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An Inquiry into the Relationship of Wealth/Income and Demographics to HIV/Aids: The Case of Kenya

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This paper uses quantitative and qualitative analyses to study the influence of socio-economic factors on the HIV/AIDS epidemic with the intent of providing insight on policies to mitigate that epidemic. After a brief synopsis of poverty and AIDS in Africa, this paper outlines key research questions, and reviews their treatment in the literature. Using published data from 6,350 individuals (drawn from the Kenya Demographic Survey of 37,000), a number of behavioural choices are analysed. Income, wealth level, occupations and location are considered under other variables. While the analysis suggests that poverty does not predispose people to HIV/AIDS, it did strongly indicate that AIDS can precipitate poverty. These findings provide insight as to how the spread of AIDS can be mitigated in Kenya and Sub-Saharan Africa.

JEL Codes: H75, I11, I39

Field of Research: Demography, Income, Wealth, HIV/AID

1. Introduction

A quantitative and a Meta-analysis are used in this study to provide insight into key risk factors for Acquired Immunodeficiency Syndrome (HIV/AIDS). Those insights are considered in terms of their effect on the formulation of sound health, education and social policies.

While many researchers and advocate groups assert that poverty is a key cause of HIV/AIDS and some have even called it a disease of poverty (Pilot et al, 2007), other studies on Sub-Saharan Africa have found a confounding positive correlation between income and HIV/AIDS. Such conflicting assertions create uncertainty and confusion in the process of developing sound health, education, social and economic policy. Policy makers must have a clear grasp of the key socio-economic factors that are related to and contribute to HIV/AIDS. This study considers complex behavioural and demographic risk factors for HIV/AIDs, along with the intensity of those risks.

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This study expands Haacker's (2002) notion of a two-way AIDS-to-Level of Income/ wealth relationship to disentangle observed correlations into plausible cause(s) and effect(s). A sample of 6,360 (drawn from CBS Kenya (2004) Kenya Demographic and Health Survey Data 2003) was analysed in terms of the relationship between HIV/AIDS and demographic and location factors in Kenya (particular attention was paid to income levels).

A two-way simultaneous relationship was found to be more appropriate than the oft asserted simple *causation-arrow* between poverty and HIV/AIDS. This distinctive contribution should assist policy makers to *define and resolve the correct problem* as they search for ways to ease HIV/AIDS harm to the socio-economic environment. Potentially confounding factors discussed in the extant HIV/ AIDS literature were considered, including: Polygamous and monogamous domestic arrangements; Multiple sexual partners outside of marriage; Different occupations; Different education levels; Gender and/or age of the head of household; Being employed and unemployed; and Geographic region.

This research should interest other countries in Sub-Saharan Africa. While poverty rates in Sub-Saharan Africa have recently declined (World Bank 2008), it is still a major issue in Sub-Saharan Africa—the number of people living on under $1.25/day increased over the last two decades from 212 to 383 to 388 million in, respectively, 1981, 1999 and 2005. White et al. (2001) assert that there are two types of poverty: 1) Chronic poverty, including: the destitute, elderly and disabled who are trapped in poverty; and 2) Transitory poverty, that can be alleviated by government intervention to reduce the incidence of, and/or vulnerability to, shocks such as harvest failures, fluctuations in prices and ill health and offer safety-nets. Given that most poverty is highly resolvable, it is vital that its relationship with HIV/AIDS be clearly defined.

If seen as a syndrome, AIDS-related illnesses (e.g. multi-drug resistant tuberculosis) are a leading cause of death in Sub-Saharan Africa (Casale & Whiteside 2006) and the fourth leading cause of death globally (Toole 2010). In 2000, Sub-Saharan Africa countries accounted for approximately 70 percent of the 36 million people infected with HIV worldwide (Cohen 2001).

Haacker (2002) highlights the costs of AIDS by noting mortality in the working age population, deterioration in the quality of health services due to overcrowded hospitals, increased economic risk and a rise in production costs, increased training, medical treatment and death-related costs, as some of the effects of the epidemic. Where children are infected, they need both access to food and medication to treat HIV related illnesses. These children are often forced to drop out of school and take up jobs to support their families.

The rest of the paper is organized as follows: The prevailing literature is reviewed to find the gaps in the field and to develop hypotheses to be tested in this study; then, the methodology is discussed, with a brief discussion of the quantitative methods used; findings from the descriptive analyses and the statistical analyses are given, next; and are followed by the final section discussion of: policy implications arising from the findings, limitations of the research, and suggestions for future research. Detailed empirical findings from the quantitative analysis are given in Appendixes.

2. Literature Review and Hypotheses Development

Per Table 1, in 1999 and 2010, the African nations worst affected by Aids are mainly located in Eastern and Southern parts of Sub-Saharan Africa. Figure 1 shows steady growth in the rate of HIV infection in Sub-Saharan African countries from 1980 to 2009.

Sub-Sahara Africa has relatively high rates of HIV infection (Table 1 and Figure 1) and is among the poorest regions in the world. This observed relationship has led many researchers to infer causality between poverty and HIV and to even declare HIV/AIDS to be a disease of poverty (Pilot et al, 2007). However, while correlation between poverty and HIV/AIDS is a necessary condition for the former to be a cause of the later, it is insufficient. This logic leads to the first two hypotheses tested in this study:

1) H_o: HIV infection rates in poor countries vary inversely with per capita incomes.
2) H_o: HIV prevalence within Kenya varies inversely with the income of individuals.

As noted above, a negative correlation between income and HIV/AIDS is insufficient proof that poverty creates a predisposition to the later. However, the absence of an income to HIV/AIDS correlation or a positive correlation is a very strong indicator that poverty should be dismissed as a cause of HIV infection.

Barnett & Whiteside (2002a, 2002b) assert that poverty predisposes a population to epidemic disease and that, via another set of pathways, epidemic disease aggravates and deepens poverty, and that a simultaneous-bi-directional relationship exists between poverty and disease. This leads to the third hypothesis in this study:

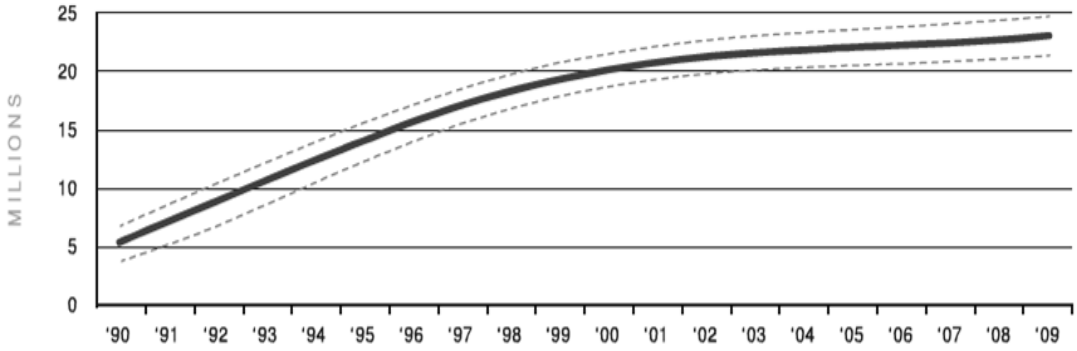
3) H_o: Individuals with AIDS suffer significant depredations in their wealth and their means to earn income.

Table 1: African Nations Worst Afflicted with HIV/AIDS (1999 & 2009/10)

Country	Adult HIV Rates %		Change
	1999	2009/10	
Botswana	35.80	24.8	(11.00)
Swaziland	25.25	25.9	0.65
Zimbabwe	25.06	14.3	(10.76)
Lesotho	23.57	23.6	0.03
Zambia	19.95	13.5	(6.45)
S. Africa	19.94	17.8	(2.14)
Namibia	19.54	13.1	(6.44)
Malawi	15.96	11.0	(4.96)
Kenya	13.95	6.3	(7.65)
Central African Rep.	13.84	4.7	(9.14)
Mozambique	13.22	11.5	(1.72)
Djibouti	11.75	2.5	(9.25)
Burundi	11.32	3.3	(8.02)
Rwanda	11.21	2.9	(8.31)
Cote d'Ivoire	10.76	3.4	(7.36)
Ethiopia	10.63	na	na
Uganda	8.30	6.5	(1.80)
Tanzania	8.09	5.6	(2.49)
Cameroon	7.73	5.3	(2.43)
Burkina Faso	6.44	1.2	(5.24)
Congo	6.43	3.4	(3.03)
Togo	5.98	3.2	(2.78)
Democratic Rep. Congo	5.07	na	na
Nigeria	5.06	3.6	(1.46)
Gabon	4.16	5.2	1.04

na – not available
Source: Whiteside (2002), Table 1; World Bank 2010b

Figure 1: Those Living with HIV/AIDS in Sub-Saharan Africa, 1990-2009



Source: UNAIDS 2010, p. 27 Year

Tladi (2006) states a lifestyle approach and a matrix of structural factors as an explanation of the poverty-to-AIDS relationship. Researchers (Alban 2001; Barnett & Whiteside 2002a; Booysen 2002; Whiteside & Sunter 2001; Wojcicki 2005) who agree with Tladi (2006), propose that different levels of poverty and related attributes - education level, comprehension of the risks, lack of resources, lack of capacity to negotiate sex and high mobility - create a predisposition for HIV/AIDS.

The reviewed literature suggests that there is no unanimously accepted or proven determinant of HIV/AIDS. World Bank reports in the last decade showed higher HIV prevalence among the richer and more educated, while amore recent population studies and analyses (De Walque 2006a, 2006b; Beegle et al., 2006; Namazzi 2010) suggest a lack of correlation between education level and HIV status (for details on education level among Kenyan adults see KNBS 2010). However, higher income and education levels enhance a person's ability to acquire treatment for the disease. Beegle et al. (2006), claim Africans who are more educated earn a higher income and live in urban areas report a higher than average HIV rate. Whiteside (2002) cites Stillwagon (2000) states that there exist a high correlation between HIV prevalence and variables commonly associated with a higher vulnerability to transmittable diseases (decreased consumption of calories and protein, unequal distribution of income, etc.). Also indicate that infected people with relatively high incomes/wealth, have a significant advantage in avoiding immediate death and, as a result, are able to persist much longer with AIDS. The remaining hypotheses tested in this study are:

4) H_o: Income levels are less important to the HIV infection rate in poor countries than other factors/behaviours that are highly correlated with per capita income (i.e. multicolinearity will be a major problem if the per capita income and these other factors are combined as independent variables in a model).
5) H_o: Education reduces the predisposition to HIV/AIDS in Kenya.
6) H_o: Geography is a key determinant of HIV/AIDS prevalence in Kenya.

The majority of studies examined in the literature review tested for a simple causal relationship between poverty and HIV/AIDS. While some found that relationship, others found a contrary correlation that disparity is confusing to many policy makers. Thus, a key contribution of this paper is an examination of a more complex two-way simultaneous relationship between poverty and HIV/AIDS that includes cultural, demographic, and behavioural factors that were not well considered in many of the reviewed studies and may have contributed to those studies yielding contrary and/or confused results.

3. Methodology

This study seeks to understand the causal relationship between income and HIV/AIDS in Kenya. Most researchers in focusing on either AIDS or poverty in Kenya did not consider cause-effect relationship while this study focuses not only on the cause but also the effect between income/wealth and HIV/AIDS relationship.

Geda et al. (2001) suggest using *Probit Models* to predict the likelihood of an individual being poor if they live in rural as opposed to urban areas and ordered *Logit Models* when considering three categories of poverty based on poverty lines (Kieyah

& Nyaga 2009; Nyaga et al. 2004) while Montana et al. (2007) propose spatial modelling techniques. This study seeks a third path: to understand the outcomes of the Econometrics and Locational-economic studies.

In the statistical analysis, 'Kenya Demographic and Health Survey Data 2003' (KDHS 2003) from the CBS Kenya (2004), is analysed using *STATA 11* statistical software (Statacorp 2009). The regression analysis uses country-specific factors, identified in the literature review, to find the behavioural risk factors and the relationship between socio-economic variables and HIV/AIDS relationship in Kenya. The KDHS national survey has interview results from 8,561 Kenyan households and contains 37,612 observations (Frölich & Vazquez-Alvarez 2009). KDHS contains 354 variables with detailed information relating to fertility, education levels, domestic violence, sanitation, employment, mortality, nutrition and HIV infection. This study uses a randomly-selected sample of 6,360 individuals to make inferential-statistic conclusions about the Kenyan population and/or selected provincial locations.

3.1 Relationship between Poverty and HIV/AIDS

This study develops wealth model and an HIV/AIDS model to describe, how:

i) HIV infection can impoverish an infected person; with *HIV infection as an independent variable and poverty as the dependent variable*, and
ii) Poverty predisposes a person to HIV infection; with poverty as an independent variable and HIV infection as the dependent variable.

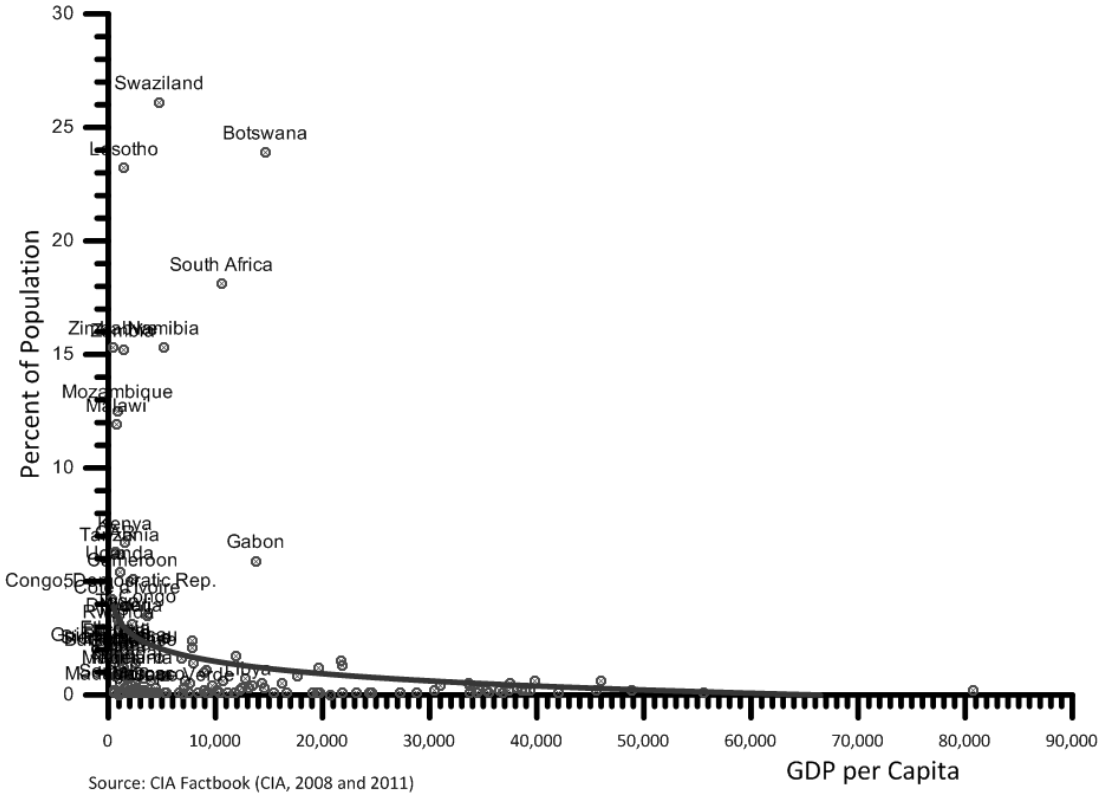
In the analysis country-specific factors (gender, provincial residence, the number of unions or spouses an individual has, religious background, the level of education attained, sex of the head of the household, employment status and the age of a respondent) are used to validate or challenge theoretical suppositions/speculation by in previous papers.

Other than age, the above factors are expressed as dummy variables (described and summarised in Table A.1, Appendix A). Two of those dummy variables (*hh_neastern* and *edu_no_preschool*) are excluded from the models so as to provide a reference for, respectively, the provincial and education dummies.

4. Analysis and Findings

Logical inspection of existing data is used to evaluate hypotheses 1 and 2. HIV infection rates in 2007/08 (CIA 2011) were contrasted with GDP/capita data in 2003 (CIA 2008), the lag is intended to reflect delays in HIV diagnosis. In Figure 2, HIV clearly appears to be a disease of poverty. However, visually there appears to be a lot of unexplained structure in the data through the Zero-$14,000 GDP/capita range and that structure may provide key insights as to how income affects HIV infection rates and the period of living with HIV/AIDS.

Figure 2: Percent of Adult Population Living with HIV vs GDP/Capita



If the sample of nations is limited to Sub-Saharan nations from the eastern half of Africa, the picture is changed greatly. Specifically, per Figure 3 (unlike the rest of the world) the prevalence of HIV among adults (ages 15-49) first rises with per capita GDP and then falls.

There is a high correlation for the relationship in Figure 3, showing an R^2 of 87.0 percent, for the function:

$$H = -0.0000007G^2 + 0.0095G - 3.821 \quad (1)$$

H = HIV Prevalence among adults (15-49)
G = GDP/Capita Purchasing-power-parity in 2003

An inspection of Figures 3 and 4 indicates that hypothesis 1 should be rejected, for most of Sub-Saharan Africa. Future research should review the relationship between income and HIV prevalence for non-Sub-Saharan countries with Purchasing Power Parity (PPP) GDP/Capita between zero and $14,000.

Figure 4, lends further support to a rejection of hypotheses 2 by showing that (except for the third quintile from the bottom) Kenyan men with higher incomes tend to have a higher HIV prevalence.

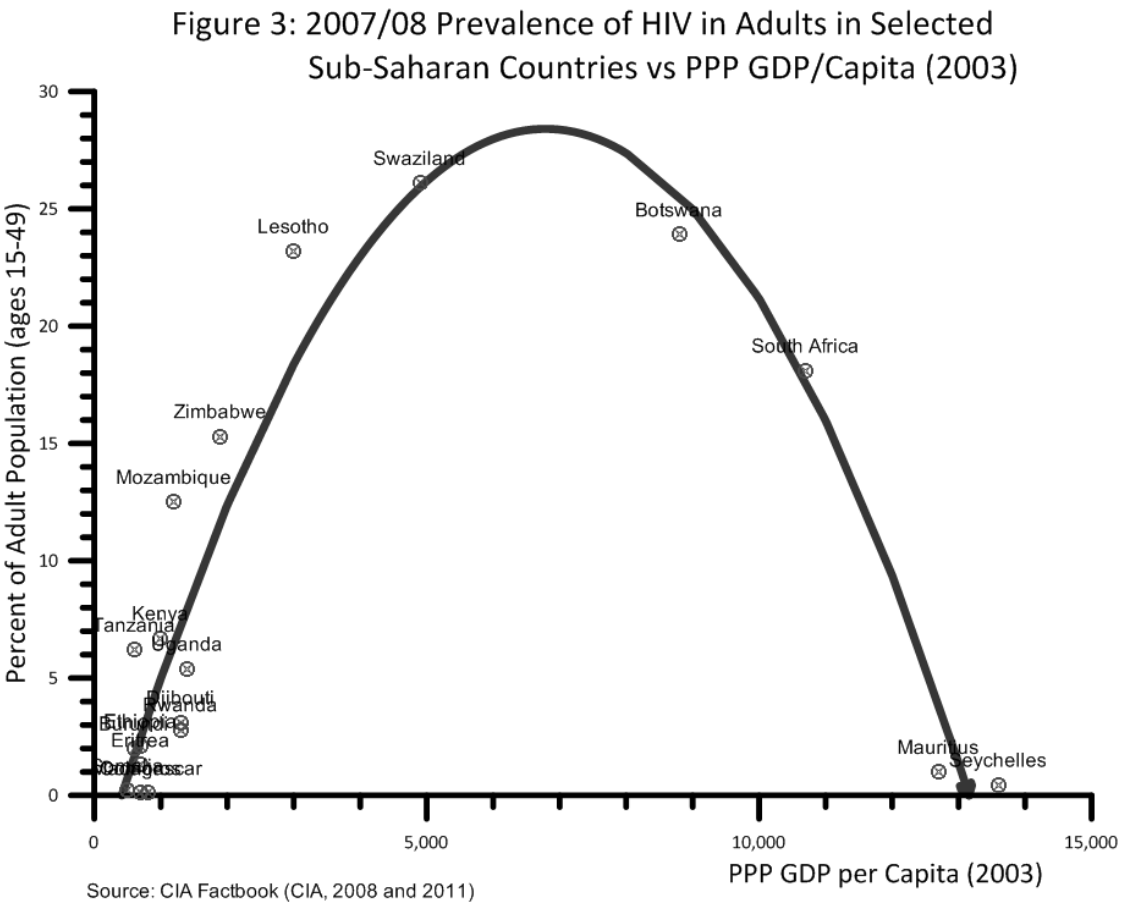
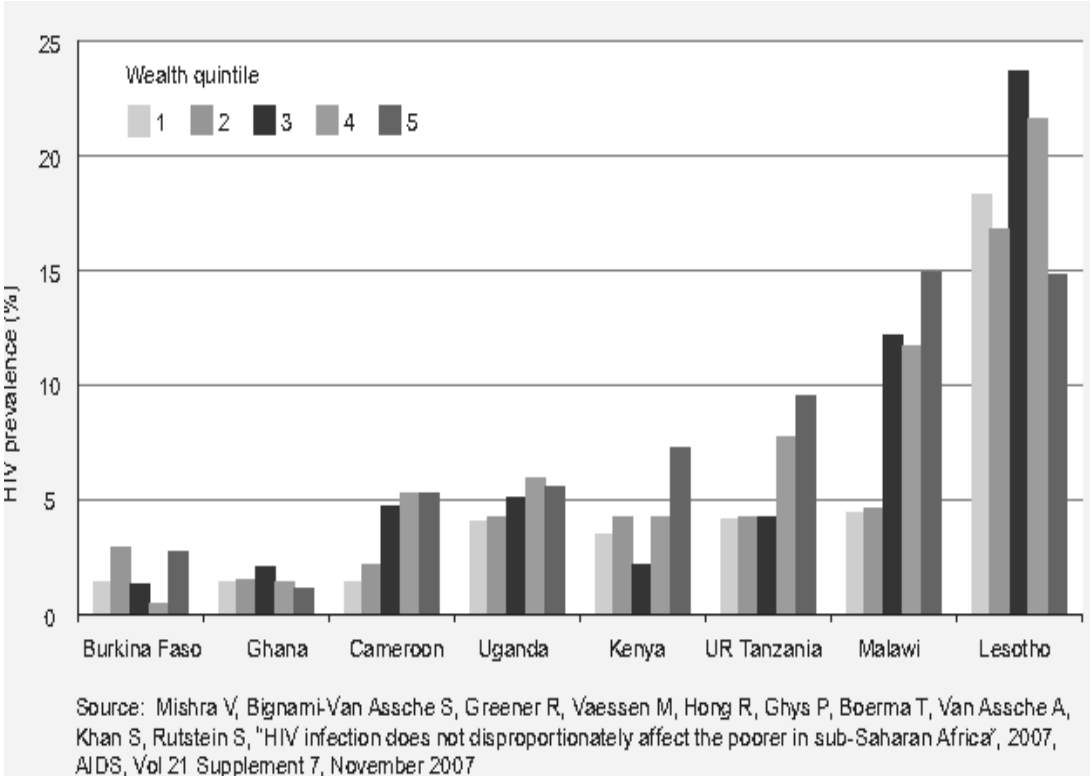


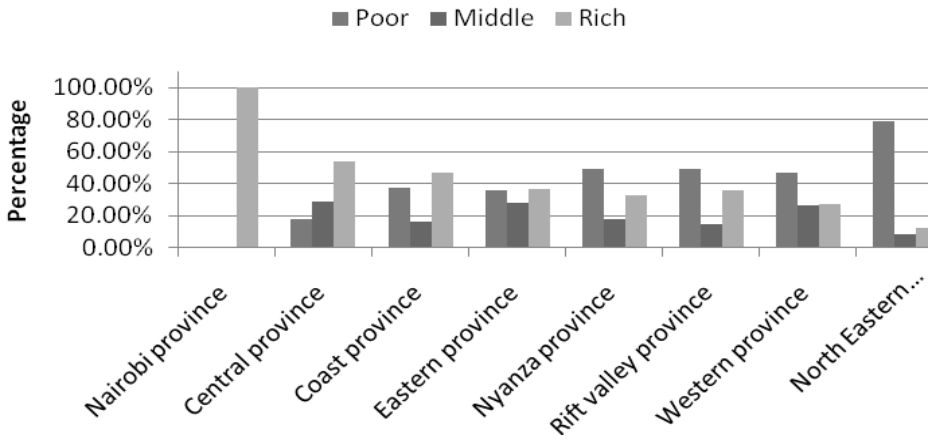
Figure 4: HIV Prevalence vs. Wealth for Males in Sub-Sahara Africa



4.1 Wealth Analysis and Outcomes

Appendix B summarises the variables used to estimate the relationships and shows the demographic details.

Figure 5: Provincial Wealth in Kenya



A provincial analysis of the data was carried out and the wealth distribution by Province is in Figure 5.

Table C.1 (Appendix C) shows the probability of factors influencing an individual achieving a given level of wealth at a 1, 5 and 10 percent level of significance. At a 10 percent level of significance, the tests indicate that the Muslim, female head and age variables are statistically insignificant to wealth. The education level, current employment status, number of spouses, HIV status, and provincial location are significantly correlated to wealth.

The estimated wealth model had negative signs for polygamy, Muslim and the age squared coefficients and positive signs for all the other estimated coefficients. The positive signs of the provincial coefficients suggests that respondents in all provinces are more likely to be wealthy than respondents in North Eastern province. Similarly, the positive sign of the education coefficients conforms to the expectation that attaining more than a pre-school level of education is associated with higher levels of wealth. As people earning an income and older people usually have increased capability to earn as well as accumulate wealth, the signs of the employed and age coefficients conform to expectations. The relationship between *age* and *wealth* is given as:

$$W = -a(Age)^2 + b(Age) + c \qquad (2)$$

W = Wealth
Age = Age of individual
a, b, c = parameters

This function suggests that age has a nonlinear relationship with wealth in the form of a second-order polynomial. When eqn (2) is differentiated with respect to age, set

equal to zero and reorder to define Age, the result indicates that the peak age for wealth is (see the Appendix C, Table C1):

$$\text{Age} = .5b/a = 0.5(0.0174)/0.0004 = 21.8 \text{ years of age} \quad (3)$$

While the "a" parameter in eqn (2) was significant to 5 percent, parameter "b" was not significant.

In Table C.1, the positive HIV test coefficient suggests Kenyans who test positive for HIV are more likely to be wealthy. The finding further supports rejecting hypothesis 2. The positive sign is reasonable, given that wealthier individuals are more mobile, more likely to have multiple sex-partners and able to live with HIV for longer periods, as compared to poor people. The negative sign of the polygamous and Muslim variables support the theoretical argument that polygamous individuals and Muslims, majority of who live in North Eastern province, are less likely be wealthy compared to monogamous individuals and people of other religious backgrounds. While literature suggests that women and female heads of households are more likely to be poor, the positive signs of the estimated coefficients suggest that Kenyan women and female heads are more likely to be wealthy compared to their male counterparts. While these findings appear to be against hypothesis 3, it is important to note that many regression models are linear in nature and that Figure 4 suggests a nonlinear relationship where middle-income groups have lower HIV risk than the two lowest income groups and that the two highest income groups have the highest risk. If higher income facilitates behaviours that predispose individuals to HIV, then HIV should vary inversely with income. Where this is not happening, it could be that the costs and disabilities associated with HIV/AIDS are shifting sufferers from higher to lower income groups after they become infected. Thus, Figure 4 strongly supports acceptance of hypothesis 3.

4.2 The HIV/AIDS Analysis

In addition to the country-specific variables used in the *ordered-probit* model, five independent dummy variables were introduced to represent five wealth categories as defined by the wealth index. The poorest-wealth dummy was omitted to index the other wealth dummies. The results of a *probit* analysis of this model are listed in Table D.1. The likelihood ratio (chi-square of 237.15 with a p-value of 0.0000) shows that at least one estimated coefficient significantly differs from zero. Moreover, the model is statistically significant, compared to a model excluding all the independent variables.

Table D1 shows that, at a 10 percent level of significance, the female, polygamous, female family head, employed, age and richer and richest wealth variables all significantly differ from zero. Contrary to theoretical arguments, the empirical evidence suggests that (once other factors are considered) an individual's provincial location, religion and education are not statistically significant in determining an individual's likelihood of being HIV positive.

The model suggests the relationship between "Age" and HIV/AIDS is of the form:

$$H = -a(\text{Age})^2 + b(\text{Age}) + c \quad (4)$$

H = HIV positive
Age = Age of individual
a,b,c = parameters

This function suggests that, like relative income (Figure 4), age has a nonlinear relationship with HIV/AIDS in the form of a second-order polynomial. When eqn (4) is differentiated with respect to age, set equal to zero and reorder to define Age, the result indicates that the peak age for HIV/AIDS is:

$$\text{Age} = .5b/a = 0.5(0.1031)/0.0017 = 30.3 \text{ years of age} \qquad (5)$$

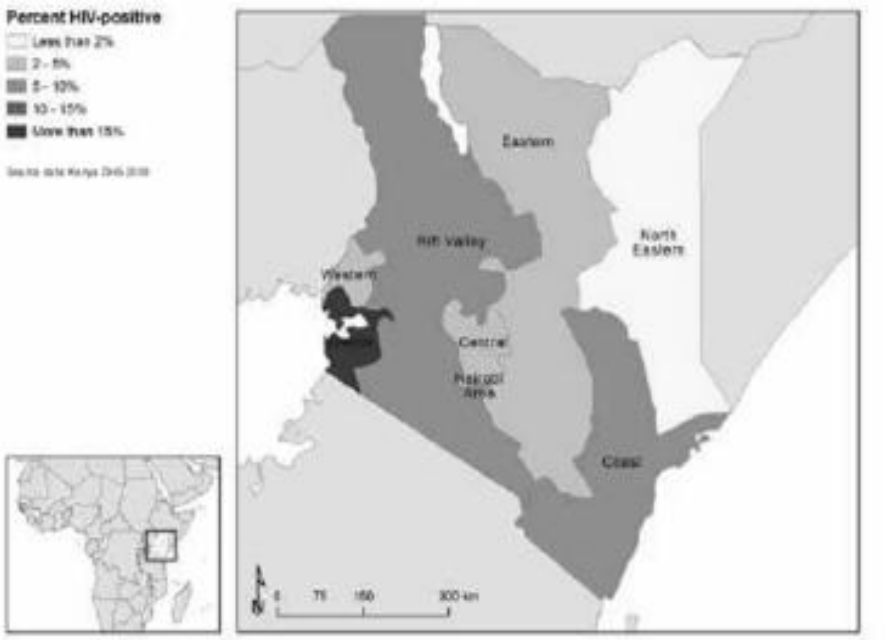
As expected, the positive signs of the female, female head and polygamous coefficients offer credence to the argument that women, female heads and polygamous people are more likely to be infected with HIV. Given that there is no rational reason to expect that a female head of household is predisposed to HIV, a more likely explanation is that an HIV infected husband has died and left his wife/wives as an HIV infected head of house(s).

The magnitude of the positive signs of the provincial coefficients support the theoretical premise and observed notion (Figure 6) that the NE province has the lowest HIV prevalence rates in Kenya. However, a lack of statistical significance for the coefficients suggests that that relationship may be explained by other factors captured in the model that also vary with provincial location. Thus, hypothesis 6 cannot be supported by the research in this study.

Evidently, (see Table D.1) employed Kenyans and Muslims are less likely to be HIV positive than the general population. Future research needs to examine the effect of Muslim customs on the risk of HIV/AIDS.

While it is generally argued that having a higher education means that an individual has a lower chance of being HIV positive, the negative sign of the primary school coefficient suggests that Kenyans with this level of education have a higher risk of HIV infection, as compared to people with no education. With the exception of this group, the signs of the other education coefficients conform to expectations. Logically, people who earn more than the poorest Kenyans are deemed more likely to be HIV positive and this is indicated by the positive signs of the wealth variables. However, this finding is inconsistent with what is reported in Figure 4 and needs to be further considered in future research.

Figure 6: HIV Prevalence by Region, Adults (Age 15-49) Kenya 2003



Adapted From: Montana, et al., 2007

Hypothesis 6 was soundly disproved by the provincial coefficients being statistically insignificant. Thus, while geography may be a significant HIV/AIDS factor across Sub-Saharan Africa, it is not a significant factor within Kenya.

5. Summary and Conclusions

Poverty does not appear to predispose individuals to HIV/AIDS. Empirical evidence from extant literature the wealth and HIV analysis in this paper suggest that higher wealth is associated with a higher HIV risk. However, more plausible explanations for this observed relationship are that wealthier Kenyans:

- Are better able to engage in behaviours that increase the exposure risk to HIV infection, and
- If HIV positive, they tend to live longer because of their increased financial capacity to effectively manage and treat AIDS related illnesses.

In terms of the eastern half of Sub-Saharan Africa, a second-order polynomial relationship exists between income and HIV/AIDS. If the relation is differentiated with respect to income, the differential set equal to zero, and reordered to define income, the result suggests the highest risk of HIV/AIDS occurs at a PPP GDP/capita of around $6,800, once incomes rise above $12,000/capita, the risk returns to low to moderate levels. Thus, poverty and HIV/AIDS are not linked by simple causality.

Age and HIV/AIDS risk appears to also have a second-order polynomial relationship. The differential for the age-to-HIV relationship suggests that age of 30.3 years is apex of HIV/AIDS risk. Thus, HIV/AIDS is very much a disease of young adults.

The positive income-to-HIV/AIDS correlation is spotty in Kenya, with middle-income Kenyans having the lowest incidence of HIV/AIDS. If higher income facilitates behaviours that predispose people to HIV/AIDS, then the converse findings of relatively high HIV/AIDS in the poor and poorest categories of Kenyans suggest that HIV/AIDS contributes to poverty by reducing the wealth of sufferers. Thus, it is likely that individuals suffering from AIDS suffer significant depredations in their wealth and means to earn income. This effect needs to be further studied in future research.

The findings of a high positive correlation between education and wealth and a high positive correlation between wealth and HIV/AIDS are contrary to the HIV model's findings that the coefficients for the education level dummies are statistically insignificant and the signs for the coefficients for secondary and higher education were negative and higher for higher education than for secondary education (whereas, the primary-education coefficient was positive). One explanation is that a little education (i.e. primary) may increase the HIV risk, but further education may progressively reduce HIV risk. This relationship needs to be further studied in future research.

While a strong relationship between geography and HIV in Kenya in Figure 6, the profoundly insignificant coefficients for the province dummies suggest that, once other factors are considered, geography is irrelevant to the prevalence of HIV/AIDS.
In summary, many socio-economic factors that appear to be useful in predicting HIV susceptibility are likely to either facilitate behaviours that predispose an individual to HIV or are highly correlated to facilitators of such behaviours. Thus, changing high-risk behaviours is likely to be a far more cost-effective way to mitigate HIV/AIDS than efforts to change the suspect socio-economic factors. The primary limitation of this study is that, based on earlier research, it was looking for simple linear relationships between socio-economic factors and HIV/AIDS. This study's findings strongly suggest that such relationships are often complex and nonlinear and that suggests that future studies should consider more complex models where socio-economic factors affect behaviours that feed into and affect HIV susceptibility and the capacity to extend the period of living with HIV/AIDS. In particular, future research should focus on behaviour patterns/trends within the Purchasing Power Parity GDP/Capita range of zero to $18,000 USD.

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Mukulu, Wright & Hettihewa

APPENDICES

APPENDIX A:

Table A.1: Country-specific factors and corresponding dummies

Factor	Dummies
Gender	Female=1 for is female and 0 otherwise
Provincial Residence	hh_nairobi = 1 for lives in Nairobi province & 0 otherwise hh_central = 1 for lives in Central province & 0 otherwise hh_coast = 1 for lives in Coast province & 0 otherwise hh_eastern = 1 for lives in Eastern province & 0 otherwise hh_nyanza = 1 for lives in Nyanza province & 0 otherwise hh_rvalley = 1 for lives in Rift Valley province & 0 otherwise hh_western =1 for lives in Western province & 0 otherwise hh_neastern =1 for lives in North Eastern province & 0 otherwise
Number of unions	hhpolygamy = 1 for is in a polygamous family & 0 otherwise
Religion	Muslim = 1 for is a Muslim and 0 otherwise
Education Level	edu_no_preschool = 1 for has ≤ pre-school, otherwise 0 edu_primary = 1 for has primary education, otherwise 0 edu_secondary = 1 for has secondary education, otherwise 0 edu_higher = 1 for has > secondary education, otherwise 0
Gender of head Household	Femhead = 1 for female head of household & 0 otherwise
Employment	Employed = 1 for is currently working & 0 otherwise

APPENDIX B: Table B.1 – Descriptive statistics for variables used in models

Dichotomous Variables	Min	Max	Frequency	Cum. Freq.	Mean %	Std Dev
Female*	0	1	18944		50.37%	
Polygamous household	0	1	3359		8.93%	
Muslim	0	1	4757		12.65%	
Employed*	0	1	16858		53.20%	
HIV test result*	0	1	422		6.64%	
Female head	0	1	10623		28.24%	
Nairobi province	0	1	4191	4191	11.14%	
Central province	0	1	5920	10111	15.74%	
Coast province	0	1	4375	14486	11.63%	
Eastern province	0	1	4653	19139	12.37%	
Nyanza province	0	1	4622	23761	12.29%	
Rift valley province	0	1	6608	30369	17.57%	
Western province	0	1	4558	34927	12.12%	
North Eastern province	0	1	2685	37612	7.14%	
Completed Pre-school education or has no education*	0	1	13357	13357	35.72%	
Completed Primary education*	0	1	17407	30764	46.55%	
Completed Secondary education*	0	1	5019	35783	13.42%	
Completed Higher education *	0	1	1610	37393	4.31%	
Poorest wealth category	0	1	7585	7585	20.17%	
Poorer wealth category	0	1	6556	14141	17.43%	
Middle wealth category	0	1	6925	21066	18.41%	
Richer wealth category	0	1	7137	28203	18.98%	
Richest wealth category	0	1	9409	37612	25.02%	
Continuous Variable						
Age*	15	49	31736		27.32	8.9436
10^{th} percentile		16				
25^{th} percentile		20				
50^{th} percentile		26				
75^{th} percentile		34				
90^{th} percentile		41				

**Note:* Each dichotomous variables take the value of 1 or 0 (e.g., Nairobi province=1 if the respondent lives in Nairobi province and 0 otherwise). While the percentages of most dichotomous variables are calculated based on the total number of observations (37,612), the percentages for variables with missing values were computed based on the total number of number of available responses. Variables with missing values include *female, employed, HIV test result, pre-school education or less, primary education, secondary education* and *higher education.* The totals used to calculate the reported percentages are 37,611, 31,687, 6,360, and 37,393 for the *female, employed, HIV test result* and *all education categories* respectively. Age refers to the current age of the respondent in years.

APPENDIX C:

$$Pr(WEALTH_i = j) = f(Female, PNairobi, PCentral, PCoast, PEastern, PNyanza, PRiftvalley \\ Pwestern, Polygamous, Muslim, Edu\_primary, Edu\_secondary, \\ Edu\_higher, Femhead, Employed, Age, Agesq, HIVpos)$$

Log Likelihood estimation:

$$\log L = \sum_{j=1}^{J} \sum_{WEALTH_i=j} \log[Pr(WEALTH_i = j] = \sum_{j=1}^{J} \sum_{WEALTH_i=j} \log\left[\Phi(\tau_j - x_i\beta) - \Phi(\tau_{j-1} - x_i\beta)\right]$$

Table C.1 —Ordered Probit Wealth Model for Kenya

Variable	Coefficient	Standard Error	Z-statistic	P(Z-
Female	0.1718***	0.0317	5.41	0.000
Nairobi province	3.2514***	0.1485	21.90	0.000
Central province	0.9049***	0.1167	7.76	0.000
Coast province	0.8888***	0.1014	8.77	0.000
Eastern province	0.5499***	0.1167	4.71	0.000
Nyanza province	0.3700***	0.1169	3.16	0.002
Rift valley province	0.4166***	0.1137	3.66	0.000
Western province	0.2910**	0.1149	2.53	0.011
Polygamous household	-0.0895*	0.0528	-1.70	0.090
Muslim	-0.0581	0.077	-0.75	0.451
Completed Primary	0.6305***	0.0547	11.54	0.000
Completed Secondary	1.1691***	0.0609	19.20	0.000
Completed Higher	1.9765***	0.0884	22.35	0.000
Female head	0.0521	0.0343	1.52	0.129
Employed	0.0725**	0.0344	2.11	0.035
Age	0.0174	0.0114	1.52	0.128
Age squared	-0.0004**	0.0002	-1.98	0.048
HIV test result	0.3558***	0.0615	5.78	0.000

Model Fit statistics		**Cut-off points**	
Log Likelihood	-7330.3062	τ_1	0.613118
Number of observations	5494	τ_2	1.320621
LR chi-squared statistic	2936.48	τ_3	1.936278
LR chi-squared p-value	0.0000	τ_4	2.715249
Pseudo R-squared	0.1669		

** indicates coefficient significant at 10% (*), 5% (**) or 1% (***) level*

APPENDIX D:

$$Pr(HIVPOS_i = 1) = f(Female, PNairobi, PCentral, PCoast, PEastern, PNyanza, PRiftvalley,$$
$$Pwestern, Polygamous, Muslim, Edu\_primary, Edu\_secondary, Edu\_higher,$$
$$Femhead, Employed, Age, Agesq, Wealth\_Poorer, Wealth\_Middle,$$
$$Wealth\_Richer, Wealth\_Richest)$$

Log Likelihood estimation:

$$log\ L = \sum_{i=1}^{N} [HIVPOS_i\ log\ \Phi(x_i\beta) + (1 - HIVPOS_i)\ log(1 - \Phi(x_i\beta))]$$

Table D.1 – Probit Model for HIV in Kenya

Variable	Coefficient	Standard Error	z-statistic	Probability of Z-statistic
Female	0.2863***	0.06010	4.7	0.000
Nairobi province	4.0941	141.5010	0.03	0.977
Central province	4.0071	141.5010	0.03	0.977
Coast province	4.1203	141.5009	0.03	0.977
Eastern province	4.0189	141.5010	0.03	0.977
Nyanza province	4.6588	141.5010	0.03	0.974
Rift valley province	4.0089	141.5010	0.03	0.977
Western province	4.1302	141.5010	0.03	0.977
Polygamous	0.2129**	0.0921	2.31	0.021
Muslim	-0.102	0.1357	-0.75	0.452
Completed Primary	0.0237	0.1080	0.22	0.827
Completed	-0.0843	0.1189	-0.71	0.478
Completed Higher	-0.1564	0.1478	-1.06	0.291
Female head	0.2181***	0.0601	3.63	0.000
Employed	-0.1251**	0.0608	-2.06	0.040
Age	0.1031***	0.0224	4.61	0.000
Age squared	-0.0017***	0.0004	-4.56	0.000
Poorer wealth	0.2026*	0.1086	1.87	0.062
Middle wealth	0.2183*	0.1121	1.95	0.051
Richer wealth	0.4678***	0.1075	4.35	0.000
Richest wealth	0.6012***	0.1097	5.48	0.000
Constant	-7.5924	141.5010	-0.05	0.957
Model Fit statistics				
Log Likelihood	-1252.6206	LR chi-squared statistic		237.15
Number of	5494	LR chi-squared p-value		0.000
Pseudo R^2	0.0865			

** indicates coefficient significant at 10% (*), 5% (**) or 1% (***) level*