Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia

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Objective: To examine the factors responsible for the disparity in HIV prevalence between young men and women in two urban populations in Africa with high HIV prevalence.

Design: Cross-sectional survey, aiming to include 1000 men and 1000 women aged 15–49 years in Kisumu, Kenya and Ndola, Zambia.

Methods: Participants were interviewed and tested for HIV and other sexually transmitted infections. Analyses compared the marital and non-marital partnership patterns in young men and women, and estimated the likelihood of having an HIV-infected partner.

Results: Overall, 26% of individuals in Kisumu and 28% in Ndola were HIV-positive. In both sites, HIV prevalence in women was six times that in men among sexually active 15–19 year olds, three times that in men among 20–24 year olds, and equal to that in men among 25–49 year olds. Age at sexual debut was similar in men and women, and men had more partners than women. Women married younger than men and marriage was a risk factor for HIV, but the disparity in HIV prevalence was present in both married and unmarried individuals. Women often had older partners, and men rarely had partners much older than themselves. Nevertheless, the estimated prevalence of HIV in the partners of unmarried men aged under 20 was as high as that for unmarried women. HIV prevalence was very high even among women reporting one lifetime partner and few episodes of sexual intercourse.

Conclusions: Behavioural factors could not fully explain the discrepancy in HIV prevalence between men and women. Despite the tendency for women to have older partners, young men were at least as likely to encounter an HIV-infected partner as young women. It is likely that the greater susceptibility of women to HIV infection is an important factor both in explaining the male–female discrepancy in HIV prevalence and in driving the epidemic. Herpes simplex virus type 2 infection, which is more prevalent in young women than in young men, is probably one of the factors that increases women's susceptibility to HIV infection.

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Introduction

Young adults are the focus of many interventions to prevent HIV transmission. It is therefore essential to understand their sexual behaviour in relation to HIV risk. Studying young adults also has the advantage that the HIV prevalence seen will reflect recent trends in HIV incidence and will be little influenced by mortality.

It has been noted in several areas in sub-Saharan Africa that the HIV prevalence in young women is high within the first few years of sexual activity, whereas that in men rises more slowly [1–4]. While this could be an artefact due to failure to include young men with higher rates of HIV seropositivity, through absence or refusal, the consistency of the finding and the magnitude of the difference make this unlikely as a full explanation.

Women may have higher HIV prevalence than men because they are more exposed to infected partners and/or because they are at higher risk of acquiring HIV infection from an infected partner. The risk of exposure to an HIV-infected partner at a young age depends on the age at sexual debut, the number of partners, and the likelihood that those partners are infected. This will depend on the type of partnership, the age of the partner and the partner's risk behaviour. The tendency for young women to have older partners both within and outside marriage is likely to increase their risk of HIV, and this has been found in a population-based study in Zimbabwe [5].

There is some evidence that HIV transmission from men to women is more efficient than from women to men [6]. Several studies of discordant couples in Africa and elsewhere have found higher seroconversion rates in the initially seronegative female partners of male index cases than in the initially seronegative male partners of female index cases [7–10], although other studies have found similar seroconversion rates for men and women in HIV-discordant partnerships [11–14]. In areas of high sexually transmitted infection (STI) prevalence, it has been suggested that any difference in male-to-female and female-to-male HIV transmission probabilities may be counterbalanced by the presence of other STIs and higher cofactor effects in female-to-male transmission [15]. Comparison of HIV transmission is further complicated by likely variation in transmission probability over the course of the infection, and the fact that discordant couples are a selected group in which transmission has not occurred in the earliest stages of infection [6].

The risk of HIV transmission to very young women may be particularly high due to immaturity of the genital tract [16]. It is also possible that the risk of transmission from men to women in the first episode of sexual intercourse for the woman (loss of virginity) may be very high [17].

In the Study on the Heterogeneity of HIV epidemics in African cities, the overall prevalence of HIV infection was higher in women than in men in three of the four cities where the study took place [18]. The difference between men and women was especially marked in the age groups younger than 25 years. In Cotonou (Benin), the overall prevalence was about the same in women as in men, but in the age group 15–24 years it was 1.3% in men and 3.1% in women. In this paper, we explore possible reasons for the discrepancy in HIV prevalence between young men and young women in the two high HIV prevalence cities, Kisumu (Kenya) and Ndola (Zambia). Sample sizes were too small to permit meaningful multivariate analyses to be carried out on the data from the other cities.

Methods

Full details of the methods have been published elsewhere [18]. In each city, households were selected by two-stage cluster sampling based on census lists, aiming for a sample size of 1000 men and 1000 women in each site. Within selected households, all individuals aged 15–49 who had slept in the house the previous night were eligible for inclusion. Individuals who gave consent were interviewed using a standardized questionnaire. The questionnaire on sexual behaviour included questions about the characteristics of the spouses and the non-spousal partners in the past 12 months. The information on non-spousal partnerships included age and marital status of the partner, duration of the partnership, number of sex acts, and whether the partner had had any other partners in the past 12 months. After the interview, blood was taken for testing for HIV, syphilis and herpes simplex virus type 2 (HSV-2), and urine was tested for gonorrhoea and chlamydia. Women took vaginal swabs for testing for *Trichomonas vaginalis*. Any individuals with symptoms of treatable STIs or who were subsequently found to have syphilis were treated. HIV testing was performed anonymously. Individuals who wanted to know their HIV status were referred for re-testing, free of charge, with full counselling.

HIV testing used an enzyme-linked immunosorbent assay, with confirmation of positive samples with a rapid test. Samples giving discrepant results were tested by Western blot or two further tests. Syphilis was tested using rapid plasma region (RPR) with further testing of positive samples by *Treponema pallidum* haemagglutination. Individuals positive on both tests were considered to have positive syphilis serology. HSV-2 tests used the Gull enzyme immunoassay test (Gull Laboratories, Bad, Homburg, Germany). Trichomonas was tested using In Pouch (Biomed Diagnostics, San José, CA, USA) and gonorrhoea and chlamydia testing used DNA amplification techniques.

Ethical approval was received from the national ethical committee in each country where the study took place

and from the Institute of Tropical Medicine, Antwerp, Belgium, the London School of Hygiene and Tropical Medicine, UK and The Population Council.

Analyses

Since the emphasis of the analysis is to assess behaviour in young adults, we have concentrated on the age groups 15–19 and 20–24 years. We have examined age at sexual debut and lifetime number of partners for men and women. To explore the differences by type of partnership, we have looked at proportions married and HIV risk associated with marriage for men and women of different ages. Details for non-marital partnerships use the information collected on all partnerships during the previous 12 months.

Risk of HIV within marriage for women was examined in relation to the age difference from their husband and by whether they were virgins at the time of marriage. Virginity at the time of marriage was not asked directly in the questionnaire and those who had sexual intercourse with their future spouse before marriage may or may not have counted them as pre-marital partners. For this analysis, we have defined virginity at marriage as either: no pre-marital partners declared; or one pre-marital partner declared and the age of onset of sexual intercourse the same as the age at marriage.

The data were analysed to explore the proportion of young women and young men with older partners and the proportion of older men with young female partners. For unmarried men and women younger than 20, we estimated the probability of infection in their partners. This was done in three different ways.

We used the HIV prevalence of men who reported that they had had sex with unmarried women younger than 20 (in the past 12 months), with and without weighting by the number of such partnerships, and the HIV prevalence of women who reported that they had had sex with unmarried men younger than 20 (in the past 12 months).

The age distribution and marital status of the partners of individuals who had only one lifetime partner was compared with the age–sex–marital status-specific HIV prevalence in the population to estimate the probability of HIV infection in the partners. (These partner characteristics were only available if the partner was seen in the past 12 months.)

To estimate the *maximum* probability of HIV infection in male partners of young women, the partnership history of each woman was examined. Since HIV seropositivity increases with age and is higher in married men, the maximum probability of HIV infection was estimated from the prevalence of HIV by age of men in the population, using the age of the oldest partner and taking the age-specific prevalence for married men if any of the woman's partners were married. Partners younger than 15 years were assumed to be HIV-negative. For men, the *minimum* probability of HIV infection in a partner was calculated similarly, using the age of their youngest partner and the HIV prevalence for unmarried women if any of the partners were unmarried.

The relative risk of HIV between women and men was compared directly in a multivariate logistic regression model, allowing for marriage, number of partners, age at sexual debut, and the presence of STIs, to assess the extent to which measured differences in behaviour and STIs could explain the observed differences in HIV prevalence. The sensitivity of the results to the accuracy of partnership histories was explored.

Associations with early onset of sexual intercourse were explored for women. Women were not asked specifically about their first partner. If first sexual intercourse carries a very high risk (close to 100%) then, in women with only one partner, HIV prevalence should be independent of years since onset of sexual intercourse — except for any new infections acquired by the men after the start of the partnership. For women aged 15–19 years declaring one partner, risks of HIV were calculated by duration of relationship and by number of episodes of sexual intercourse.

Episodes of intercourse could be estimated for partnerships occurring within the past 12 months. Duration of partnerships (time between first and last episode of intercourse) was recorded. For current partnerships information was collected on number of episodes of sexual intercourse in the past month, and for past partnerships information was collected on number of episodes in the past year. To estimate number of episodes in the whole partnership, the following assumptions were made: that the rate of intercourse was constant; that current partnerships with no intercourse in the past month had a rate of once every 2 months; that relationships lasting 0 or 1 day consisted of one episode of intercourse; and that current relationships with no sex in the past month but with 2–30 days between the first and last episode of intercourse consisted of two episodes of intercourse. It was also assumed that marital partnerships had high rates of intercourse. Since many assumptions were made, episodes were grouped broadly: 1–5, 6–20 and > 20.

Results

Response rates and reporting bias

Of the selected households, at least one adult was interviewed in 94% of households in Kisumu and in 88% of those in Ndola. Response rates were higher in women than men. Overall, in Kisumu, 62% of eligible men and 75% of eligible women were both interviewed and HIV

tested. Response rates were slightly better in Ndola, and were similar for the 15–19-year-old age group as overall [18]. The main reason for not being included was not being found at home despite repeat visits. Some individuals refused HIV tests but, in both sites, some of the men were seen during a second round of interviews in which few HIV tests were taken. There were few differences in reported sexual behaviour between those HIV tested and those not tested in Ndola. In Kisumu, a higher proportion of the women who were not HIV tested than of those tested were not sexually active, and men who were not HIV tested had fewer non-spousal partners than those tested [19]. In both sites, those seen but not HIV tested had higher educational status than those tested.

HIV prevalence, onset of sexual activity, and number of partners

There was a striking difference in the prevalence of HIV between sexually active young men and young women in both cities (Fig. 1a). Whereas in those aged older than 25 years the HIV prevalence in men and women was similar, in the 15–19 year olds the prevalence in women was about six times as high as that in men, and in those aged 20–24 it was about three times as high.

The proportion of adults who had ever been sexually active was similar for men and women in the different age groups within each site. In Kisumu, in the age group 15–19 years, 73% of men and 70% of women were sexually active. The corresponding figures for Ndola were 54 and 60%. For the age group 20–24 years, the percentages were 95% for men and women in Kisumu, 88.5% for men in Ndola and 93.5% for women in Ndola. Of those currently aged younger than 25, 55% of men and 44% of women in Kisumu, and 31% of men and 34% of women in Ndola had been sexually active by age 15. In Kisumu, HIV results were available from 110 individuals who denied sexual activity: 8/67 women and 0/43 men were HIV-positive. In Ndola, 8/107 women and 3/66 men who denied sexual activity were HIV-positive. Other STIs have also been identified in some of these individuals [19].

In all age groups, men reported many more partners than did women (Fig. 1b). A higher lifetime number of partners was associated with increased risk of HIV in both sites. This was seen for both men and women but, for a given number of partners, the HIV prevalence in women was much higher than that in men in each site (Fig. 1c).

Associations with marriage

Men married at an older age than women: in both sites, the median age at first marriage was 25 years for men and 19 years for women [20]. Among those younger than 20 who were sexually active, more than 40% of women and less than 4% of men were married. The risk of HIV was greater in those who were married compared with those who were unmarried for men in all age

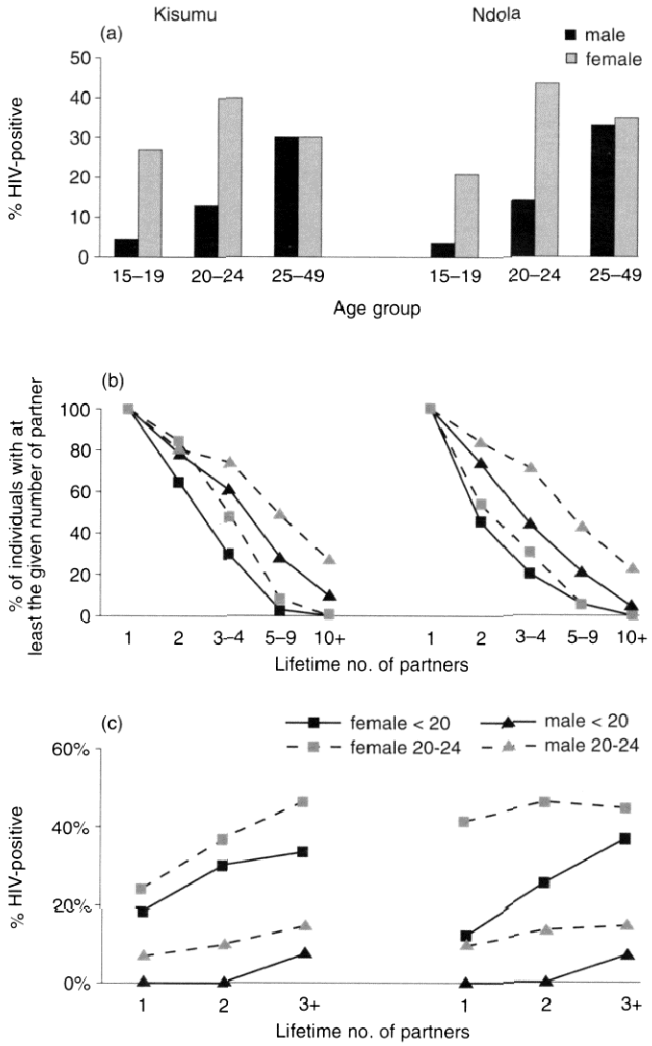

Fig. 1. Comparison of HIV risk and lifetime number of partners in men and women in Kisumu, Kenya and Ndola, Zambia. **(a)** HIV prevalence in sexually active individuals; **(b)** lifetime number of partners; **(c)** association between lifetime number of partners and HIV status.

groups, and for women younger than 25 (Table 1). Among women aged 25 and older, there was a high risk of HIV in the few who were never married: in Kisumu, 7/13 (54%) of never-married women older than 25 were HIV-positive; and in Ndola, 9/19 (47%) were HIV-positive. The HIV prevalence was slightly higher in those in polygamous marriages than in monogamous marriages, although these were uncommon among individuals younger than 25. Only two men younger than 25 were in polygamous marriages in each site. In Kisumu, 41 women aged between 15 and 24 years were in polygamous marriages, of whom 19 (46%) were HIV-positive. In Ndola there were only five such women, of whom two (40%) were HIV-positive. There was also a high prevalence of HIV among those that were divorced or widowed, but again there were small numbers among the under-25s. The much higher prevalence of HIV in women than in men was seen in never-married individ-

Table 1. Proportion of ever sexually active individuals who were HIV-positive in Kisumu and Ndola, by marital status, sex and current age

	Kisumu				Ndola			
	15–19 years		20–24 years		15–19 years		20–24 years	
Married	Male	Female	Male	Female	Male	Female	Male	Female
Never	3.9 (4/104)	22.3 (21/94)	8.3 (9/109)	34.8 (16/46)	3.3 (2/60)	16.5 (13/79)	9.7 (9/93)	38.3 (18/47)
Ever	25.0 (1/4)	32.9 (25/76)	26.3 (10/38)	41.4 (60/145)	0.0 (0/1)	27.3 (15/55)	28.6 (8/28)	45.9 (72/157)
Total	4.6 (5/108)	27.1 (46/170)	12.9 (19/147)	39.8 (76/191)	3.3 (2/61)	20.9 (28/134)	14.1 (17/121)	44.1 (90/204)

The percentage HIV-positive and the number of individuals HIV-positive/total are shown.

uals, in all age groups and in both sites, and in married individuals younger than 25. Among ever-married individuals aged 25–49 years, the prevalence of HIV infection was 31% in men and 29% in women in Kisumu, and 35% for both men and women in Ndola.

In almost all partnerships, men were older than their wives. For the younger women, those with a small age difference from their (first) husband had lower HIV prevalence in both sites. For women younger than 20, none of those with a husband aged less than 4 years older was HIV-positive, compared with 38% in Kisumu and 34% in Ndola of those with older husbands ($P = 0.02$ in Kisumu and $P = 0.09$ in Ndola). With the definition of virginity used, of those with HIV results in Kisumu, 9/338 (3%) ever-married men and 111/672 (17%) ever-married women were virgins at the time of marriage. In Ndola, the proportions were higher: 27/347 (8%) ever-married men and 325/643 (51%) ever-married women. Women who were virgins at the time of marriage had lower risks of HIV in all age groups than those who were not [Mantel–Haenszel relative risk, stratified for age group: 0.53 (95% confidence interval, 0.35–0.81) in Kisumu, and 0.65 (0.52–0.80) in Ndola]. The trends were similar after excluding women with (declared) post-marital partners (extra-marital partners or subsequent spouses).

Non-marital partnerships

In both sites, more men than women had non-marital partners, and their partners were younger and more likely to be single (Table 2). In Kisumu, 21% of women and 48% of men declared non-marital partnerships in the past 12 months; women declared up to three partnerships, men up to 10. In terms of partnerships (rather than individuals), among women younger than 20, 18% of non-marital partnerships were with men older than 24 and only 9% were with ever-married men. Two thirds of non-marital partnerships of men of all ages were with women younger than 20. Among men older than 24, 27% of partnerships were with women younger than 20 and 63% were with never-married women.

In Ndola, there were fewer individuals with non-marital partnerships: 15% of women and 37% of men declared non-marital partnerships in the past 12 months, women declared up to three partnerships and men up to 13, with one reply of 'many'. Among women younger than 20, 19% of non-marital partnerships were with men older than 24 and only 6% were with ever-married men. Of non-marital partnerships of men of all ages, 55% were with women younger than 20. Among men older than 24, 27% of partnerships were with women younger than 20 and 80% were with never-married women.

In terms of individuals (Table 2), among women younger than 20 in both sites, about one-fifth had had at least one partner older than 24, and 10% in Kisumu and 6% in Ndola had had at least one ever-married partner. The majority of individuals in both sites thought that at least one of their partners had had other partners in the past 12 months (data not shown).

One-third of the men with non-marital partners in Kisumu and one-half of those in Ndola were older than 24. One-third of these older men in both sites had had at least one partner younger than 20. Among men younger than 20, very few had had relationships with women older than 19 and, for one-half, the oldest partner was younger than 17. In Kisumu 5% and in Ndola 12% of men younger than 20 had had an ever-married partner.

There was no correlation in either site between the HIV status of unmarried women and the age group of their oldest non-marital partner, or whether they had had any married partners, but numbers are small and the information was limited to partners in the past 12 months.

The prevalence of HIV in unmarried men and women younger than 20 and in their partners was explored further (Table 3). The three techniques for estimating the HIV prevalence in the partners are described in 'Methods'. In Kisumu, the prevalence of HIV among women with one lifetime partner (19.6%) was higher than that in men who declared sex with young unmarried women, or that estimated from the ages of their partners, where known. In Ndola, the HIV prevalence in these groups was similar.

Analogous calculations were performed for the men (Table 3). Very few women (31 in Kisumu and four in Ndola) declared unmarried male partners younger than

Table 2. Characteristics of non-marital partners of men and women of different ages in Kisumu and Ndola

	Kisumu			Ndola		
	< 20 years	20–24 years	25–49 years	< 20 years	20–24 years	25–49 years
Men						
Any non-marital partners past 12 months (*n*/*n*, %)	112/141 (79.4)	129/182 (70.9)	127/440 (28.9)	43/68 (63.2)	79/137 (57.4)	113/435 (26.0)
Any partners < 20 years old (%)[a]	99.1	83.9	33.3	100	79.4	33.7
All partners < 20 years old (%)[a]	98.2	66.9	23.3	97.2	66.2	19.6
Any single partners (%)[a]	97.3	93.7	68.4	88.4	93.5	83.3
Women						
Any non-marital partners past 12 months (*n*/*n*, %)	89/197 (45.2)	45/228 (19.7)	69/536 (12.9)	47/150 (31.3)	30/228 (13.2)	59/510 (11.6)
All partners < 20 years old (%)[a]	37.0	0.0	1.8	12.8	0.0	0.0
Any partner 25+ years old (%)[a]	22.2	75.0	94.6	20.5	75.0	100
Any ever-married partners (%)[a]	10.1	34.1	89.4	6.4	20.0	83.1

[a] Percentage of those with declared non-marital partners.

Table 3. Observed and estimated prevalence of HIV in unmarried individuals younger than 20 and their partners

	Kisumu		Ndola	
	Male	Female	Male	Female
Observed HIV prevalence in individuals				
Unmarried < 20 with one lifetime partner	0.0 (23)	19.6 (46)	0.0 (15)	14.6 (48)
Unmarried < 20, sexually active	3.9 (104)	22.3 (94)	3.3 (60)	16.5 (79)
Estimated HIV prevalence in partners				
Method 1: prevalence among those having sex with unmarried individuals < 20 years old				
Crude prevalence in partners	25.8 (31)	11.3[a] (194)	25.0 (4)	15.5[a] (103)
Method 2: based on age distribution and marital status of partners of those with only one partner				
Expected prevalence in partners	18.4 (17)	8.6 (35)	9.4 (4)	12.8 (12)
Method 3: based on age distribution and marital status of partners of those with partner details				
Expected prevalence in partners	16.9 (107)	9.5 (75)	9.5 (36)	11.6 (37)

Data show the HIV prevalence (%) and the number of individuals on whom the figure is based. [a] Similar results were obtained when the estimate was weighted by the number of unmarried female partners younger than 20 per man, and when men having sex with women with unknown age and/or marital status were included.

20, although more than 80% of the declared partners of these men were in the age groups included in the survey. The third method listed earlier estimates the *maximum* likely prevalence of HIV in the non-marital partners of single women younger than 20 and the equivalent *minimum* likely prevalence for the partners of men. For women, this estimated maximum HIV prevalence in the partners was less than the observed HIV prevalence even in those with only one partner. For men, the estimated minimum HIV prevalence in the partners was much higher than their observed HIV prevalence, even in those with multiple partners. In Kisumu, the estimated HIV prevalence in the partners of young men was higher than that estimated for the partners of young women; the estimates for men and women were similar in Ndola.

To see whether men who have sex with young women have particularly high rates of HIV, indirect standardization was used to calculate the expected HIV prevalence of men in the population having the same age and marital status distribution as men who had sex with unmarried women younger than 20. This gave HIV prevalence of 10.4% in Kisumu and 12.8% in Ndola. These were similar to the observed HIV prevalence (11.3 and 15.5%, respectively).

Risk of HIV for women compared with men

The risk of HIV in women was compared directly with that in men (Table 4). In both sites, the difference was most apparent in the younger age groups, increased after adjusting for lifetime number of partners and decreased after adjusting for marriage. Adjusting for age at sexual

Table 4. Relative risk of HIV for women compared with men in different age groups and by marital status

	Kisumu			Ndola		
	Adjusted for age only	Also adjusted for lifetime partners, marriage and age at sexual debut	Also adjusted for syphilis and HSV-2	Adjusted for age only	Also adjusted for lifetime partners, marriage and age at sexual debut	Also adjusted for syphilis and HSV-2
Age group (years)						
15–19	7.9 (3.0–20.6)	9.3 (2.9–30.0)	5.9 (1.5–24.0)	7.7 (1.8–33.9)	15.2 (2.3–99.4)	6.7 (0.91–49.5)
20–24	4.4 (2.5–7.7)	5.1 (2.4–11.0)	1.7 (0.66–4.5)	4.9 (2.7–8.8)	4.9 (2.3–11.1)	2.5 (1.0–6.2)
25–29	1.5 (0.84–2.6)	1.8 (0.83–3.8)	1.4 (0.57–3.3)	2.1 (1.3–3.5)	3.5 (1.8–7.1)	2.2 (1.1–4.8)
< 25 years						
Unmarried	7.0 (3.4–14.3)	13.5 (5.4–34.0)	5.2 (1.8–15.2)	6.0 (2.7–13.3)	7.0 (2.6–18.7)	4.5 (1.5–13.0)
Married	1.8 (0.83–3.8)	2.7 (1.1–6.8)	1.3 (0.41–4.3)	2.3 (0.96–5.7)	5.7 (1.8–18.2)	2.5 (0.68–9.4)

Data presented as odds ratios (95% confidence intervals). HSV-2, herpes simplex virus type 2.

debut made little difference, and additionally adjusting for number of partners in the past year also made little difference. The association between gender and HIV was little altered by adjusting for syphilis but decreased after adjusting for HSV-2. Additionally, adjusting for other STIs (chlamydial infection and gonorrhoea) had no influence on the results. Among ever-married individuals, the association was less marked than in never-married individuals. Among never-married individuals younger than 25 in both sites, the odds of HIV in women was more than four times that in men after adjusting for all the other factors. There was no interaction with HSV-2 or with other STIs. The increased risk of HIV among women compared with men was seen in groups of individuals with and without HSV-2, and with and without any evidence of STIs. [For the analysis excluding those with any STIs, those with trichomoniasis (which was known only for women) or clinical ulcers (which was known only for men) were also excluded.]

Since women may under-report the number of sexual partners, this analysis was repeated after doubling or tripling the number of partners they reported and also without including number of partners in the regression equation. For never-married individuals younger than 25, the adjusted odds ratio of HIV in women decreased slightly but was still about 3.5 times that of men in both sites in all these scenarios.

Risk of transmission to pre-menarchal women

Age at menarche was not asked. In both sites, HIV prevalence in women with onset of sexual intercourse before age 15 was similar to that in those who started later, both overall and by current age group, with or without adjusting for other factors such as marital status, total number of partners, and HSV-2 and other STIs.

Risk of transmission from men to women in the first episode of sexual intercourse for the woman (loss of virginity)

For women aged 15–19 declaring one lifetime partner, risks of HIV were calculated by duration of the partnership and by estimated episodes of sexual intercourse (Table 5). Risks of HIV were high after short-duration partnerships and those with few episodes of intercourse, but numbers were small.

After excluding women with any evidence of other STIs, 3/15 (20%) women in Kisumu and 4/29 (13.8%) women in Ndola with only one partner and sexual activity of less than 2 years were HIV-positive. In Kisumu 2/5 women and in Ndola 0/4 women with an estimated one to five episodes of intercourse and no evidence of other STIs were HIV-positive.

Discussion

The striking difference of the prevalence in HIV between young women and young men that has been noted elsewhere was confirmed in Kisuma (Kenya) and Ndola (Zambia). The three factors that may contribute to this are: (1) artefact, due to differences in sampling and refusal of HIV testing; (2) different risks of encountering infected partners for men and women; and (3) different per-partnership transmission risks for men and women.

Response bias

Response rates including HIV results were above 60%. In both sites, they were higher for young women than for young men. Most of those who did not respond were never found at home despite repeated visits. It is possible that individuals who were never found at home have different sexual behaviour characteristics and different HIV levels from those who could be contacted [19].

Table 5. HIV prevalence (HIV+) among 15–19-year-old women with one declared lifetime partner

	Kisumu		Ndola	
	HIV+/*n*	%	HIV+/*n*	%
Years since sexual debut				
≤ 1	7/30	23.3	5/47	10.6
> 1	4/29	13.8	3/24	12.5
Number of episodes of intercourse				
1–5	3/10	30.0	1/7	14.3
6–20	4/13	30.8	0/4	0.0
> 20[a]	2/20	20.0	1/22	4.6

[a] All but seven of these individuals were married.

Among those who were interviewed and who were sexually active, those who were HIV tested had similar numbers of partners and marital status to those who were not tested. Given the very large differences in HIV prevalence between young men and women, it is unlikely that it can all be explained by differential biases in response.

Risk of encountering HIV-infected partners

In neither site was there any evidence that women started sexual activity younger than men or had more partners at a young age. In all age groups, men reported more partners than did women. There are, however, some reasons for questioning the validity of the partnership data. Even after excluding partners from outside the age range of the survey and partners from outside the city, as well as partnerships with high activity women, men in Kisumu and Ndola reported about three times more non-spousal partners in the past year than did women, and the difference in the reported number of partnerships was more marked in the younger age groups than in the older age groups [19]. This suggests that women, especially young women, under-report the numbers of their partners. It is possible that men tended to over-report sexual partners, but in both cities about 8% of men who claimed never to have been sexually active had evidence of STIs, and Demographic and Health Surveys recorded more non-spousal partners than in our surveys [19].

There is also direct evidence that there was some under-reporting by the women. In Kisumu 8/67 women and in Ndola 8/107 women who denied sexual activity were HIV-positive and some had other STIs (making non-sexual transmission of HIV an unlikely explanation) [19]. Very few women declared unmarried male partners younger than 20, whereas the information from the unmarried men younger than 20 suggests that there should have been many more. Moreover, the HIV prevalence in young unmarried women with one lifetime partner was implausibly high given the HIV prevalence in men in the population and the fact that the efficiency of transmission of HIV is less than 100%. Further evidence comes from data on married couples who were both seen in the study. In Kisumu, of 22 women who claimed one lifetime partner and had an HIV-negative husband, two were HIV-positive. In Ndola, six of 71 such women with HIV-negative husbands were HIV-positive. (Equivalent figures for men were one of four in Kisumu and one of 10 in Ndola.)

Many more young women than young men were married, and ever having been married was associated with HIV seropositivity for women and men. However, the high female : male ratio in HIV prevalence was seen strongly in never-married individuals, so differences in marriage patterns do not explain the discrepancy. The continued lower prevalence of HIV in those who were virgins at marriage also suggests that much of the HIV in women is acquired before marriage.

About one-fifth of non-marital partnerships of women younger than 20 were with men aged 25 or older. In contrast, almost all of the partners of men younger than 20 were also younger than 20. To see whether the age difference in non-marital partnerships explained the differences seen in HIV prevalence, the probability of infection in the partners of unmarried men and women younger than 20 was estimated. Because the HIV prevalence among young women was so high, even in the analysis that aimed to maximize the estimate for the male partners of women and minimize it for female partners of men, the estimated risk of infection in the partners of young unmarried individuals was higher for men than for women in Kisumu. In Ndola, the risk was similar for the partners of the men and of the women. In both sites, men had many more partners than did the women, so these estimates suggest that the risk of having sex with an infected partner is higher for young men than for young women in both sites, despite the age differences in partnerships.

The three different methods used to estimate the HIV prevalence in partners gave similar results, although some

were based on small numbers. The most reliable estimate of HIV prevalence in male partners is likely to be the HIV prevalence measured in men who declared unmarried female partners younger than 20. However, this method did not work well for estimating the HIV prevalence in female partners because few women declared young male partners, giving unstable and probably biased results. The best estimate of HIV prevalence in the female partners is probably that based on the age and marital status distribution of the men's partners (method 3 Table 3). The use of these different methods to obtain estimates of HIV prevalence for the partners of the men and of the women has the advantage that both rely on the men's partnership histories, so their comparison avoids any differences in reporting bias between men and women. Although all the results suggest similar risks of HIV in the partners of the men and the women, it is possible that a general population survey would miss a small 'core group' of men with high HIV prevalence and many young female partners, which could lead to the calculated HIV prevalence in the partners of young women being underestimated by the methods used.

Transmission risk

To disentangle the effects of behavioural risk factors for HIV infection and of factors that influence the transmission of HIV during sexual intercourse, gender was treated as a risk factor for HIV, and the analysis was adjusted for age, behavioural factors and STIs. After adjusting for age, the odds of being HIV infected in the age groups younger than 25 years was 7.0 for unmarried women in Kisumu and 6.0 for unmarried women in Ndola. The risk was lower for married women. The odds ratios were highest in the age group 15–19 and decreased with age. Adjusting for reported lifetime number of sex partners, marital status and age at first sexual intercourse did not decrease the odds ratios associated with female sex. Because there is evidence that women under-reported their partners, the numbers of partners reported by women were artificially increased and this decreased the odds ratios, although they still remained high. This suggests that behavioural factors partly explain the high odds ratios for women but do not offer a full explanation, and that male-to-female transmission of HIV is higher than female-to-male transmission.

Transmission probability is likely to be influenced by the presence of other STIs [21,22]. The most striking differences between men and women were in the prevalence rates of ulcerative STIs. The prevalence rates of positive syphilis serology and of HSV-2 infection in men younger than 25 in Kisumu were 1.7 and 14.3%, respectively; in women, the corresponding prevalence rates were 4.7 and 58.9%. In Ndola 5.6% of young men had positive syphilis serology and 13.4% were HSV-2-positive, while in women the corresponding prevalence rates were 15.3 and 49.4% [22,23]. Adjusting for syphilis and HSV-2 did decrease the odds ratios, suggesting that these STIs play an important role in explaining the differences in HIV prevalence between young men and young women. Further adjusting for gonorrhoea and chlamydia did not affect the results. Men were not tested for trichomoniasis, but excluding all those with STIs, including women with *T. vaginalis* infection, had little effect on the odds ratios.

After adjusting for behavioural factors and for STIs, the odds ratio for HIV infection associated with female sex was still in the range of 6–7 for the age group 15–19 years, and 2–3 for the age group 20–24 years. Differences in prevalence of other STIs can thus not fully explain the apparent differences between male-to-female and female-to-male transmission of HIV. There may have been some under-adjustment for STIs. Since the study was cross-sectional, we will have missed some past infections, and *T. vaginalis* results were only available for about one-half of the women. HSV-2 serology measures infection, but does not indicate whether there were clinical episodes. It has been suggested that bacterial vaginosis (BV) in women increases their susceptibility to HIV [24], but we did not test for BV and could thus not allow for this factor. Even in the absence of another STI, however, it is thought that the transmission of HIV from men to women is more efficient than the transmission from women to men, because in women a larger mucosal surface is exposed to HIV-containing genital secretions than that in men [25].

Cervical ectopy has been found to be associated with an increased risk of HIV infection in some studies, but not in others [26–29]. Cervical ectopy and other biological features of the immature female genital tract are possible explanations for the finding that the discrepancy between men and women in HIV prevalence is greatest in the younger age groups. In Kisumu and Ndola, there was no evidence that onset of sexual intercourse younger than the age of 15 carried a particularly high risk of HIV transmission for women. This does not support suggestions that the immature genital tract is particularly susceptible to transmission [16], but we did not have information on the age of menarche. The very high prevalence of HIV following few episodes of sexual intercourse or short times since the first episode of intercourse in women who only had one partner, and the finding that the risk did not increase with more episodes of intercourse or longer duration of partnership, are consistent with a high risk of transmission at the first episode of intercourse when the hymen is broken.

A high proportion of women who denied ever having been sexually active was infected with HIV and other STIs. While these individuals provide evidence of underreporting of partners, and their exclusion from analyses may have biased the results slightly, presuming that only a fraction of them were actually sexually active and that the amount of sexual activity is likely to have been low,

they again suggest high transmission probabilities with very limited amounts of sexual activity.

Conclusions

In these two cities with a very high prevalence of HIV in the general population, a large proportion of young men and young women are exposed to HIV-infected partners. Despite the tendency for women to have older partners, young men are probably at least equally exposed to HIV due to their larger number of partners and to the high HIV prevalence in very young women. The much higher prevalence of HIV seen in young women than in young men therefore suggests that their greater susceptibility to infection is an important factor both in explaining the difference in HIV prevalence and in driving the epidemic. HSV-2 is likely to be an important contributor to this increased susceptibility. We cannot ascertain from these data whether loss of virginity is associated with a particularly high risk of transmission to these women, but there is evidence of high rates of HIV positivity following few episodes of sexual intercourse, consistent with a high transmission probability. Interventions must target young women before the start of sexual activity.

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