Spatial Variations in HIV/AIDS:
A case study of Kenya within Sub-Saharan Africa

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This paper analyses the link between increased mobility of individuals through education and work as a determinant of the risk of contracting HIV/AIDS in a Sub-Saharan African setting. Using data compiled from Demographic Health Survey and UN databases, regions at the nation state and district level are assessed according to levels of wealth and education to try and prove a positive correlation between these factors and levels of HIV prevalence. A key aim of this project is to try and prove this link at a micro as well as macro level of analysis, and show that HIV/AIDS is not necessarily correlated to areas of poverty.

Introduction

An understanding of culture is crucial to a study of the Human Immunodeficiency Virus (HIV) and the global variations in its prevalence. It is frequently assumed that affluent countries have escaped the strongest influence of the virus because they have both health care and educational systems that prevent the spread of epidemics. However if one looks at some of the basic history of the HIV virus it is clear that this is not the case. The first crisis of HIV and the disease it causes, Acquired Immune Deficiency Syndrome (AIDS) occurred in the USA in the 1980s, one of the richest countries in the world (MacQueen 1994).

Today Sub-Saharan Africa is in the midst of a HIV/AIDS crisis, and with it the stigma that AIDS is a virus of poverty. The ActionAid website states that "the HIV/AIDS crisis in developing countries is inextricably linked with poverty" (ActionAid 2003). Once seen as being a 'gay' virus, and now seen as being a 'black' virus, HIV/AIDS is now associated with images of poverty and suffering, something previously acquainted with stereotypes of famine in Ethiopia (Craddock 2004). This paper will outline the case that it is impossible to assume that the HIV virus targets only one subset of the population equally, and highlight a hypothesis that cultural influences are the best level of analysis for AIDS, irrespective of whether the research is based in the developed or developing world.

This study focuses on the level and direction of correlation between HIV prevalence in the general population in Sub-Saharan Africa based on indicators of wealth and schooling. There will be analysis at the nation state level, and also regional analysis within Kenya to examine the extent that trends observed at the continental scale apply at a micro level. The paper will postulate that contrary to widely held beliefs about AIDS and poverty in Africa, in general, it is groups of people that are of higher economic status and those who have received the most schooling that are at most risk from contracting HIV/AIDS.

The three aims of the study are:

1) To identify key factors that influence HIV prevalence, and explain how these factors are dependent on social and economic influences.

2) To assess statistically the extent that education and wealth are positive indicators of HIV prevalence within Sub-Saharan Africa.

3) Through analysis of the spatial variation of education and wealth within Kenya, determine the correlation of these two factors with HIV prevalence at a regional scale.

The spread of HIV

HIV/AIDS has a unique pattern of dispersal, as the primary method of transmission is heterosexual intercourse (Stein 2000). Most illnesses such as TB, influenza and SARS are spread by proximity, leading to an easily demonstrated geographical pattern of growth (MacQueen 1994). Viruses such as malaria are carried by parasites that create an even spatial infection pattern limited to areas where the parasites can breed. However HIV is spread by intercourse, an act that requires a high degree of intimacy, which leads to very different patterns of spread and risk (Shannon, Pyle and Bashshur, 1990). As there is still no cure or vaccine for HIV/AIDS, quality of health care is not necessarily a barrier to the spread of the virus itself, as infected people can continue to infect others regardless of success in treating or identifying the symptoms.

To understand how HIV spreads, this paper will draw on three models of transmission: reproductive health, sexual networking and sexual culture. The first model describes the chance of a person contracting HIV through intercourse with an infected person. The second level of analysis describes the number of sexual links a person partner has. Sexual culture defines the societal norms relating to the discussion of sex, norms about polygamy, and the level to which intercourse is seen as deviant in society. By analysing all these factors together we can build an strong framework for understanding the regional variations in HIV and AIDS.

Variance in Transmission

HIV can be transmitted by direct contact of many bodily fluids, such as blood, semen, saliva, vaginal secretions and breast milk. Important methods of transfer are needle

sharing, intercourse, blood transfusions, birthing and breast feeding. Although needle sharing for intravenous drug use is very low in Sub-Saharan Africa (UNODC 2003), it is important to note that in areas where health care budgets and expertise is low, needles are often reused within health clinics without sterilisation (Oppong and Kalipeni 2004). This could be an important method of transmission in some parts of Africa.

Heterosexual intercourse is the most common method of HIV transfer (Johnson and Laga 1988, Sherr 1993) and in Kenya accounts for 74% of infections (Republic of Kenya 1991), despite being a relatively inefficient method of transfer. It is estimated that only one in one thousand sexual acts with an otherwise healthy infected partner actually leads to contraction of the virus (Bloor 1995). However this factor can be increased substantially by the presence of other sexually transmitted diseases such as genital warts and herpes sores which provide more open wounds for infection (Stein 2000). Typically, regions of economic poverty are those with higher prevalence of Sexually Transmitted Diseases (STD's), as the diagnosis and treatment of medical conditions is poor (Rugalema 2004).

Reproductive Health

Reproductive health analogies, based on methods used to assess factors that effect contraception, can be borrowed here to look at the likelihood of contracting HIV. A model of reproductive determinants is usually used in demographic analysis to measure the potential fertility of subject groups in developing countries, but the proximate determinants are similar for pregnancy and HIV infection. The intention is not to suggest that conception is analogous to a viral infection, but to use these ideas as a framework for assessing the likelihood of a person to contract HIV from intercourse. Indeed with regards to HIV infection these factors are equally applicable to men as well as women.

The model in Figure 1 describes factors that effect the frequency of intercourse, and probability of conceiving. If a person is very young or very old they are unlikely to be sexually active, and if a couple is living together, they are more able to have regular intercourse. Cultural norms will influence intercourse greatly; some societies

may not tolerate sex before marriage, and after marriage there are norms that dictate if married couples live together (Caraël 1997). Demographers are familiar with using these factors to predict fertility, but many of the factors can also be applied to HIV infection risks.

Frequency of Intercourse
Age Age at first marriage/intercourse Religion/cultural influence Communal living Polygamy Education Health care Societal Norms
Probability of Conception after Intercourse (or contracting HIV from intercourse)
Health Age Contraceptive use Fertility Sterility
Successful Gestation (time from HIV to AIDS)
Nutrition Health Previous pregnancies Sanitation/Clean water Health care Abortion

Figure 1 After Bongaarts 1983
(factors in grey applicable only to reproduction)

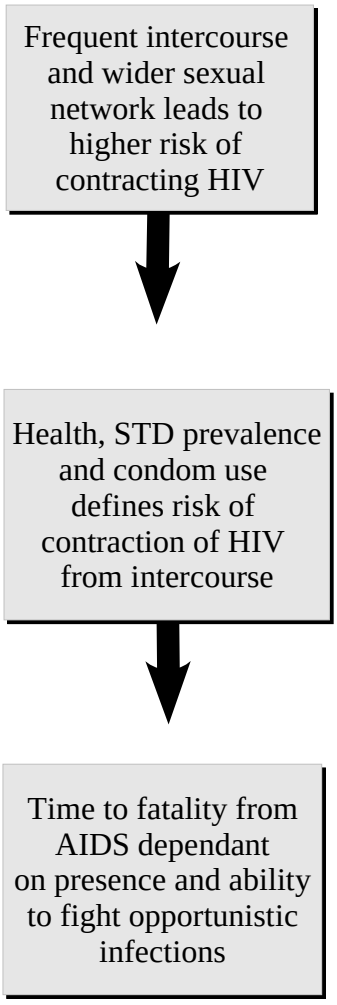


Figure 2 Determinants of intercourse based HIV infection

All factors that increase the frequency of intercourse make it more likely for a person to become infected with HIV, especially considering the low rates of transmission. These factors are outlined in the first section of Figure 1. This risk is also increased by the second set of factors in the table, based on the use of barriers against infection (esp. condoms) and health, especially with regard to STDs that provide open wounds for infection. It could also be considered that there is an equivalent 'gestation period' from infection with HIV to development into full blown AIDS, and it proving fatal. This period is based on the health of the infected person at infection and after infection, and

especially the local conditions that may increase the likelihood of secondary infections that eventually weaken the immune system and lead to death. HIV itself is not fatal – but the weakening of the immune system leaves the body open to opportunistic infections from which the body is unable to recover (Stein 2000).

Figure 2 illustrates the three different risk stages of HIV infection and development of AIDS as a parallel to determinants of fertility. It should be noted that the model is equally applicable to economically rich and poor nations. However in much of Sub-Saharan Africa where health care and sanitation is lacking, AIDS kills much quicker than in more economically developed countries because of the high presence of secondary illnesses (French et al. 2000).

Fertility in the conception model can be alluded to virility of a strain of HIV and viral load of an infected partner. In in the initial and final stages of HIV infection viral load is very high, and thus the virus is much more likely to be transmitted by intercourse (MacQueen 1994).

Sexual Culture

Many of these factors described above would seem to point to a model where the economically disadvantaged are those at highest risk from contracting HIV from intercourse, due to the relative expense of condoms, lack of diagnosis and treatment for STD's, poor nutrition and lack of preventative education about HIV. However the societal influences that lead to education about sexual awareness and norms for sex and marriage can have an influence on this regardless of monetary influences. Herdt calls this the 'sexual culture' of a region, and defines this as:

> "*a consensual model of cultural ideals about sexual behaviour in a group*"
>
> – Herdt 1997

Many authors have noted that sexual culture in many, but not all, African nations is much more liberal than in the West. To encourage higher fertility, many cultures do not socially prohibit polygamy, sex before marriage and infidelity (Caldwell and Caldwell 1987, Watkins 2000, Shannon et al. 1990). Thus it can be clearly seen that the potential

for a sexually transmitted disease to spread is very high in such cultures considering the high number of people who had multiple sexual partners. However it has been recently noted that with the influence of Western culture, and in particular Christianity, there has been a drop in the number of polygamous unions (Kaleeba 2004). Despite this there is still an underlying cultural understanding that men are not naturally inclined to be in monogamous relationships, so the use of prostitutes is not always seen as being immoral (Olubuloye 1997). Sex-work is also more casual than in some Western cultures, with many women taking on occasional sex for money to supplement income, especially with regards to bar work (Lyons 2004).

Sexual Networking

Although sex with a large number of partners will only increase the chance of conception if there are significant levels of sterility in a region, it is normally not an important influence. Therefore the reproductive determinant model above also does not take into account what is probably the biggest influence in HIV infection, sexual networking. While most people can be considered to be fertile, most people do not have HIV, so the number of past indirect sexual contacts a person has (ie how many people one has had intercourse with) has a large effect on the likelihood of having intercourse with a HIV infected person (Rothernberg et al. 1997). These sexual networks can be defined as "groups of persons who are connected to one another sexually" (Wohlfeiler and Potterat 2003) through both monogamist and concurrent relationships where one person in a union has more than one sexual partner at a time. Concurrent sexual relationships carry a high risk of HIV transmission, especially as partners often revisit old unions. This is particularly true for males in migratory work such as miners, army workers and truck drivers. Often these groups of people will have a girlfriend or regular sex worker in the region in which they work as well as at home (Bloor 1995).

One could assume that it is the wealthier countries who have higher levels of migratory work as the economy has shifted from subsistence production to mining export based industries, and with it an infrastructure that needs large numbers of miners and truck drivers. Thus the richer countries in Africa may have higher rates of HIV than those with no form of migratory work.

Sexual networking also takes place in a local context within the workplace and educational institutions. It has been shown that women who work in factories tend to be more aware of contraceptive methods due to informal networking with fellow colleagues on the subject (Agadjanian 2000). Perhaps social networking in the workplace could also lead to increased sexual networking, where people have sexual unions with people they have met through work. This would provide a much wider sexual network, possibly across an urban area, and hence higher risk for those people who took part in workplace unions. Types of work in more economically advanced countries may be even dangerous to HIV infection if companies can afford a high degree of mobility. Large businesses may include long national and international business trips, greatly increasing the spatial area of the sexual network if any unions are formed as a result of this travelling. Cheap air travel has allowed sexual networks to bridge societies and cultures across the globe, greatly increasing the chance of contracting a foreign infection even if it is not rife in the local population (Klovdahl 1985). Again this would suggest higher HIV rates in more economically developed countries.

Education

Education and awareness is frequently cited as a key method to reduce the spread of HIV (Mbuga 2003). However there is some evidence that schooling is not being effective enough at preventing HIV. A recent ActionAid report suggested that many schools do not have the proper materials or staff training to educate students about HIV, and despite classes being scheduled in the curriculum, teachers are often absent or embarrassed to discuss sexual health (Boler, Ibrahim, Adoss and Shaw 2003). The same survey found that 44% of students stated that casual sexual relationships are common in school. This is in line with other research that shows a high level of sexually active pupils in secondary schools (Mbugua 2004, Oloko and Omoboye 1993). Thus rather than being a process that reduces the risk of HIV, schooling may in fact be an important transmission ground, and may also allow a wider sexual network when schools serve a large region. Indeed if one considers those who go on to higher education, these institutions are usually situated in major urban areas and attract students of the most sexually active age from all over the country, even internationally. It could therefore be expected that countries with higher levels of education and wealth would have

correspondingly high numbers of HIV infections (Kirunga and Ntozi 1997, Hargreaves and Glynn 2002).

Data

The study uses data from three main sources. The national level dataset comes from the 2002 UNDP Human Development Index 2002, using HIV prevalence data from the same publication based on 2001 data, as this is the most recent revision. There are 33 Sub-Saharan African countries in the study, omitting only those nations for which complete data was not available.

The indicator for wealth used in the study is GDP (Gross Domestic Product) is measured in 2000 US dollars, adjusted for purchasing power parities (PPP). This is a well studied variable which is more applicable to local costs of living and culture than GNI or other economic indicators. To measure educational variation, the variables of adult literacy and enrolment ratios are used. Adult literacy is a good measure of the effectiveness of schooling, and educational enrolment ratios indicate the combined primary, secondary and tertiary gross enrolment ratio (UNDP 2002). This shows average length of schooling in a nation and forms a good indication of the proportion that go onto higher education. If the theory of sexual networking in schools is accurate, one would expect countries with a high proportion of tertiary education to have higher levels of HIV.

The Human Development Report provides indices (where the highest possible score sets the highest value of 1 and the lowest of 0) and nominal data. Nominal data is used in the study as the index system could have a tendency to exaggerate trends. However a compound non-weighted figure for the GDP index as added to the education index is included to allow later assessment of whether GDP is an indicator of education and vice versa. An index scale is the only way to properly weight and combine these two variables.

For the regional Kenya study, the main source of data is the Kenya Demographic and Health Survey (DHS) of 1998 which is based on over 7000 interviews. This survey has a focus on demographic and health centred issues, and may have a tendency to

oversample rural areas. From this a composite indicator of wealth status is published, based on the presence of material factors such as radios, house building materials etc. which provides a relative scale of wealth. This was rescaled so that the a region with the average wealth index scored a value of 1 to remove negative values. For all other indicators answers to individual survey questions were averaged, and this mean used for the region. Invalid or missing responses were removed from the survey before calculating averages. Also included are responses to questions on condom use, age at marriage, and age at first intercourse to provide context and show regional variety in social norms and act as predictors of HIV.

HIV prevalence data came from the 2001 Kenya NASCOP surveillance system, based on HIV prevalence in women attending antenatal clinics in rural and urban areas of Kenya. There was some discrepancy between the names of regions used between the two sources, due largely to agglomerations of political boundaries and regional differences in spelling. These were checked against political boundaries as defined by the government of Kenya electoral boundaries (KenyaWeb 2002). This process also removed some adjacent regions that gave duplicate data. These were assumed to be part of the same district, and the duplicate region excluded from analysis. The tables in Appendix E shows the full dataset. Maps were created based on a UN base map of the districts, digitised for this project in an ArcGIS system to display spatial representation of variance in the data. In total there are 33 regions in the study which have data for both DHS surveys and NASCOP data. Data was incomplete for many of the scarcely populated regions in the north of the country.

It is important to note that the two Kenya sources represent different levels of analysis. Both are sample based, however the DHS survey is based on individual responses, not regional figures as the data in the NASCOP database is, although the DHS data has been interpreted at a regional level. This means that there is no direct correlation between the people who answered the survey and their personal HIV status, only averages for their region. Even so the presence of excellent DHS and HIV datasets were a key reason to choose Kenya for this study. It also represents a medium level HIV epidemic.

Data from the raw Kenya DHS database was grouped according to region of recipient,

and key variables were selected for analysis. Mean figures were calculated for these variables by region, and these were matched with regional HIV prevalence data (Appendix E). These variables were then run through correlation and regression tests to assess strength of relationships at linear, cubic and quadratic levels. The regional data was also inserted into a GIS mapping system to spatially demonstrate the variance of HIV and its determinants especially with regards to the railway network. Infection in major cities was also mapped using data from the United States Census Bureau surveillance database, to demonstrate higher HIV rates on cities close to the railway.

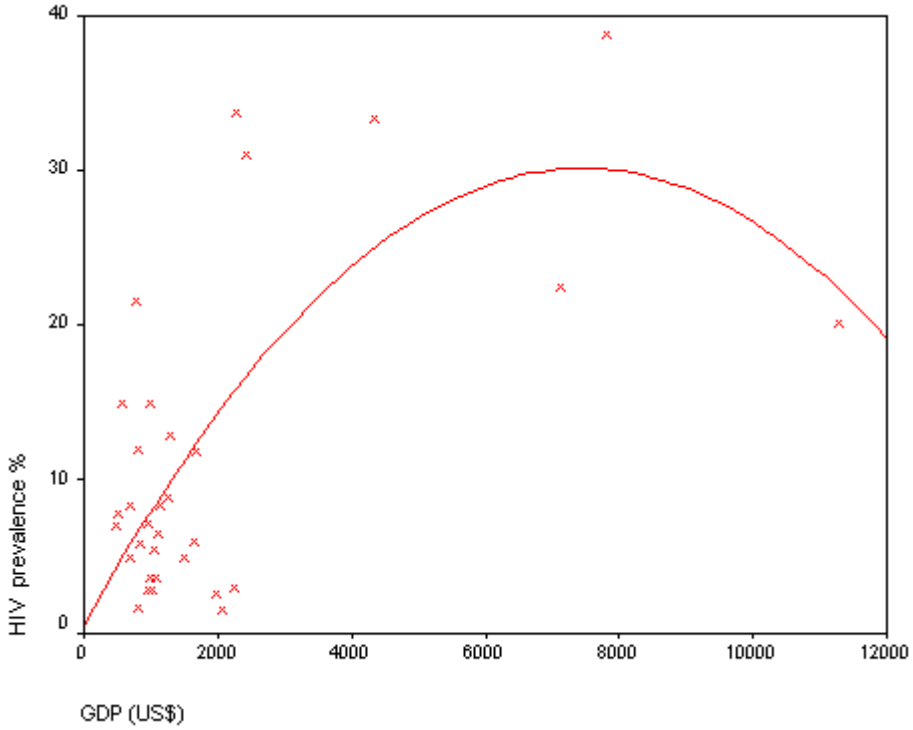
Most prevalence rates published for HIV/AIDS for developing countries are actually based on whether women, usually at post-natal clinics, test positive for the HIV virus in blood samples (NASCOP 2002). Women are socially and biologically more likely to contract HIV than men (Laga et al. 2001, Commonwealth Secretariat, UNDP 2001), and obviously all patients at a post-natal clinic are sexually active, and therefore represent a higher risk group than the general population. It can therefore be concluded that this data represents HIV prevalence levels that are higher than the general population, as the sample is comprised entirely of sexually active women. This would positively skew results, but presumably to the same extent for each figure. No country conducts random HIV tests at a significant national level.

Results for National Data

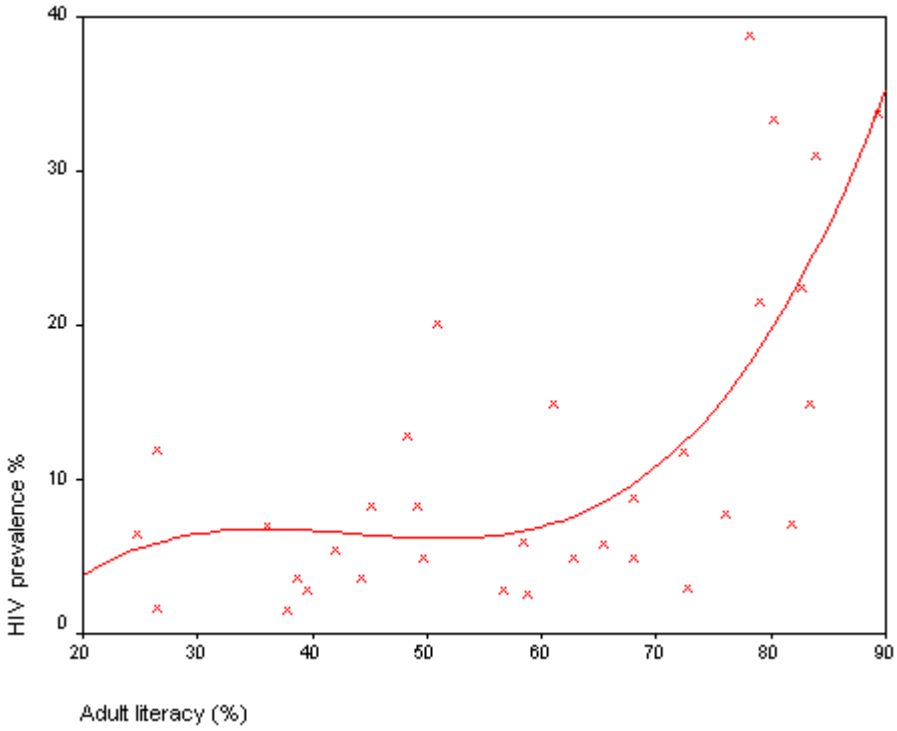
Table 1 R-squared co-efficients for indicators at nation state level

	HIV prevalence (%)	Combined Education and GDP index	GDP (US$)	Adult literacy (%)	Educational Enrollment Ratios
HIV prevalence (%)	-	.730	.567	.595	.509
Combined Education and GDP index	.730	-	.795	.734	.740
GDP (US$)	.567	.795	-	.247	.538
Adult literacy (%)	.595	.734	.247	-	.531
Educational Enrolment Ratios	.509	.740	.538	.531	-

Shaded boxes indicate correlation is significant at the 0.01 level (2-tailed test).



Graph 1 **GDP (US$ ppp) against HIV in Sub-Saharan Africa, cubic line of fit**



Graph 2 **Adult Literacy (%) against HIV in Sub-Saharan Africa, quadratic fit**

The results at the nation state level show a very high degree of positive correlation between the two key socio economic factors and HIV prevalence based on linear Person tests for significance. GDP and adult literacy explain 56.7 and 59.5 percent of the trend in HIV variance, respectively. These are both significant correlations at the 99% confidence level. Education enrolment levels are a weaker predictor of HIV variance than adult literacy, but still highly significant. The combined index of GDP and education is the strongest predictor of HIV prevalence, explaining some 73% of the trend. We clearly find that education and GDP are positively correlated to HIV levels.

There is also significant correlation between GDP and educational enrolment levels, but interestingly not between GDP and adult literacy. There is strong correlation between the GDP/education index and education levels and GDP, but this should be discounted as they are direct measures of each other. All variables demonstrate a positive relationship.

The significance of the trend is increased greatly by the use of cubic and quadratic analysis over the linear methods represented in Table 1. Graph 1 showing GDP and HIV suggests a quadratic relationship, which increases the r-squared value by 0.12 over the linear analysis. This is interesting because it shows an inverted U-shaped curve, where by the richest nations seem to have relatively low HIV levels.

Conversely an exponential curve seems to be present in the data for adult literacy and HIV, as a cubic fit line gives an increase in significance of 0.17 over linear analysis. Thus we can conclude that there is a statistically significant correlation between HIV variance and GDP or education. This does not however prove a causation, and to check the validity of the theory we should look also at the trends at a local level.

Results of Regional Data

Table 2 **R-squared co-efficients for indicators at the regional scale (Kenya)**

	Av. Years of Education	Wealth Index	% HIV NASCOP	% currently use condom	% have piped water	Av. Age at Marriage	Av. Age at first Intercourse
Av. Years of Education	-	.811(**)	.236	.197	.598(**)	.282	.210
Wealth Index	.811(**)	-	.286	.207	.826(**)	.280	-.024
HIV NASCOP	.236	.286	-	.203	.244	-.127	-.177
% currently use condom	.197	.207	.203	-	.370(*)	.136	-.125
% have piped water	.598(**)	.826(**)	.244	.370(*)	-	.305	-.073
Av. Age at Marriage	.282	.280	-.127	.136	.305	-	.576(**)
Av. Age at first Intercourse	.210	-.024	-.177	-0.13	-.073	.576(**)	-

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

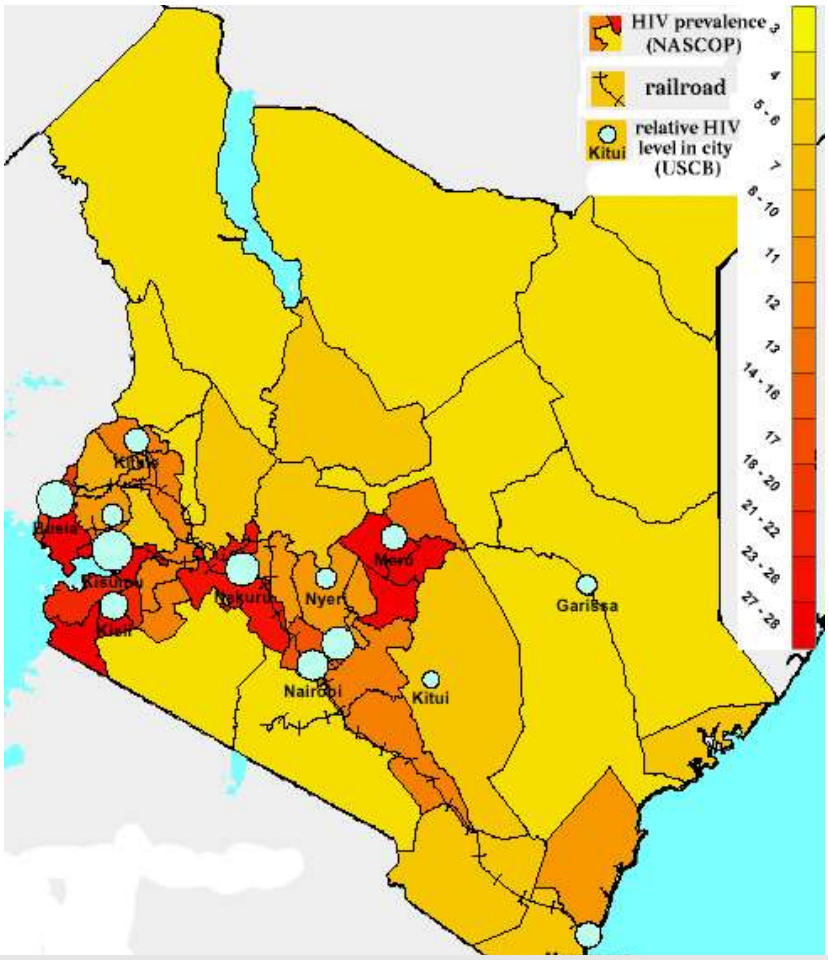
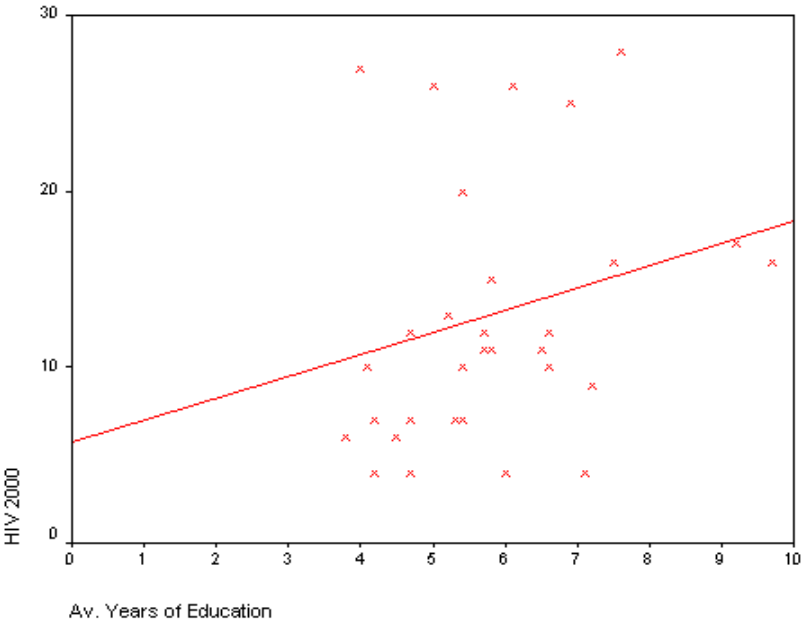
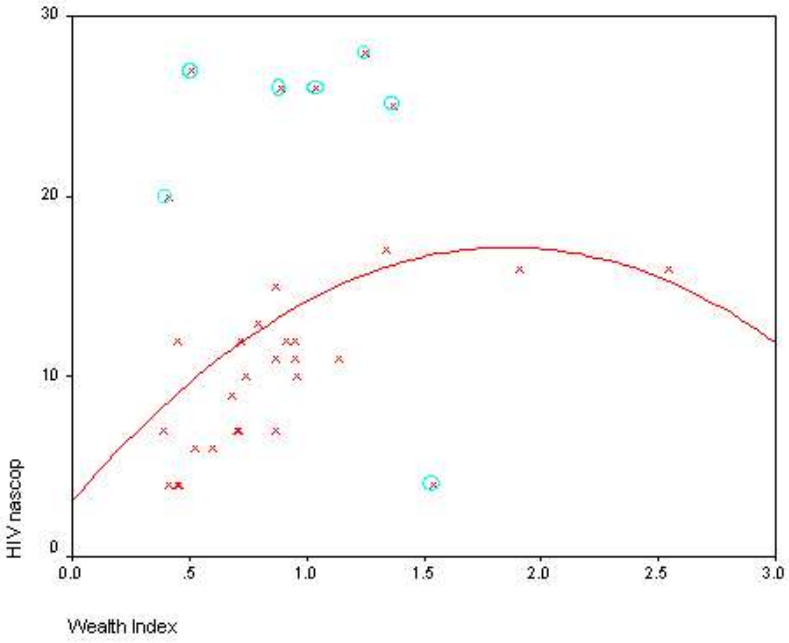


Figure 3 **Spatial variation of HIV within Kenya, NASCOP regional surveillance**



Graph 3 **Average Years of Education against HIV in Kenya, linear fit**



Graph 4 **DHS Wealth Index against HIV in Kenya, cubic fit, outliers in blue**

The data in this first model shows a very low level of correlation between HIV and the key indicators, with the average number of years of education in a region explaining only 23.6% of HIV prevalence, and the wealth index accounting for just a little more at 28.6%. Neither of these variables are statistically significant. However, the direction of the trend in both cases is still positive. Wealth is still strongly and significantly

positively correlated with education, as one would expect.

This survey also suggests that the use of condoms as the primary means of contraception has a low positive correlation with HIV, and an opposite trend would surely be expected as condoms are a barrier to HIV transmission (Stein 2000). However it must be noted that even in the region with the highest level of condom use (Elgeyo-Marakwet) only 4.3% of people surveyed used condoms as their primary means of contraception, so this variable is unlikely to have much impact.

The spatial analysis map shows that there are definite clusters of HIV around the central and Western areas around Lake Victoria. They also show regions bisected by the railway network have higher HIV incidence than the surrounding areas. This suggests that the railway is acting as a pathway for HIV infection. Cities on or near the railway also have high HIV levels.

The scatter plot of the data in Graph 3 indicates a very random dispersion for years of education, suggesting no relationship. However the graph of wealth index against HIV seems to show some distinct trends. There is a definite cluster of six points above the main fit line in both graphs. As outliers have a large effect in reducing Pearson values, the clear outliers shown in blue in Graph 4 were removed from the dataset, and the statistics run again with the remaining 24 regions.

Regional Data – Removed outliers

Table 3 **R-squared co-efficients for indicators at regional scale (Kenya), no outliers**

	Av. Years of Education	Wealth Index	% HIV NASCOP	% currently use condom	% have piped water	Av. Age at Marriage	Av. Age at first Intercourse
Av. Years of Education	-	.698(**)	.633(**)	.219	.389	.199	.360
Wealth Index	.698(**)	-	.726(**)	-.007	.681(**)	.180	.020
HIV NASCOP	.633(**)	.726(**)	-	-.169	.244	.232	.116
% currently use condom	.219	-.007	-.169	-	.117	.417	.303
% have piped water	.389	.681(**)	.323	.117	-	.290	.064
Av. Age at Marriage	.199	.180	.232	.417	.290	-	.531(*)
Av. Age at first Intercourse	.360	-.177	.116	.303	.064	.531(*)	-

(**) indicates significant at 0.01 level, (*) significant at 0.05 level

Removing these regions from the study has had the expected effect of making the correlation between wealth and education with HIV strongly significant, in line with the nation state level data. Appendix J shows the difference removal of these outliers has on the line of best fit. This has also reversed the trend where condom use was a positive indicator of HIV, which was illogical. However this model has a lower level of correlation between wealth and education, a correlation that should not decline if it was justifiable to remove certain items of data from the study, as this is a variable known to be correlated.

Most importantly. there is also no clear unifying feature of the removed regions, so there can be no justification for their being excluded in the study. None of the regions removed have a high urban population, are in a particular geographical area, or are selectable by any of the variables in the study. Hence this model must be thrown out, and the null hypothesis of there being no significant correlation between HIV and wealth or education within Kenya cannot be rejected.

Discussion

The results show clearly that there is a high degree of correlation between countries with high levels of HIV and those with high levels of GDP and literacy. Although it is likely that the two indicators are related, as education allows higher incomes, and vice versa, this is still an important trend. Economically active countries in many parts of Africa often have patterns of migrant work, especially in mining, trucking and army communities that leads to high use of sex workers while men are away from their partners at home (Bloor 1995).

Perhaps most significant of all is the presence of what seems to be an inverted bell curve of best fit for GDP at the regional level. This can be seen in graph 1and to a lesser extent graph 4. This suggests a Kuznets curve pattern for HIV and affluence. The Kuznets curve hypothesis is most commonly used to explain the theory of how CO_2 production by a nation varies as it becomes more economically developed (Roberts and Grimes 1997). The theory is that the poorest countries which have almost no industrial sector have very low levels of CO_2 output. However as nations develop an industrial sector, CO_2 output increases rapidly, due to the use of cheap fuels and inefficient processes . Environmental damage is put second to profit taking and obtaining a return on investments. As a country becomes wealthy, it can afford to take heed of environmental warnings, and use processes and regulations that reduce CO_2 output, such as alternative fuels, energy efficient light bulbs, catalytic converters etc. which were previously too much of an expense for countries at take-off stages of development.

So could this model apply to HIV in Sub-Saharan Africa as well? Could it be that the least developed countries are relatively safe from a HIV epidemic while the population is immobile and consists largely of small communities? Do middle income countries have high rates of HIV because they have large numbers of mobile workers in primary and secondary industries? And then once an epidemic has taken hold, is it mostly the more affluent countries that have the ability to prevent or reverse the crisis by being able to afford treatment and give effective education about prevention, or by a shift to tertiary, and hence less migratory, businesses? Certainly this seems possible, if a little extraordinary.

South Africa seems to fit the Kuznets hypothesis well. It is the wealthiest country in Sub-Saharan Africa, and has a HIV prevalence of 20% - much lower than some of the middle income countries (like Kenya). However, although HIV rates are declining in the under 20 age group, rates are still rising as a whole (UNAIDS 2003). This might suggest that as the youngest sections of the population seem to be learning and, the decline in HIV rates has begun, as South Africa has had the capacity to provide effective programs in recent years.

However applying these cultural generalisations to the whole continent is erroneous. South Africa has only recently begun steps to tackle the HIV crisis, indeed President Mbeki has as recently as September 2003 stated he has never known anyone that died of AIDS (BBC News, 2003). In contrast Uganda which has only 13% of South Africas per-capita GDP (UNDP 2003) has seen the percentage of its population infected with HIV drop from as high as 20% in 1993 to 5% by the time of the 2000 UN survey this report uses (Uganda Ministry of Health 2003) a drop which was largely attributed to positive and open government policies of discussing and treating HIV.

Another possible explanation for the positive correlation between wealth and HIV would be that countries which can afford good healthcare and medical training are better at detecting the symptoms of AIDS and diagnosing the myriad of opportunist infections as being caused by immune deficiency. In this situation reported HIV rates would be a function of the number of AIDS surveys conducted. This might be true to a certain extent if national prevalence data was estimated using sources such as figures for diagnosed cases. However where surveillance systems are used such as in Kenya, HIV reports are based on viral load tests conducted on general subsets of the population, and so HIV reports are much more accurate. Most HIV/AIDS studies in Africa are sponsored by external organisations such as the WHO and USAID, so the expenditure of local governments on HIV surveys should not be linked to the GDP of the country.

It must also be considered that education can be a function of GDP, and vice versa, so it may not be appropriate to find separate explanations for both, and it is difficult to remove the correlation of one from the other. It is interesting to note that education was the better indicator of HIV at the national level, while the local study found wealth was

more significant. However the local and national studies use different indicators so some variance is to be expected.

The maps showing spatial variation of the key variables within Kenya visually show general correlation between regions with high wealth, education and HIV (Appendices A-C). Figure 1 also highlights the impact of the route of the railway through Kenya, and this supports the mobility thesis of HIV. As regions with good communications are also likely to have more industry and business, it is not surprising to also see some correlation with wealth and education along the same routes.

The Kenya regional datasets show that the wealth/education correlation found in the nation state analysis does not hold up well at the regional level. One could interpret this in many ways: the most persuasive being that there is no such simple explanation of HIV variation, and the nation state data averages over too large an area and is reporting a false trend. It should be noted that at a smaller level of analysis a lot more factors can significantly influence the data, especially with such a complex phenomenon as HIV.

It could also be argued that Kenya is not typical of the wealth/education pattern – and the hypothesis might still be significant in other countries. It is certainly true that Kenya has a very high national HIV prevalence for its wealth, but it fits much better in the adult literacy pattern found in this study. One could also state that the variables used in the Kenya analysis are not suitable. Statistics relating to years of adult education were used over those referring to adult literacy as it was theorised that the longer a person was schooled, the wider their potential sexual network would be, and those who went on to further education would be in cities where sexual networks were wider still. It is probably significant that most schools in Kenya are single sex, so are not significant places for young people to expand their heterosexual sex network (Mbugua 2004). Thus the hypothesis that schooling leads to increased HIV levels through an increased sexual network must be rejected on the basis of this study. Perhaps adult literacy as used in the nation state analysis is a better measure, because it might dictate how much people can take heed of written articles and advertisements about AIDS prevention, and the likelihood of obtaining employment in a built up and heavily infected area would be higher for literate persons, irrespective of how long they were schooled for.

The wealth index used in the Kenya study is by no means ideal, but it is not possible to calculate an equivalent of GDP on a regional basis in Kenya as the census does not yet publish such information. The DHS Wealth survey is based largely on the quality of accommodation, which might in the case of young people be more applicable to their parents abode, and not their own income if they are still living at home. The DHS programme tends to have family households as its target sample group because its primary function is to measure changes in fertility, and for this family units are the best level of analysis. This means it might under sample one of the key risk groups of HIV – single young persons who do not have a family. These people are the highest risk group for HIV infection and therefore if the data is not accurately representing them, it would significantly undermine the expected correlation.

Another possibility is that the Pearson co-efficient may not be a good method for assessing relationships at this level, as it is strongly influenced by outliers, and we are only trying to explain a general trend not a perfect relationship. If one were to eyeball a line of best fit for the plot of wealth and HIV in Graph 4, there is a clear pattern where there is an increase of 10% in HIV prevalence for each increase of a value of 1 in the wealth index, passing through the origin. This does ignore the outliers, but the two points that are two low for this pattern are Nairobi and Mombasa – the two biggest cities where the Kenyan government focuses their HIV prevention campaigns. The top six points that have the highest HIV rates are either close to Nairobi on the train line and major roads both a major transmission mechanism for HIV (Tanser et al. 2000), or at the West of the country around Lake Victoria – a major port and transport area with Uganda and Tanzania. Different areas will have different sexual cultures and dominant religious ideas; it is not surprising that there are areas that do not follow one set trend.

There is also no direct link between the data from the DHS survey and HIV rates. Averages are made across regions because the 1998 DHS survey does not ask recipients their HIV status. Thus it is not yet possible to correlate individual responses to questionnaires and their sexual risk factors with a person's HIV status, although blood testing for HIV and other infections will form part of the 2003 DHS survey once it is published (CBS 2003). This would allow much better analysis of all social and economic factors in the survey and their effect on HIV.

Also a temporal analysis of the HIV wealth and education link is not possible at a regional scale, as the NASCOP survey only had more than 30 stations for HIV surveillance after 2000, and with any fewer data points it is impossible to do meaningful significance tests. This prevents us from assessing if the pattern holds true over time and this is essential to conclusively prove the Kuznets hypothesis. One can also not examine the effect of AIDS in reducing income as it debilitates workers in particular regions.

Conclusions

This study identified a possible relationship in which high levels of education and wealth would act as mobilising factors resulting in regions with high incidences of HIV. This was shown to have a strong statistical significance at a nation state level, especially when cubic lines of best fit were plotted. This led to discussion of a Kuznets curve theory for the HIV epidemic in Sub-Saharan Africa. It should be noted that this Kuznets curve pattern does not exist when global data of HIV and wealth is plotted, which shows that the trend is only applicable to sexual culture in African nations.

The regional analysis within Kenya failed to find a conclusive trend, but still demonstrated that the correlation was positive, and HIV was not more endemic in poorer regions. Of all the variables tested, wealth and education were the best predictors of HIV prevalence, more significant than direct predictors of sexual activity such as first age at intercourse and condom use. As there are so many factors that can effect HIV infection rates, it is naïve to expect one to be a perfect indicator, but the study still demonstrates the importance of considering mobility enabling factors.

The thesis should not be rejected entirely on the failure of the Kenya study, and it would certainly be worthwhile to repeat the study with the 2003 DHS survey which will include HIV testing, and correlate it with the Kenyan governments own spatial poverty report, published as this paper was being completed. It would also be beneficial to study other countries at such a regional level, especially Latin America and Asia who have quite different HIV epidemics.

This study could easily be interpreted as having a strong anti-development message, as it seems to show that conventional economic development leads to high risk HIV activities through the creation of mobile populations such as truck drivers, development of urban centres which can be centres of epidemics and by introducing children to wider sexual networks through the implementation of Western based centralised learning environments. Post-development theories might suggest that a European/ Washington based path to development is therefore creating changes in local cultures that enable HIV epidemics to take hold. If international Western based organisations are advocating development through exploiting national resources, selling goods for export, and encouraging foreign investment, they are creating jobs that are high risk for HIV, namely miners, truck drivers and international businessmen, who would also require Westernised schooling.

Although this view maybe a little extreme, it does highlight the importance of a using a multidisciplinary approach to HIV research, and in so doing create an academic culture that allows organisations at all levels to consider the implications of their actions on HIV. This is equally important to all nations, not just countries in Africa. China for example has recently made steps to enter the global market, and already is seeing HIV rates rise rapidly in recent years (UNAIDS 2003).

The picture is not entirely bleak though, Brazil has recently had huge successes in reducing HIV rates (UNAIDS 2003). It should be considered that Brazil is a high income developing country, and thus fits the HIV Kuznets hypothesis well. Here AIDS has been combated by access to cheap drugs, an open sexual culture and excellent governmental policy. Perhaps once a country reaches a certain level of economic development, democratically responsible and stable governments appear, and are able to enforce policies that more accurately consider the welfare of the people, both with regards to the environment, and HIV.

Even so, as this paper demonstrates, it is only by carefully considering local culture and mobility functions of HIV that governments and international forces can take confident steps to reduce the spread of this epidemic.

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