

Mobility and the spread of human immunodeficiency virus into rural areas of West Africa

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Background In eastern and southern Africa, the human immunodeficiency virus (HIV) epidemic appeared first in urban centres and then spread to rural areas. Its overall prevalence is lower in West Africa, with the highest levels still found in cities. Rural areas are also threatened, however, because of the population's high mobility. We conducted a study in three different communities with contrasting infection levels to understand the epidemiology of HIV infection in rural West Africa.

Method A comparative cross-sectional study using a standardized questionnaire and biological tests was conducted among samples in two rural communities of Senegal (Niakhar and Bandafassi, 866 and 952 adults, respectively) and a rural community of Guinea-Bissau (Caio, 1416 adults). We compared the distribution of population characteristics and analysed risk factors for HIV infection in Caio at the individual level.

Results The level of HIV infection was very low in Niakhar (0.3%) and Bandafassi (0.0%), but 10.5% of the adults in Caio were infected, mostly with HIV type 2 (HIV-2). Mobility was very prevalent in all sites. Short-term mobility was found to be a risk factor for HIV infection among men in Caio (adjusted odds ratio (aOR) = 2.06; 95% CI: 1.06–3.99). Women from Caio who reported casual sex in a city during the past 12 months were much more likely to be infected with HIV (aOR = 5.61 95% CI: 1.56–20.15). Short-term mobility was associated with risk behaviours at all sites.

Conclusions Mobility appears to be a key factor for HIV spread in rural areas of West Africa, because population movement enables the virus to disseminate and also because of the particularly risky behaviours of those who are mobile. More prevention efforts should be directed at migrants from rural areas who travel to cities with substantial levels of HIV infection.

Keywords Africa, HIV infection, migration, Senegal, Guinea-Bissau, prevention

Sub-Saharan Africa is the region of the world hardest hit by HIV infection: 70% of all those with human immunodeficiency virus (HIV)/AIDS worldwide live there.¹ The pandemic is not

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distributed homogeneously, however. In countries such as Zambia, Zimbabwe or Namibia, more than 25% of adults are infected, while in countries such as Senegal or Gambia, the prevalence does not exceed 2%.² The heterogeneity of the spread of HIV is also found within countries, and infection rates are usually higher in urban than rural areas. Moreover, HIV infections in rural areas most often come from urban sources, and migration has often been found to be one of their principal risk factors in studies of rural populations.^{3–6} Mobility and migration enable the virus to shift from urban centres to the countryside, and populations living in interfaces such as trading centres^{7,8} or main roads^{9,10} are infected at higher rates than those living in isolated villages. Round trips between villages and cities are not *per se* a vector for HIV: the key issue is the behaviours of migrants and travellers. Previous studies in Africa found that migrants have more risk behaviours than non-migrants.^{5,11,12} Two non-exclusive explanations seem likely. Firstly, travelling exposes migrants to new behaviours. Previous observations showed that risk behaviours are more frequent in towns than in nearby rural areas.^{13,14} Secondly, migration disrupts traditional social constraints on and control of sexual behaviour. Married people often travel without their spouse and thereby increase their risk of extramarital sex. It can sometimes be very difficult for migrants to find a sex partner among local inhabitants of the area into which they have moved. This can lead them to have sex with commercial sex workers, who have much higher rates of HIV infection than the general adult population.

Finally, it is possible that changes in sexual behaviours, for example following marriage disruption, may lead to changes in mobility behaviours and could partly explain the association observed between sexual behaviours and mobility. This has not yet been documented, however.

A recent study in Uganda¹⁵ found that migrants reported higher levels of sexual risk-taking behaviours but also higher rates of condom acceptance than among non-migrants. Travellers are more likely to report condom use according to a study in Tanzania¹³ and to our study in southern Senegal.¹¹ This opens the way for specific prevention among mobile populations.

To identify the key determinants of HIV infection in rural West Africa, we conducted standardized comparative surveys in three rural settings with highly mobile populations and levels of HIV infection that we expected to be heterogeneous. Two of these areas are located in regions where nearby cities have very low HIV infection levels and the third is located in a region where the nearby cities have relatively high HIV levels.¹⁶

Methods

Setting

All three study areas are located in rural West Africa (two in Senegal and one in Guinea-Bissau), have polygamous matrimonial systems, and have been monitored demographically for up to 25 years. Because all new vital events (births, deaths, marriages, and migrations) are recorded periodically, a population list is available from which random samples can be easily and accurately drawn.

Niakhar

The survey was conducted in July 1997 in the region of Fatick, in central Senegal. The population of the area has been under

demographic follow-up since 1983. As of 1 January 1997, 29 104 individuals lived in the study area.¹⁷ Most of the population farms and belongs to the Sereer ethnic group: 74% are Muslim, 20% Catholic, and 3% Protestant. Although very few report they are animists (1%), all follow traditional rites to some degree.

Bandafassi

The survey was conducted in March 1998 in the region of Tambacounda in southeast Senegal, near the borders with Guinea and Mali. The population of this area has been under demographic surveillance for the past 25 years. In 1998, the population in the study area was 9576. The population consists mostly of farmers belonging to one of three ethnic groups. The Peul (57% of the population) are Muslims, while the Bedik (28%) and Malinke (16%) include Muslims, animists, and Christians.

Caio

The survey area is located in the region of Cacheu in northwest Guinea-Bissau, near the Senegalese border. Between March 1997 and January 1998, all consenting adults gave blood samples for HIV testing. The interviews were conducted in May and June 1998. The population of this area has been under demographic surveillance since 1989. The population in the study area in 1996 was 10 500. The population here too is mainly farmers, more than 95% of whom belong to the Manjako ethnic group. The distribution of religions is: 79% of the population report themselves to be animists, 20% Catholic, and 1% Muslim.

Study sample

The demographic databases for Bandafassi and Niakhar were used to build a random sample of adults aged 15–59 years. A sample size of 1000 adults was sought. Because we estimated the proportion of people away from the area as 20% in Niakhar and 34% in Bandafassi from the demographic follow-up data, we set the initial sample sizes at 1200 and 1510, respectively. Eligible subjects from Niakhar and Bandafassi were asked to answer the study questionnaire and to give blood samples for HIV testing. In Caio, the biological data came from a sero-survey conducted between March 1997 and January 1998. All 5528 residents who were ≥ 15 years according to the demographic database were eligible for the study: 3104 participated. The sample was drawn from the population eligible for the earlier study (whether or not they had participated). The sample included 1920 adults. Because the serological data showed a high prevalence of HIV-2 and its prevalence, unlike that of HIV type 1 (HIV-1), is elevated in older age groups, the Caio survey also included those > 59 years.¹⁸

Interview

Interviewers were recruited from the local population of each area. They went through a 4-day training period made up of coursework and individual interview simulation. They were taught to translate the questionnaire extemporaneously from written French or Portuguese to the local spoken language (they do not write or read it, since schooling is in French in Senegal and in Portuguese in Guinea-Bissau). Much of the training period was devoted to standardizing the translation. After informed consent was obtained, the interviews took place in private settings to protect confidentiality.

Content of the questionnaire

We derived a questionnaire from the Knowledge Attitudes Behaviour and Practices (KABP) questionnaire of the World Health Organization's Global Program on AIDS¹⁹ and from our experience during previous sexual behaviour surveys in another area of Senegal.¹¹ This questionnaire was designed to study risk factors for HIV infection as well as perceptions of AIDS and its prevention, while taking the local socio-cultural context into account. The questionnaire was first tested during a 1995 pilot study.²⁰

The following personal information was recorded: age, sex, marital status, religion, education, ethnic group, and occupation. The level of exposure to radio and television was also recorded. Long-term mobility was measured by the question: 'have you been away from your village for at least one month during the past 12 months?' Short-term mobility was measured by the question: 'have you been away from your village for at least one day and one night in the past 4 weeks?' Information about departure and arrival dates, destination, and reason for migration was recorded for up to two long-term voyages in the past 12 months and up to four short-term trips in the past 4 weeks.

Respondents were asked to provide information on up to four regular sexual partners and four casual partners in the past 12 months. A regular partner was defined as a sexual partner with whom the participant had sex regularly for at least one year, including spouses (even if married less than one year). A casual partner was defined as a partner who was not regular. The respondent was asked to provide for each, when possible, age, ethnic group and marital status, site (away or in the village), condom use, exchange of gift and of money for sex, and period and duration of the partnership. The Caio study area was divided into a peripheral and a central zone; almost all shops and facilities were in the latter, which was also the closest part of the study area to the only road to the nearest urban centre. Men were asked how many commercial sex workers they had sex with in the past 12 months. They were also asked whether they noticed any sexual discharge, sore or ulceration in the past 12 months, whether they were circumcised and, if so, at what age. Hospitalization and injection histories were recorded. A final part of the questionnaire was devoted to knowledge and perception of HIV and other sexually transmitted diseases (STD).

Biological tests

Between 1 and 2 ml of blood were collected from each consenting participant. Samples at all sites were screened for HIV with the commercial enzyme-linked immunosorbent assay (ELISA) ICE BASE PACK (Murex Diagnostics, Dartford, UK). Positive samples in Senegal were confirmed with a commercial immunoblot (BIO-RAD, NOVAPATH) for HIV-1 and with a homemade immunoblot for HIV-2 (whole virus lysate of HIV-2: MS-U937). Samples were classified as HIV-1 according to the manufacturer's criteria and as HIV-2 when anti-env, -pol, or -gag antibodies were recognized. Positive samples in Caio were confirmed with commercial tests from Murex Diagnostics (Wellcozyme I for HIV-1 and ICEHIV-2 for HIV-2). Samples that were positive for both ELISA were tested by Pepti-Lav (Diagnostics Pasteur, Marnes-la Coquette, France) to confirm dual infections.

Ethics

Ethical approval for the study in Senegal was obtained from the national AIDS control programme and the national ethics committee, in Guinea-Bissau from the Ministry of Public Health's Co-ordination unit of Health Research and in Gambia, from the Joint Ethics Committee of the Gambian government and the Medical Research Council laboratories.

Analysis

All analyses were performed separately for each sex. Statistical significance was always set at 0.05. The analysis was conducted in three steps: (1) an ecological analysis compared the distribution of variables in populations with low and with high levels of HIV infection; (2) analyses on the individual level were performed for the population with a high HIV prevalence; (3) and finally the sexual risk taking behaviours of mobile and non-mobile participants were compared.

Ecological analysis

We determined whether the two populations in Senegal, where the level of infection was low, differed for any of the variables from the population in Guinea-Bissau, which had a relatively high level of infection. Only variables that differed significantly between either Niakhar or Bandafassi and Caio for at least one sex are presented in Table 1. A χ^2 test was used to compare proportions and a Wilcoxon-Mann-Whitney rank test to compare medians.

Analysis at the individual level

We performed univariate and multivariate analyses of the risk factors for HIV infection in Caio. Univariate comparisons used χ^2 or Fisher exact tests, as appropriate. Descending stepwise logistic regression was used to select the predictors of HIV infection in the univariate analysis with a *P*-value below 20% for the multivariate analysis.²¹ Finally, HIV levels were analysed according to the destinations of short-term trips.

Mobility and sexual behaviours

Because the multivariate analysis found that short-term mobility was associated with HIV infection, we completed the analysis by comparing the sexual behaviour reported by those who did and did not travel. A model was built for each behavioural variable for each gender and included the following potential confounding variables, when significant: age, matrimonial status, educational level, access to radio and television, religion, and ethnic group.

All statistical computations were performed with SPSS 9.0 for Windows (SPSS Inc. 1997, Chicago, IL).

Results

Sample characteristics and human immunodeficiency virus prevalence

Niakhar

The initial sample included 1200 adults 15–59 years (600 men and 600 women): 314 (26%) were away from their village, deceased, or mentally disabled and could not be interviewed. Another 20 (2% of those present) refused to participate. The final sample consisted of 404 men and 462 women. The ongoing demographic surveillance made it possible to compare the mean age of respondents (32 years for men and 34 for women)

Table 1 Sample size and selected socio-demographic and behavioural characteristics of the respondents

	Men					Women				
	Niakhar	Bandafassi	Caio ^a	P (N/C) ^b	P (B/C) ^c	Niakhar	Bandafassi	Caio ^a	P (N/C) ^b	P (B/C) ^c
Sample										
Initial sample size	600	755	954			600	755	966		
Absent, unable to participate, or deceased	189	257	271			125	134	215		
Refusals	7	58	12			13	109	6		
Respondents	404	440	671			462	512	745		
Marriage										
Estimated median age at marriage ^d	26	26	29			16	17	19		
Mobility										
Long-term mobility in the last 12 months	39%	19%	21%	<10 ⁻³	ns	26%	7%	22%	0.11	<10 ⁻³
Short-term mobility in the last 4 weeks	33%	56%	35%	ns	<10 ⁻³	29%	35%	24%	0.09	<10 ⁻³
Circumcision										
Is circumcised	99%	96%	72%	<10 ⁻³	<10 ⁻³	1%	97%	1%	ns	<10 ⁻³
Median reported age at circumcision	15	14	16	<10 ⁻³	4	8	8	8	ns	ns
Sexual behaviour										
Median reported age at first sex ^e	19	18	17	<10 ⁻³	<10 ⁻³	16	14	18	<10 ⁻³	<10 ⁻³
Married respondents who reported one or more non-spousal regular partner ^{e,f}	4%	8%	23%	<10 ⁻³	<10 ⁻³	4%	10%	3%	ns	0.002
Reported at least one casual partner ^{e,f}	22%	23%	21%	ns	ns	5%	7%	2%	0.02	<10 ⁻³
Reported at least one casual partner in a city ^{e,f}	13%	2%	17%	0.09	<10 ⁻³	8%	0%	3%	<10 ⁻³	<10 ⁻³
Reported at least one partner with exchange of money ^{e,f}	12%	33%	11%	ns	<10 ⁻³	11%	20%	2%	<10 ⁻³	<10 ⁻³
Reported one or more contact with a commercial sex worker ^{e,f}		0%	2%	8%	<10 ⁻³	<10 ⁻³				
Reported condom use in the last 4 weeks ^e	2%	17%	28%	<10 ⁻³	0.007	6%	7%	12%	0.01	0.09
Miscellaneous										
Ever been in school	49%	61%	87%	<10 ⁻³	<10 ⁻³	21%	50%	45%	<10 ⁻³	0.07
Has drunk alcohol in the past week	19%	31%	80%	<10 ⁻³	<10 ⁻³	5%	25%	84%	<10 ⁻³	<10 ⁻³

^a Sample sizes are given for the whole sample (ages 15 and more) but comparisons of variables are restricted to the age group 15–59.

^b P-values for comparison between Niakhar and Caio (ns means > 0.20).

^c P-values for comparison between Bandafassi and Caio (ns means > 0.20).

^d Age at which 50% of the sample is ever married.

^e Among sexually active respondents.

^f In the last 12 months.

and non-participants (28 and 26, respectively). These differences were statistically significant for both men and women ($P < 10^{-3}$). Of the 245 men and 396 women tested for HIV infection, one man was found to be infected with HIV-1 (0.4%) and 2 women with HIV-2 (0.6%).

Bandafassi

The initial sample included 1510 adults 15–59 years (755 men and 755 women): 391 (26%) were away from their village, deceased or mentally disabled and could not be interviewed. Another 167 (15% of those present) refused to participate. The final sample included 440 men and 512 women. The mean age of the respondents was 33 years for men and 34 for women; for the non-participants, 30 and 32 years, respectively. Again, the differences were statistically significant for men ($P = 0.001$) and women ($P = 0.03$). None of the 393 men and 462 women tested was infected with HIV.

Caio

An initial sample of 1920 adults aged ≥ 15 years (954 men and 966 women) was drawn from those who participated in the

serological survey between March 1997 and January 1998 (but were not necessarily tested for HIV infection): 486 (25%) were away from their village, deceased, or mentally disabled and could not be interviewed. Another 18 (1%) refused to answer the questionnaire. The final sample thus consisted of 671 men and 745 women. The mean age of the respondents was 38 years for men and 42 for women, and for non-respondents, 30 and 34 years, respectively. Again, these differences were statistically significant for men and women ($P < 10^{-3}$).

Of those who were tested and who participated in the questionnaire (616 men and 675 women aged ≥ 15 years), 10.5% were infected with HIV (1.5% with HIV-1, 7.5% with HIV-2, 1.4% with both, and 0.2% with an undetermined type). More women were infected than men, and the difference is even higher when HIV-1 is excluded (6% of the men and 9% of the women).

Ecological analysis

Table 1 summarizes the variables that differed between Caio, the site with relatively high HIV levels and either or both of the

sites with low HIV levels. To ensure comparability, the sample from Caio was restricted to those aged 15–59 for this analysis.

The sample was sorted by age at interview. Age at marriage was estimated by the age at which half of the sample was or had ever been married; it was higher in Caio for men (29 years in Caio, 26 in Niakhar and in Bandafassi) and women (19, 16, and 17 years, respectively).

Median age at first sexual activity was significantly lower among men from Caio (17) than those from Niakhar (19) or Bandafassi (18). Conversely, this age was significantly higher among women from Caio (18) than those from the other sites (16 in Niakhar and 14 in Bandafassi). These results, together with those for age at marriage, suggest that women but not men have their first sexual relations and marry at nearly the same age. Moreover, the gap for men between age at first sexual activity and age at marriage is substantial and even wider for the men from Caio (12 years) than from Niakhar (7 years) or Bandafassi (8 years).

Both men and women from Caio were more than twice as likely to report alcohol consumption in the past week than those from the other sites (80% of the men and 84% of the women versus less than 32% of respondents from the other two sites). They also reported condom use in the past 4 weeks at a higher rate than respondents from the other sites. More men from Caio had any schooling than those from Niakhar and Bandafassi, while the women from Caio were more likely to have any schooling than those from Niakhar.

Married men, but not women, from Caio reported non-spousal regular partners more often (for men: 23% versus 4% in Niakhar and 8% in Bandafassi). Respondents from Caio, men or women, were not more likely than those from Senegal to report casual partners, casual partners in a city or partners with an exchange for money.

Sexual contacts with exchange of money and commercial sex are clearly two different concepts: one-third of the male respondents reported sex with an exchange of money in Bandafassi, but only 2% reported contacts with sex workers. The highest proportion of men reporting contacts with sex workers was in Caio (8%). Nobody in Niakhar reported contact with sex workers.

Men from Caio were less likely to report being circumcised: male circumcision was almost universal in Niakhar and Bandafassi while 72% of the men from Caio reported they were circumcised. This reflects both a lower rate of male circumcision in Caio and a later age at circumcision. It is nonetheless likely that a substantial proportion of the men from Caio will never be circumcised: 9% of those >29 years are not. Female circumcision is almost non-existent in Niakhar and Caio, but universal in Bandafassi.

Both long- and short-term mobility were very common in all three sites. Long-term mobility was most frequent in Niakhar, where it was reported by 39% of the men and 26% of the women. In Bandafassi it was reported by 19% and 7%, respectively, and in Caio by 21% and 22%. Short-term mobility was most frequent in Bandafassi, reported by 56% of the men and 35% of the women. In Niakhar it was reported by 33% and 29%, respectively, and in Caio by 35% and 24%.

Individual-level analysis

Because of the low HIV prevalence at the sites in Senegal, the risk factor analysis was restricted to Caio. The HIV prevalence varied greatly by age group, and the age distribution is the result

of the combination of two different and well-known age distributions: a peak at young ages for HIV-1 and prevalence that increases with age for HIV-2. These groups were pooled for the risk factor analysis however, to ensure sufficient statistical power. Because mobility could be associated with seeking health care, we excluded from the multivariate analyses all respondents who reported at least one short-term trip for a medical reason. The multivariate analysis thus considered 520 sexually active men and 626 sexually active women from Caio. Table 2 presents the results of the univariate analysis of risk factors for HIV infection and Table 3 the multivariate analysis.

Among men, HIV prevalence was highest in the 30–39 age group and was associated with no schooling, more than one partner in the past 12 months, and short-term mobility. When adjusted for all the variables in the model, only age (adjusted odds ratio [aOR] = 11.1 [95% CI: 3.65–33.9] for those 30–39 years and aOR = 11.1 [95% CI: 3.42–35.7] for those 40–59, compared with those 15–29) and short-term mobility (aOR = 2.06; 95% CI: 1.06–3.99) remained associated with HIV infection. Among women, the factors associated with HIV infection in univariate analysis were age, living in central Caio, no schooling, casual partners in a city, and short-term mobility, especially for a medical reason. In the multivariate analyses, factors associated with an increased risk of HIV infection among women were age (aOR = 6.70 [95% CI: 3.81–16.0] for those 40–59 years and aOR = 5.06 [95% CI: 1.56–20.2] for those >59, compared with those 15–29), living in central Caio (aOR = 1.79; 95% CI: 1.05–3.06), and casual sex in a city (aOR = 5.61; 95% CI: 1.56–20.2).

Only 16 men reported that a wife was not currently living in Caio, and 140 women a husband residing elsewhere. The HIV prevalence among these 16 men was 18.8%, twice the level of the general adult population (but not significant, probably because of the absence of statistical power: $P = 0.17$, Fisher's exact test). The rates of HIV infection were similar for the women whose husbands did live in Caio and for those whose did not (10.7% [N = 140] versus 11.1% [N = 505]).

Respondents in Caio were asked to state where they went for up to four short-term trips. This enabled us to compare HIV infection levels according to destination for the participants. Men who reported at least one short-term trip to Bissau were more likely than the men who reported short-term trips elsewhere to be infected with HIV (15.7% versus 6.5%, $P = 0.005$). When a short-term trip to Bissau was included in the multivariate risk factor analysis, it was a better predictor of HIV infection than overall short-term mobility (aOR = 3.44; data not shown). No specific destination was significantly associated with an increased probability of HIV infection among women.

Mobility and sexual behaviours

Because the risk factor analysis strongly suggested the importance of short-term mobility and (for women) associated risk behaviours, we investigated this issue further at all three sites by comparing behavioural variables between those who reported short-term mobility and those who did not. Table 4 shows the associations of risk behaviours and condom use with short-term mobility, adjusted for potential confounding social and demographic characteristics. Short-term mobility was associated with a higher frequency of risk behaviours for men in Bandafassi (casual partner in the last 12 months: aOR = 1.9) and Caio

Table 2 Univariate analysis of risk factors for HIV infection in Caio

	Men			Women		
	% HIV positive	N ^a	P	% HIV positive	N ^a	P
Age group			>10 ⁻³			>10 ⁻³
15–29	1.3	308		3.9	232	
30–39	17.1	111		8.7	184	
40–59	14.6	82		21.3	108	
>59	11.3	115		15.9	151	
Residence			0.05			0.02
Peripheral	5.9	341		8.1	372	
Central	10.2	275		13.9	303	
Marital status						
Married in monogamous union	10.3	156		7.7	156	
Married in polygamous union	16.2	117		9.6	322	
Divorced	11.8	17		13.3	15	
Widowed	21.4	14		22.1	104	
Never married	2.6	312		5.1	78	
Ever been in school			0.003			>10 ⁻³
No	13.9	151		14.1	447	
Yes	5.8	465		3.9	228	
More than 1 partner in the last 12 months			0.01			ns
No	6.0	447		10.8	669	
Yes	12.4	169		0	6	
Reported ≥1 casual partner^b			ns			ns
No	9.7	442		11.1	637	
Yes	5.5	91		11.1	9	
Reported partner(s) in a city^{b,c}			ns			0.09
No	9.0	457		10.7	629	
Yes	9.3	75		25.0	16	
Reported partner(s) with exchange of money^{b,c}			ns			ns
No	8.7	483		11.2	634	
Yes	12.2	49		0	11	
Left the village for one day and night or longer in the past 4 weeks (short-term mobility)						
No	5.9	423		9.1	528	
Yes, without any medical reason	11.0	181	0.03	14.1	128	0.09
Yes, with a medical reason	27.3	11	0.03	31.6	19	0.007
Left the village for one month or more in the last 12 months (long-term mobility)			ns			ns
No	7.4	502		10.6	127	
Yes, without any medical reason	8.2	97		11.7	103	
Yes, with a medical reason	17.6	17		8.3	24	
Had been in hospital in the last 5 years			ns			ns
No	6.9	493		10.4	539	
Yes	10.9	119		11.9	135	
Had received a transfusion during those hospitalization(s)			ns			ns
No	10.6	104		10.6	113	
Yes	15.4	13		18.2	22	

^a Variations in the total number of respondents are due to a small number of non-responses.

^b Among those sexually active.

^c In the past 12 months.

Discussion

We present here the first study to use comparative standardized data from different settings to study the epidemiology of the spread of HIV in rural areas of West Africa. It provides evidence that mobility is a key feature of the spread of HIV throughout rural areas. The ubiquity of mobility means that it cannot explain why HIV prevalence is high in some regions and low in others, but it is a clear risk factor when HIV infection reaches

(more than one partner in the last 12 months: aOR = 2.8) and for women in Niakhar and Caio (casual partner in the past 12 months: aOR = 8.3 and 5.7, respectively). Among men from Bandafassi and women from Niakhar, short-term mobility was also associated with an increase in reported condom use (aOR = 3.3 and 5.3, respectively). This trend was also observed in Caio, where it was not, however, statistically significant.

Table 3 Multivariate logistic regression analysis of risk factor^a for human immunodeficiency virus infection in Caio among men (N = 520) and women (N = 626)

	Odds ratio ^b	95% CI	P
Men			
Age group			<10 ⁻³
15–29	1		
30–39	11.1	3.65–33.9	<10 ⁻³
40–59	11.1	3.42–35.7	<10 ⁻³
>59	7.64	2.32–25.2	<10 ⁻³
Short-term mobility			
No	1		
Yes	2.06	1.06–3.99	0.03
Women			
Age group			0.008
15–29	1		
30–39	2.22	0.91–5.43	
40–59	6.70	3.81–16.0	ns
>59	5.06	1.56–20.2	<10 ⁻³
Residence			
Peripheral	1		
Central	1.79	1.05–3.06	0.03
Reported casual partner(s) in a city in the last 12 months			
No	1		
Yes	5.61	1.56–20.2	0.008

^a Respondents who reported short-term mobility with a medical reason were excluded from the analysis.

^b Odd ratios adjusted for all variables in the model.

substantial levels. This is probably related to the particular risky behaviour of both male and female travellers and migrants, presumably at their destinations. These conclusions are supported by the body of observations made throughout this paper: (1) mobility is very prevalent at all three sites but was not more frequent in Caio than the other sites; (2) in Caio, HIV infection is associated with short-term mobility among men and with casual sex in a city among women; (3) short-term mobility is associated with risk behaviours at all three sites; (4) in Caio, particularly high HIV infection levels were found for men who reported trips to Bissau, the capital where the level of HIV-2 infection is relatively high.²¹ It is not certain, however, that the HIV epidemic in Bissau preceded that in Caio. Nor is it clear why HIV infection is higher in Bissau than in the urban centres of Senegal. Even if the differences reflect a gradient spreading from the epicentre of the HIV-2 epidemic, the prevalence would be even higher if all populations were at the same risk, given the time elapsed since it began and the intensive population mobility in West Africa. Some authors have hypothesized that the war for independence against the Portuguese colonial forces may help to explain the epidemic in Guinea-Bissau.²²

We sought to identify social, demographic, and behavioural factors that might be associated with HIV infection at the population and the individual level so that we could explain its heterogeneity at our three sites. No factors, however, were found to be a risk factor in Caio or to distinguish Caio from the two Senegalese populations with low levels of infection. The associations observed between HIV infection and mobility do not, however, imply that mobility is the only source of HIV within the Caio area. Support for a broader range of sources

Table 4 Comparison of sexual behaviour between those reporting short-term mobility and those who did not, by site and gender

	Niakhar				Bandafassi				Caio			
	Mobile		Non-mobile		Mobile		Non-mobile		Mobile		Non-mobile	
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	aOR ^a	aOR ^a
Men												
No. of respondents	132	20.5 (25)	23.1 (53)	272	—	245	17.1 (33)	194	188	352	—	—
Casual partner (s) ^b	0	0	0	0	—	2.9 (7)	0	—	7.9 (14)	19.8 (54)	8.5 (23)	—
Sexual contact with commercial sex worker (s) ^b	2.5 (2)	5.2 (7)	—	—	5.0 (8)	7.8 (9)	—	—	26.3 (21)	14.3 (17)	—	—
Non-spousal partners (married men) ^b	17.7 (3)	22.2 (6)	—	—	6.9 (2)	7.7 (2)	—	—	25.9 (28)	8.2 (19)	2.8 (1.4–5.5)***	—
≥1 partner ^b	4.4 (3)	2.6 (3)	—	—	20.9 (149)	11.1 (8)	3.3 (1.1–9.6)***	—	34.0 (36)	23.1 (28)	—	—
Women												
No. of respondents	132	11.1 (14)	2.3 (7)	330	8.3 (2.6–27.0)***	180	5.5 (18)	331	138	441	—	—
Casual partner (s) ^b	7.5 (9)	2.8 (8)	—	—	—	8.9 (16)	6.8 (10)	5.5 (18)	—	5.3 (7)	1.0 (4)	5.7 (1.5–21.5)***
Non-spousal partners (married women) ^b	25.0 (1)	10.0 (1)	—	—	—	6.6 (19)	14.3 (1)	6.6 (19)	—	3.0 (3)	1.4 (5)	—
≥1 partner ^b	13.5 (13)	3.8 (8)	—	—	5.3 (1.7–16.7)***	8.8 (8)	14.3 (1)	6.4 (9)	—	0	0	—
Reported condom use in the last 4 weeks ^b	—	—	—	—	—	—	—	—	15.0 (6)	10.7 (15)	—	—

^a Adjusted odds ratio. Potential confounders included age, matrimonial status, educational level, access to radio and TV, religion, and ethnic group. They were included only when statistically significant.

^b In the past 12 months.

*** P ≤ 0.05, ** P ≤ 0.10.

comes from the findings among women: both residence in the central area and a casual partner in a city during the past year were independently associated with an increased risk of HIV infection. This result suggests that mobility alone cannot explain the HIV prevalence observed in Caio.²³

Surveillance of HIV prevalence in Ziguinchor, Senegal, during the late 1980s found that prostitutes from Guinea-Bissau were more likely to be infected with HIV-2 than those from elsewhere.²⁴ Further observation indicated that many of the prostitutes working in Bissau and Ziguinchor came from Caio. This led the Medical Research Council to conduct a study in 1989–1991 to investigate the epidemiology of HIV in the area in 1989–1991.^{16,23} No woman in our survey reported working as a prostitute while outside the village. On the other hand, the question was not specifically asked: rather, we asked the reasons for short- and long-term absences. In an in-depth qualitative study in Caio, no women reported commercial sex work either (Enel C, *personnal communication*), but the sample was small (25 women). The strong association between casual sex in a city and HIV infection may reflect commercial sex work by some women.

Despite the predictive role of short-term mobility in the 4 weeks before the survey, identified in multivariate risk factor analyses, this mobility should not be misinterpreted as a genuine exposure variable: the interview was conducted shortly or immediately after the serological survey. The variable is used as an index of mobility habits. Another concern is the reliability of self-reported data on behaviours related to AIDS and sexuality. A reliability survey we carried out in another rural area of Senegal showed that the same interview procedure (questionnaires filled out by local interviewers) provided very reliable data on sexual behaviour in married couples.²⁵

Participants were consistently older than those who were not interviewed, at all three sites. The principal reason for non-participation was that the pre-selected sample members were not at home on any of the repeated occasions that the interviewer tried to contact them. Non-participation is therefore associated with mobility and could lead to selection bias. We do not see, however, how this selection bias could differ significantly from one site to another. We therefore think that even if it is likely that mobility was underestimated in our study, the comparison of population characteristics between sites remains valid. Because those who are most mobile are also probably at the greatest risk of HIV infection, it is likely that both the overall HIV prevalence and the magnitude of the association between the risk of HIV infection and mobility have been underestimated in our study. The very large age difference between participants and non-participants in Caio is explained by the fact that permanent migration is very common in this area. Many adults >30 years were reported by their family to be part of the population, although they had been living elsewhere for a long time.

The study areas had a relatively low level of HIV infection compared with southern and eastern Africa. The prevalence level in Caio, however, is similar to that in the capital city, Bissau.²⁶ It is also consistent with the findings of an earlier (1989–1991) study in the same area,¹⁶ with an increase from

0.1% of adults infected with HIV-1 in 1990 to 1.5% now. This augmentation confirms the trend found in the nearby region of Ziguinchor, Senegal, where the prevalence of HIV-1 has risen while that of HIV-2 remains stable.^{27,28}

Mobility appeared to be a key factor in the spread of HIV spread in rural areas of West Africa, not only because population movements enable the virus to disseminate but also because of the particularly risky behaviour of those who are mobile. More prevention efforts should be directed at migrants from rural areas who travel to cities with substantial levels of HIV infection.

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KEY MESSAGE

- We studied the epidemiology of the spread of human immunodeficiency virus (HIV) in three rural areas of West Africa. Mobility appeared to be a key feature of the spread of HIV throughout rural areas. The ubiquity of mobility means that it cannot explain why HIV prevalence is high in some regions and low in others, but it is a clear risk factor when HIV infection reaches substantial levels. This is probably related to the particular risky behaviour of travellers, presumably at their destinations.

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