)

\* Model I adjusted for all variables shown (Age, gender, place of residence, religion, marital status, educational level)

## 4 Discussion

This analysis of a nationally representative sample of the Ethiopian population found that HIV prevalence increased with relative wealth. The positive association between household wealth and HIV prevalence persisted but was considerably attenuated after taking into account other SES and demographic variables. Education was also an important socioeconomic determinant of HIV prevalence in Ethiopia. Increasing educational level increased odds of HIV prevalence, but a post school level of education became protective after adjusting for other variables.

Other factors which increased the odds of prevalent HIV infection were being age 35-39 years old vs. other age groups, being female and living in urban compared with rural areas. Orthodox and Catholic individuals were also more likely to be HIV-positive than Muslims and Protestants. Widowed, divorced or married individuals compared with those never in a union had a higher odds of HIV prevalence.

Our study provides additional evidence of a strong dose-response in the association between prevalent HIV infection and household wealth as documented in other large, nationally representative datasets from Demographic and Health Surveys in Kenya, Tanzania, Uganda, Malawi and other African countries (3,5,9). The size of these datasets, and the fact that such studies are nationally representative increases confidence in our findings. We found that the relative effect of wealth on HIV prevalence and the odds ratios were comparable for men and women, which contradicts with other studies which have documented gender differences in the association (6,20,21).

A few studies have previously reported different results, either null or a negative association between wealth and HIV prevalence (11,22). The most important difference could be measurement of household wealth and its use in the context of Ethiopia. Household wealth in the Ethiopian DHS is constructed using an index based on household ownership of consumer durables; most of these commodities are purchased with cash in modern markets such as television, radio, bicycles, etc. or are related to modern lifestyle such as electricity. Traditional forms of wealth such as cattle and land are either not included in the index or constitute a small minority in the indicator variables used to form the index (23), given that more than 80% of the population live in rural areas. Variability in the measure of household wealth could result in conflicting results. Since wealth index was not measured thoroughly, this may lead to information bias (misclassification bias) and this may under- or over-estimate the positive association between prevalent HIV infection and wealth index.

Our analysis suggests that the association between relative wealth and prevalent HIV infection was partially confounded by other factors such as place of residence. Relatively wealthier adults were more likely than poorer adults to live in urban areas where HIV was more prevalent. There was a 30% higher odds of HIV prevalence among adults living in urban areas than adults in rural areas, independent of wealth and other variables. In other countries, Monica et al have previously reported that the urban poor were most affected by HIV (24). In our study, by contrast, relatively wealthier households were more affected in urban areas than their poorer counterparts: more than 95% of all HIV-positives within urban areas were in highest wealth quintiles. In recent years there has been a high level of migration from rural to urban areas in Ethiopia, resulting in rapid urbanization. More than 90% of urban residents are in the highest two wealth quintiles. As people move from rural to urban areas and acquire assets such as radio, television, electricity, etc. they would be categorised into the highest two wealth quintiles. This could explain the discrepancy with the study by Monica et al (24).

Education also partially confounded the association between wealth and HIV prevalence. The odds of HIV increased with increasing education and relatively wealthier individuals were more likely to be more educated than poorer ones, as has been documented in studies in Uganda, Malawi, Ethiopia and Kenya (7,8,21,22,25). More educated individuals (those with primary and secondary education) had higher levels of extramarital sex and earlier sexual debut (26), which eventually increased their risk of HIV. However for individuals who had higher than secondary education, education was protective after taking into account wealth and other variables. Higher education may influence the structure of sexual networks and reduce HIV risk (27). In this study, as indicated in Table 1, about a quarter of the population

fell into the highest wealth quintile, whereas only 5% of the population had higher education. Thus the protective effect would be small in absolute terms. However an increase in the rate of higher education over time may have a bigger effect on HIV prevalence in the future. Indeed, the percentage of higher education increased from 1.4% to 4.4% among women and from 2.4% to 7.3% among men in 2011 compared to 2005 (17,28).

Marital status appeared to be strongly associated with HIV status, even after adjusting for all other factors. Compared with those never in a union, all forms of marital status increased the odds of HIV prevalence. Being widowed increased the odds 18-fold. It is likely that these individuals had been married to partners who had died of HIV/AIDS, which would be the reason for the higher HIV prevalence compared to those never in a union. Gender was also found to be a major determinant of HIV prevalence. The higher odds of HIV prevalence among women compared to their male counterparts of similar characteristics underscores the important role of interventions aimed at addressing factors such as gender violence, inequality and discrimination in tackling increased women's vulnerability to HIV infection in Ethiopia and other similar contexts.

The association between wealth and HIV prevalence is likely to be mediated by behavioural factors, in particular risky sexual practices. It is likely that wealthier individuals with more education and, living in urban areas, have easier access to more sexual partners (29). In addition, greater social networking and the ability to use resources for transactional sex would contribute to the higher prevalence of HIV in wealthy urban areas (13). Indeed we found that HIV-positive individuals were more likely to have had an STI in the previous year, and had more recent and lifetime sex partners (Table 2). Unlike other studies, this study did not adjust for behavioural/potential mediating factors as we were interested in the "total" effect of wealth on HIV infection. Most studies considered these factors as confounders and adjusted for them, which may be the reason for the null or negative effect of wealth on HIV prevalence due to over-adjustment (5,24,30).

The strength of this study is the use of a large nationally representative sample where each economic stratum of the population was included and sampling weights were used to ensure representativeness at national and subnational levels. In addition, this survey had the highest response rate since the 2005 DHS.

Non-response for HIV testing was higher among wealthier, more educated, urban adults and the sensitivity analysis confirmed that adults from the highest wealth quintiles, urban areas and adults with higher education were more likely to refuse HIV testing. This indicates

differential non-response as these groups of adults are more likely to have increased odds of HIV infection. However, if there had been complete response among these groups, the positive association between wealth and HIV prevalence would have been even stronger.

There are several potential limitations to be considered in interpreting the results of the study. As this study can only estimate the relationship between wealth and HIV status at a given moment in time, reverse causation requires consideration as a possible explanation for some results. This is likely as the study is unable to distinguish between the effect of household wealth on HIV status and the effect of HIV status on household wealth. If the effect of HIV status on wealth were taken into account, this could weaken the true estimates of association. In addition, the estimates of the study may be affected by the prevalence-incidence bias where patients with long duration prevalent HIV were more likely to be sampled in cross-sectional studies than HIV cases with short survival. In general, caution is needed in drawing causal inferences from cross-sectional studies.

Another limitation is that mediating factors were based on self-report. Although wealth status and confounders were also based on self-report, reporting bias may not be a significant problem as reporting these may not be affected by social desirability or recall biases as most of variables used to construct wealth index are what the respondents possessed during the time of the survey. In addition, prevalent HIV infection was ascertained from another database, hence dependent error of wealth status-prevalent HIV infection is minimal. Dependent error of wealth status with respect to confounders is possible but self-reports are less likely to be affected by social desirability or recall biases as reporting their educational and occupational status does not have social undesirability and recalling their educational or occupation is not an issue, indicating that the error is minimal.

In summary, our analysis shows a strong wealth-gradient in HIV prevalence, with most of the HIV burden in Ethiopia confined to wealthier urban areas. Therefore HIV prevention and treatment programs should be targeted in these areas in order to achieve greater impact. While HIV prevalence is low, effective prevention methods are needed to ensure that prevalence does not increase more generally. As urbanization increases, this may become a more serious challenge. The relationship between SES measures and HIV prevalence is dynamic and is likely to change over time. Ongoing research is necessary to track changes over time and to develop and implement timely intervention strategies. Moreover, the effect of household wealth on HIV prevalence tends to vary in urban and rural areas due to the high correlation of urban status and being in the upper wealth quintile. Hence future research is required to determine the effect of wealth in urban and rural areas.

## 5 Source of funding

None.

## 6 Conflict of interest

None.

## 7 Abstract

**Background:** Evidence on the association between wealth and HIV prevalence is conflicting and likely to be context specific. Despite limited research on the topic in Ethiopia, the 2005 Demographic and Health Survey reported a positive association between household wealth and HIV prevalence.

**Objective:** This study examines the relationship between household wealth and HIV prevalence in 2011 taking into account the effect of a number of demographic and other socioeconomic status variables.

**Methods:** Data from the cross-sectional, population-based 2011 Ethiopian Demographic and Health Survey were used. A total of 28 532 respondents with information on HIV status and household wealth were included in the analysis of which 15 517 were women and 13 015 were men.). The association between household wealth (measured by an index based on household ownership of durable assets and other amenities) and HIV prevalence was examined using descriptive and multivariate logistic regression methods.

**Results:** The HIV prevalence for adults aged 15-49 years was 1.47%. HIV positive respondents were more likely to be older, female, living in urban areas, widowed or separated, more educated and wealthier than those HIV negative. HIV prevalence increased with household wealth in a dose response relationship. Adults in the highest wealth quintile had a five times higher odds of HIV prevalence than those in the lowest wealth quintile, after taking into account other SES and demographic variables (aOR=4.90; 95% CI=2.35-10.15). Independently of wealth, school education and urban residence were also found to be significant risk factors for HIV prevalence in Ethiopia. Post school education was found to be protective. Gender was also found to be a major risk factor for HIV prevalence as women had 21% higher odds of HIV prevalence compared to men after controlling for other factors.

**Conclusion:** Interventions should be tailored to address higher risk relatively wealthy urban areas. Considering the change in epidemiology of HIV transmission due to increase in awareness and use of interventions and the epidemic maturity, further research is required to determine dynamics of HIV transmission in each economic stratum and in rural urban areas.

## 8 References

- (1) Global H. AIDS response: epidemic update and health sector progress towards universal access: progress report 2011. Geneva, UNAIDS 2011.
- (2) USAID-Ethiopia. HIV/AIDS Health Profile. HIV/AIDS 2012.
- (3) 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.
- (4) Gillespie S, Kadiyala S, Greener R. Is poverty or wealth driving HIV transmission? *AIDS* 2007;21:S5-S16.
- (5) Johnson K, Way A. Risk factors for HIV infection in a national adult population: evidence from the 2003 Kenya Demographic and Health Survey. *JAIDS J Acquired Immune Defic Syndromes* 2006;42(5):627-636.
- (6) Rathavuth Hong, Vinod Mishra, Pav Govindasamy and Macro International Inc. Calverton, Maryland, USA. Factors associated with prevalent HIV infection among ethiopian adults: further analysis of the 2005 Ethiopian Demographic and Health Survey. 2008.
- (7) Smith J, Nalagoda F, Wawer MJ, Serwadda D, Sewankambo N, Konde-Lule J, et al. Education attainment as a predictor of HIV risk in rural Uganda: results from a population-based study. *Int J STD AIDS* 1999;10(7):452-459.
- (8) 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):1835-1840.
- (9) Msisha WM, Kapiga SH, Earls F, Subramanian S. Socioeconomic status and HIV seroprevalence in Tanzania: a counterintuitive relationship. *Int J Epidemiol* 2008;37(6):1297-1303.
- (10) Bärnighausen T, Hosegood V, Timaeus IM, Newell M. The socioeconomic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa. *AIDS* 2007;21(Suppl 7):S29.
- (11) Hargreaves JR, Bonell CP, Morison LA, Kim JC, Phetla G, Porter JD, et al. Explaining continued high HIV prevalence in South Africa: socioeconomic factors, HIV incidence and sexual behaviour change among a rural cohort, 2001-2004. *AIDS* 2007;21:S39-S48.

- (12) Pettifor AE, Levandowski BA, MacPhail C, Padian NS, Cohen MS, Rees HV. Keep them in school: the importance of education as a protective factor against HIV infection among young South African women. *Int J Epidemiol* 2008;37(6):1266-1273.
- (13) Dodoo F, Zulu EM, Ezeh AC. Urban–rural differences in the socioeconomic deprivation–Sexual behavior link in Kenya. *Soc Sci Med* 2007;64(5):1019-1031.
- (14) Mermin J, Musinguzi J, Opio A, Kirungi W, Ekwaru JP, Hladik W, et al. Risk factors for recent HIV infection in Uganda. *JAMA: The Journal of the American Medical Association* 2008;300(5):540-549.
- (15) Magadi M, Desta M. A multilevel analysis of the determinants and cross-national variations of HIV seropositivity in sub-Saharan Africa: evidence from the DHS. *Health Place* 2011;17(5):1067-1083.
- (16) World Bank. Development Data Group. World Development Indicators 2012. : World Bank-free PDF; 2012.
- (17) Central Statistics Agency and ORC Macro. Ethiopia Demographic and Health Survey 2011. Addis Ababa and Calverton 2012:253-265.
- (18) Shavers VL. Measurement of socioeconomic status in health disparities research. *J Natl Med Assoc* 2007;99(9):1013.
- (19) Poverty, health inequality, and its health and demographic effects. Annual Meeting of the Population Association of America, Los Angeles, California; 2000.
- (20) Lopman B, Lewis J, Nyamukapa C, Mushati P, Chandiwana S, Gregson S. HIV incidence and poverty in Manicaland, Zimbabwe: is HIV becoming a disease of the poor? *AIDS* 2007;21(Suppl 7):S57.
- (21) Fortson JG. The gradient in sub-Saharan Africa: socioeconomic status and HIV/AIDS. *Demography* 2008;45(2):303-322.
- (22) Kirunga CT, Ntozi JP. Socio-economic determinants of HIV serostatus: a study of Rakai District, Uganda. *Health Transition Review* 1997:175-188.
- (23) Bingenheimer JB. Wealth, wealth indices and HIV risk in East Africa. *International Family Planning Perspectives* 2007;33(2):83.
- (24) Magadi MA. The Disproportionate High Risk of HIV Infection Among the Urban Poor in Sub-Saharan Africa. *AIDS and Behavior* 2013:1-10.
- (25) Dallabetta GA, Miotti PG, Chipangwi JD, Saah AJ, Liomba G, Odaka N, et al. High socioeconomic status is a risk factor for human immunodeficiency virus type 1 (HIV-1) infection but not for sexually transmitted diseases in women in Malawi: implications for HIV-1 control. *J Infect Dis* 1993;167(1):36-42.

(26) De Walque D. Does education affect HIV status? Evidence from five African countries. *The World Bank Economic Review* 2009;23(2):209-233.

(27) Hargreaves J, Morison L, Kim J, Bonell C, Porter J, Watts C, et al. The association between school attendance, HIV infection and sexual behaviour among young people in rural South Africa. *J Epidemiol Community Health* 2008;62(2):113-119.

(28) Central Statistics Agency and ORC Macro. Ethiopian Demographic and Health Survey 2005. Addis Ababa and Calverton 2006. 2006:31-45.

(29) Fox AM, Barham B, Boucher S, Barnett T, Whiteside A, Decosas J, et al. The HIV-poverty thesis re-examined: poverty, wealth or inequality as a social determinant of HIV infection in sub-Saharan Africa? *T J Biosoc Sci* 2012;44(4):459.

(30) Hargreaves JR, Glynn JR. Educational attainment and HIV-1 infection in developing countries: a systematic review. *Tropical Medicine & International Health* 2002;7(6):489-498.

## **Part D: Appendices**

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# Appendix A: Consent Forms

## a. Household Consent Form

### Introduction and Consent

Hello. My name is \_\_\_\_\_ and I am working with the Central Statistical Agency (CSA). We are conducting a national survey about various health issues. We would very much appreciate your participation in this survey. This information will help the government to plan health services. The survey usually takes between 10 and 15 minutes to complete. As part of the survey we would first like to ask some questions about your household. Whatever information you provide will be kept strictly confidential, and will not be shared with anyone other than members of our survey team.

Participation in this survey is voluntary, and if we should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time. However, we hope you will participate in the survey since your views are important.

At this time, do you want to ask me anything about the survey?

May I begin the interview now?

Signature of interviewer: \_\_\_\_\_

Date: \_\_\_\_\_

## b. Individual Consent

### Informed consent form

Hello. My name is \_\_\_\_\_ and I am working with the Central Statistical Agency (CSA). We are conducting a survey about health all over Ethiopia. The information we collect will help the government to plan health services. Your household was selected for the survey. The survey usually takes about 30 to 60 minutes. All of the answers you give will be confidential and will not be shared with anyone other than members of our survey team. You don't have to be in the survey, but we hope you will agree to answer the questions since your views are important. If I ask you any question you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time.

Do you have any questions?

May I begin the interview now?

Signature of interviewer: \_\_\_\_\_

Date: \_\_\_\_\_

## Appendix B: Ethical Approval Letters

### a. Ethical approval letter to conduct EDHS

**ETHIOPIAN HEALTH AND NUTRITION RESEARCH  
INSTITUTE (EHNRI)  
SCIENTIFIC AND ETHICAL REVIEW OFFICE (SERO)  
SCIENTIFIC AND ETHICAL REVIEW COMMITTEE (SERC)**

**PROJECT APPROVAL FORM**

PROJECT No. EHNRI/SERO/SERC/03/2002

**PROJECT TITLE**  
2010 Ethiopian Demographic and Health Survey

**COMMENT OF SERC**  
The above entitled project has been reviewed and was found to be scientifically valid and ethically clear. The outcome of the project is expected to provide evidence based information on population, health and nutrition at national level.

**DECISION**  
APPROVED  NOT APPROVED

**SIGNATURE OF THE SERC MEMBERS**

Name	Signatures
1. <u>Dr. Shetudemma</u>	<u>[Signature]</u>
2. <u>Dr. Belete Tegegn</u>	<u>[Signature]</u>
3. <u>Getachew Adhiso</u>	<u>[Signature]</u>
4. <u>Dr. Aseged Woldeu</u>	<u>[Signature]</u>
5. <u>Melke Tadesse</u>	<u>[Signature]</u>
6. <u>Abebe Bekete</u>	<u>[Signature]</u>
7. _____	_____
8. _____	_____

Date of Approval Sept. 3

COMMENT AND FINAL DECISION OF THE INSTITUTE'S DIRECTOR

OK

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

APPROVED

NOT APPROVED [ ]



NAME \_\_\_\_\_

TSEHAYNESH M. ESSELE (PhD)  
Director General

SIGNATURE \_\_\_\_\_

*[Handwritten signature]*

DATE \_\_\_\_\_

**b. Approval letter to use EDHS 2011 raw data (translation below)**

00871/45/17  
5/4/2005



ለኢትዮጵያ ማዕከላዊ ስታትስቲክስ ኤጀንሲ  
አዲስ አበባ

ጉዳይ:- የ2011 Ethiopian Demographic and Health Survey የመረጃ ጥያቄን ይመለከታል

የመስሪያ ቤታችን የስራ ባልደረባ የሆኑት አቶ መስረት አሰፋ የኔሁን በደቡብ አፍሪካ ኬፕ ታውን የኒሽርሲቲ የድህረ-ምረቃ ትምህርታቸውን በ Public Health Epidemiology መርሃ-ግብር እየተከታተሉ የሚገኙ ሲሆን የመመረቂያ የምርምር ስራቸውን በ Ethiopian Demographic and Health Survey, 2011 ላይ ለማድረግ ይፈልጋሉ።

በመሆኑም የ 2011 የ Ethiopian Demographic and Health Survey ጥሬ መረጃ (Raw Data) ለምርምሩ ይረዳቸው ዘንድ በመስጠት ትተባበሯቸው ዘንድ የተለመደ የስራ ትብብራችሁን እንጠይቃለን።



ከሰላምታ ጋር  
ምህረት ህሉና ንጉሜ  
የአርሶ አደር የጤና ማዕከልና የጊዜያዊ መዘናኛ  
ዳይሬክቶሬት ዳይሬክተር

**ግልባጭ፣**

- ለአርሶ አደር ጤና ማዕከል ስራ ለማስፈጸም የሚያስፈልጉት ጤና ጥበቃ
- ለአቶ መስረት አሰፋ የኔሁን ባሉበት

Translation of the above letter

To Ethiopian Central Statistics Agency

Addis Ababa

Subject: **Request for the 2011 Ethiopian Demographic and Health Survey data**

Mr. Meseret Aseffa Yenehun, who is staff of the organization (Ministry of Health), is doing his Postgraduate Degree in Public Health Epidemiology at the University of Cape Town, Cape Town, South Africa and he has planned to conduct his dissertation using Ethiopian Demographic and Health Survey 2011.

This is therefore to kindly request your organization to give the raw dataset of Ethiopian Demographic and Health Survey 2011.

Sincerely yours,

Signature

Mihret Hiluf Nigussie

Agrarian Health promotion and Disease

Prevention Directorate Director

CC:

- Agrarian Health promotion and Disease Prevention Directorate  
Ministry of Health
- Mr. Meseret Aseffa Yenehun

**c. Letter of approval from UCT Research Ethics Committee**

UNIVERSITY OF CAPE TOWN



Faculty of Health Sciences  
Human Research Ethics Committee  
Room E52-24 Groote Schuur Hospital Old Main Building  
Observatory 7925  
Telephone [021] 406 6338 • Facsimile [021] 406 6411  
e-mail: [shuretta.thomas@uct.ac.za](mailto:shuretta.thomas@uct.ac.za)  
Website: [www.health.uct.ac.za/research/humanethics/forms](http://www.health.uct.ac.za/research/humanethics/forms)

24 May 2013

**HREC REF: 298/2013**

**Mr M A Yenehun**  
**c/o Ms M Cornell**  
Public Health & Family Medicine  
Falmouth Building

Dear Mr Yenehun

**PROJECT TITLE: ASSOCIATION BETWEEN HOUSEHOLD WEALTH STATUS AND HIV PREVALENCE IN ETHIOPIA**

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

**Approval is granted for one year till the 30<sup>th</sup> May 2014**

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: [www.health.uct.ac.za/research/humanethics/forms](http://www.health.uct.ac.za/research/humanethics/forms))

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

**Please quote the HREC. REF in all your correspondence.**

Yours sincerely

**PROFESSOR M BLOCKMAN**  
**CHAIRPERSON, FHS HUMAN ETHICS**

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

s.thomas

# Appendix C

## Instructions for authors: Tropical Medicine & International Health

From Tropical Medicine and International Health Journal website:

[http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1365-3156/homepage/ForAuthors.html](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-3156/homepage/ForAuthors.html), accessed 30/11/2013

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Authorship is constituted by significantly participating in

*(1) conception and design of the study;*

*(2) analysis and interpretation of data;*

*(3) drafting the paper or substantially revising it.*

To be an author, each contributor must have participated in drafting or revising the paper **and** in at least one of the other two categories.

- For animal or human studies that involve data collected actively and purposely, we require a signed statement from the corresponding or primary author that ethical approval was granted by the Ministry of Health or another appropriate institution in the country where the research was conducted **and** by ethical approval committees of affiliated research institutions elsewhere, if applicable.

### **Text**

The text should follow the IMRD format. Abstracts must not exceed 250 words and be structured into Objectives, Methods, Results and Conclusions.

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Authors should refer to the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals* (<http://www.icmje.org/index.html>) published by the International Committee of Medical Journal Editors. Briefly, the methods section should include a clear description of the eligibility and exclusion criteria for the study, and a description of the source population. Statistical methods should be described with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When data are summarised in the Results section, give numeric results not only as derivatives (e.g. percentages) but also as the absolute numbers from which these were calculated. Restrict tables and figures to those needed to explain the argument of the paper and to assess its support. Use graphs as an alternative to tables with many entries; do not duplicate data in graphs and tables. Avoid non-technical uses of technical terms in statistics, such as 'random' (which implies a randomizing device), 'normal', 'significant', 'correlations', and 'sample'. Appropriate indicators of uncertainty (such as confidence intervals) should be presented, and reliance solely on statistical hypothesis testing, such as the use of *P* values, should be avoided as this fails to convey important information about effect size.

### **Declarations of Interest**

Authors must acknowledge and declare any interests and sources of funding, such as receiving funds or fees by, or holding stocks and shares in, an organisation that may profit or lose through publication of their paper. Declaring a competing interest will not lead to automatic rejection of the paper, but we would like to be made aware of it.

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## Appendix D: Supplementary Tables

### a. Association between wealth and HIV prevalence stratified by gender

Gender is a very important determinant of health as the burden of disease varies by gender, hence stratified analysis by gender is common in health research. There is a strong association between wealth and HIV prevalence in Ethiopia when the analysis is not stratified by gender. When stratified by gender, women in the highest wealth quintile had highest HIV prevalence and the magnitude of the association increases with increasing wealth. Among men, those in the highest wealth quintile had highest HIV prevalence. However, the wealth gradient in HIV prevalence was weaker compared to women as those in the fourth wealth quintile did not have statistically significant higher prevalence of HIV compared to the lowest quintile.

Another important variable influencing HIV prevalence is age. The HIV prevalence varies between women and men at different age categories. Our analysis shows that the highest HIV prevalence is between 25 to 39 years of age among women and 35 to 44 years of age for men. Women aged between 15 to 19 years had a higher prevalence of HIV than men in the same age category. The protective effect of being resident in rural areas was also higher among men than women; 61% and 56% protective effect respectively.

The effect of education on HIV prevalence varied between men and women. Though the univariate analysis did not show significant difference, the multivariate analysis shows that women with primary and secondary education had statistically significant higher prevalence of HIV than those with no education, whereas the difference in HIV prevalence was not significant among men with primary and secondary education compared to no education. The protective effect of higher education was almost statistically significant among men, but statistically insignificant among women. This may indicate that though women have the same level of education, the burden of HIV is still higher which may be attributed to other unexplained factors such as social influence.

Table 1A Univariate and multivariate models\* examining associations with HIV prevalence for women and men

Baseline characteristics	Crude for women OR (95% CI)	Model I* for women OR (95% CI)	Crude for men OR (95% CI)	Model I* for men OR (95% CI)
<b>Wealth index</b>				
Lowest	1.00 (ref)	1.00(ref)	1.00 (ref)	1.00 (ref)
Second	1.08 (0.42-2.81)	1.07 (0.41-2.81)	1.73 (0.51-5.93)	1.78 (0.51-6.21)
Middle	1.60 (0.66-3.89)	1.57 (0.64-3.84)	3.14 (1.04-9.51)	3.11 (1.01-9.60)
Fourth	3.29 (1.52-7.11)	2.95 (1.31-6.61)	2.51 (0.76-8.36)	2.20 (0.67-7.25)
Highest	11.31 (5.84-21.92)	4.20 (1.83-9.64)	15.20 (6.20-37.28)	6.34 (1.68-23.95)
<b>Age categories(yrs)</b>				
15-19	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
20-24	4.39 (1.91-10.09)	3.55 (1.47-8.60)	9.32 (1.51-57.50)	8.33 (1.30-53.33)
25-29	14.65 (6.88-31.18)	11.32 (5.14-24.92)	40.37 (6.99-233.08)	28.83 (5.51-150.9)
30-34	18.71 (8.54-40.99)	13.76 (6.00-31.55)	44.16 (9.14-213.27)	24.19 (4.37-133.9)
35-39	15.11 (6.48-35.24)	10.35 (4.05-26.43)	132.33 (28.33-618.07)	91.96(17.33-487.9)
40-44	9.18 (3.93-21.43)	6.41 (255-16.13)	93.53 (19.40-450.77)	61.43 (11.00-343.0)
45-49	9.05 (3.63-22.53)	4.67 (1.69-12.94)	60.07 (12.20-295.90)	46.81 (8.34-262.8)
<b>Place of Residence</b>				
Urban	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Rural	0.15 (0.10-0.21)	0.44(0.24-0.81)	0.14 (0.09-0.24)	0.39 (0.13-1.19)
<b>Religion</b>				
Orthodox	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Catholic	0.94 (0.22-4.03)	0.70 (0.23-2.23)	1.16 (0.16-8.23)	1.42 (0.18-11.31)
Protestant	0.27 (0.15-0.48)	0.36 (0.20-0.65)	0.52 (0.26-1.06)	0.70 (0.34-1.46)
Muslim	0.32 (0.20-0.52)	0.48 (0.29-0.79)	0.23 (0.11-0.47)	0.29 (0.14-0.64)
Traditional	0.01 (0.002-0.09)	0.02 (0.003-0.19)	1(omitted)	Omitted
Other	0.97 (0.23-4.09)	1.35 (0.14-12.89)	0.98 (0.13-7.18)	Omitted
<b>Marital Status</b>				
Never in union	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Married	2.71 (1.61-4.55)	1.73 (0.95-3.14)	5.18 (2.77-9.67)	1.65 (0.72-3.78)
Living with partner	7.06 (2.78-17.89)	3.41 (1.36-8.53)	14.43 (5.33-39.05)	2.51 (1.06-5.93)
Widowed	26.12 (14.17-48.16)	16.58 (8.01-34.33)	50.10 (15.97-157.17)	19.33 (4.53-82.54)
Divorced	8.82 (4.67-16.66)	4.01 (1.99-8.08)	16.44 (5.83-46.38)	4.44 (1.52-12.96)
Separated	13.35 (6.65-26.80)	4.30 (1.88-9.85)	53.79 (17.06-169.62)	9.64 (2.73-34.06)
<b>Educational level</b>				
None	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Primary	1.72 (1.65-2.55)	1.86(1.19-2.91)	1.38 (0.72-2.65)	1.23 (0.61-2.47)
Secondary	3.44 (1.80-6.57)	2.19 (1.07-4.50)	3.09 (1.55-6.16)	1.18 (0.50-2.76)
Higher	1.21 (0.57-2.58)	0.57 (0.25-1.30)	1.91 (0.91-4.02)	0.40 (0.15-1.07)

\* Model I adjusted for all variables shown (Age, gender, place of residence, religion, marital status and educational level)

## b. Comparison of those that did and did not have HIV test

Table 2A is an analysis to check whether the participants who were tested for HIV and included in the analysis had similar demographic and socioeconomic characteristics to those not tested for HIV. If those tested for HIV were different from those who were not tested, it may lead to bias. However, the table shows that those who are tested and not tested for HIV have similar in most of the variables. However, there are some exceptions:

- Higher proportion of people was in the highest wealth quintile among those not tested (46%) than tested for HIV (24%).
- Those who were tested were more likely to be from rural areas (78%) than not tested for HIV (57%)

However, due to the non-proportional allocation of the sample to the different regions and to their urban and rural areas, sampling weights were used for analyzing the 2011 EDHS data to ensure representativeness of the survey results at the national and subpopulation levels. There are three types of weights in the DHS data namely household, individual (women and men) and HIV weights. The HIV sample was reweighted to adjust for non-response. These weights were used to adjust for differential probabilities of selection within households, differential non-response and residual discrepancies between the sample and the population on a profile of census demographic and geographic variables.

Table 2A Baseline characteristics of sample stratified by HIV testing (sensitivity analysis)

Baseline characteristics	Total (%) (N=31 905)	HIV tested (%) (N=29 812)	No HIV test (%) (N=2 093)	P-value*
Household Wealth Index				
Lowest	17.4	17.7	13.3	<0.0001
Second	18.5	18.8	13.1	
Middle	18.9	19.2	12.5	
Fourth	20.1	20.4	15.4	
Highest	25.1	23.9	45.8	
Age: mean(yrs)	29.0	28.95	29.05	0.8491
Categories (yrs)				
15-19	23.9	23.9	24.3	<0.0001
20-24	17.9	17.9	17.3	
25-29	18.6	18.5	18.6	
30-34	12.1	12.1	12.1	
35-39	12.2	12.2	10.5	
40-44	8.1	8.1	9.1	
45-49	7.3	7.3	8.2	
Gender				
Female	53.9	54.3	47.3	<0.0001
Male	46.1	45.7	52.7	
Religion				
Orthodox	48.1	47.8	53.0	<0.0001
Catholic	1.0	1.0	1.2	
Protestant	20.5	20.8	15.8	
Muslim	28.4	28.4	28.4	
Traditional	0.8	0.7	0.9	
Other	1.2	1.2	0.8	
Marital Status				
Never in union	32.9	32.4	42.1	<0.0001
Married	56.8	57.4	45.8	
Living with partner	3.2	3.2	4.1	
Widowed	1.9	1.9	2.4	
Divorced	3.7	3.7	4.1	
Separated	1.4	1.4	1.6	
Place of residence				
Urban	23.0	21.9	42.7	<0.0001
Rural	77.0	78.1	57.3	
Educational level				
None	42.4	42.8	36.2	<0.0001
Primary	44.0	44.3	38.3	
Secondary	8.0	7.8	12.1	
Higher	5.6	5.2	13.4	