Gender Disparity in HIV Prevalence: A National-Level Analysis of the Association between Gender Inequality and the Feminisation of HIV/AIDS in sub-Saharan Africa

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Abstract

The HIV pandemic in sub-Saharan Africa is often described as undergoing a 'feminisation' in which female HIV prevalence exceeds that of male in most age groups and countries. However much of the variation between countries in the female-to-male (FTM) ratio of HIV prevalence remains unexplained. This paper uses information from DHS, World Bank, UNDP and UNAIDS to identify correlates of the FTM ratio at the country level, with a focus on gender inequality. The FTM ratio is investigated overall and for two age groups. Divergent results by age suggest that the influence of particular mechanisms depend on the age group in question, with epidemiological and demographic variables in particular demonstrating strong associations with the FTM ratio for 25-49 year olds. The mechanisms influencing gender disparity in HIV prevalence between younger adults remain unclear, with few significant correlates observed for the 15-24 age group.

Keywords: HIV/AIDS; gender; inequality; feminisation; sub-Saharan Africa

Résumé

La pandémie du VIH en Afrique subsaharienne (ASS) est souvent décrite comme subissant à une «féminisation»; la prévalence du VIH des femmes dépasse celui des hommes pour la plupart des âges, et de pays. Cependant beaucoup de la variation entre le ratio VIH femmes/hommes (F/H) reste inexpliquée. Ce document utilise les données du DHS, la Banque mondiale, le PNUD et l'ONUSIDA pour identifier les corrélats du ratio F/H au niveau des pays, concentré sur l'inégalité des sexes. Le ratio F/H est analysé ensemble (15-49), et également en utilisant deux groupes d'âge séparé (15-24 et 25-49). Les résultats divergents selon l'âge indiquent que l'influence de mécanismes particuliers dépend du groupe d'âge en question, avec les variables épidémiologiques et démographiques en particulier, démontrant de fortes associations avec le ratio F/H pour les jeunes âgés de 25-49 ans. Les mécanismes qui influent les disparités entre les sexes dans la prévalence du VIH entre les jeunes adultes restent ambigu, avec quelques corrélats significatifs observés pour le groupe d'âge 15-24 ans.

Mots clé: VIH / SIDA; sexe; l'inégalité; féminisation; Afrique sub-saharienne

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Introduction

The UNAIDS estimates that 58% of all adults living with HIV in 2011 were women (UNAIDS 2012a, UNAIDS 2012b). In most countries in sub-Saharan Africa age-specific HIV prevalence is higher in women than in men and gender disparity in the prevalence of HIV is most pronounced in younger adults; in some parts of sub-Saharan Africa the prevalence of HIV infection among women aged 15–24 is up to eight times that among men in the same age group (UNAIDS 2010). This paper studies the ratio between female and male HIV prevalence in a number of sub-Saharan African countries, exploring whether gender inequality is a contributory factor in the variation between countries.

It has long been recognised that the susceptibility of men and women to HIV infection is different (UNAIDS 1999) and many studies have identified biological (Boily et al. 2009, O'Farrell 2001), behavioural (Bongaarts 2007), social (Dunkle et al. 2004) and economic (Greig and Koopman 2003) factors significantly associated with increased susceptibility in women.

Considerable research effort has focused on exploring whether differences in sexual behaviour between men and women can explain the higher HIV prevalence of women within countries or determines the extent of variation in the sex ratio of HIV prevalence between countries. Given that males generally exhibit riskier sexual behaviours, such as multiple sex partners (Boileau et al. 2009), concurrency (Mah and Halperin 2010), and lower use of HIV testing services (Obermeyer et al. 2009), we might expect that HIV prevalence would be higher for men. However some studies suggest that the odds of infection are nearly 70% higher for females in comparison to males when controlling for sexual behaviour (Magadi 2011). A study by Hertog (2008), sought to identify correlates of national female-to-male (FTM) sex ratio of HIV prevalence in 16 countries in sub-Saharan Africa. The correlates most strongly associated with the FTM sex ratio of HIV prevalence were; percentage of males circumcised and the FTM ratio of other sexually transmitted diseases. However, the final multivariate regression model at the regional level explained only 17% of the total variation in the HIV prevalence sex ratio.

Less attention has been given to exploring the relationship between indicators of gender inequality and the FTM sex ratio of HIV prevalence across countries with a generalised epidemic in sub-Saharan Africa. Gender inequality is often discussed as a potential reason for this imbalance in HIV prevalence between males and females, particularly as the reason for higher HIV prevalence among young women, and most countries within the region achieve a low ranking on the Gender Inequality Index (UNDP 2011a). Previous research on the FTM ratio of HIV prevalence has already examined measures reflecting inequality in education and employment alongside the female-to-male ratio of the percentage of adults who agree that it is possible to take action to avoid contracting AIDS (Hertog 2008). Research into female empowerment has suggested that autonomy may be important with regard to HIV related outcomes (Greig and Koopman 2003, Bloom and Griffiths 2007), however social, political and psychological dimensions of empowerment have been largely ignored due to difficulties in measuring them (Malhotra and Schuler 2005).

The aim of this study is to examine the relationship between gender equity and the FTM ratio of HIV prevalence overall (15-49 year olds) and for two age groups: 15-24 year olds and 25-49 year olds. We use data available from 25 national HIV surveys conducted in sub-Saharan Africa. Indicators of gender inequality are considered together with other biological, behavioural, epidemiological, demographic and contextual factors that have been shown to, or can be postulated to, influence the FTM ratio of HIV prevalence.

Literature Review

In previous research on the correlates of the FTM ratio, Hertog's 2008 study found a weak association between the FTM ratio of HIV prevalence and sexual behaviour variables (the sex ratio of premarital sexual activity and the percentage of women's current marriages that are polygamous). Differences across countries in sexual behaviour, such as age at first marriage, age at sexual debut and large age differences between spouses have been linked to variation in HIV prevalence (Carael and Holmes 2001) and are also likely to influence the FTM ratio of HIV prevalence. For example, Bongaarts (2007) reported that late marriage after sexual initiation leads to a long period of premarital intercourse for women, increasing their risk of acquiring HIV. Given that sexual debut and marriage occur at an early age in many parts of sub-Saharan Africa, we would expect behavioural variables to be most strongly associated with the FTM ratio of HIV prevalence among 15-24 year olds.

There is some evidence that differences in HIV prevalence between men and women may be an artefact due to earlier female infection and lower mortality, rather than reflecting a difference in lifetime risk for men and women (Garenne and Lydié 2001). Biases and selection effects which affect the pattern of age and sex differences in infection and mortality may ultimately influence the numbers of men and women living with HIV (Gregson and Garnett 2000).

The influence of epidemiological factors on the FTM ratio of HIV prevalence has been considered in other research by including variables reflecting the maturity of the epidemic. The development of the HIV epidemic has gone through a number of stages, starting with sex workers and their (male) clients before developing into a generalised epidemic where women have a higher prevalence (Garenne and Lydié 2001, Hertog 2008). Yet research has only found a weak association between the HIV sex ratio and the proxy used for maturity of the epidemic (the year the first HIV/AIDS case was reported) and the accuracy of this proxy for measuring epidemic maturity is questionable. It is likely that the AIDS epidemic began in many countries before being officially recognised. Alternatively, the year the epidemic peaked might give more of an indication as to whether the epidemic is still in a growing, or in an endemic steady state phase.

Gender disparities in HIV prevalence may also be exaggerated by the longer average survival time for women with HIV (Gregson and Garnett 2000). The significant increase in access to antiretroviral treatment (ART) in the past decade is also likely to have influenced sex-specific mortality rates and, consequently, FTM ratios of HIV prevalence. Research suggests that women have better clinical and viro-immunological responses to ART than men (Collazos et al. 2007) and that men are at higher risk of mortality on treatment (Chen et al. 2008). Available evidence also suggests that disproportionately more women than men have initiated ART in a number of sub-Saharan African countries (see for example Muula et al. 2007). Increased access to ART, which appears to be benefitting women more than men, is likely to have the effect of inflating overall levels of HIV prevalence in women.

Several studies in Africa have suggested the importance of socioeconomic, institutional and cultural differences such as wealth, income inequality, mobility and urbanisation on the distribution and determinants of HIV (Parkhurst 2010, Piot et al. 2007, Greig and Koopman 2003). The influence of such factors on sexual behaviours has been increasingly acknowledged, with contextual variables receiving more attention in epidemiological research (Boerma and Weir 2005). Whilst an increasing number of surveys are including items on a number of important indicators, many of these contextual variables are not captured in Demographic and Health Surveys (DHS) and therefore were not examined in previous research on the FTM ratio of HIV prevalence (Hertog 2008). Such indicators are however available at the country level from other sources and it is therefore possible to include a number of contextual factors in this analysis.

With respect to gender inequality, there is a plethora of evidence suggesting that a wide range of factors increase women's HIV risk and risky sexual behaviours at the individual level, including poverty, marginalization and economic dependence (Greig and Koopman 2003); sexual coercion and sexual violence (Dunkle et al. 2004, Andersson et al. 2008, Maman et al. 2002, Jewkes et al. 2003); inability to negotiate sex and less participation in decision making, particularly with regard to sex, (Bloom and Griffiths 2007, Langen 2005); lower levels of literacy and education (Snelling et al. 2007, Burgoyne and Drummond 2008), and stigma and discrimination. Previous research has included several measures of gender equality in analysis of variation in the FTM ratio of HIV prevalence including inequality in education, employment and the FTM ratio of the percentage of adults who agree that it is possible to take action to avoid contracting AIDS. Little association between these measures and the FTM ratio of HIV prevalence has been found (Hertog 2008).

This paper utilises the wide range of data now available from both DHS and other sources to include several additional measures of gender equality, related to labour force participation, political participation and overall levels of gender equality, which are hypothesised to be important with regard to HIV related outcomes at the country level.It is hypothesised that measures of gender inequality will be more strongly associated with the FTM ratio in 15-24 year olds as young women are considered particularly vulnerable and lack autonomy (Weiss et al. 2000).

Data and methods

All countries in sub-Saharan Africa where there is considered to be a generalised HIV epidemic (prevalence over 1% amongst 15-49 year olds) were eligible for inclusion in the study. Countries selected were those where individual HIV test results were available for women and men from the most recent household surveys. A full list of the 25 countries included in this analysis, including the year of the survey and the percentage of respondents with HIV, by gender and age group, are shown in Table 1.

Table 1: Data sources and HIV epidemic indicators for 25 sub-Saharan African countries

Country	Year	Data Source	Overall HIV prevalence	Overall (15-49 years)			15-24 years			25-49 years		
				Males	Females	Ratio	Males	Females	Ratio	Males	Females	Ratio
Benin	2006	DHS	1.2	0.8	1.5	1.9	0.3	1.0	3.3	1.1	1.8	1.6
Botswana	2008	AIDS Impact Survey	25.0	19.6	29.2	1.5	4.8	10.7	2.2	28.6	39.3	1.4
Burkina Faso	2010	DHS	1.0	0.8	1.2	1.5	0.5	0.3	0.6	1.0	1.8	1.8
Burundi	2010	DHS	1.4	1.0	1.7	1.7	0.2	0.8	4.0	1.6	2.5	1.6
Cameroon	2011	DHS	4.3	2.9	5.6	1.9	0.5	2.7	5.4	4.8	7.8	1.6
Congo	2009	DHS	3.2	2.1	4.1	1.9	0.7	2.4	3.4	2.8	5.3	1.9
Cote D'Ivoire	2005	DHS	4.7	2.9	6.4	2.2	0.3	2.4	8.0	4.8	9.9	2.1
DRC	2007	DHS	1.3	0.9	1.6	1.8	1.0	0.5	0.5	0.9	2.5	2.8
Ethiopia	2011	DHS	1.4	1.0	2.1	2.1	0.1	0.5	5.0	1.6	3.2	2.0
Ghana	2003	DHS	2.2	1.3	2.3	1.8	0.1	1.1	11.0	2.2	3.1	1.4
Guinea	2005	DHS	1.5	0.9	1.9	2.1	0.6	1.2	2.0	1.2	2.3	1.9
Kenya	2008	DHS	6.4	4.3	8.0	1.9	1.1	4.5	4.1	6.8	10.3	1.5
Lesotho	2009	DHS	23.0	18.0	26.7	1.5	4.2	13.6	3.2	31.5	37.2	1.2
Liberia	2007	DHS	1.6	1.2	1.9	1.6	0.5	1.6	3.2	1.5	1.9	1.3
Malawi	2010	DHS	10.7	8.1	12.9	1.6	1.9	5.2	2.7	13.1	18.3	1.4
Mali	2006	DHS	1.3	0.9	1.4	1.6	0.5	0.9	1.8	1.2	1.7	1.4
Mozambique	2009	DHS	11.5	9.2	13.1	1.4	3.7	11.1	3.0	11.7	13.4	1.6
Rwanda	2010	DHS	3.0	2.2	3.7	1.7	0.4	1.5	3.8	3.8	5.3	1.4
Sierra Leone	2008	DHS	1.5	1.2	1.7	1.4	0.5	1.4	2.8	1.5	1.9	1.3
South Africa	2008	National HIV PICBS*	16.9	11.7	20.2	1.7	3.6	13.9	3.9	11.7	20.2	1.7
Swaziland	2006/7	DHS	25.9	19.7	31.1	1.6	5.9	22.7	3.9	36.3	38.6	1.1
Tanzania	2011/12	DHS	5.7	4.6	6.6	1.4	1.1	3.6	3.3	7.2	8.6	1.2
Uganda	2011	DHS	7.3	5.0	7.5	1.5	1.1	4.3	3.9	7.6	9.1	1.2
Zambia	2007	DHS	14.3	12.3	16.1	1.3	4.3	8.5	2.0	17.8	21.2	1.2
Zimbabwe	2010/11	DHS	15.2	12.3	17.7	1.4	3.6	7.3	2.0	19.3	25.0	1.3
Median						**1.64**			**3.3**			**1.4**
IQR						**(1.49-1.88)**			**(2.33-3.98)**			**(1.27-1.64)**

* PICBS - Prevalence, Incidence, Behaviour and Communication Survey.

Dependent variable: FTM ratio of HIV prevalence

The dependent variable for this analysis was the FTM ratio of HIV prevalence in the population. This was calculated for three different age groups: adults aged 15-49, 'young adults' aged 15-24 years and 'older adults' aged 25-49 years. The FTM ratio of HIV prevalence was calculated by dividing female HIV prevalence by male HIV prevalence. The HIV prevalence rates were calculated from the survey datasets where these were not reported directly in the final reports. Survey weights were used at all times to account for the differential chances of individuals being selected into each survey. In order to normalise the distributions and to reduce the impact of outliers the FTM ratios were transformed onto a natural log scale. The HIV prevalence and the untransformed ratios are given in Table 1.

Gender equity indicators

The Gender Inequality Index (GII) score for 2011 (UNDP 2011a) was chosen to give an indication of overall levels of gender equality within a country. The GII encompasses five indicators in three dimensions, and is used to assess the losses on human development caused by gender inequality in the three dimensions of reproductive health, empowerment, and labour market participation, whilst excluding the earned income component which has been considered controversial in other indices (UNDP 2011b). The three dimensions are captured in one composite measure, as a score of between 0 and 1, and this score is interpreted as a percentage. Values close to 0 indicate that the potential human development lost due to gender inequality is low. As the GII is a new index which has only been in used since 2010, it was not possible to compare associations with the FTM ratio of HIV prevalence over time. Other indices, such as the Gender Development Index (GDI), the Gender Empowerment Measure (GEM), the African Gender Development Index (AGDI), the Standardised Index of Gender Equality (SIGE) and the Global Gender Gap Index (GGI) were considered for use but were not available for all countries.

Additional measures of female empowerment were included in an attempt to include other dimensions of empowerment which might be related to gender disparity in HIV prevalence. These included the percentage of female seats in parliament, taken from the World Bank WDI database (World Bank 2013), and the female-to-male ratio of labour force participation (UNDP 2011a).

Biological and Behavioural variables

A number of biological and behavioural variables were calculated from the DHS and household surveys from South Africa and Botswana. Previous research found that the FTM ratio of premarital sexual activity was not associated with the FTM ratio of HIV prevalence (Hertog 2008). However a long period of premarital intercourse has been shown to increase women's risk of acquiring HIV (Bongaarts 2007), therefore several measures which may be related to female HIV risk are examined, including median age at sexual debut, median age at first marriage and the interval (in years) between average age at sexual debut and average age at marriage. Finally, prevalence of male circumcision (MC) was included as male circumcision has been shown to have a protective effect for men but no reduction in HIV transmission to female partners (Wawer et al. 2009). This may result in a reduced proportion of men with HIV in countries where MC is more common, although the longer-term effects of male circumcision on risk of HIV transmission to women was not assessed.

Other contextual variables

In addition to using data on HIV prevalence and sexual behaviours from the DHS and other household surveys, contextual variables from other sources were included. Previous research on the FTM ratio of HIV prevalence did not include contextual variables. Yet research has found that several contextual variables explain much of the variation in female HIV prevalence across urban populations in 72 countries (Over 1998). It was therefore considered important to include a number of contextual variables which are known to be related to risk behaviours in men and women (Parkhurst 2010, Piot et al. 2007, Greig and Koopman 2003).

Measures of a countries wealth, development and inequality were included as poverty and inequality may create more active markets for commercial and casual sex. These measures included the Human Development Index (HDI) (UNDP 2009), Gini index (UNDP 2009) and GNI per capita (current US$, Atlas Method), available from the World Bank WDI database (World Bank 2013).

The percentage of the population foreign born, available from the World Bank WDI database (World Bank 2013), was used as a proxy to indicate levels of migration. Alternative measures of migration such as remittances as a percentage of the country's GDP were also considered. However a lack of data in a large proportion of countries precluded the use of this measure.

Epidemiological and Demographic variables

Two variables were included to control for the maturity of the epidemic: year the first HIV/AIDS case was reported, available from country reports, and the year the epidemic peaked, based on UNAIDS estimates (UNAIDS 2013). Previous research found only a weak association between the year the first HIV/AIDS case was reported and the FTM ratio of HIV prevalence, and the accuracy of this proxy is questionable. As nearly all epidemics in sub-Saharan African countries reached their peak over a decade ago in the 1990s or early 2000s (Bongaarts et al. 2008) it may be more useful to use the year the epidemic peaked, which gives more of an indication as to how long the epidemic has been in an endemic steady state phase. Total HIV prevalence is also likely to be correlated with the FTM ratio of HIV prevalence as a general pattern in starting date of the epidemic and trends in HIV prevalence has been observed by region; the epidemic began in West Africa but remained at a low level, whilst Southern Africa appeared to be affected last, although rates there are now the highest in Africa and in the world. It is therefore expected that countries with a higher overall HIV prevalence will have more equal distribution of HIV infected men and women than in epidemics with a lower total HIV prevalence as HIV prevalence in these countries will have peaked more recently.

Male to female population sex ratios are also included and mean age in the population are included as a masculine population sex ratio and young population age structure are thought to be associated with high-risk sexual behaviours (Over and Piot 1993).

Total life expectancy at birth and the female to male ratio of life expectancy at birth, available from the World Bank WDI database (World Bank 2013), were included as women's younger average age of infection is likely to exaggerate the difference in life expectancy between men and women. The maternal mortality ratio (UNDP 2011a) was also included as it is considered a good indicator of both the strength of a country's health system and an indicator of the status of women within that country (Freedman 2005, Freedman 2000). Similarly, both overall levels of ART coverage as well as relative levels of ART among men and women (WHO 2008, WHO 2011) are likely to be associated with the FTM ratio of HIV prevalence. We would expect an excess in mortality in males, particularly in the older age groups to be associated with a high FTM ratio of HIV prevalence.

Data for two time points have been included where possible in order for all factors to investigate the potential time-lag effect of the explanatory factors, where the prevalence and FTM ratios observed at a point in time are more related to factors that occurred at time of infection than at the time of the survey. It is expected that the current context is unlikely to be associated with FTM ratios amongst the older age groups as a large proportion of infections were likely to have occurred a number of years prior to the surveys.

Methods

An ecologic study design was utilised in this analysis, with countries as the unit of study, for two main reasons: firstly there has been little investigation of the factors which may influence this gender imbalance at a macro level; secondly several of the variables included in the analysis do not have analogues at the individual or regional level.

Simple Pearson correlation coefficients were employed to assess the relationship between the dependent variables and the potential explanatory variables. Within-country variation in the female-to-male (FTM) ratio of HIV prevalence can also be large, this issue is not addressed in this paper. The associations were additionally tested using Spearman's rank correlation coefficients (not shown in this paper), using both the log transformed and original dependent variables, to ensure that the choice of a parametric measure versus a nonparametric measure did not bias the results. Results did not differ by choice of method.

Results

From the descriptive statistics in Table 1, it can be seen that the prevalence of HIV among women was generally higher than among men of the same age, with a median FTM prevalence ratio of 3.3 [interquartile range (IQR) 2.3–4.0] among 15–24 year olds, in comparison to 1.6 (IQR 1.5–1.1) among 15-49 year olds and 1.4 (IQR 1.3–1.6) among 25-49 year olds. In all countries the FTM ratio of HIV prevalence was above one for the 15-49 and 25-49 age groups, indicating that at the country level female prevalence is invariably higher than male prevalence. However for the 15-24 year old age group two countries, Burkina Faso and the Democratic Republic of Congo showed the opposite, with more males with HIV than females. It was therefore decided to calculate the correlations between the FTM ratios and the explanatory factors both with and without these two countries for the youngest age group.

Gender Inequality

Several of the indicators of gender equality were significantly correlated with the FTM ratio of HIV prevalence (see Table 2). The Gender Inequality Index measures the percentage loss in achievement due to gender inequality (UNDP 2011b) and thus we would expect that as this score increases the FTM ratio of HIV prevalence also increases. This is seen to be significant (at the 10% level) for 25-49 year olds. Interestingly a negative correlation is seen for the younger age group, although the correlation is not significant and is close to zero when Burkina and DRC are excluded. Other measures of gender inequality (percentage of female seats in parliament in 1997 and the female to male ratio of labour force participation in 1990) were negatively correlated with the FTM ratio of HIV prevalence among 15-49 year olds. The association between these gender inequality variables are only significant for the whole age range and are not significant for the 25-49 year olds. Overall there are few significant correlations between the identified gender inequality variables and the FTM ratio of HIV prevalence, either indicating that there is no relationship or that the variables selected are not capturing fully the inequality between males and females.

Table 2: Pearson correlation coefficients between explanatory variables and the female-to-male ratio of HIV prevalence among three age groups for 25 countries

	15-49 age group		15-24 age group		15-24[1] age group		25-49 age group	
Gender Inequality								
GII score	0.154		-0.249		-0.061		0.391	+
% female seats in parliament (1997)	-0.354	+	-0.086		-0.143		-0.257	
% female seats in parliament (2009)	-0.142		-0.337		-0.013		-0.377	
Female to male ratio: Labour force participation (1990)	-0.397	*	-0.128		-0.091		-0.166	
Female to male ratio: Labour force participation (2005)	-0.259		-0.085		-0.001		-0.042	
Biological and Behavioural Variables								
Prevalence of male circumcision	0.477	*	0.057		0.348		0.433	*
Median age at sexual debut (female)	-0.135		0.141		0.175		-0.207	
Median age at first marriage (female)	0.037		0.293		0.366		-0.076	
Interval between sexual debut and age of marriage	0.228		0.240		0.305		0.142	
Epidemiological and Demographic Variables								
Total HIV prevalence	-0.434	*	0.039		-0.247		-0.560	**
Year first AIDS case reported	-0.058		0.004		-0.067		-0.156	
Year epidemic peaked	-0.242		0.192		0.021		-0.495	*
Mean age in the population	0.126		0.317		0.184		-0.124	
Male-to-female population sex ratio	0.512	**	0.178		0.324		0.356	+
Male-to-female population sex ratio (15-24 year olds)	0.530	**	0.084		0.354	+	0.424	*
Male-to-female population sex ratio (25-54 year olds)	0.288		0.031		0.177		0.213	
Total life expectancy (2007)	0.488	*	0.411	*	0.567	**	0.256	
Female to male ratio of life expectancy at birth (2007)	0.624	***	0.179		0.343		0.600	**
Total ART coverage (2010)	-0.250		0.015		-0.390	+	-0.423	*
Female to male ratio: ART coverage (2010)	0.051		0.189		0.411	+	0.023	
Female to male ratio: ART coverage (2007)	-0.156		0.268		0.361		0.333	
Maternal mortality ratio (2008)	-0.166		-0.217		-0.293		0.003	
Contextual Variables								
Human Development Index (HDI) 2005	0.087		0.425	*	0.229		-0.266	
Gini index	-0.204		0.008		-0.133		-0.267	
GNI per capita (1995)	-0.018		0.103		-0.038		-0.204	
GNI per capita (2007)	-0.049		0.093		-0.038		-0.201	
% population foreign born (1995)	0.444	*	0.143		0.275		0.354	+
% population foreign born (2005)	0.324		0.304		0.499	*	0.202	

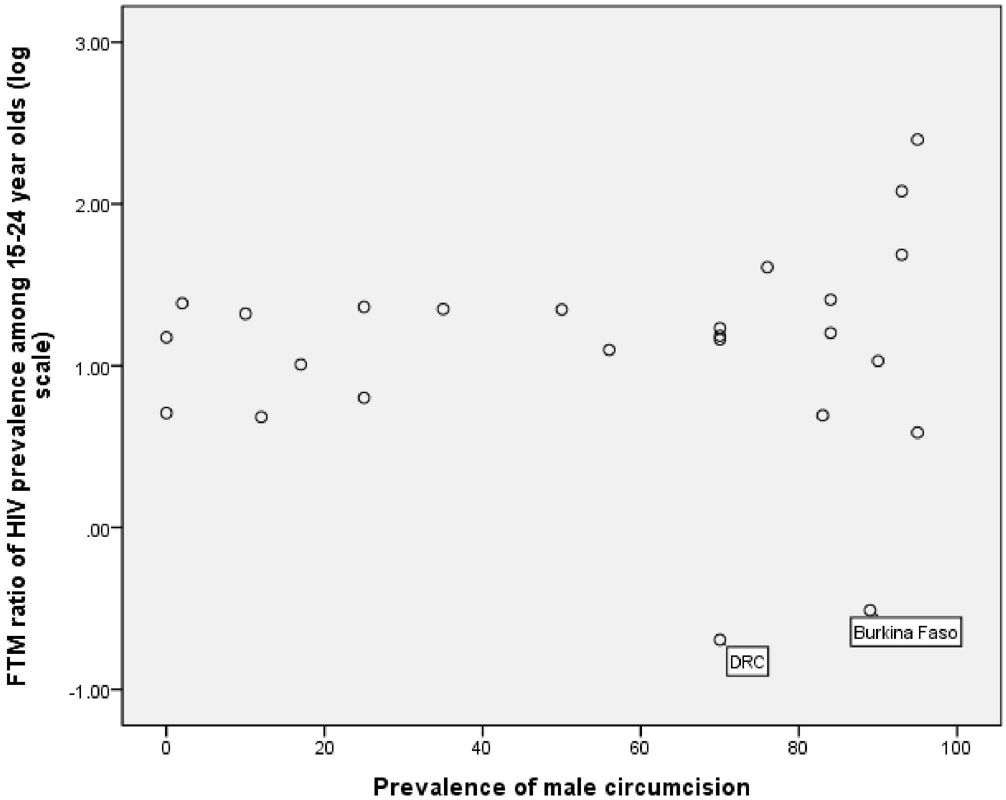
+ = p<0.10; * = p<0.05; **=p<0.01; *** = p<0.001

1. Pearson correlation between explanatory variables and the FTM ratio for 15-24 year olds excluding Burkina Faso and DRC.

Biological and behavioural

Concurring with Hertog's (2008) analysis and the hypothesis stated earlier, the percentage of males circumcised is positively correlated with the FTM ratio of HIV prevalence among 15-49 year olds. However this is only significant for the 25-49 age group. An examination of the HIV prevalence sex ratio plotted against the percentage of males circumcised suggests that generally countries with a higher prevalence of male circumcision have a higher female-to-male ratio of HIV prevalence, however, it is apparent when looking at all three age groups that countries with high levels of male circumcision (the majority of which are in Western Africa) display more variation in the FTM ratio of HIV prevalence than countries with lower levels of male circumcision, a relationship which is particularly obvious when looking at the graph for the 15-24 years age group (see Figure 1).

Figure 1: Female-to-male ratios of HIV prevalence and prevalence of male circumcision



None of the sexual behavioural variables (median age at first sex, median age at first marriage, and the length of the interval between age at first sex and age at marriage) were significantly correlated with the dependent variables.

Epidemiological and demographic

HIV prevalence was significantly negatively correlated with the FTM ratio of HIV prevalence in both the total population (aged 15-49) and the older adult population (aged 25-49), indicating that in countries with a higher overall HIV prevalence the relative numbers of men and women infected with HIV are more equally distributed than in epidemics with a lower total HIV prevalence. That there is no correlation with HIV prevalence in the younger age group demonstrates the usefulness of examining different age groups of the population independently. The relationship between HIV prevalence and the FTM ratio of HIV prevalence among 25-49 year olds becomes stronger in comparison to the 15-49 age range, suggesting that analysing all ages together may mask potential interesting associations between the FTM ratio and some explanatory variables.

The year when the epidemic peaked in each country was seen to be significantly related to the FTM ratio amongst 15-49 year olds, while the standard indicator of the maturity of the epidemic, the year the first HIV/AIDS case was recorded, was not in any age range. The correlation with the peak year suggests that the maturity of the epidemic is either associated with an increase in incidence among females or an increase in mortality in males. Given the general age and sex distribution of HIV prevalence for this age group across sub-Saharan African countries it is most likely that excess male mortality in this age group is related to a reduction in the FTM ratio.

There is also a strong positive correlation between the female-to-male ratio of life expectancy and the FTM ratio of HIV prevalence; in countries where women live on average longer than men the proportion of women living with HIV in comparison to men also increases, an association that can be seen both in the total population and older adult population. In comparison, the relationship between the FTM ratio of HIV prevalence among 15-24 year olds and the FTM ratio of life expectancy is neither strong nor significant.

The FTM ratio of ART coverage is not significantly correlated with any of the dependent variables except for in the 15-24 age group for the reduced number of countries. Furthermore the overall level of ART coverage is negatively correlated among the 25-49 age group and the same 15-24 age group excluding Burkina Faso and DRC, suggesting that the FTM ratio of HIV prevalence becomes more equal as an increasing proportion of the population have access to ART. As men access ART at a later stage and at older ages it was expected that there would be a relationship between ART coverage and the FTM ratio among older cohorts. However there is also a significant relationship among the 15-24 age group (when excluding Burkina Faso and DRC) suggesting that total ART coverage and the relative number of males accessing ART also influence the relative numbers of males and females living with HIV among younger age groups.

As Hertog (2008) found, no association was evident between the indicator for population age structure (mean age of the population) and any of the dependent variables. However, several of the variables reflecting the population sex structure (the male-to-female population sex ratio in the total population and in 15-24 year olds) were positively correlated with the FTM ratio among 15-49 year olds and 25-49 year olds, indicating that in populations with masculine sex ratios HIV prevalence is higher in women.

Contextual factors

Few of the contextual variables included in the analysis were significantly correlated with any of the dependent variables. However, a measure of migration (the percentage of the population that was migrant in 1995) was positively associated with the FTM ratio of HIV prevalence in the 15-49 and 25-49 age groups. The same variable for 2005 is significant for the 15-24 age group with the reduced number of countries, suggesting that the recent context with regard to levels of migration may be influential with regard to the FTM ratio of HIV prevalence among younger age groups. Interestingly, one other variable which is significant among the contextual variables is correlated only with the FTM ratio of HIV prevalence among 15-24 year olds. The FTM ratio of HIV prevalence among 15-24 year olds for all 25 countries is significantly correlated with the Human Development Index, although the correlation is not significant when only 23 countries are included.

Discussion

The Demographic and Health Survey series allows a greater depth of analysis to be undertaken with respect to HIV in sub-Saharan Africa than ever before. Due to the standardisation of the questionnaires there is good comparability between the surveys from different countries. Coupled with the collection of biomarkers, including HIV status, there is a wealth of data available to analyse and research questions, such as the ones posed in this study, can now be answered. In this study a large proportion of countries in sub-Saharan Africa that have a generalised HIV epidemic were included due to the availability of data, enhancing the reliability of the study results.

The results shown suggest that the association between explanatory variables and the FTM ratio of HIV prevalence was similar between the 25-49 age group and the 15-49 age group, and indeed these two dependent variables are correlated with each other ($r=0.726$, $p=0.000$). This may be explained by the fact that across sub-Saharan Africa HIV prevalence generally peaks in both men and women past the age of 25, and therefore the majority of infections will be represented by this age group. However, the fact that the majority of infections are concentrated in older adults has implications with regard to the accuracy of estimates for the 15-24 age group; the level of uncertainty around HIV prevalence is likely to be larger in an age group where prevalence is relatively lower.

A consequence of this is that confidence intervals for the FTM ratio of HIV prevalence may include one or overlap in different countries, even when there are large differences in the point estimates. Furthermore, the fact that there were more males than females amongst the 15-24 year olds in Burkina Faso and DRC highlights the vulnerability of men in some contexts. Whilst the literature on HIV and gender inequality emphasises the vulnerability of young women (e.g. Weiss et al. 2000), it can be taken from these two countries that young men may actually be more vulnerable to HIV infection than young women in some contexts.

It is clear that many of the significant correlations between variables representing the economic context and gender inequality were measures from several decades ago, suggesting that the context during the early years of the epidemic remains important in explaining gender dynamics within the epidemic. The younger age group, after the outliers of Burkina Faso and DRC were removed, were more affected by recent factors.

It is also noteworthy that male circumcision and the other behavioural variables included were not significantly correlated for the younger age group of 15-24 year olds, with or without the inclusion of the outlier countries. The lack of a correlation with male circumcision in the younger age group may be explained by the fact that in countries where traditional male circumcision is common it is often carried out on adolescents or young men around the age of sexual debut (Wilcken et al. 2010). Those who have already initiated sexual activity without being circumcised will not have benefitted from the protective effect of circumcision during this period, with the benefit only becoming apparent among the population in the long term. Furthermore, the risk of HIV transmission may be increased if sexual intercourse occurs before the surgical wound has healed.

It is surprising that the other behavioural variables included also showed no apparent relationship with the FTM ratio for any age group, although this does concur with previous research (Hertog 2008). The behavioural variables tested here, including sexual debut, first marriage and the interval, along with those tested by Hertog, including premarital sexual intercourse and polygamous marriage, show little relationship with the FTM ratio. Yet there may still be a behavioural basis for gender disparities in HIV prevalence which was not addressed in this analysis or in other research.

Based on the evidence available from the 25 national two-sex HIV prevalence surveys, it seems that the variables included in the analysis fail to explain the vast majority of the variation in the sex ratio of HIV prevalence. The age and sex distribution of HIV prevalence are likely to be affected by other factors which have not been measured in this analysis. It is also possible that inaccuracy in the point estimates of HIV prevalence for the age groups may be to blame; there is a high degree of variation in the width of the confidence intervals surrounding the point estimates of HIV prevalence and this uncertainty is likely to be increased when further disaggregating the total population by age and sex.

Limitations

The limitations of ecological analyses are well known (Greenland and Morgenstern 1989). In particular, the "ecological fallacy" results from making a causal inference about individual phenomena on the basis of observations of groups. An association at the country level may be due to complex biases which do not apply at the individual level. Nevertheless, an ecological approach has certain advantages in examining possible relationships between the FTM ratio of HIV prevalence and gender inequality, as associations may be detectable when comparisons are made between different countries that would not be evident within any one country (Rose 1992).

Whilst it is acknowledged that more advanced methods such as multiple regression would enrich the analysis, the small number of countries included limited the methods to those suitable for such a small sample size. Given that the female-to-male ratio of HIV prevalence is likely to be influenced by a combination of factors, multiple regression would enhance understanding of the mechanisms through which the FTM ratio of HIV prevalence is affected by controlling for several explanatory variables simultaneously and as well as identifying possible confounding variables. Nonetheless, ecological analyses such as those based on the '4 cities' study have had important roles in the identification of causal relationships with regard to HIV prevalence.

Conclusions

This paper has used a new database which compiled a range of factors likely to influence the FTM ratio of HIV prevalence with the aim of investigating the relationship between gender equity indicators and the FTM ratio of HIV prevalence in two age groups. Nationally representative surveys of HIV seroprevalence from the Demographic and Health Surveys (DHS) are currently the best available source of sex-specific measures of national HIV prevalence and are most well suited to address questions of sex ratio dynamics on a national scale. Furthermore, the standardised questionnaire and HIV testing procedure facilitates comparisons across countries and data from the DHS allowed several behavioural aspects to be taken account of far better than using other datasets.

It was expected that female prevalence would be slightly higher than male prevalence due to greater female biological susceptibility (Boily et al. 2009, O'Farrell 2001), however in many countries prevalence among young women is unacceptably high in comparison to young men. Whilst it must also be borne in mind that high levels of male circumcision may inflate the FTM prevalence ratio by resulting in a reduced proportion of men with HIV, this association was not a significant explanatory variable for the variation in the FTM ratio among 15-24 year olds. Furthermore, although some have argued that young women are biologically more vulnerable than older women, this does not appear to be an issue in countries such as Guinea and Mali where the FTM ratio remains relatively low and stable across age groups, despite a large proportion of young women in these countries being sexually active before the age of 15. Current programmes aimed at delaying sexual debut, reducing the number of sexual partners and increasing condom use should continue to be supported and expanded, particularly targeting young women and their sexual partners. In addition, whilst prevalence is generally low in Burkina Faso and DRC, where male prevalence was found to be higher than females for 15-24 year olds, it is essential that at risk groups whether male or female are targeted and given the skills, tools, or incentives to protect themselves as well as their partners. It is generally the most socially disenfranchised groups which are the most likely to be infected, and men's risk of HIV may be heightened by contextual and structural factors such as residential segregation, unstable housing and homelessness, unemployment and migratory work (Higgins et al. 2010).

Finally, it must also be acknowledged that inequality in the female-to-male ratio of HIV prevalence may also be a product of gender inequality in uptake of ART for males and consequently higher mortality among men. Whilst the association between explanatory variables related to the level of ART and relative numbers of males and females accessing ART were only significant at the 10% level for the younger age group excluding Burkina Faso and DRC, these associations suggest that addressing inequality in AIDS treatment for males may not only reduce the FTM ratio at older ages but also among younger age groups.

Achieving an improved understanding of the roles of sex and gender in HIV/AIDS epidemics is crucial for the future of HIV/AIDS research and initiatives aimed at prevention and treatment of the disease. Whilst gender inequality as measured here is not related to gender inequality in HIV prevalence among either age group, a number of other epidemiological and contextual variables were significantly correlated with the FTM ratio of HIV prevalence. In addition, significant relationships between the FTM ratio of HIV prevalence and other explanatory variables among the two age groups demonstrate that examining the entire population may mask associations; a number of variables became significant or more strongly significant when the FTM ratio of HIV prevalence was disaggregated into two separate age groups in comparison to the FTM ratio of HIV prevalence among the total population.

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