Stable antenatal HIV-1 seroprevalence with high population mobility and marked seroprevalence variation among sentinel sites within Nairobi, Kenya

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Objectives: To monitor and analyse trends in HIV-1 seroprevalence among antenatal women in Nairobi, Kenya.

Design: Six sequential surveys were carried out among antenatal clinic attenders at four Nairobi City Council health centres between November 1991 and April 1997.

Methods: A total of 6828 women attending for first antenatal clinic visit were administered a standard questionnaire to obtain demographic information and were screened for HIV-1.

Results: HIV-1 seroprevalence rose from 12.1% in the first survey to 16.2% in the third, completed in October 1993. No rise was observed in subsequent surveys, and seroprevalence among women under the age of 20 declined after the third survey. Significant differences in seroprevalence ($P < 0.001$) were observed in all survey rounds between women who reported that their province of origin was Nyanza (22.4% overall), compared with those from other provinces in western Kenya (14.1%), and the eastern group of provinces (8.9%). The rise in HIV-1 seroprevalence observed between 1991 and 1993 was almost entirely attributable to the rising seroprevalence among women from Nyanza. There were considerable differences in HIV-1 seroprevalence among the four health centres, partly accounted for by differences in the proportion of clinic attenders from different provinces of origin, which also changed significantly over time.

Conclusions: HIV-1 seroprevalence has stabilized in antenatal women attending these health centres in Nairobi, and may be declining among women in the youngest age group. This may reflect stabilization of HIV-1 incidence, but further observation is required. The levels of infection among Nairobi residents reflect the evolution of the HIV epidemic in their provinces of origin, and changing client composition influences HIV-1 seroprevalence at different clinics. HIV sentinel surveillance should be carried out at multiple sites in large urban centres to monitor accurately the evolution of the HIV epidemic and the impact of control efforts in reducing transmission.

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Introduction

HIV-1 seroprevalence has been recorded among women attending antenatal clinics in eastern and southern Africa for over a decade, with levels increasing in recent years to 30% or more in many urban centres [1–6]. Pregnant women are valuable as a sentinel group because they are sexually active, attend health facilities for reasons other than illness, and come from different social groups within society. Recent data from Uganda and other countries in eastern and southern Africa have, however, shown that HIV seroprevalence among pregnant women may significantly underestimate the true seroprevalence in women, because of decreased fertility associated with HIV infection [7–9]. This bias increases with age and the duration of infection, and it has therefore been suggested that it will increase as the HIV epidemic matures [7]. Monitoring the true course of the HIV epidemic under these circumstances will become increasingly problematical.

Some countries in the region may be reaching an endemic phase of the epidemic, as evidenced for example by a community-based study from Uganda, which suggested that HIV seroprevalence has begun to stabilize [10]. Community HIV seroprevalence in this endemic phase of the epidemic will be sustained by young people commencing sexual activity entering the susceptible population pool, and it is anticipated that peak HIV incidence will be concentrated in the younger age groups [11]. In Malawi, for example, antenatal women under 20 years of age have the highest age-specific annual HIV-1 seroincidence, at almost 6% per annum [12]. In this paper, we review the findings from an antenatal clinic HIV sentinel surveillance program in Nairobi, Kenya, and seek to contribute to the examination of strategies for monitoring the HIV-1 epidemic in eastern and southern Africa.

Materials and methods

To monitor the impact on the HIV-1 epidemic of an intervention programme consisting of strengthened sexually transmitted disease control services and focused peer-mediated education programmes among high-risk groups, a sentinel surveillance programme among women attending antenatal clinics in Nairobi was established. Pregnant women were screened for HIV-1 in four geographically distinct Nairobi City Council health centre antenatal clinics located in lower socioeconomic areas of the city, between November 1991 and April 1997. Women received HIV pre-test counselling from a trained nurse, and verbal consent to participate in the study was obtained. Six survey rounds, each involving all four clinics, were completed, and in rounds two to six, the first five antenatal women presenting to a clinic each day were recruited. Each clinic was re-visited daily until approximately 250–300 women were recruited, which generally took 2–3 months. The four clinics were visited in sequence, and when a given survey round was completed, the next began. The first survey round was conducted somewhat differently from the others, in that four nurses were involved in enrolment, and essentially all antenatal women presenting to a given clinic each day were recruited. It was completed therefore in a much shorter time period. Over 95% of women identified agreed to participate. A standardized questionnaire was administered and a 10 ml sample of blood was drawn and transported to the laboratory at the Department of Medical Microbiology of the University of Nairobi. Samples were tested using a standard enzyme immunoassay (EIA) technology (Behring Werke, Marburg, Germany). Positive samples were confirmed for HIV-1 using a recombinant EIA system (Recombigen, Cambridge Biotech Corporation, Worcester, MA, USA). Results were conveyed to the women with post-test counselling at a follow-up visit 1 week later. The study was approved by the ethical review committee of the Kenyatta National Hospital in Nairobi. Statistical analysis was undertaken using SPSS for Windows, version 8.0.

Results

Table 1 shows HIV-1 seroprevalence rates among the 6828 women who were screened, stratified by the province of origin, marital status, health centre attended and survey round. HIV-1 seroprevalence ratios for categories within each stratum are also shown, compared with a reference category. Approximately one-third of the women reported that their province of origin was Nyanza province, in the extreme west of the country, and about one-quarter came from Western or Rift Valley provinces, two neighbouring provinces in western and central-west Kenya (Fig. 1). HIV-1 seroprevalence was significantly higher in women from Nyanza than in the other provinces (22.4%, 95% confidence interval (CI) 20.9–23.9), and women from Western and Rift Valley provinces were more likely to be HIV-1 infected (14.1%, 95% CI 12.7–15.5) than women from Central, Eastern, Northeastern, Coast and Nairobi provinces (8.9%, 95% CI 8.3–9.5), $P < 0.001$. Because of this heterogeneity in HIV-1 seroprevalence, provinces were stratified into three groups for subsequent analysis: Nyanza province, the western group of provinces (Western and Rift Valley provinces), and the eastern group of provinces (the remainder).

The mean age of HIV-seropositive women was 22.5 years, which was not significantly different from

Table 1. HIV-1 seroprevalence among antenatal women attending four Nairobi City Council health centres between November 1991 and April 1997, stratified by province of origin, marital status, health centre attended and survey round

	HIV-1 seroprevalence	HIV-1 seroprevalence ratios (95% CI), compared with reference category	*P* value (chi-square test for trend)
Province of origin			< 0.001
Northeastern	7.3% (10/137)	1	
Coast	8.2% (5/61)	1.12 (0.40–3.14)	
Central	9.0% (162/1810)	1.23 (0.66–2.27)	
Eastern	9.1% (68/748)	1.25 (0.66–2.36)	
Nairobi	9.6% (9/94)	1.31 (0.55–3.10)	
Western	13.9% (207/1485)	1.91 (1.04–3.52)	
Rift Valley	15.5% (34/219)	2.13 (1.09–4.17)	
Nyanza	22.4% (509/2274)	3.07 (1.68–5.59)	
Marital status			0.13
Married	14.6% (857/5885)	1	
Single	15.0% (132/882)	1.03 (0.87–1.22)	
Divorced	16.3% (8/49)	1.12 (0.59–2.12)	
Widowed	54.5% (6/11)	3.75 (2.17–6.45)	
City Council Clinic			< 0.001
Health Centre C	9.3% (175/1882)	1	
Health Centre B	14.9% (240/1613)	1.60 (1.33–1.92)	
Health Centre D	15.8% (248/1570)	1.70 (1.42–2.04)	
Health Centre A	19.3% (341/1763)	2.08 (1.75–2.47)	
Survey round			0.005
1. Nov 1991–Feb 1992	12.1% (122/1005)	1	
2. Mar 1992–Sept 1992	12.9% (136/1055)	1.06 (0.84–1.34)	
3. Oct 1992–Oct 1993	16.2% (179/1102)	1.34 (1.08–1.66)	
4. Nov 1993–Nov 1994	14.8% (185/1247)	1.22 (0.99–1.51)	
5. Dec 1994–Mar 1996	15.7% (188/1201)	1.29 (1.04–1.59)	
6. May 1996–Apr 1997	15.9% (194/1218)	1.31 (1.06–1.62)	
Total	14.7% (1004/6828)		

the mean age of the HIV-seronegative women (22.0 years). Over 85% of women were married. HIV-1 seroprevalence at different clinics varied by as much as twofold. Women attending Health Centre A had the highest seroprevalence in all survey rounds (19.3% overall, 95% CI 17.6–21.0), and those attending Health Centre C the lowest (9.3% overall, 95% CI 8.4–10.2). Women attending Health Centres D and B had intermediate seroprevalences. An upward linear trend over time in HIV-1 seroprevalence was observed from November 1991 to October 1993, after which it stabilized.

Table 2 shows time-trends in age-specific HIV-1 seroprevalence stratified by province group of origin, as well as time-trends by clinic for all ages. The higher seroprevalences in Nyanza and the western group of provinces are seen in all age groups. Although seroprevalence stabilized overall after the third survey round (completed at the end of 1993), seroprevalence among the youngest age group (19 years of age and under) declined from that point on. The decline between the third and sixth survey rounds was statistically significant ($P = 0.04$, chi-square test for trend). As can be seen in the HIV-1 seroprevalence data for all ages, women from Nyanza almost exclusively accounted for the rise in HIV-1 seroprevalence observed over the first three survey rounds; seroprevalence among women from the other province groups was essentially stable over the entire period. Health

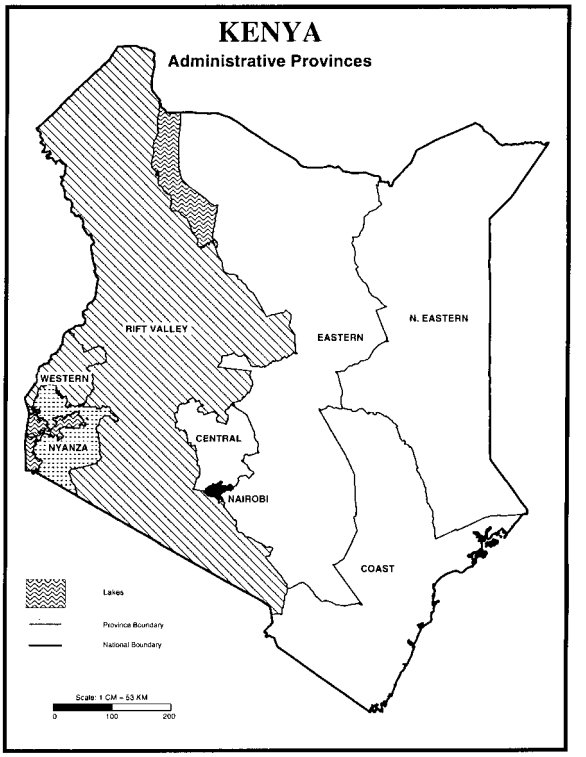

Fig. 1. Map of Kenya showing administrative provinces. For purposes of analysis in this paper, provinces were grouped into: Nyanza province; western group of provinces (Western and Rift Valley provinces); and eastern group of provinces (Central, Eastern, Northeastern, Coast and Nairobi provinces).

Table 2. Time trends in age-specific HIV-1 seroprevalence among antenatal women attending four Nairobi City Council health centres between November 1991 and April 1997, stratified by province group of origin, and time trends by health centre for all ages

	Survey round						
	Nov 1991–Feb 1992	Mar 1992–Sept 1992	Oct 1992–Oct 1993	Nov 1993–Nov 1994	Dec 1994–Mar 1996	May 1996–April 1997	Total
Age ≤ 19	9.9% (19/191)	14.3% (33/230)	18.1% (42/232)	16.0% (45/282)	11.9% (29/244)	12.5% (37/295)	13.9% (205/1474)
Eastern	6.9% (5/72)	5.1% (5/99)	10.7% (9/84)	10.6% (11/104)	2.6% (2/77)	1.1% (1/91)	6.3% (33/527)
Western	15.8% (9/57)	24.5% (12/49)	15.4% (8/52)	12.5% (9/72)	9.3% (5/54)	11.9% (10/84)	14.4% (53/368)
Nyanza	8.1% (5/62)	19.5% (16/82)	26.0% (25/96)	23.6% (25/106)	19.5% (22/113)	21.7% (26/120)	20.6% (119/579)
Age 20–24	11.9% (57/478)	12.9% (63/489)	17.2% (86/499)	13.9% (79/569)	17.7% (93/526)	16.2% (85/524)	15.0% (463/3085)
Eastern	7.2% (16/223)	7.8% (16/206)	10.8% (23/212)	9.0% (23/256)	8.0% (17/212)	10.5% (23/220)	8.9% (118/1329)
Western	14.6% (20/137)	12.7% (16/126)	15.6% (17/109)	12.4% (15/121)	13.2% (17/129)	15.3% (22/144)	14.0% (107/766)
Nyanza	17.8% (21/118)	19.7% (31/157)	25.8% (46/178)	21.4% (41/192)	31.9% (59/185)	25.0% (40/160)	24.0% (238/990)
Age 25–29	15.4% (40/259)	12.8% (31/243)	14.4% (40/278)	16.4% (47/286)	14.6% (44/302)	18.9% (56/296)	15.5% (258/1664)
Eastern	13.9% (16/115)	9.8% (10/102)	8.9% (10/112)	7.5% (10/134)	9.3% (11/118)	14.8% (22/149)	10.8% (79/730)
Western	11.4% (9/79)	7.3% (4/55)	10.7% (6/56)	17.5% (10/57)	20.8% (20/96)	16.4% (12/73)	14.7% (61/416)
Nyanza	23.1% (15/65)	19.8% (17/86)	21.8% (24/110)	28.4% (27/95)	14.8% (13/88)	29.7% (22/74)	22.8% (118/518)
Age ≥ 30	7.8% (6/77)	9.7% (9/93)	11.8% (11/93)	12.7% (14/110)	17.1% (22/129)	15.5% (16/103)	12.9% (78/605)
Eastern	0% (0/17)	10.5% (4/38)	8.3% (4/48)	8.2% (4/49)	9.1% (5/55)	16.3% (7/43)	9.1% (24/264)
Western	11.1% (3/27)	4.8% (1/21)	13.0% (3/23)	11.8% (2/17)	20.0% (8/40)	11.5% (3/26)	13.0% (20/154)
Nyanza	15.8% (3/19)	11.8% (4/34)	18.2% (4/22)	18.2% (8/44)	26.5% (9/34)	17.6% (6/34)	18.2% (34/187)
All ages	12.1% (122/1005)	12.9% (136/1055)	16.2% (179/1102)	14.8% (185/1247)	15.7% (188/1201)	15.9% (194/1218)	14.7% (1004/6828)
Eastern	8.4% (37/441)	7.9% (35/445)	10.1% (46/456)	8.8% (48/543)	7.6% (35/462)	10.5% (53/503)	8.9% (254/2850)
Western	13.7% (41/300)	13.1% (33/251)	14.2% (34/240)	13.5% (36/267)	15.7% (50/319)	14.4% (47/327)	14.1% (241/1704)
Nyanza	16.7% (44/264)	18.9% (68/359)	24.4% (99/406)	23.1% (101/437)	24.5% (103/420)	24.2% (94/388)	22.4% (509/2274)
Health centre							
C	8.3% (25/300)	8.5% (28/330)	9.8% (30/307)	8.4% (29/345)	10.5% (31/295)	10.5% (32/305)	9.3% (175/1882)
B	13.3% (36/270)	13.8% (29/210)	16.3% (40/245)	12.5% (35/281)	18.2% (56/307)	14.7% (44/300)	14.9% (240/1613)
D	8.9% (17/191)	13.2% (25/190)	17.0% (43/253)	18.0% (59/328)	15.6% (46/295)	18.5% (58/313)	15.8% (248/1570)
A	18.0% (44/244)	16.6% (54/325)	22.2% (66/297)	21.2% (62/293)	18.1% (55/304)	20.0% (60/300)	19.3% (341/1763)

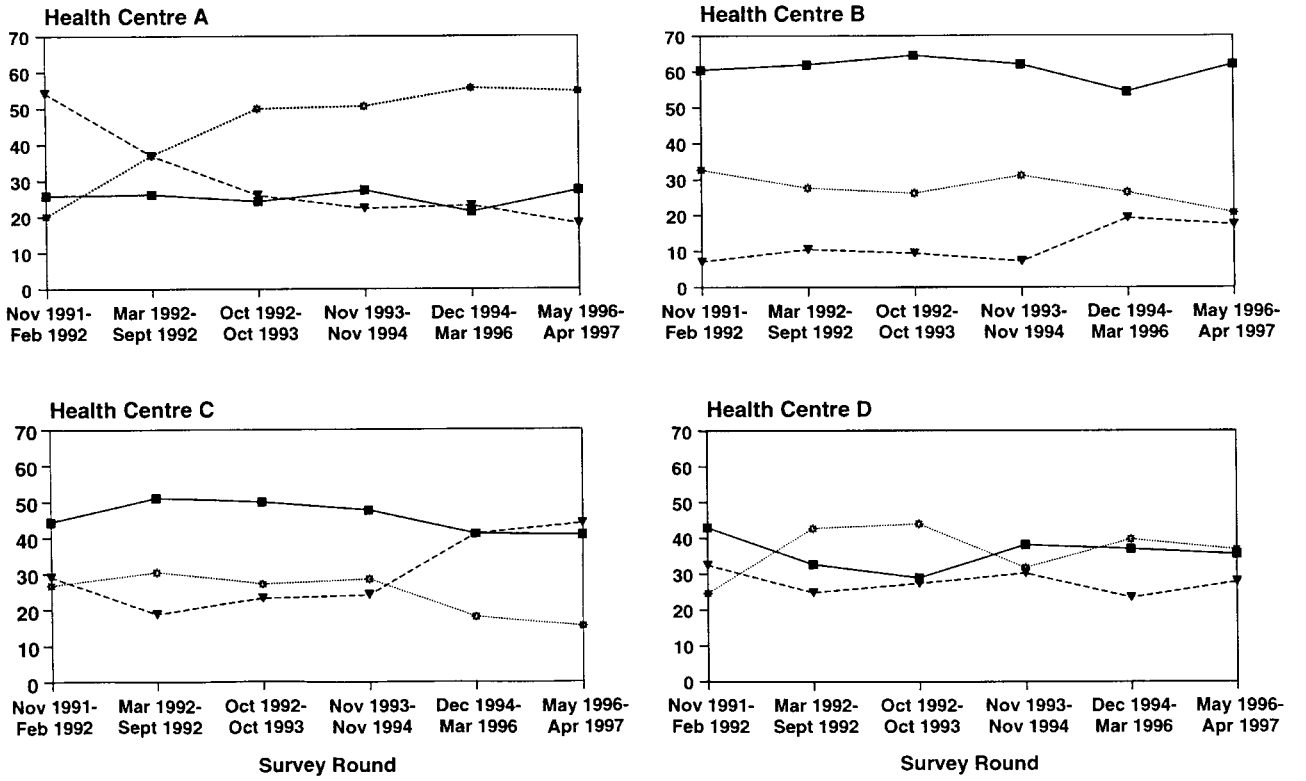

Fig. 2. Percentage of antenatal women screened for HIV-1 in each survey round and clinic, by province group of origin. —■—, Eastern; —▼—, Western; —❦—, Nyanza.

Centre D was the only individual clinic that showed a significant change in HIV-1 seroprevalence over the entire period, with an increase from 8.9 to 18.5% ($P = 0.008$, chi-square test for trend). Seroprevalence also rose among women attending Health Centre A, but the increase was not statistically significant.

Figure 2 shows the proportion of women screened in each survey round by province group of origin, for each clinic. Declines were observed in the proportion of women from Nyanza attending Health Centres B and C (33–21%, $P = 0.006$ and 27–15%, $P < 0.001$, respectively). The percentage of women from Nyanza attending Health Centre A rose from 20 to 55% ($P < 0.001$). An increase from 25 to 37% for Health Centre D was not statistically significant.

A multiple logistic regression model was constructed to assess further the temporal and geographical correlates of HIV infection. Age, marital status, province group of origin, clinic attended and survey round were the variables included in the model. The significant predictors of HIV infection were the clinic attended (adjusted odds ratio (OR) 1.19, 95% CI 1.12–1.26, $P < 0.001$), province group (adjusted OR 1.64, 95% CI 1.51–1.78, $P < 0.001$) and survey round (adjusted OR 1.05, 95% CI 1.01–1.10, $P = 0.02$).

Discussion

HIV-1 seroprevalence overall was almost 15% in this 'low-risk' group of pregnant women, over 85% of whom reported that they were married. There were significant variations in HIV-1 seroprevalence by the clinic attended and by the province of origin. Differences by province of origin were consistent with those found in unlinked, anonymous testing performed by the Kenyan National Sentinel Surveillance Survey of 1995, which reported HIV-1 seroprevalences in pregnant women of 27% in Kisumu (Nyanza province), 22% in Busia (Western province), and 13% in Mombasa (Coast province) [13]. The overall increase observed in HIV seroprevalence between 1991 and 1993 was largely due to increased seroprevalence among women from Nyanza province; seroprevalence among women from other provinces was essentially stable. Since 1993, HIV-1 seroprevalence has remained relatively unchanged, and may be declining in the youngest age group. This is consistent with a recent report of stabilizing or even declining HIV seroprevalence among antenatal women in urban settings in Uganda [14], and may reflect a reduction in the rate of increase of HIV-1 transmission. This is supported by observed declines in sexual risk behaviour among the same antenatal women in Nairobi over the period of study [15].

There were also major differences over time in the province of origin of women attending the different clinics. This change in the make-up of the clientele could reflect migration from outside Nairobi into the area, migration within Nairobi, or changes in the patterns of use of clinics. It is noteworthy that less than 2% of women gave their province of origin as Nairobi. The likely explanation for this is that whereas people may have lived in Nairobi for many years, they still perceive themselves as part of a family group that lives in the ethnic home province. In a fertility and family planning study in two rural areas in Western and Eastern provinces, Ferguson [16] observed that pregnant women from rural areas with husbands working in Nairobi often move there during pregnancy to join their husbands and to obtain antenatal care. That study also found regional differences in male migration, with 59% of men from Western province living away from home compared with 21% from Eastern province. Differences in patterns of movement may be associated with important differences in male sexual risk behaviour, such as use of commercial sex. A prospective study in an adult male workplace population from the coastal city of Mombasa [17] found that married men who reported being away from their wives in the 3 months before a follow-up visit were almost five times more likely to acquire a symptomatic sexually transmitted disease (STD).

Differences in the province of origin partly explain the differences in HIV-1 seroprevalence among the four health centres. It has been noted that fertility levels vary widely in different localities in Nairobi, localities with the highest fertility being those occupied largely by ethnic groups from rural areas with the highest fertility [18]. This was interpreted as suggesting that the cultural practices of the ethnic groups that migrate to Nairobi remain the same, perpetuating the customs that led to the differential fertility rates. It may be that this logic also applies to sexual network patterns, contributing to differences in HIV-1 seroprevalence. The clinic attended was also, however, a significant predictor of HIV-1 infection in the multivariate model, suggesting that there are also local elements of sexual behaviour and networking that are important, independent of ethnic group.

Hunter and colleagues [19,20] have reported that the lack of circumcision in the husband is associated with increased HIV-1 seroprevalence among pregnant women in Nairobi [19] and with increased seroincidence in pregnant women in Dar es Salaam [20]. The main ethnic group that does not practice male circumcision in Kenya comes principally from Nyanza province. The association in general between the lack of male circumcision and the risk of HIV infection has been reviewed previously [21]. It is not possible in the current study, however, to disentangle the effects of an increased biological risk of HIV-1 acquisition from the behavioural factors that increase transmission risk. The absence of information on the circumcision status and migration patterns of the study women's regular male partners is a limitation of the study. Another limitation is that we do not have information on the length of residence in Nairobi, which precludes any detailed assessment of the importance of local influences.

Gregson and colleagues [11] have suggested methods of using age-specific HIV prevalence data to measure HIV incidence in stable endemic conditions. They note that very young women who attend for antenatal care may be at a higher risk of HIV infection. The finding of declining HIV-1 seroprevalence in recent years among antenatal women aged 19 and under is encouraging, but caution should be exercised in interpreting falls in HIV seroprevalence as falls in incidence, even in young people, because apparent declines may at least in part be accounted for by mortality, migration and higher absenteeism among HIV-positive individuals [22].

It may be appropriate in HIV surveillance programmes to focus on sampling younger women, the age of highest seroincidence, because this will potentially provide the most sensitive monitor of change and intervention impact. In this study, screening only 18–21-year-olds would have included approximately one-third of the total. Such selective sampling may require working for a longer period of time in more sites in order to achieve an adequate sample size. One way to reduce costs would be to use finger-prick testing with dried blood spot technology. This has been successfully used for HIV-1 and HIV-2 screening in West Africa, with testing carried out over 1 month after specimen collection, the sample having been refrigerated at 4°C [23]. The materials required for the collection of each sample cost under 2 US cents.

This study demonstrates that HIV sero-surveillance may be greatly affected by changes in the composition of the populations surveyed. Changes in the population of women attending antenatal clinics can seriously confound the assessment of trends in HIV seroprevalence over time. Migration from the western provinces has contributed to the growth of Nairobi [24], and there is every prospect that such migration will continue to bring to the city many people vulnerable to HIV infection. Local influences may affect trends, and large differences in HIV seroprevalence may be present within the same city, as has also been observed in Addis Ababa [25]. Caution should therefore be exercised in the interpretation of results of sentinel surveillance data. It is important to collect at least minimal information on age, origin and other socio-demographic characteristics in order to assess bias arising from changing populations. The majority of data used to estimate the burden of HIV in Africa are drawn from antenatal surveillance

[7], underscoring the importance of appropriate surveillance methods and interpretation to monitor accurately the evolution of the HIV epidemic and the impact of control efforts in reducing transmission.

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