

ORIGINAL RESEARCH ARTICLE

# The role of health care in the spread of HIV/AIDS in Africa: evidence from Kenya

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**Summary:** It is commonly asserted that the sub-Saharan African HIV/AIDS epidemic is predominantly due to heterosexual transmission. However, recent re-examination of the available evidence strongly suggests that unsafe health care is the more likely vector. The present report adds to the evidence for health-care transmission by showing that Kenyan women who received prophylactic tetanus toxoid injections during pregnancy are 1.89 times (95% confidence interval [CI]: 1.03–3.47) more likely to be HIV-1 seropositive than women who did not receive this vaccination. In contrast, recent sexual behaviour (condom use, number of partners) was not related to HIV status. The findings are unconfounded by reverse causality (all injections were purely prophylactic rather than for treatment of any HIV-related illnesses, and none of the women reported knowing that she was HIV seropositive). Focus on a specific injection may have improved participant recall. The results are consistent with health care being a very important vector for HIV in sub-Saharan Africa. It is recommended that there be a reallocation of resources to address health-care transmission of HIV/AIDS.

**Keywords:** HIV, Africa, Kenya, heterosexual transmission, health care

## Introduction

It has been estimated that the vast majority of HIV-seropositive persons live in sub-Saharan Africa, and that AIDS has led to a substantial decrease in life expectancy.<sup>1</sup> It is widely asserted that heterosexual intercourse (usually misinterpreted to refer to penile–vaginal intercourse) is responsible for the majority of HIV infections in sub-Saharan Africa.<sup>1</sup> However, a series of review articles cast grave doubt on this hypothesis by showing that the existing evidence is inconsistent with the prevailing hypothesis.<sup>2–7</sup> The evidence against the prevailing hypothesis includes that traditional estimates of HIV transmission efficiency and reported rates of heterosexual partner change (as well as the associated networks) are not sufficient to generate HIV epidemics of the scale reported in sub-Saharan Africa. In addition, in Zimbabwe, it was shown that classical sexually transmitted diseases (STDs) were decreasing while HIV rates (and condom use) have been increasing, which suggests that HIV is not behaving like an STD.<sup>6</sup> African studies have shown that the HIV risk associated with having treatment (injections) for STD is greater than the HIV risk associated with actually having STDs.<sup>5</sup>

The reviews suggest that infections by unsafe medical care (including but not limited to con-

taminated injections) and other punctures play the dominant role in spreading HIV in sub-Saharan Africa.<sup>2–7</sup> Studies conducted in the Masaka district in Uganda<sup>8</sup> and in the Kisea ward in Tanzania<sup>9</sup> show that injections are positively associated with HIV infections. However, the majority of studies that began to examine the role of unsafe health-care exposures used methods likely to greatly underestimate the role of unsafe health care (for reasons including inadequate measurement of unsafe health-care exposures, and using analytic models which prioritize the default assumption of heterosexual transmission).<sup>10</sup> For example, a recent study which claimed to exclude injections as a source of HIV<sup>11</sup> failed to quantify injections, was unclear about the types of injections or related ‘needle pricks’, and used very long recall periods.<sup>12</sup> Of note, the study found there was little or no significant HIV risk associated with sexual behaviour variables.<sup>11,12</sup>

It has been argued by representatives of the World Health Organization and some of their collaborators that unsafe injections are not sufficiently common in African health-care settings to play a dominant role in HIV transmission. Furthermore, they claim the potential problem of reverse causality hampering the interpretation of the studies mentioned above, because HIV seropositives are more likely to be ill, and therefore might receive injections for the treatment of HIV-related illnesses.<sup>13</sup> Despite their public policy of defending the prevailing hypothesis (and claiming that unsafe

injections are uncommon in sub-Saharan Africa), the World Health Organization and the Joint United Nations Programme on HIV/AIDS (UNAIDS) wisely recommend to their own employees to avoid injections in sub-Saharan Africa, and to use their own needles.<sup>14</sup>

The present paper overcomes the potential problem of reverse causality by estimating the impact of receiving tetanus toxoid injections on HIV serostatus, using data from a general population study conducted in Kenya. Because these injections are given for the prevention of neonatal tetanus and not for treatment of any HIV-related illnesses, the causality problem postulated by Schmid<sup>13</sup> does not arise.

The focus on a specific type of injection, occurring during a personally relevant time period (pregnancy), may improve participant recall as compared with querying about injections in general.<sup>15</sup>

## Methods

Data used for this analysis were from the 2003 Kenya Demographic and Health Survey (KDHS). This survey provides information on sexual behaviour, use of family planning methods, and information on maternal health. In addition, the survey provides HIV-1 serostatus on over 76% of the women and 70% of the men. HIV prevalence rates are significantly higher for women than for men (8.7 versus 4.6%<sup>16</sup>).

The KDHS data provide information regarding tetanus toxoid injections, which are provided during pregnancies for the prevention of neonatal tetanus. The KDHS data on tetanus injections are for the most recent birth in the five years preceding the survey, so the present paper restricts the analysis to women who gave birth in those past five years ( $n = 1620$ ). Women in the analysed sub-sample are younger (72% are aged 20–34 years, compared with 32% of women who did not give birth in the preceding five years), more likely to be married, and more likely to live in poorer households than women who did not give birth during the five years preceding the survey.

## Results

A summary of sexual behaviour and tetanus injections is presented in Table 1. Prevalence of tetanus injections is high, with almost 85% of women receiving one or more tetanus injections during pregnancy. HIV prevalence is 1.8 times higher for women who received one or more tetanus injections compared with women who did not receive the vaccination. Women who received tetanus injections received a mean of 1.75 tetanus injections, with only 1.4% receiving four or more injections.

Condom use was reported by 3.5% of women at most recent intercourse. Of note, HIV prevalence is nearly twice as high among the condom users

**Table 1** Descriptive statistics

	Sample (%)	HIV+	$\chi^2$
Received tetanus injection(s)			
No	15.18	5.33	
Yes	84.82	9.61	4.65*
Condom used last intercourse			
No	96.54	8.39	
Yes	3.46	16.00	3.54†
Number of partners in previous 12 months			
No partner	10.62	11.05	
One partner	87.77	8.52	1.23
Two or more partners	1.61	15.38	0.41
Relationship to last partner			
No partner	10.62	11.05	
Spouse/cohabiting	81.22	7.60	2.45
Boyfriend/fiancé	6.61	17.76	2.52
Other partner	1.55	24.00	3.31†
Ever received money/gift for sex			
No	96.54	8.52	
Yes	3.46	12.00	0.74

Note:  $\chi^2$  statistics are based on the Pearson test of independence. \*5%, and †10% significance level

( $P < 0.1$ ). A total of 10% of the sub-sample reported having had zero sexual partners in the previous 12 months. The majority of women had only one sexual partner and only 1.97% reported two or more partners in the previous 12 months. HIV seropositivity prevalence was nominally lowest among women reporting one partner; however, the difference in HIV seropositivity prevalence between women reporting one and zero partners in the past 12 months was not statistically significant.

None of the women reported knowing that she was HIV seropositive.

The majority of women last had sexual intercourse with their spouse or cohabiting partner. Extramarital partnerships were not common, and all but eight married women reported that their last intercourse was with their spouse. Only 3.46% of sexually active women in the sub-sample reported sexual intercourse in exchange for money/gifts.

In addition to the univariate analyses already presented, the probability of HIV seropositivity is also estimated by using a multivariate Logit model. Odds ratios (and 95% confidence intervals [CIs]) for having received injections and for number of sexual partners are presented in Table 2. Odds ratios for other sexual behaviour variables were non-significant. As detailed in Table 3, tetanus injection history was not associated with any of the sexual behaviour variables.

According to the prevailing hypothesis, HIV risk is accumulated over all sexual partners, but the number of lifetime partners is not available. Therefore, all regressions control for age of the respondent assuming that the lifetime number of partners increases (or does not decrease) with age. Furthermore, the risk of HIV seropositivity would depend on HIV prevalence in the transmitting group (sexual contacts, sources of contaminated blood). However, risk profiles of contact groups are not

**Table 2** Regression results for HIV seropositivity

	Odds ratio	95% confidence interval	Odds ratio	95% confidence interval
Received tetanus injections				
No	1.00		1.00	
Yes	1.87	1.05–3.40	1.89	1.03–3.47
Number of partners in past 12 months				
No partner			1.00	
One partner			0.72	0.42–1.22
Two+partners			1.05	0.31–3.61

Note: All regressions control for regional prevalence and respondent age

**Table 3** Tetanus injections and sexual behaviours

	Tetanus injection (%)	$\chi^2$
Condom used last intercourse		
No	84.75	
Yes	92.00	1.99
Number of partners in past 12 months		
Zero partner	83.04	
One partner	85.17	
Two and more partners	76.92	1.81
Relationship to last partner		
No partner past 12 months	83.04	
Spouse/cohabiting	84.82	
Boyfriend/fiancée	88.57	
Other partner	80.00	2.02
Ever received money/gift or favour for sex		
No	85.11	
Yes	82.00	0.37

Note:  $\chi^2$  statistics are based on the Pearson test of independence (all are non-significant)

available, so regional HIV prevalence rates are used as a proxy (HIV prevalence rates are estimated for the 72 districts of Kenya from the HIV test results of all men and women tested in this survey).

Table 2 shows a strong positive relationship between a history of any tetanus toxoid injections and HIV seropositivity. Women who received at least one tetanus injection during their last pregnancy are 1.9 times more likely to be HIV seropositive than women who did not receive a tetanus injection. However, only 5% of the women in the study reported being aware that injections present a risk for HIV/AIDS. Neither number of sexual partnerships in the previous 12 months nor receiving money/gifts for sex was related to HIV status.

## Discussion

The present paper shows that having received one or more tetanus toxoid injections during pregnancy significantly doubles the risk to be infected with HIV-1 in Kenya. Because 85% of women in the sub-sample received tetanus vaccinations, this result supports the large and growing body of evidence that contaminated punctures in health-care settings play an important role in acquiring HIV. No

significant relationship between recent heterosexual behaviour (including condom use) and HIV status was found.

The odds ratios of being HIV seropositive as a function of receiving tetanus injection are similar in sign and significance across alternative model specifications including other sexual behaviours (and similar to the results of the univariate analysis), demonstrating the robustness of the results and suggesting a lack of confounding.

It should be noted that other sources of unsafe health care (including but not limited to other injections) were not measured, thereby greatly underestimating the role of unsafe health care in the spread of HIV in Kenya and other venues with similar epidemiological features.

The lack of association between measures of sexual behaviour and HIV risk is consistent with the results of the African four cities study.<sup>17</sup> The failure of sexual exposure dose dependency is one indicator that the prevailing HIV transmission hypothesis does not fit the empirical data.<sup>7</sup>

Some readers might conjecture that this lack of support for the prevailing hypothesis is due to misreporting of sexual behaviour. Although there is indeed misreporting of sexual behaviour,<sup>18</sup> there is no evidence that the patterns of misreport have the procrustean pattern required to support the prevailing hypothesis. In addition, technologies exist to greatly reduce misreport, but studies performed in sub-Saharan Africa have not made use of them as has been recommended.<sup>10</sup>

Studies that have reported concordance or incident seroconversion between sexual partners have usually not examined whether the partners have the same strain of HIV. One study which did so found that the partners often had different genetic subtypes of HIV, suggesting that they obtained their HIV from different sources, rather than from each other, as is usually presumed.<sup>3,19</sup> Even if spouses were to have the same strain of HIV, that would not in itself be a sign of sexual transmission, because of the high prevalence in some regions of home injection kits which are shared by family members.<sup>3,20</sup>

More importantly, there was a study which avoided the myriad potential confounds of risk-factor epidemiology, and directly addressed the question of whether reasonably healthy vaginal tissue can be directly infected by HIV exposure. Biopsies of vaginal and cervical tissue were taken from various women, and appropriate laboratory methods were used to inundate the tissue samples with HIV under optimal growth conditions for 24 hours. The result was that none of the reasonably healthy vaginal or cervical samples could become infected (unlike rectal tissue samples from the same women, which were readily infected<sup>21</sup>). A similar study by researchers from the Centers for Disease Control and Prevention<sup>22</sup> led to similar results, and the authors noted: 'Our data show that urogenital epithelial cells cannot be infected with NSI or SI

phenotypic isolates of HIV-1' (p 1208). Unfortunately, the one sexual activity which is shown to be an HIV/AIDS risk for reasonably healthy persons (anal intercourse) is not the topic of significant prevention efforts, particularly in sub-Saharan Africa (where the practice of anal intercourse, both heterosexual and homosexual, is no less common than in wealthier Western countries).<sup>4</sup>

Tetanus injection history was not associated with any of the sexual behaviour variables, which suggests an absence of confounding.

The present examination of the association of tetanus injections with HIV seropositivity eliminates the risk of reverse causality, especially given that none of the women in the study knew that she was HIV seropositive. The fact that the women were queried about a specific type of injection received during a personally relevant time period may have improved participant recall.<sup>15</sup>

The implied HIV transmission efficiency (2.45%) is almost exactly the point estimate (2.3%) calculated by using a sophisticated method derived from known iatrogenic HIV outbreaks.<sup>23</sup> This recent calculation supersedes earlier estimates that were less empirically grounded and nearly an order of magnitude smaller. The 2.45% transmission efficiency would apply if all of the tetanus injections were unsafe; if the low 50% unsafe injection estimate suggested by WHO<sup>24</sup> is used, the transmission efficiency would be 4.9%, which is still within the range of transmission efficiencies calculated by Gisselquist.<sup>23</sup> However, the actual transmission efficiency in our sample might be lower than 2.45% if the women who received tetanus injections were more likely to receive other types of injections (and other unsafe punctures) than women who did not receive the tetanus injections.

The prevailing hypothesis regarding HIV transmission is not consistent with either our results, or with the other evidence noted above. There is an urgent need to reallocate prevention resources (which are currently overwhelmingly spent on targeting vaginal intercourse) for ensuring the safety of injections and other puncturing procedures in health-care and informal settings. This could prevent not only future HIV infections but also infections with the many other diseases (including Hepatitis B virus, Hepatitis C virus, and Ebola) that can be transmitted in health-care settings. People also need to be made more aware of the risks associated with unsafe injections. Such awareness may lead directly to fewer HIV/AIDS cases.<sup>3,25</sup>

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(Accepted 2 June 2006)