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Socioeconomic status and risk of HIV infection in an urban population in Kenya

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Summary

OBJECTIVE To examine the relationship between socioeconomic status (SES), risk factors for HIV infection and HIV status in an urban population with high prevalence of HIV infection in sub-Saharan Africa.

METHODS Cross-sectional population survey of adults from the city of Kisumu, Kenya, in 1996. Around 1000 men and 1000 women aged 15–49 years were interviewed using a structured questionnaire, and most gave a venous blood sample for HIV testing. SES was represented by a composite variable of educational status, occupation and household utilities. Multiple regression was used to examine whether SES was associated with HIV infection or with risk factors for HIV infection.

RESULTS Human immunodeficiency virus prevalence was 19.8% in males and 30.2% in females. Higher SES was associated with a more mobile lifestyle, later sexual debut and marriage among both sexes, and with circumcision among men aged 25–49 and condom use among women aged 25–49. Higher levels of alcohol consumption were associated with an increased risk of HIV infection and were more common amongst those of higher SES. HSV-2 infection was strongly associated with an increased risk of HIV infection and was more common among those of lower SES. HIV was associated with a lower SES among females aged 15–24 whereas in males aged 15–24 and females aged 25–49 there was some indication that it was associated with higher SES. Among males aged 25–49 there was no association between HIV infection and SES.

CONCLUSIONS Risk of infection was high among groups of all SES. Risk profiles suggested men and women of lower SES maybe at greater risk of newly acquired HIV infection. New infections may now be occurring fastest among young women of the lowest SES.

keywords Africa, epidemiology, heterosexual transmission, HIV prevalence, risk factors, socioeconomic status

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Introduction

Epidemiological studies in Africa have described socioeconomic correlates of HIV infection in different settings. In many countries, urban areas carry a greater burden of infection than rural areas (Allen *et al.* 1991; Fylkesnes *et al.* 1997). Studies conducted in rural areas have reported an increased risk of HIV infection among the more educated (Grosskurth *et al.* 1995; Smith *et al.* 1999), and among those in business compared with other occupations (Berkley *et al.* 1989). In urban areas, businessmen, higher salary bracket employees and the more educated are also at greater risk of infection (Ryder *et al.* 1990; Killewo *et al.* 1993; Fylkesnes *et al.* 1997; Kilian *et al.* 1999), whilst in one study those with more schooling and those who owned their own home were at decreased risk of infection (Bassett *et al.* 1996). A recent review of the literature reported that in five large, appropriately analysed studies conducted in Africa up to 1996, an increased level of education was associated with increased risk of infection (Hargreaves & Glynn 2000). The demographic characteristics of those newly infected may change over time (Fylkesnes *et al.* 1997, 2001). It has been postulated that early in the epidemic HIV risk is linked to higher socioeconomic status (SES) and travel, but that this pattern may dissolve as the epidemic spreads in a given population (Over & Piot 1993).

SES is a broad term describing economic and social circumstances. SES is difficult to measure directly and studies have previously used a number of proxy measures to indicate different socioeconomic groups (Dallabetta *et al.* 1993; Killewo *et al.* 1993; Seeley *et al.* 1994; Grosskurth *et al.* 1995; Fylkesnes *et al.* 1997). SES may be determined by background and by early and late life experiences. Equally, SES itself is likely to affect behaviour throughout life. Family background may, in part, determine inherited wealth and attendance at school, whilst educational attainment and later life choices will affect earning capacity and will likely affect lifestyle, including sexual, marital and health seeking behaviours. There are thus many pathways through which an individual's SES may be related to risk of infection with HIV. Any such link would have important consequences for health professionals, health policy makers and for those seeking to model the economic impact of the HIV pandemic (Over & Piot 1993).

Few studies have primarily focused on the relationship between SES and HIV infection within severely affected populations. In examining such a relationship, statistical analyses must appropriately control for confounding variables without 'overadjusting' for factors that may be on the causal pathway. In this paper we present data from a population-based survey conducted in the city of Kisumu, Kenya, in 1996. In addition to examining SES as a potential risk factor for HIV infection, we investigate how this might be mediated through other potential risk factors for HIV.

Materials and methods

A population-based survey was conducted in Kisumu, Kenya during 1996 as part of a study on factors determining the differential spread of HIV infection in four African cities. The methodology has been reported in full elsewhere (Buve *et al.* 2001a). Briefly, two-stage sampling was used to obtain a random sample of around 1000 men and 1000 women. Trained interviewers visited households and sought consent to interview all adults (15–49 years) who had slept in the house the previous night. Up to three visits were made to each house in order to interview eligible individuals. After the interview, consent was sought for the second part of the study, in which a sample of venous blood was taken and urine samples were collected to test for HIV and other sexually transmitted infections (STIs). Males underwent a clinical examination for signs of STIs and women were asked to provide a self-administered vaginal swab.

Symptomatic STIs were treated syndromically at the time of the interview and people with positive syphilis serology were traced and treated free of charge. Individuals wishing to know their HIV status were referred to a local health facility for free counselling and testing.

Laboratory methods

Serum samples were first tested for HIV by ELISA (ICE HIV-1.0.2., Murex Diagnostics, Dartford, UK, or HIV-1/HIV-2 3rd Generation Plus, Abbott Laboratories, IL, USA) and results confirmed with a rapid test (Capillus HIV-1/HIV-2, Cambridge Diagnostics, Galway, UK, or HIV Multispot, Sanofi Diagnostics Pasteur S.A., Marne La Coquette, France). Samples giving discrepant results were tested with HIV 2.2 Blot (Genelabs, Singapore) or using an algorithm with Vironostika HIV Uniform II Plus O (Organon Teknika, Boxtel, The Netherlands) followed by Enzygnost Anti-HIV 1/2 Plus (Behring Diagnostics, Marburg, Germany) and INNO-LIA HIV Confirmation (Innogenetics, Zwijnaarde, Belgium) if necessary.

Chlamydial infection was ascertained on a urine sample which was first tested with the Amplicor Chlamydia trachomatis PCR test (Roche Diagnostics, Branchburg, NJ, USA). Samples that tested positive were confirmed with the LCX *Chlamydia trachomatis* assay (Abbott Laboratories, Abbott Park, IL, USA). Only individuals who were positive on both tests were considered as suffering from a chlamydial infection. Syphilis serology was assessed with the

RPR Card test (Becton Dickinson and Company, Cockeysville, MD, USA) and with the Serodia®-TP.PA (Fujirebio Inc., Tokyo, Japan). Individuals testing positive on both the RPR and the TPPA were considered as having recently acquired and/or having untreated syphilis. The diagnosis of trichomoniasis was established by inoculating a self-administered vaginal swab into a culture medium for *T. vaginalis* (InPouch™ TV, Biomed Diagnostics, San José, USA), which was read according to the manufacturer's instructions after 3 and 5 days.

Definition of socioeconomic status

A composite variable for SES was derived based on household utilities, educational level and employment. First, a score was derived for each person based on facilities in the household (0 = no water or electricity, 1 = water or electricity, 2 = water and electricity) and level of education achieved (0 = primary not completed, 1 = primary completed, 2 = secondary or more). For men who were not currently students, an additional component to the score was based on current employment status (0 = unemployed, 1 = low income, e.g. manual work, 2 = high income, e.g. service workers, management). SES was then categorized according to the total score into high, medium and low. For women and male students, the cutoffs were 0–1 = low SES, 2 = medium SES, 3–4 = high SES. For the remaining males, the cutoffs were 0–2 = low SES, 3–4 = medium SES, 5–6 = high SES. It was not possible to assign an SES score to 43 males and 11 females because of missing data.

Statistical analysis

Socioeconomic status, HIV prevalence and risk profiles were thought to differ in important ways by both age and sex, and HIV infections among the young are more likely to have been acquired recently and may give a better picture of current, rather than past, risk profiles. Therefore, analysis was conducted separately for males and females, and for two age-groups (15–24 and 25–49 years).

The distribution of risk factors for HIV was compared between the three levels of SES using means, medians or proportions as appropriate. Depending on the type of data analysed, Mantel–Haenszel test-for-trend, Kruskal–Wallis or Cox regression were used to test whether there were significant differences in levels of risk factors across SES groups, adjusting for age.

Risk factor analysis for HIV in the sexually active population in all four cities has been described elsewhere (Auvert *et al.* 2001a). For the analysis described in this paper, risk factors for HIV were examined using multiple

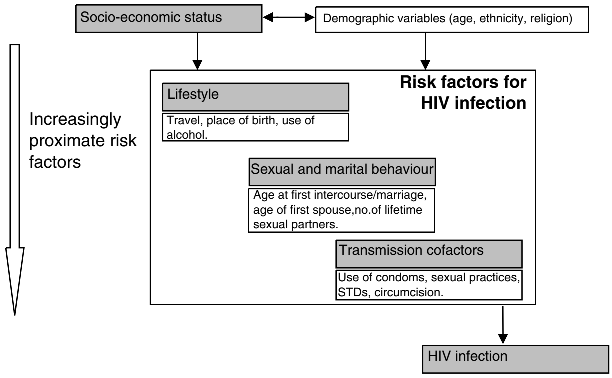

Figure 1 Hierarchical conceptual framework for examining the potential effect and mechanisms of the relationship between SES and HIV infection.

logistic regression models that included variables in the model based on the hierarchical conceptual framework shown in Figure 1. Two sets of models were fitted. Age and ethnic group were always included in both sets of fitted models. The first set of analyses did not include SES, therefore examining risk factors for HIV ignoring SES. Factors higher in the hierarchy that significantly improved the logistic regression models were retained in the model when factors lower in the hierarchy were examined (Victora *et al.* 1997). Similarly, odds ratios (OR) were calculated adjusting only for variables above them in the hierarchy (Figure 1). This approach avoids adjustment for variables that might be on the causal path. The second set of analyses included SES first in the model and then added risk factors that were significant from the first set of analyses. This enabled us to examine how any influence of SES on risk of HIV infection might be mediated through differences in more proximate risk factors.

Results

The response rate for men was lower than for women (19% of males did not take part against 11% of females). Only 5% of both males and females actively refused to be interviewed; most non-participation was because of repeated absence from the house when the interviewers visited. Overall, 25% of interviewed men and 16% of interviewed women did not provide a blood sample for analysis. For both men and women the refusal rate was higher in those of higher SES. Thirty-four per cent of men and 18% of women of higher SES refused to provide blood compared with 18% of men and 13% of women of lower SES. Data enabling SES to be categorized were available for 786 males and 1059 females and of these 622 males and 893 females provided blood for HIV testing.

Household utilities, education and employment for non-student men were the variables used to categorize SES. Thirty-five per cent of households had neither running water nor electricity, with a similar proportion having both facilities. Males were more likely than females to have completed secondary school education (35% of males compared with 19% of females). Thirty-four per cent of males aged 15–24 were still students. Males aged 15–24 were more likely to be unemployed than males aged 25–49 (20% of younger males were categorized as unemployed, compared with only 3% of males in the older age group).

Socioeconomic status and potential risk factors for HIV infection

Tables 1a and 1b show the association between SES various potential risk factors for HIV infection. In both sexes, those of increasing SES were more likely to be Protestant and less likely to be from the Luo ethnic group. Individuals of higher SES were significantly less likely to have been born in Kisumu, and were more likely to have travelled out of the city at least twice in the last year. Alcohol consumption in the last month tended to be more common among the older age groups and increased slightly with SES in both sexes.

There were only small differences in the proportions of young men who had ever been married across groups. However, older males of the highest SES had a later age of sexual debut (18 years) and first marriage (26 years) than those of the lowest SES (15 and 24 years, respectively). The number of lifetime sexual partners did not differ significantly between the different socioeconomic groups for either younger or older men. Among females, sexual debut and first marriage were also later in those of higher SES in both age groups. Among older women, those of lower SES tended to have a greater age difference from their spouse (10.3 years younger) compared with those with higher SES (7.6 years younger). There was no evidence of differences

Table 1a Potential risk factors for HIV infection in males by socioeconomic status and age

	Socioeconomic status							
	Males (15–24 years old)				Males (25–49 years old)			
	Low	Medium	High	*P*-value*	Low	Medium	High	*P*-value*
Number of men	150	137	82		95	169	153	
Demographic characteristics								
Protestant	52%	58%	65%	0.043	46%	50%	65%	0.002
Non-Luo ethnic group	16%	23%	20%	0.488	14%	25%	37%	< 0.001
Lifestyle								
Born in Kisumu	57%	38%	27%	< 0.001	48%	23%	10%	< 0.001
2+ Trips out of city in last year	31%	34%	49%	0.027	37%	51%	69%	< 0.001
Drank alcohol in last month	14%	25%	27%	0.028	41%	40%	48%	0.123
Sexual behaviour and marital status								
Ever had sexual intercourse	79%	88%	83%	0.604	100%	100%	99%	0.329
Median no. of lifetime partners	3	3	3	0.603	7	7	5	0.070
Median age at first intercourse	15	15	16	0.285	15	16	17	0.002
Ever-married	15%	15%	13%	0.275	96%	92%	88%	0.100
Median age at first marriage†	–	–	–	–	24	24	26	0.003
Mean age difference at first marriage†	–	–	–	–	6.2	5.9	5.8	0.803
Transmission cofactors								
Genital ulcer on examination	2.5%	0.8%	5.9%	0.260	5.3%	2.4%	2.0%	0.228
Circumcised	22%	29%	22%	0.950	18%	28%	47%	< 0.001
Syphilis	2.7%	0.9%	0.0%	0.115	3.9%	7.4%	2.4%	0.757
HSV-2	14%	9%	18%	0.642	64%	59%	46%	0.051
Chlamydia	2.5%	5.4%	6.1%	0.221	2.5%	0%	1.0%	0.321
Condom use‡	19.6%	31.1%	29.3%	0.153	8.8%	7.4%	16.2%	0.071

* *P*-value from Mantel–Haenszel test-for-trend, Kruskal–Wallis test for heterogeneity or Cox proportional hazard depending on type of data adjusted for age.
† Not possible to calculate statistics in the younger age-group owing to lack of events.
‡ Condom use includes ever use with a marital partner, or recent use with a non-marital partner.

Table 1b Potential risk factors for HIV infection in females by socioeconomic status and age

	Socioeconomic status							
	Females (15–24 years old)				Females (25–49 years old)			
	Low	Medium	High	*P*-value*	Low	Medium	High	*P*-value*
Number of women	216	145	159		250	132	157	
Demographic characteristics								
Protestant	49%	55%	57%	0.130	51%	42%	62%	0.016
Non-Luo ethnic group	11%	20%	29%	<0.001	13%	26%	33%	< 0.001
Lifestyle								
Born in Kisumu	31%	21%	17%	0.002	27%	15%	7%	< 0.001
2+ Trips out of city in last year	20%	22%	25%	0.334	30%	33%	44%	0.002
Drank alcohol in last month	4%	4%	4%	0.929	9%	14%	15%	0.087
Sexual behaviour and marital status								
Sexually active	81%	83%	80%	0.374	100%	100%	99%	0.753
Median no. of lifetime partners	2	2	2	0.075	3	3	2	0.109
Median age at first intercourse	15	16	17	<0.001	15	15	17	< 0.001
Ever-married	38%	59%	58%	<0.001	98%	96%	94%	0.179
Median age at first marriage	18	20	21	<0.001	17	17	20	< 0.001
Mean age difference at first marriage	−8.8	−8.1	−8.4	0.797	−10.3	−9.9	−7.6	0.006
Transmission cofactors								
Sex during menses	12%	12%	17%	0.232	9%	9%	12%	0.567
Ever practiced dry sex†	5.1%	0%	0.8%	0.009	3.6%	3.8%	0.6%	0.087
Use of modern contraception	11%	10%	22%	0.019	18%	25%	47%	< 0.001
Syphilis	3.6%	6.8%	2.5%	0.731	2.9%	3.7%	5.6%	0.181
HSV-2	59%	51%	41%	<0.001	87%	82%	76%	0.026
Chlamydia	9.2%	4.9%	7.6%	0.577	1.8%	2.5%	0.8%	0.316
Condom use‡	10.8%	14.7%	16.8%	0.156	0.9%	4.3%	14.2%	< 0.001

* *P*-value from Mantel–Haenszel test-for-trend, Kruskal–Wallis test for heterogeneity or Cox proportional hazard depending on type of data adjusted for age.
† Wiping with cloth, towel or handkerchief to dry vagina before sex (insertion of herbs not reported).
‡ Condom use includes ever use with a marital partner, or recent use with a non-marital partner.

in number of lifetime partners between SES groups for women.

In males aged 25–49, circumcision was much more common in the high SES groups (OR adjusted for age comparing high SES with low SES: 3.95; 95% CI 2.11–7.39). However, this association was not apparent in younger males in whom circumcision was less common. Current or untreated syphilis and HSV2 antibodies were more common among the older males. HSV2 infection was associated with lower SES in older males (OR adjusted for age comparing high SES with low SES: 0.52; 95% CI 0.27–1.00), but this association was not seen for the younger males. Chlamydial infection was more common among young males but with no apparent association with SES. Condom use was reported more commonly by younger males, possibly reflecting a higher number of non-marital partnerships.

Intercourse during menstruation and dry sex did not appear to be associated with either age or SES of females. The prevalence of chlamydial infection was higher in younger women with no apparent association with SES. HSV2 infection was associated with lower SES in both younger and older women (OR adjusted for age comparing high SES with low SES: 0.40; 95% CI, 0.24–0.67 in 15–24-year olds; 0.50; 95% CI, 0.27–0.91 in 25–49-year olds). Condom use was more commonly reported by women aged 15–24 than women aged 25–49 years. However, among 25–49-year-old women, condom use was strikingly higher in those of high SES compared with very low rates in the other SES groups (OR adjusted for age comparing high SES with low SES: 15.0; 95% CI 3.31–68.27). The use of any modern contraceptive method was also associated with higher SES in women aged 25–49 (OR adjusted for age comparing high SES with low SES: 3.44; 95% CI 2.12–5.56).

Table 2 Risk factors for HIV infection by age and sex (excluding socioeconomic status)

Risk factor*	Prevalence of HIV for each level of risk factor (%) No	Yes	Unadjusted odds ratio (95% CI)	Adjusted odds ratio† (95% CI)
Males (15–24 years old)				
Ever married	5.2 (13/252)	25.6 (10/39)	6.3 (2.5, 16.3)	4.6 (1.6, 12.8)
> 3 Lifetime partners	4.4 (5/115)	13.1 (17/130)	3.3 (1.2, 9.4)	2.9 (1.0, 8.5)
HSV-2	2.9 (7/243)	38.9 (14/36)	21.5 (6.9, 66.7)	15.8 (5.3, 46.8)
Males (25–49 years old)				
Non-Luo ethnic group	36.8 (85/231)	13.3 (10/75)	0.3 (0.1, 0.5)	0.2 (0.1, 0.5)
Drank alcohol in last month	26.0 (45/173)	37.6 (50/133)	1.7 (1.0,2.8)	1.9 (1.1, 3.2)
> 20 years at first marriage‡	44.0 (22/50)	29.1 (67/230)	0.5 (0.3, 1.0)	0.7 (0.5, 1.1)
> 3 years older than first wife‡	41.4 (24/58)	28.8 (63/219)	0.6 (0.3, 1.0)	0.5 (0.2, 0.9)
> 3 Lifetime partners	24.0 (12/50)	32.3 (81/251)	1.5 (0.7, 3.0)	1.3 (0.6, 2.8)
Circumcised	37.5(79/211)	16.0 (15/94)	0.3 (0.2, 0.6)	0.5 (0.2, 1.2)
Current genital ulcer	29.8 (88/295)	60.0 (6/10)	3.5 (1.0, 13.0)	3.4 (1.0, 11.7)
HSV-2	11.6 (14/121)	40.8 (64/157)	5.3 (2.7, 10.4)	5.4 (2.7, 11.0)
Females (15–24 years old)				
Non-Luo ethnic group	33.8 (116/343)	15.7 (13/83)	0.4 (0.2, 0.7)	0.4 (0.2, 0.7)
Ever married	21.6 (44/204)	38.3 (85/222)	2.3 (1.5, 3.5)	1.8 (1.1, 2.9)
> 17 years at first marriage‡	30.5 (36/118)	47.1 (49/104)	2.0 (1.2, 3.5)	2.0 (1.1, 3.7)
> 3 Lifetime partners	27.6 (102/369)	47.4 (27/57)	2.4 (1.3, 4.2)	1.7 (0.9, 3.0)
Use of modern contraception	35.4 (99/280)	16.3 (8/49)	0.4 (0.2, 0.8)	0.4 (0.2, 0.8)
HSV-2	9.8 (19/193)	46.3 (94/203)	7.9 (4.3, 14.4)	6.7 (3.6, 12.7)
Females (25–49 years old)				
Drank alcohol in last month	28.5 (118/414)	42.3 (22/52)	1.8 (1.0, 3.3)	1.9 (1.0, 3.3)
> 3 Lifetime partners	25.0 (86/348)	45.3 (53/117)	2.5 (1.6, 3.9)	2.6 (1.6, 4.0)
Syphilis	29.8 (132/410)	68.8 (11/16)	5.2 (1.7, 15.5)	5.2 (1.5, 8.1)
HSV-2	13.7 (10/73)	32.8 (116/354)	3.1 (1.5, 6.3)	3.2 (1.6, 6.5)
Condom use§	27.9 (107/383)	54.6 (12/22)	3.1 (1.3, 7.4)	2.8 (1.2, 6.8)

* Only risk factors which significantly improved the model ($P < 0.05$) are included in the table.
† Adjusted for age, ethnicity and other variables higher in the hierarchical framework (Figure 1).
‡ Model run only on those who were ever married.
§ Condom use includes ever use with a marital partner, or recent use with a non-marital partner.

Risk factors for HIV infection

Table 2 shows those variables that were significantly associated with HIV infection for men and women in each of the two age-groups. These are discussed more fully for all four cities elsewhere (Auvert *et al.* 2001a). Drinking alcohol in the last month was significantly associated with HIV infection for both males and females aged 25–49 years. Among 15–24-year olds, being married was associated with an increased risk of HIV infection for both males and females. Among men aged 25–49, later age at marriage and a larger age difference from their spouse were both associated with a reduced risk of HIV infection. However, among married 15–24-year-old women, later age at marriage was associated with an increased risk of HIV infection. Reporting more than three lifetime sexual partners was associated with an increased risk of HIV infection in all groups (although this was not significant for 25–49-year-old males).

HSV2 infection was also highly associated with HIV infection in all groups and this has been examined more closely for all four cities elsewhere (Weiss *et al.* 2001). The use of a modern contraceptive method was associated with a reduced risk of HIV infection in women aged 15–24, while having ever used a condom was associated with an increased risk in 25–49-year-old women. Among men aged 25–49, circumcision was associated with a significantly decreased risk of HIV infection in unadjusted analyses. Male circumcision was highly associated with ethnic group, being rare among the Luo and more common among the other ethnic groups. The importance of male circumcision in preventing HIV infection is discussed in more detail for all four cities elsewhere (Auvert *et al.* 2001b).

Association between SES and HIV infection

Table 3 and Figure 2 show the relationship between SES and HIV in groups of different age and sex. Among males aged 15–24 and females aged 25–49, those classified as of medium SES were at the highest risk, while those of the lowest SES were at the lowest risk of infection. There was no association between SES and HIV for males aged 25–49. However, among females aged 15–24, there was a significant trend with those in the lowest SES group being at increased risk of infection (OR adjusted for age and ethnicity, comparing high SES with low SES: 0.52; 95% CI, 0.31–0.88).

Models 2 and 3 in Table 3 present OR associated with SES upon inclusion of significant risk factors for HIV into the model. A sexual behaviour variable was added first

Table 3 Socioeconomic status as a risk factor for HIV infection by age and sex

	Prevalence of HIV (%)	OR adjusted for age and ethnicity (95% CI)	*P*-value	OR: Model 1* (95% CI)	OR: Model 2† (95% CI)	OR: Model 3‡ (95% CI)
Males (15–24 years)						
Low SES	5.0 (6/119)	1.0		1.0	1.0	1.0
Medium SES	11.0 (12/109)	2.2 (0.8, 6.2)	0.096	3.0 (1.0, 9.0)	2.8 (0.9, 8.4)	3.1 (0.8, 12.3)
High SES	7.9 (5/63)	1.6 (0.5, 5.7)	0.437	1.9 (0.5, 6.8)	2.1 (0.5, 8.2)	1.2 (0.3, 5.1)
Males (25–49 years)						
Low SES	32.5 (27/83)	1.0		1.0	1.0	1.0
Medium SES	34.1 (44/129)	1.2 (0.7, 2.2)	0.813	1.2 (0.6, 2.2)	1.1 (0.6, 2.1)	1.3 (0.7, 2.7)
High SES	25.5 (24/94)	0.8 (0.4, 1.7)	0.306	0.8 (0.4, 1.6)	0.8 (0.4, 1.6)	1.5 (0.7, 3.4)
Females (15–24 years)						
Low SES	37.4 (68/182)	1.0		1.0	1.0	1.0
Medium SES	27.3 (30/110)	0.7 (0.4, 1.2)	0.077	0.8 (0.5, 1.3)	0.8 (0.5, 1.3)	0.7 (0.4, 1.3)
High SES	23.1 (31/134)	0.5 (0.3, 0.9)	0.007	0.6 (0.4, 1.0)	0.6 (0.4, 1.0)	0.5 (0.3, 1.0)
Females (25–49 years)						
Low SES	25.7 (57/222)	1.0		1.0	1.0	1.0
Medium SES	39.5 (47/119)	1.8 (1.1, 3.0)	0.008	1.7 (1.1, 2.9)	1.7 (1.0, 2.8)	1.8 (1.0, 3.1)
High SES	28.8 (36/125)	1.0 (0.6, 1.7)	0.529	1.0 (0.6, 1.7)	1.1 (0.6, 1.8)	1.1 (0.6, 2.0)

* Adjusted for age, ethnicity and lifestyle variables significantly associated with HIV, including marriage and alcohol use in the last month.
† Adjusted for age, ethnicity, lifestyle and sexual behaviour variables significantly associated with HIV, including > 3 lifetime sexual partners.
‡ Adjusted for age, ethnicity, lifestyle, sexual behaviour and transmission probability factors significantly associated with HIV, including HSV2, genital ulceration, syphilis and circumcision.

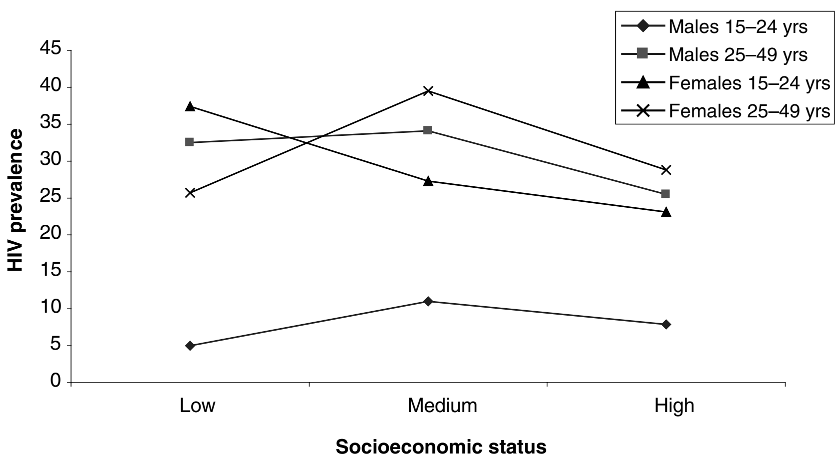

Figure 2 Prevalence of HIV infection among groups of different age, sex and socioeconomic status.

(Model 2), followed by factors that alter the probability of transmission of HIV (Model 3). A fall in the OR for HIV associated with SES upon inclusion to the model of a more proximate factor in the hierarchical framework (Figure 1) would suggest that differences in that factor between SES groups are responsible for mediating part of the difference seen in HIV infection rates.

Among men aged 15–24, the OR associated with medium SES rose upon inclusion of marriage to the model. Inclusion of HSV2 caused a substantial drop in the OR associated with the highest SES level. Among young men, higher levels of HSV2 among the highest SES groups may mediate some of the difference in HIV by SES. Among all other age and sex groups, HSV2 antibodies were detected significantly more often among lower SES groups, although inclusion of this factor in the model did not significantly alter the ORs associated with different SES levels. Among women of both age groups there were few changes in the ORs for SES groups upon inclusion of more proximate factors to the model.

Discussion

Cultural background does not determine behaviour but it does provide social actors with a framework for making decisions (Epstein 1981), and this also describes well the potential importance of socioeconomic status as a risk factor for HIV infection. Relevant behaviours may be sexual, marital, social, health seeking or recreational, and SES may affect the opportunity for, timing and patterns of such behaviours. The natural history of the HIV epidemic has differed between population groups (e.g. urban and rural populations) that may also differ in terms of SES. Because of the widening diversity in the burden of HIV in the richer and poorer nations of the world, HIV has been characterized as a disease of poverty. There have been calls for changes in macro-economic policy, greater resource allocation to HIV prevention and treatment efforts and lowering drug prices (Cameron 2000). However, less work has been carried out to understand the link between socioeconomic status and risk of HIV infection within the worst affected, often the poorest populations.

A number of previous studies have investigated the relationship between educational attainment and HIV. Educational attainment has been considered as a proxy measure for SES, but may also be interpreted more directly. In this study, we used a composite measure of SES to group individuals. Such a measure, incorporating household facilities, education and employment, should be more robust to misclassification than individual proxy measures used on their own. As might be expected, in the current population, educational attainment correlates significantly with SES among groups of both ages and sexes. However, patterns of HIV infection among different SES groups are not matched among groups of differing educational attainment. In particular, no association is seen between HIV infection and educational attainment among women aged 15–24 (data not shown). Direct comparison between the results presented here and studies that have used educational attainment as a marker of SES may not be appropriate. While this limits the comparability of the results presented here, it also highlights the need for care in assessment of SES in epidemiological studies. A gold standard scale of SES is difficult to imagine. While a measure of income may be more accurate, its usefulness is likely to differ by age (in the young, parental income may be more important), sex (husband's income may be a better marker in women), setting (land ownership may be more relevant than income in some areas) and by other factors. To what extent our proxy measure accurately reflects economic power is not fully known. However, our SES variable correlates well with other markers of increased economic activity, such as travel and alcohol consumption, in both males and females.

Appropriate analysis is imperative when considering how distally acting factors, such as SES, may be causally related to acquisition of HIV infection. Specifically, ORs must be appropriately adjusted for confounding factors, but must not be 'overadjusted' by including potential mediators of the relationship into statistical models. In this paper, we have attempted to elucidate the interplay between SES, risk factors and HIV infection through an analysis based on a hierarchical conceptual framework. The results are confusing. While some factors were associated with both SES and HIV infection, their inclusion to a regression model did not alter the OR associated with SES. There may be limitations to this approach. First, as with any cross-sectional study, we do not know whether any of these factors are the same as they were at the time of actual infection with HIV. This may be particularly important in the use of the proposed analytical technique to investigate pathways of mediation and causality. There are also likely to be lifestyle, behavioural and transmission factors for which we had no data. Additionally, in any survey asking questions on sexual behaviour, the data needs to be interpreted cautiously. Aspects of validity are discussed in detail for all four cities elsewhere (Buve *et al.* 2001b). The hierarchical conceptual framework approach may have limitations in its ability to assess mediation among cross-sectional data. Nevertheless, it is necessary to consider potential pathways of causality in examining the link between SES and behavioural or health outcomes.

Higher SES groups were significantly more likely not to provide a blood sample for HIV testing, particularly among men. If those who refused to provide a sample were either more or less likely to be HIV infected, then our estimate of HIV prevalence among high SES groups may be biased. Those who did not provide a sample may have done so because they perceived themselves to be at high risk of infection, or may have refused because of characteristics that put them at lower risk of infection. Consequently, it is impossible to assess the extent or direction of bias with the current data. Nevertheless, estimates of HIV prevalence, particularly among high SES groups, must be interpreted with some caution.

Our data show diversity in the relationship between SES and current HIV status amongst those of differing sex and age in an urban population in Kenya. In males aged 15–24 and females aged 25–49, there was some indication that those of the lowest SES were at decreased risk of HIV infection, whilst among females aged 15–24, the pattern is for higher levels of HIV infection in those of lower SES. Among 25–49-year-old males, HIV infection did not appear to be associated with SES. This finding is at odds with the simplistic notion that HIV affects only the poorest sectors of society. In fact, risk of infection was high among all groups. Results among younger groups may reveal the pattern of new infections. Among young men, prevalence was low and estimates are based on a low number of infections. However, among young women, those of the lowest SES are at increased risk. This pattern fits with the theory that those of low SES will be at disproportionately higher risk of new infection as the HIV epidemic matures. This pattern has been suggested in other settings (Fylkesnes *et al.* 1997, 2001; Kilian *et al.* 1999).

There is further evidence to suggest this pattern may be occurring in this analysis. Risk factors in this study were broadly grouped as 'lifestyle', 'sexual and marital behaviour' and 'transmission cofactors'. Lifestyle factors are likely to have less importance in defining individual risk of infection as the epidemic spreads widely putting the general population at high risk. In this data, lifestyle factors that have been associated with HIV risk, such as alcohol use and travel, were concentrated among high SES groups. Alcohol consumption may be a marker of lifestyle more likely to put a person at risk (e.g. attending clubs and bars where casual sex is available).

Further down the causal chain, lower SES was associated with earlier sexual debut and marriage. Such sexual behaviours will remain important risk factors for infection in a widespread, generalized HIV epidemic. This is particularly true if condom use remains low and the prevalence of other STDs is high. This would suggest that those of lower SES may be at high risk of newly acquiring HIV infection.

Finally, important factors affecting the probability of transmission of HIV were concentrated among low SES groups in this analysis. Such factors include the presence of HSV-2 antibodies and use of condoms. HSV2 and HIV are coming to be recognized as mutually enhancing infections and HSV2 may play an important role in the epidemic spread of HIV (Weiss *et al.* 2001). HSV2 infection has also been found to be highly associated with reported lifetime partners and has been suggested as a marker of risky sexual behaviour (Obasi *et al.* 2000; Weiss *et al.* 2001). Condom use in this study was low, and was more common in higher SES groups for men and women in both age groups. Another recent analysis of this data showed greater condom use among more educated men and women (Lagarde *et al.* 2001). Condom use is a complex variable in discussing HIV risk because, while the use of a condom in a single episode reduces risk of transmission, having ever used a condom is also thought to be a marker of risky sexual behaviour in many settings. In this analysis, condom use was associated with an increased risk of HIV in women aged 25–49. Nevertheless, it is clear that condom use can prevent new HIV infections and should be promoted among groups of all SES.

In this urban population with a relatively mature HIV epidemic, there is little difference in the levels of prevalent HIV infection in males of differing socioeconomic status. However, newer infections among young women appear to be more common amongst those of lower SES. Additionally, sexual behaviours and STIs that may be important in determining risk of new infection are more widespread amongst those of lower SES of both sexes. Successful health interventions will need to reach those of the lowest SES, in whom the potential for further infection with HIV may be greatest. Further critical examination of the link between poverty and HIV infection is necessary. Evaluations of structural and environmental interventions that seek to address such imbalances are long overdue.

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