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Mobility and AIDS:

Moving towards infection

AIDS is a spacial disease. More so than any infectious virus such as SARS, smallpox or TB, the spread of AIDS is closely linked to the movement of people. As economic empowerment allows people to travel further and live in more mobile spaces such as cities, could it follow that wealth increases chance of HIV infection? And what about other forms of social networks such as education? And do higher rates of education actually increase probability of catching AIDS? As the process of education itself means the movement of people, and eventual freedom to work in urban areas, could higher rates of education actually be bad for health? This paper will attempt to answer these questions with reference to the patterns of AIDS found in Sub-Saharan Africa for macro scale analysis into what is increasingly being seen as a spacial problem.

AIDS is mostly distributed by people having sex. There are lots of other potential ways to get HIV(1)/ AIDS, such as blood transfusions, sharing needles, kissing, birthing and breastfeeding, but the biggest transmitter is heterosexual intercourse (Johnson and Laga 1988). Anal intercourse between homosexual men carries a high HIV risk due to rectal tearing, but the creation of small tears in the vagina in heterosexual intercourse means that women are at high risk as well (AIDS.org 2003, Sabatier 1989). In fact women are more likely than men to contract HIV through heterosexual intercourse (Harlap 1991).

Sex is a social and emotional act, whether it is occurring in or outside of marriage, with prostitutes or peers. Scientific literature sometimes forgets this, and is startled by such discoveries as

> "*The deciding factor in sexual intimacy seems not to be health preservation, but the partners mutual recognition of one another's emotions*"
>
> *(Calvez 1995)*

Indeed there is research that shows that even when people are aware of condom use, some people believe that HIV does not apply to them (Estrin 1999). When considering the spread of HIV in other cultures it is important to realize differences in social norms. Much health policy has been weakened by either lack of knowledge of cultural customs or local perceptions of health and fertility policy as being foreign and alien (Watkins 2000).

In Sub-Saharan Africa it is important to realize that sexual freedom is much greater than in many developed countries, but different regions have different traditions. Sex with multiple partners before marriage is not frowned upon in many areas (Watkins 2000, Shannon et al. 1991) and in some native religions priority is given to fertilization rather than faithfulness in marriage (Caldwell and Caldwell 1987). Although polygamy is not as common in Africa as it once was, it is still an contributing factor to high levels of sexual activity with multiple partners (Watkins 2000). This increases the risk of spreading sexually transmitted disease, but within rural areas, isolated tribes and communities tend to

couple with relatively small groups of people, somewhat reducing the risk of infection from outside.

Sub-Saharan Africa shows a vary varied spread of HIV that has changed dramatically over time. In the late 1980's the highest rates of HIV prevalence was in middle Africa, but today it is the southern nations which have seen rapid increase and the highest rates of AIDS in the world, while AIDS rates did not increase greatly in the central African regions (WHO/UNAIDS 2002). Explaining this trend is not easy.

It is generally assumed that education plays a key role in the prevention of AIDS through awareness of how it is spread, and as a key instrument in changing sexual behavior (Umeh 1997). However analysis of literacy rates in Sub-Saharan Africa seem to suggest otherwise. In general it seems that the rates of literacy and education enrollment are positively and not negatively correlated to the percentage of HIV in a country.

This paper postulates that while a nation is poor and uneducated, levels of mobility and interaction are low thus reducing the risk of catching HIV. Once people in a nation are wealthier and can afford to travel and be around other mobile people in a modern workplace, their chances of catching a sexually transmitted disease are higher compared to unempowered rural dwellers.

The data used in this analysis is taken from various UN studies collaborated together in the 2002 Human Development Report. The Human Development Index (HDI) has been used before to measure demographic trends, for example Bongaarts and Watkins found that HDI explains 60% of fertility change (Bongaarts and Watkins 1996). Here HDI will be used to predict levels of HIV in 32 Sub-Saharan African countries expecting to show that higher levels of development measured by HDI will lead to greater levels of HIV prevalence at a national level.

HDI is a composite indicator based on life expectancy at birth, adult literacy rate, combined primary, secondary and tertiary gross enrollment ratio, and GDP per capita levels adjusted for PPP (HDR 2002). It would be expected that there is a negative relationship between AIDS and life expectancy, so education and GDP will be assessed separately to quantify their success at explaining HIV rates.

AIDS is very difficult to measure, especially in the tropics where hot temperatures can interfere with results (Sabatier 1989). It is also an expensive process, and difficult to conduct random trials. And while the symptoms of AIDS the disease are easy to spot, HIV the virus shows no outward effect for many years (Umeh 1997). Many developing countries like Kenya use sentinel survey sites at antenatal clinics where pregnant women are used as the population sample (NASCOP 2001).

There are obvious problems with this method of analysis, perhaps the most obvious being that the sample set only includes pregnant, and therefore sexually active women, who as already discussed are more likely to contract HIV than men. This suggests that AIDS statistics tend to be overestimations, although for the purpose of this study it can only be assumed that the inaccuracy is constant from country to country. It is quite possible that HIV estimation is poorer in less developed countries that cannot afford extensive and accurate HIV surveys. However, there is a lot of aid money available to developing countries for AIDS research, and often surveys are sponsored by NGOS or governments in developed countries.

Method

32 countries from Sub-Saharan Africa were chosen for the study, out of a possible 47. The countries excluded from the data set were rejected solely because data for them was incomplete, or they did not feature in the HDR. It could be inferred that this applies a bias to the study, as data is less likely to be collected for poorer countries, those experiencing conflict, or with remote and difficult to access populations. However it does not seem that lower development countries are particularly excluded from the data set, as data is complete for four out of the five poorest countries in the world. The 32 country set also includes a spread of countries with HIV prevalence from 38% to under 2%.

The first level of analysis was the relationship between adult HIV prevalence and HDI index value for the year 2000. The plot of correlation shows a clear positive trend where higher levels of HDI seem to indicate higher HIV rates. The Pearson product correlation value is very close to +1 indicating a strong positive relationship. At the level of r-squared statistical indicators suggest that HDI accounts for 32% of the variation in HIV prevalence. This is not a perfect relationship by any means, but the direction of the correlation is indisputable. As HDI is a composite indicator, it now makes sense to take apart the separate components and assess each one for significance in leading to higher HIV levels.

When conducting this analysis the first step was to eliminate the life expectancy portion of HDI. As AIDS causes death, and therefore directly reduces life expectancy, it has a negative relationship in HDI, contrary to the positive relationship between total HDI and HIV prevalence. When assessed separately there was indeed a weak negative relationship, but with r = 0.25, hence a poor correlation.

At this stage we are presented with two possible paths of study, one is to use the HDI index of GDP and education relative to the other countries in the survey, weighted so that the highest possible figure attains a value of one, and the lowest scoring zero. The other option is to take real figures for GDP as a per capita dollar figure, and education as a percentage of literate adults and also ratio of primary to tertiary enrollment. It seems fairer to choose the absolute rather than relative values here, as the weighting in creation of indices infers a smoothing effect which would exaggerate trends.

	HDI	***Adult Literacy***	***GDP per capita (ppp)***	***combined enrollment ratios***	***combined education and gdp***	***% urban population***
pearson value (r)	0.958	0.818	0.817	0.884	0.730	0.153
r-squared	0.321	0.329	0.371	0.423	0.533	0.023

r and r-squared analysis of isolated and combined indicators (in grey)

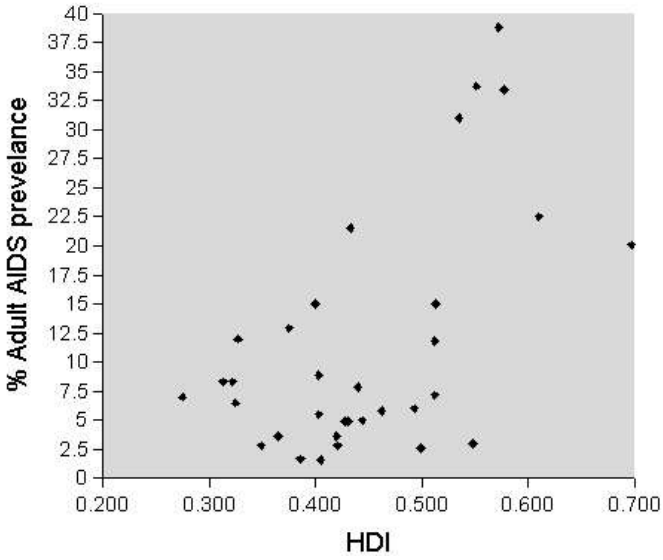
As can be seen from the above table, all of the indicators show a strong positive relationship, with the exception of percentage of urban population within a country, which is included for later discussion. The highest single predictor for percentage of HIV in a country is the combined primary, secondary and tertiary enrollment ratios, the r-squared statistic states that this explains 42% of the relationship. After this ranks GDP per capita, which explains 37% of the trend and next adult literacy which accounts for a 33% explanation.

As previously expounded, it would be expected that the removal of life expectancy from the data set would increase the correlation between education and GDP with HIV. This is indeed what we find – the indicator that combines enrollment, literacy and GDP scores an r-squared value of 53%, (model 2) the highest correlation of any other figure. This compound indicator was defined as the sum of the

education and GDP indexes as published in the HDR. The relationship can be predicted as follows:

*HIV prevalence (model 2) = (GDP index + education index) * 27.9 – 15.9*
where 27.9 = gradient and
-15.9 = y intercept

Country	Adult AIDS prevalence % (2000)	HDI Index rating
South Africa	20.1	0.697
Namibia	22.5	0.610
Swaziland	33.44	0.577
Botswana	38.8	0.572
Zimbabwe	33.73	0.551
Ghana	3	0.548
Lesotho	31	0.535
Kenya	15	0.513
Cameroon	11.83	0.512
Congo	7.15	0.512
Sudan	2.6	0.499
Togo	6	0.493
Nigeria	5.8	0.462
Uganda	5	0.444
Tanzania	7.83	0.440
Zambia	21.52	0.433
Congo DR	4.9	0.431
Cote d'Ivoire	4.9	0.428
Eritrea	2.8	0.421
Benin	3.61	0.420
Gambia	1.6	0.405
Angola	5.5	0.403
Rwanda	8.88	0.403
Malawi	15	0.400
Mali	1.65	0.386
CAR	12.9	0.375
Chad	3.61	0.365
Guinea-Bissau	2.81	0.35
Ethiopia	12	0.327
Burkina Faso	6.5	0.33
Mozambique	8.3	0.322
Burundi	8.3	0.31
Sierra Leone	7	0.275



Pearson correlation (r) = 0.958

R squared = 0.32

32% of Adult AIDS prevalence is explained by HDI (model 1)

	National % HIV	Life expectancy index	Education index	GDP Index	% urban population	Adult Literacy rates	GDP + EDU index	% enrollment
South Africa	20.1	0.45	0.88	0.76	50	91.3	1.33	93
Namibia	22.5	0.81	0.81	0.69	31	82	1.62	78
Swaziland	33.44	0.32	0.77	0.64	26	90.4	1.09	72
Botswana	38.8	0.25	0.75	0.71	50	88.3	1.01	70
Zimbabwe	33.73	0.3	0.81	0.55	35	97.2	1.11	65
Ghana	3	0.53	0.62	0.5	38	91	1.15	42
Lesotho	31	0.34	0.76	0.5	28	90.5	1.1	61
Kenya	15	0.43	0.72	0.39	33	95.1	1.15	51
Cameroon	11.83	0.42	0.65	0.47	49	93.1	1.07	43
Congo	7.15	0.44	0.75	0.39	63	97.4	1.19	63
Sudan	2.6	0.52	0.5	0.48	36	57.8	1.02	34
Togo	6	0.45	0.59	0.45	33	75.4	1.04	62
Nigeria	5.8	0.44	0.58	0.37	44	86.8	1.02	45
Uganda	5	0.32	0.6	0.42	14	78.8	0.92	45
Tanzania	7.83	0.43	0.61	0.28	33	75.1	1.04	32
Zambia	21.52	0.27	0.68	0.34	40	78.1	0.95	49
Congo DR	4.9	0.44	0.51	0.34	30	61.4	0.95	31
Cote d'Ivoire	4.9	0.8	0.44	0.47	46	46.8	1.24	38
Eritrea	2.8	0.45	0.46	0.35	19	55.7	0.91	26
Benin	3.61	0.48	0.4	0.38	42	37.4	0.88	45
Gambia	1.6	0.35	0.39	0.47	33	36.6	0.74	45
Angola	5.5	0.34	0.36	0.51	34	42	0.7	23
Rwanda	8.88	0.25	0.58	0.37	6	66.8	0.83	40
Malawi	15	0.25	0.65	0.3	25	60.1	0.9	73
Mali	1.65	0.44	0.37	0.35	30	41.5	0.81	28
CAR	12.9	0.32	0.39	0.41	41	46.7	0.71	24
Chad	3.61	0.35	0.39	0.36	24	42.6	0.74	31
Guinea-Bissau	2.81	0.33	0.38	0.34	24	38.5	0.71	37
Ethiopia	12	0.31	0.35	0.32	18	39.1	0.66	27
Burkina Faso	6.5	0.36	0.23	0.38	19	23.9	0.59	23
Mozambique	8.3	0.24	0.37	0.36	40	44	0.61	23
Burundi	8.3	0.26	0.38	0.3	9	63.9	0.64	18
Sierra Leone	7	0.23	0.33	0.27	37	36	0.56	27

It should be noted here that to a certain extent education can be considered a function of GDP, as governments with larger budgets are able to spend more per child on education. Thus the combined index of education and GDP could be considered an exaggerated effect as education is a factor of GDP, and it could be claimed that GDP is being counted twice. The relationship between GDP index and educational index gives a r-squared value of 0.37, confirming a significant correlation. One could therefore assume that the true correlation between GDP plus education and HIV is less than the previous figure, and could be estimated thusly:

(GDP + EDU) – (GDP v. EDU correlation) = model 3
0.53 – 0.37 = 0.16
therefore 16% of the HIV variance is truly explained by GDP and education

This may seem like a much more insignificant relationship, but it does prove that education has a significance over and above levels of wealth in a nation, and that education is the more powerful predictor. Also it could be argued that one does not want to remove the relationship that GDP has on education, as education is a true effect of wealth. One could also argue that the relationship is

reciprocal, as an educated workforce are able to earn more money.

Another possible comment would be that as AIDS is highest in urban areas, this is also skewing the relationship. One could assume that the more developed and wealthier a nation, the more people are living in urban areas hence earning higher incomes than those employed in subsistence farming. The data from the UN dataset disproves this however; a quick study of the significance of the relationship between percentage of urban population in an area and HIV rates shows only a 0.2% correlation, so this aspect can be largely ignored.

Another aspect of investigation that proved insignificant was correlation between youth education and AIDS, it was postulated that as young people between the ages of 15 and 24 are the most sexually active, there would be correlation between education in this age group and total HIV rates for the population. However significance was very low, only a 22% correlation. This can also seen to stand against the mobility hypothesis, however it is not appropriate to try and correlate a measurement of one section of the population against another factor that refers to total population. If HIV prevalence rates were also available for this age group, the data may well prove more significant.

Another aspect to be considered is the fact that the relationships may not be linear, for adult literacy for example, plotting the data indicates a powered curve which begins to tail off as HIV rates reach over 30%. Non-linear analysis is beyond the scope of this paper, especially when combined with the GDP and enrollment factors which demonstrate more linear trends.

Discussion

So having shown that there is a significant and positive relationship between education, GDP and HIV, the question is why. One could easily expect a negative relationship, for two reasons; the first, that education should increase awareness of AIDS and hence reduce its prevalence; and secondly, a higher level of national wealth should mean greater expenditure on AIDS prevention and treatment programs. So why does the data appear to indicate that the opposite phenomenon is true?

This study does not disprove the link of education lowering AIDS. Literacy and school enrollment ratios are not ipso facto indicators of education about AIDS. Although AIDS awareness may be taught in schools, how literate a person is does not need to effect their ability to protect themselves from AIDS, especially when radio, television, peer education and even nursery rhyme and pop songs are used to increase awareness (Sabatier 1989).

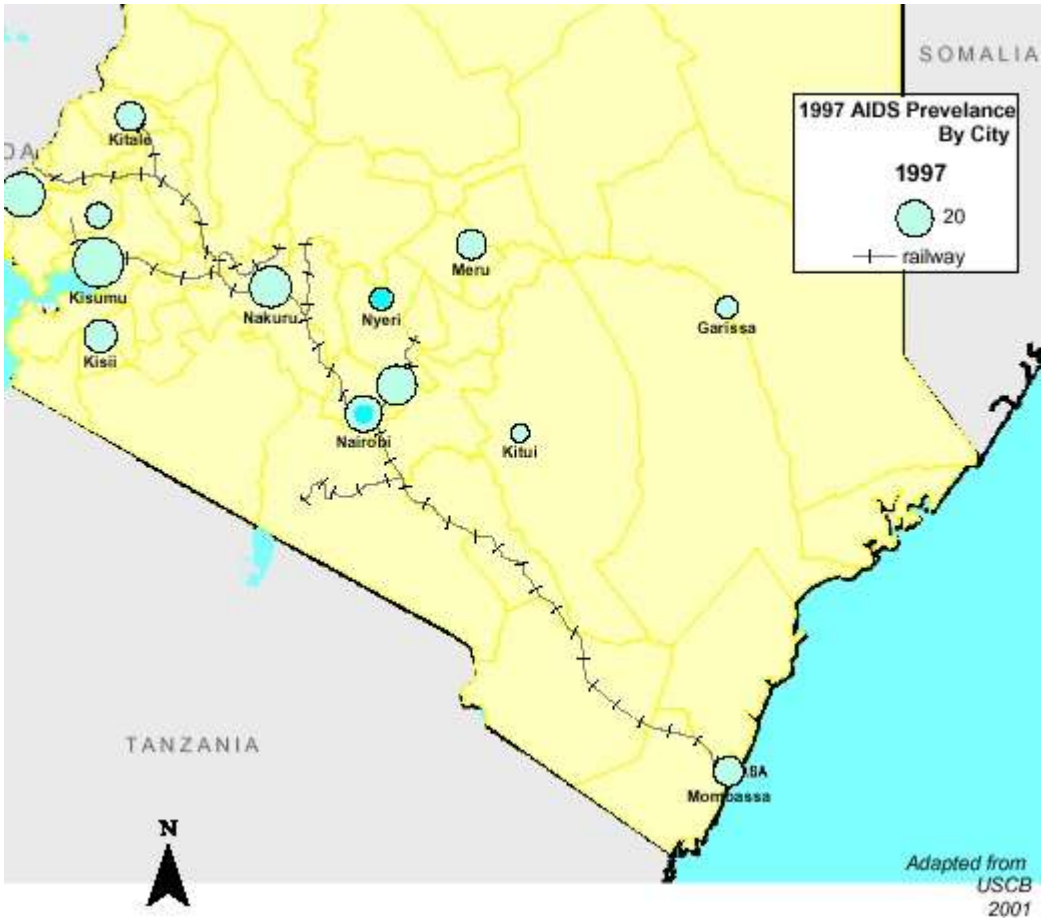
However the effect by which HIV may be spreading by education is actually very well researched with regards to the spread of another concept – the spread of the ideal of small family size and family planning through schools and work. Social networking literature would explain this effect with ease, stating that the process of being schooled means that children travel further and mix with a wider group of peers who are also highly mobile. This increases opportunities not only to hear about family planning measures, but also increases likelihood of sexual interactions with people from a broader geographical area. This increases the chance of one person being HIV positive, and hence spreading it to others.

Educated people are also more likely to get formal employment, again an important location of large social networks (Agadjanian 2000). Here people are able to mix and sexually interact in a wider circle, where the number of sexual links is much greater, and hence risk of infection greater than subsistence farming in an isolated rural community. This type of work need not take place in an urban area for it to be greatly increasing 'sexual networking'.

Enrollment in higher education, once again is an experience which creates more social opportunities, both in terms of informal sexual liaisons, and the creation of long term relationships with people from vast expanses of the nation, and indeed the world. In general people from other countries do not come to a nation to partake in farming, they come to university for education, to cities to find work, or even to run a business. This creates a large melting pot of people from areas of potential infection.

This explanation would also help to explain the trend by which GDP is also a good predictor of HIV prevalence, as people who are educated, especially beyond primary school and in a workplace will be earning more, and raising national GDP.

Migration can also bring infection to a new area, but requires monetary means, due not only to the costs of migration, but also the high opportunity costs and risk involved (Massey 1988 and DeJong 2000). The very poor cannot afford to migrate, and therefore are immobile and less prone to alien disease. Those with moderately low levels of income have the financial means to migrate, and the financial incentive to find better rates of pay. Those who can afford to move, be it by train, bus or car are able to get to areas where they may put themselves at higher risk of contracting AIDS.



This map illustrates a possible mobility/AIDS relationship in Kenya, it shows that the cities with the largest percentage of people with HIV are mostly located along the railway network. This implies that those are most mobile are at higher risk of contracting HIV.

Further to this is another possible partial explanation, and that is that GDP measures negative societal costs. A country with high levels of crime and disease will have high levels of GDP due to the costs of

repairing damage from crime, and for treating illness. This could be having an effect here, where the very high cost of treating people from AIDS means that health care expenditure is contributing to high GDP.

This would imply a different direction of causality, where high AIDS was leading to high GDP rather than vice versa. As always it should be pointed out that it is difficult to assess levels of influence in this relationship, AIDS could well be ***causing*** high education, as it provides a pressure for governments to educate their population as a preventative measure.

However this direction of determinants is unlikely, as AIDS reduces a persons economic capacity to work. For example one estimate suggests that the GDP of Kenya is 15% lower than it would be without the impact of AIDS (DFID 2001). Ideally temporal analysis would be performed here show that education and GDP varied with HIV prevalence, as this would prove the hypothesis that HIV was the independent variable, as well as cementing the relationship by showing correlation over a period than for one static year of analysis.

Conclusion and caution

This paper showed a possible relationship where increased levels of GDP and education enrollment and literacy provided a good indicator of high HIV levels in Sub-Saharan African nations.

One very important aspect of this study is that the data only shows significant correlation in countries of Sub-Saharan Africa. One early hypothesis for this study was that a relationship similar to a Kuznets curve would be shown, where HIV was highest for middle income countries, where they had the financial means to have high mobility, but not the means for high levels of preventative research and post HIV health care. It was postulated that this would explain why HIV is lowest in the very least and very highest developed countries. However correlation over a sample set of all countries for this analysis showed very weak correlation, and no curve as predicted.

This is not however disheartening, in fact it proves that it is correct to limit the field of study to one dominant culture, rather than try and force one explanation in variation on the entire world. In Europe and Asia for example sexual relations are more restricted, and this definitely has had an effect on reducing the spread of AIDS.

While this paper has shown a surprising relationship between GDP, education and HIV, it should be noted that this analysis was only conducted at a macro level, and a lot of the explanations cited would need local level analysis to properly qualify them. Also the dataset should not be considered to be of the highest accuracy, AIDS rates are all estimations based on local studies, and thus no attempt at calculating error margins for the relationships were attempted.

It is also not suggested that increasing the wealth and levels of education in Africa is undesirable, but that when planning AIDS prevention campaigns this relationship should be considered as a focus for designing local policy. It also does not suggest that AIDS education has failed, but just that it is not closely linked to literacy. Just because mobility can lead to AIDS, this does not necessarily mean that it has to. Many nations are now seeing falling levels of HIV nationally, and education has not declined in Sub Saharan Africa. Although it could be argued from this study that stagnation in economic growth for many of these countries could be helping reduce AIDS rates.

As a final note of caution, it must be considered that AIDS is a very complicated and multi-faceted issue, and none of these indicators provided greater than 50% explanation for the trends. There is no

one factor that can explain AIDS, and to really find answers one should look at the reasons on a local, and be wary of statistics and generalizations that claim more knowledge than those who are directly involved with AIDS treatment every day.

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