Factors influencing the difference in HIV prevalence between antenatal clinic and general population in sub-Saharan Africa

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Objective: To compare HIV prevalence in antenatal clinics (ANC) and the general population, and to identify factors determining the differences that were found.

Design: Cross-sectional surveys in the general population and in ANC in three cities.

Methods: HIV prevalence measured in adults in the community was compared with that measured by sentinel surveillance in ANC in Yaoundé, Cameroon, Kisumu, Kenya, and Ndola, Zambia.

Results: In Yaoundé and Ndola, the HIV prevalence in ANC attenders was lower than that in women in the population overall, and for age groups over 20 years. In Kisumu, the HIV prevalence in ANC attenders was similar to that in women in the population at all ages. The only factors identified that influenced the results were age, marital status, parity, schooling, and contraceptive use. The HIV prevalence in women in ANC was similar to that in the combined male and female population aged 15–40 years in Yaoundé and Ndola, but overestimated it in Kisumu. In Yaoundé and Ndola, the overall HIV prevalence in men was approximated by using the age of the father of the child reported by ANC attenders, but this method overestimated the HIV prevalence in Kisumu, and did not give good age-specific estimates.

Conclusion: Few factors influenced the difference in HIV prevalence between ANC and the population, which could aid the development of adjustment procedures to estimate population HIV prevalence. However, the differences between cities were considerable, making standard adjustments difficult. The method of estimating male HIV prevalence should be tested in other sites.

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Introduction

Accurate surveillance of HIV is essential for monitoring the epidemic, measuring trends, predicting the burden of disease, and assessing the impact of interventions. The most widely used measure of general population HIV seroprevalence is sentinel surveillance among antenatal clinic (ANC) attenders.

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There are several potential biases in inferring general population HIV prevalence from findings among ANC attenders [1,2]. Not all pregnant women attend ANC, and attendance is likely to vary by age, locality, socio-economic status, education level, parity, ethnic group and religion, factors that are also likely to be associated with HIV status [3]. ANC only see sexually active women, those not (consistently) using contraceptives, and those who are fertile. HIV infection may reduce fertility directly, or indirectly through association with other sexually transmitted diseases, and for social as well as biological reasons. For example, widows may have a high prevalence of HIV, and in some settings infertile women may be at higher risk of acquiring HIV [4]. Several studies have reported lower fertility rates among HIV-positive women [5,6].

The relative importance of the different biases will vary in different populations and over time. Several previous studies in sub-Saharan Africa have compared HIV prevalence in ANC attenders and the general population. In five sites in Tanzania, Uganda and Zambia, the overall HIV prevalence in ANC has been found to be 10–30% lower than that in women in the population [7–11]. A study in Addis Ababa found higher HIV prevalence in ANC than in the population, but it was measured 2 years later [12]. Biases in the under 20s may be different, and this group is important for estimating HIV incidence. The HIV prevalence in teenagers in ANC was higher than that in women of the same age in the population in two areas of Zambia [11], and similar to that in women in the population in a study in Uganda [10].

Although subject to bias, ANC-based sentinel surveillance forms the basis for national estimates of HIV prevalence in many places [13]. To establish what biases are important and what factors should be recorded in order to improve estimates of general population HIV prevalence requires a comparison of ANC and population data in several sites. We had the opportunity to link a study in ANC to a multicentre population-based study. We also tested a novel method of estimating male HIV prevalence from ANC data, by asking women the age of the father of the child.

Methods

The Multicentre Study on Factors Determining Differences in HIV Spread between African Cities conducted general population surveys in 1997–1998 in Kisumu (Kenya), Ndola (Zambia), Yaoundé (Cameroon) and Cotonou (Benin) [14]. In each city, households were selected by two-stage cluster sampling based on census lists, aiming for a sample size of 1000 men and 1000 women at each site. Within selected households, all individuals aged 15–49 years who had slept in the house the previous night were eligible for inclusion. If consent was given, individuals were interviewed and blood was taken for testing for HIV, syphilis and other sexually transmitted diseases (STD). Treatable STD were treated. HIV testing was performed anonymously, using an enzyme-linked immunosorbent assay (ELISA), with confirmation of positive samples using a rapid test or second ELISA. Discrepant samples were tested by Western blot or two further tests. Individuals who wanted to know their HIV status could be re-tested free of charge, with full counselling.

In Yaoundé, Kisumu and Ndola, data on HIV prevalence in women attending ANC in late 1998 were collected, following existing sentinel surveillance procedures as closely as possible. During routine surveillance, women attending ANC for the first time in that pregnancy are asked a few questions on sociodemographic characteristics. Blood is taken to screen for syphilis and treatment is provided if necessary. The blood remaining from syphilis testing is tested for HIV, and the results are later linked with anonymized personal information and are not available to the study subjects or interviewers.

The ANC included in the study were chosen from among the larger clinics in which routine screening for syphilis is conducted, to give a reasonable geographical spread over each city. In Yaoundé, six ANC were used, chosen from 10 where on-site syphilis screening is conducted. Antenatal care is also available at a number of small health centres and private clinics. In Kisumu, two ANC were used, which cover at least 80% of women attending ANC in the city. In Ndola, five ANC were used, thus including approximately 40% of women seen in ANC in the area included in the population survey.

More questions were asked than in routine surveillance, and larger numbers of women were interviewed. In Yaoundé and Kisumu, we aimed to interview 1500 women. In Ndola, data were collected for 3 months on women of all ages, and were then restricted to women aged 15–19 years, to increase the sample size for this age group. For all analyses except those in which the 15–19 age-group is considered separately, only the first 3 months of data have been used.

Serological tests for syphilis followed the current practice of the local laboratory. HIV testing used an ELISA, and positive sera were confirmed using a rapid test. External quality control testing of a sample of positive and negative specimens was carried out for each laboratory at the Institute of Tropical Medicine in Antwerp, Belgium. Patient names were not recorded on the questionnaire or entered on the database. HIV

data were entered on separate databases allowing later linkage using identity numbers.

Analyses

Analyses compared the prevalence of HIV in ANC and the general population at each site, and determined what factors influenced the validity of ANC HIV prevalence results as estimates of HIV status of the general population. In both the population survey and ANC information was available on: age; schooling; ethnic group; religion; occupation (homemaker, sales/office workers, professionals, students, manual workers/others); time in the city; age at first sex; marital status; type of marriage (customary, civil/religious, consensual); age at first marriage; time since first marriage; interval between sex and marriage; rapid plasma reagin (RPR) status.

In ANC, detailed fertility questions were asked, but in the population survey the only fertility question was to married women asking about children in that marriage. The influence of parity has thus been analysed only among currently married individuals; however, the questionnaire in ANC did not distinguish previous children within the current marriage from other children, and women in the population may not have mentioned children who had died. In the general population, women were asked about current contraceptive use. ANC attenders were asked about contraceptive use since they last gave birth, if multiparous, or ever, if primiparous. Modern contraceptive use has been defined as the use of the pill, intrauterine device, injections, diaphragms, foam or jelly, or condoms.

Factors that were both differently distributed between ANC attenders and the general population and were associated with HIV status are likely to influence the HIV results obtained from ANC surveillance compared with those in women in the population. All available factors were examined to see if they confounded the relationship between ANC attendance and HIV, using logistic regression. Analyses were repeated excluding women who were current modern contraceptives users, with and without also excluding those from ANC who had used modern contraceptives before the current pregnancy. As the focus of the analysis was on identifying factors as confounders the cluster design of the surveys was ignored.

To estimate male HIV prevalence, information on age of the father of the child reported by ANC attenders was used. It was assumed that these men had the HIV status of the female respondent in ANC. These data were directly standardized to the age distribution of men seen in the population survey, using 5 year age groups, to allow comparison with HIV prevalence in men measured in the population survey.

Ethical approval

Ethical approval was received from the appropriate ethical committees in Cameroon, Kenya and Zambia, and from the Institute of Tropical Medicine, Antwerp, Belgium, and the London School of Hygiene and Tropical Medicine, London, UK.

Results

In Yaoundé, 1532 women were interviewed in ANC, aged 12–41 years (age missing for one). HIV status was available for all women. The HIV prevalence varied between clinics: 4.0, 4.4, 4.8, 8.9, 10.0 and 10.2% ($P = 0.009$). The two clinics with 4.0 and 4.8% HIV prevalence accounted for 70% of the women seen. The increased risk in three of the clinics compared with the others remained after adjusting for the available risk factors.

In Kisumu, the age range in ANC was 13–45 years (missing for 18). A total of 1495 women were interviewed, although HIV status was missing or inconclusive for 15. HIV prevalence was 30.6% and was very similar in the two clinics. In Ndola, 1514 women were interviewed in ANC, including the oversampling of teenagers. The age range was 12–47 years (missing for four). HIV status was missing for three women. Four of the clinics gave similar HIV prevalences (27.3–31.7%), with a lower HIV prevalence (17.7%) in one of the smaller clinics ($P = 0.09$). As in Yaoundé, the difference in HIV prevalence between the clinics was not explained by adjusting for the factors measured in the study.

In the general population surveys, of the selected households, at least one adult was interviewed in 75% in Yaoundé, 89% in Kisumu and 88% in Ndola. Of the women identified as eligible in these households in the three sites (Yaoundé, Kisumu and Ndola), respectively, 86, 89 and 89% were interviewed, and 78, 75 and 81% were both interviewed and gave blood for HIV testing. Of eligible men, 76, 82 and 75% were interviewed, and 70, 62 and 65% were both interviewed and gave blood. The main reason for not being interviewed was not being found at home, despite repeat visits. Some of the interviewees refused blood tests, but in Kisumu and Ndola some of the men were seen during a second round of interviews in which few HIV tests were taken. There were few differences in reported sexual behaviour between those bled and those not bled, but those not bled were more likely to have received secondary or higher education.

The HIV prevalence results are shown in Table 1. Women in the general population had a higher prevalence of HIV than those seen in ANC in

Table 1. Antenatal clinic and population HIV prevalence in three cities.

	Yaoundé		Kisumu		Ndola	
	HIV + /N	HIV + % (95% CI)	HIV + /N	HIV + % (95% CI)	HIV + /N	HIV + % (95% CI)
Total women in ANC	85/1532	5.5 (4.5–6.8)	453/1480	30.6 (28.3–33.0)	279/1021	27.3 (24.6–30.2)
Total population, age 15–49 years	116/1913	6.1 (5.0–7.2)	392/1515	25.9 (23.7–28.2)	435/1534	28.4 (26.1–30.7)
Women	79/1017	7.8 (6.2–9.6)	269/893	30.1 (27.1–33.3)	290/910	31.9 (28.8–35.0)
Men	37/896	4.1 (2.9–5.6)	123/622	19.8 (16.7–23.1)	145/624	23.2 (20.0–26.8)
Age standardized[a], age 15–40 years						
ANC attenders		5.2 (4.0–6.3)		29.2 (26.2–32.2)		26.0 (23.1–29.0)
Women in population		7.7 (6.0–9.4)		31.1 (27.9–34.3)		32.7 (29.6–35.8)
Men in population		3.9 (2.6–5.2)		19.0 (15.9–22.2)		21.0 (17.9–24.0)
Total population		5.8 (4.7–6.9)		25.1 (22.9–27.3)		26.8 (24.6–29.0)

CI, Confidence interval; ANC, antenatal clinics.
[a]Directly standardized to a standard sub-Saharan African age distribution (using 5 year age groups) (World Population Prospects, 1998 revision, volume 2, sex and age. ST/ESA/SER.A/180 Department of Economic and Social Affairs, Population Division, UN, New York).

Yaoundé and Ndola, and a similar prevalence in Kisumu. As women seen in the population were over 14 years, and there were few women in ANC over 40 years, further analyses have been restricted to those aged 15–40 years. A few women were thus excluded from ANC data (three under 15 and three over 40 years in Yaoundé, all HIV negative; 12 under 15 and four over 40 years in Kisumu, one HIV positive; five under 15 and 10 over 40 year in Ndola, two HIV positive).

In Yaoundé, the HIV prevalence in ANC was higher than that in the female population up to the age of 20 years, even after excluding those who had never been sexually active (Fig. 1). Thereafter, the HIV prevalence in ANC was less than that in the female population. In Ndola, there was a slight overestimation of HIV prevalence in ANC up to the age of 18 years, but thereafter ANC HIV prevalence was lower than that in women in the population, so overall for the 15–19 year age group ANC attenders had a similar HIV prevalence to the female population. In Kisumu, the HIV prevalence in ANC attenders was very similar to that in women in the general population at all ages.

As all women in ANC are sexually active, to identify other factors influencing the difference in HIV prevalence between ANC and the general population, women in the population who denied ever having been sexually active were excluded: 90 women in Yaoundé (one HIV positive), 67 in Kisumu (eight HIV positive), and 106 in Ndola (eight HIV positive). Some of these women had evidence of other STD, suggesting that a proportion of women who denied sexual activity had in fact been sexually active.

Table 2 shows the factors that were associated with HIV among sexually active women in the general

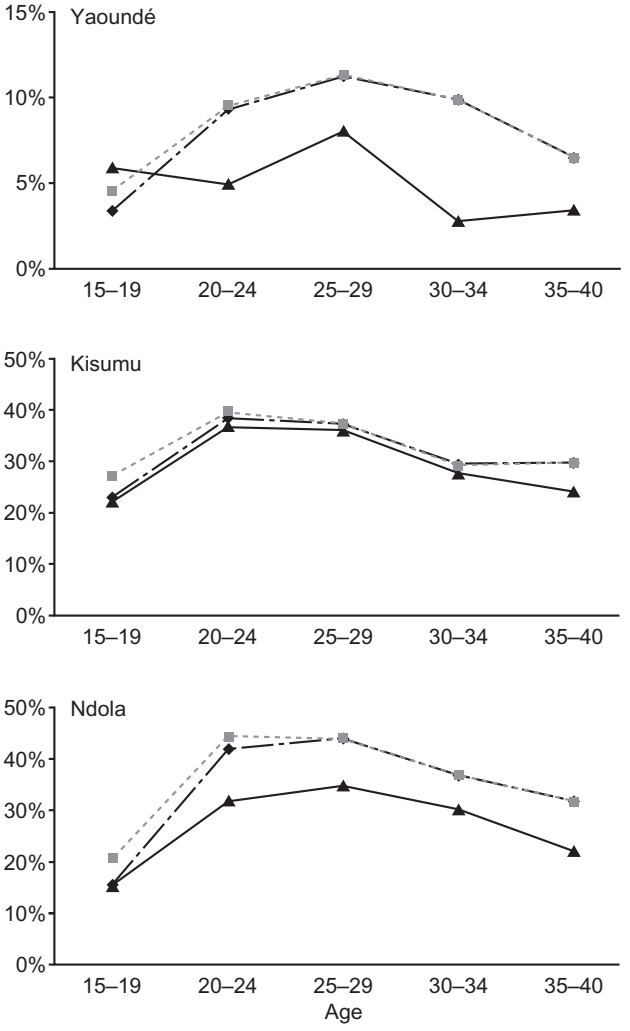

Fig. 1. HIV prevalence in women seen in the population and in antenatal clinics in three cities. –·–◆–·– General population; - - - -■- - - - sexually active; —▲— antenatal clinics.

Table 2. Factors associated with HIV prevalence in sexually active women in the general population and factors differently distributed between women in antenatal clinics and the general population.

	Factors associated with increased HIV prevalence in the population			Factors more common among women in ANC than in the population		
	Yaoundé	Kisumu	Ndola	Yaoundé	Kisumu	Ndola
Age group	20–29	20–29	20–29	Younger age	Younger age	Younger age
Schooling	Less educated	–	–	More education	More education	More education
Ethnic group	Non-Bamileke	Luo	–	–	–	–
Religion	–	–	Catholics	Protestants & catholics	Protestants & catholics	Non-catholics
Occupation	Non-students	Sales/office workers	Non-professionals	Homemakers	Homemakers	Homemakers
Marital status	Past married	Past married	Past married	Never and currently married	Never and currently married	Currently married
Time in city	–	–	–	Recent arrivals	Recent arrivals	Longer residence
Age at first sex	–	–	Earlier debut	Later debut	Later debut	Later debut
Rapid plasma reagin status	Positive	Positive	Positive	–	–	–
Modern contraceptive use	–	Non-users	–	Used	–	Used
Type of marriage	–	–	–	Customary	Customary	Customary consensual
Age at marriage	–	–	–	Older age	Older age	Older age
Time since first marriage	Shorter	–	Shorter	Shorter	Shorter	Shorter
Interval sexual debut to marriage	–	Longer[a]	Longer	–	–	Shorter
Previous child in marriage	No children	No children	No children	No children[b]	No children[b]	No children[b]

– Implies no significant differences between the groups.
[a]Due to confounding by age.
[b]There were interactions between age and previous children. Among younger women those without previous children were more likely to be seen in antenatal clinics (ANC) than those with children, and among women over 30 years those with previous children were more likely to be seen in the ANC than those without children.

population, and the factors that were differently distributed between women seen in ANC and in the population survey. In all sites, compared with women in the population, women in ANC were, on average, younger, more educated, had later sexual debuts and older ages at marriage, and were more likely to have no employment outside the home and to be currently married. Among older women, married women in ANC were more likely to have previous children than those in the population, and among younger women, those in ANC were less likely to have previous children than those in the population. In Yaoundé and Kisumu, women in ANC were more likely than those in the population to have been in the city for less than 2 years, and 21 and 29 women, respectively, gave the current pregnancy as the reason for moving. In Ndola, women in ANC were less likely than those in the population to have been recent arrivals in the city, and only one woman gave pregnancy as the reason for moving.

Age, marital status, occupation, parity and RPR status were associated with HIV prevalence in all sites. Education was only associated with HIV status in Yaoundé (with higher HIV prevalence in those with less education). Other factors with less consistent patterns are shown in Table 2.

To see which of these many factors that might influence the relationship between HIV prevalence in ANC and the population actually did so, a logistic regression analysis was conducted (Table 3). The crude overall odds ratio was below 1.0 at all sites (implying lower HIV prevalence in ANC than in the female population). Factors that 'explain' the difference in HIV prevalence between ANC and the female population will bring the odds ratio closer to 1.0. Adjusting for age made little difference. Adjusting for marital status increased the odds ratio in Kisumu and Ndola, and adjusting for education increased the odds ratio in Yaoundé. Excluding modern contraceptive users reduced the odds ratio in Kisumu (although it remained higher than in the other sites). The frequency of modern contraceptive use in the population was similar in all sites. None of the other factors (ethnic group, religion, occupation, time in the city, age at first sex, or RPR status) influenced the overall odds ratio.

The differences between HIV prevalence in ANC and in the sexually active women in the population were different in the different age groups (especially in Yaoundé) and by marital status (in Yaoundé and Ndola), although these interactions were not statistically significant at the 5% level. Among married women, there were big differences between those with and without previous children (Table 3), and this interaction was highly statistically significant at all sites ($P < 0.005$). Within each of the strata the effect of

Table 3. Comparison of HIV prevalence in sexually active women aged 15–40 years in antenatal clinics and the general population.

	Yaoundé			Kisumu			Ndola		
	Population HIV + % (n)	ANC HIV + % (n)	OR (95% CI)	Population HIV + % (n)	ANC HIV + % (n)	OR (95% CI)	Population HIV + %(n)	ANC HIV + %(n)	OR (95% CI)
Overall									
Crude	8.6 (829)	5.6 (1525)	0.63 (0.45–0.87)	33.2 (739)	30.8 (1447)	0.90 (0.74–1.1)	36.7 (730)	27.4 (1002)	0.65 (0.53–0.80)
Adjusted for age			0.60 (0.43–0.83)			0.87 (0.72–1.1)			0.66 (0.53–0.81)
Adjusted for age and marital status			0.63[a] (0.44–0.90)			0.95 (0.77–1.2)			0.77 (0.61–0.96)
No contraceptives[b]	8.8 (704)	5.6 (1525)	0.61 (0.42–0.89)	35.5 (605)	30.8 (1447)	0.85 (0.69–1.1)	37.5 (587)	27.4 (1002)	0.69 (0.55–0.88)
Age group (years)[c]									
15–19	4.5 (155)	5.9 (306)	0.84 (0.30–2.3)	27.1 (170)	22.2 (472)	0.72 (0.48–1.1)	20.7 (135)	15.4 (254)	0.66 (0.36–1.2)
20–29	10.3 (417)	6.3 (942)	0.68 (0.43–1.1)	38.4 (359)	36.4 (824)	1.0 (0.78–1.3)	44.0 (375)	32.8 (570)	0.69 (0.51–0.91)
30–40	8.2 (257)	2.9 (277)	0.41 (0.17–0.96)	29.0 (210)	26.5 (151)	1.1 (0.65–1.7)	34.1 (220)	27.5 (178)	1.1 (0.67–1.7)
Marital status[d]									
Never	7.4 (380)	7.4 (285)	1.1 (0.61–2.0)	28.8 (153)	26.0 (265)	0.91 (0.58–1.4)	27.8 (144)	28.9 (76)	1.2 (0.62–2.3)
Married	8.4 (381)	4.9 (1166)	0.46 (0.29–0.74)	30.6 (510)	31.1 (1138)	0.96 (0.76–1.2)	34.1 (469)	27.1 (908)	0.72 (0.56–0.93)
Past marriage	16.7 (66)	9.5 (74)	0.58 (0.20–1.7)	59.2 (76)	57.9 (38)	0.92 (0.40–2.1)	58.1 (117)	38.9 (18)	0.51 (0.18–1.4)
Previous child[d,e]									
No	18.4 (87)	5.2 (325)	0.25 (0.11–0.56)	42.7 (96)	26.2 (309)	0.47 (0.28–0.77)	59.1 (88)	23.2 (246)	0.26 (0.14–0.47)
Yes	5.6 (287)	4.8 (841)	0.71 (0.39–1.3)	27.9 (412)	33.1 (816)	1.2 (0.90–1.5)	28.4 (380)	28.7 (659)	0.96 (0.73–1.3)

The table shows odds ratios for the association between antenatal clinic (ANC) use and HIV. Odds ratios less than 1.0 imply lower prevalence in the ANC than in the population.
[a]Adjusting additionally for schooling increased the odds ratio (OR) in Yaoundé to 0.78 [95% confidence interval (CI) 0.51–1.2] but had no influence at the other sites. The main change was in the 20–29 years age group.
[b]Excluding current users of modern contraceptives from the population. OR adjusted for age and marital status. Additionally excluding past users of modern contraceptives from the ANC attenders gave very similar odds ratios. In Yaoundé modern contraceptives were used by 15.8% of the women in the population and 22.6% in ANC, in Kisumu they were used by 18.3% of the population and 17.7% in ANC, and in Ndola they were used by 19.6% of the population and 35.2% in ANC.
[c]OR adjusted for marital status.
[d]OR adjusted for age.
[e]Information only available for married individuals.

other potential confounders was investigated, and no further confounders were identified.

Information on the age of the father of the child was available for all except 85 women in Yaoundé, 16 in Kisumu and 15 in Ndola. The results, directly standardized to the age distribution of men seen in the population survey, were compared with the HIV prevalence in men in the population survey (Table 4). In Ndola, only 10 women reported that the father was under 20 years of age, so the confidence intervals for this group are wide. The overall HIV prevalence estimated for men aged 15–49 years was very close to that measured in men in the population in Yaoundé and Ndola, but was overestimated in Kisumu. Estimates for individual age groups were not always close to those observed, especially in Kisumu.

Discussion

In Yaoundé and Ndola, the overall ANC HIV prevalence was similar to the combined HIV prevalence for men and women from the population survey, but in Kisumu it was higher. In previous studies, ANC HIV prevalence has either been similar to the combined male and female HIV prevalence [7,9,11] or lower [10,11]. The apparent similarity in Yaoundé and Ndola hides the very different HIV prevalence seen in men and women and at different ages. In Yaoundé and Ndola, comparing ANC HIV prevalence with that in all women or sexually active women showed the previously reported pattern of underestimation in all but the youngest age group. In Ndola, the overestimation in the youngest women was slight, and was only seen in under 18s, a lower age than that reported previously from Zambia [11]. The overestimation is attributed to greater sexual activity among young women seen in ANC compared with their peers in the general population, and the subsequent underestimation to lower fertility associated directly or indirectly with HIV.

In Kisumu, the prevalence of HIV in women in ANC and the population was remarkably similar at all ages. An association between HIV status and fertility is expected, and among multiparous women in ANC, HIV caused a similar prolongation of the birth interval in all three sites [15]. This suggests that there may be factors biasing the results in the opposite direction in Kisumu.

Many factors were identified that might influence the differences in HIV prevalence in ANC and the population (Table 2), but the logistic regression analysis showed that the only important factors were age, marital status, having a previous child, education status (in Yaoundé), and contraceptive use (in Kisumu).

Using the age of the father of the child (collected in ANC) gave overall estimates of HIV prevalence in men that were close to those measured in the population in Yaoundé and Ndola, but overestimated male HIV prevalence in Kisumu (in line with the higher than expected HIV prevalence in women in ANC in Kisumu, compared with the population). However, in some age groups the discrepancies between measured and estimated HIV prevalence were marked, and the estimates in the youngest age group were based on small numbers, particularly in Ndola. It is perhaps surprising how close the overall estimates were, given that concordance even in married couples is always less than 100%. In several studies in sub-Saharan Africa [6,16–18], the proportion of HIV-positive wives with HIV-positive husbands and the proportion of HIV-positive husbands with HIV-positive wives were similar, both estimated at 60–70%, so overall the HIV prevalence estimates may balance out.

At all sites, ANC data were collected approximately one year later than population data, but HIV prevalence in these cities has been stable for a few years. In Ndola, ANC sentinel surveillance HIV prevalence in 1994 was 27.5% (95% confidence interval 23.6–31.5), almost identical to our finding [19]. In Yaoundé, HIV prevalence measured in 4100 women aged 18–38 years attending the central ANC was 3.6% in 1994/5 and

Table 4. Estimation of HIV prevalence in men using the age of the father of the child, compared with HIV prevalence measured in the population surveys.

Age (years)	Yaoundé		Kisumu		Ndola	
	Observed	Estimated[a]	Observed	Estimated[a]	Observed	Estimated[a]
15–19	0.0	0.0	3.5 (1.1–7.9)	5.8 (0.28–11.3)	3.7 (1.0–9.1)	10.0 (0.25–44.5)
20–29	2.2 (0.94–4.2)	4.0 (2.4–5.7)	18.3 (13.6–23.7)	29.1 (25.6–32.6)	19.8 (15.1–25.3)	21.1 (17.5–25.0)
30–39	9.9 (6.2–14.7)	6.1 (4.2–7.9)	33.1 (25.8–41.1)	34.5 (30.2–38.8)	39.6 (32.2–47.4)	34.4 (29.6–39.2)
40–49	5.7 (2.3–11.5)	5.0 (1.8–8.1)	27.7 (18.4–38.6)	36.5 (27.9–45.0)	25.8 (17.1–36.2)	28.5 (19.7–37.2)
All ages	4.0 (2.8–5.5)	3.8 (2.9–4.7)	19.8 (16.7–23.1)	26.0 (23.6–28.4)	23.2 (20.0–26.8)	23.9 (19.8–27.9)

[a]Estimated using the age of the father of the child, directly standardized to the age distribution of men seen in the population survey, using 5 year age groups.

4.7% in 1995/6 [20]. In our study, 4.1% of women in this age group attending this clinic were HIV positive. For Kisumu, ANC sentinel surveillance of 200–400 women each year found an HIV prevalence of 20% in 1991–1993, 30.4% in 1994, 27.3% in 1995, and 34.9% in 1997 (US Bureau of Census HIV/AIDS Surveillance Database).

In interpreting ANC results, the differences between the clinics within Yaoundé, and to a lesser extent, Ndola, are worrying. These differences could not be explained by any variables measured, suggesting that there are geographical differences in HIV risk within small areas that are not reflected in individual risk profiles. The choice of ANC for surveillance and their relationship to the population survey area will have a critical influence on the results. In this study, the numbers seen in each clinic included should have been proportional to the size of the catchment population for that clinic, but in both Yaoundé and Ndola many ANC were not included in the study.

In comparing ANC results with the general population, the representativeness of the population survey results also needs to be questioned. In the population surveys response rates were reduced mainly by the failure to find individuals. Individuals who are not at home or who refuse to be interviewed and tested may have different risks of HIV from those who are found and take part [21]. If those who were missed had higher HIV rates than those included, this would worsen the underestimation seen in ANC estimates. The inclusion rate for men was lower than that for women at each site, which may partly explain the lower HIV prevalence found in men than in women. Another problem with the population data was the inaccurate reporting of sexual activity: many of those who claimed never to have been sexually active had HIV [21].

Despite the differences seen between the sites, there were some constant features. At all sites the HIV prevalence in the never-married women was similar among ANC attenders and among sexually active women in the population, and the HIV prevalence in currently married women in ANC was similar to the HIV prevalence in currently married women with children in the population. High HIV prevalence was seen in married women without children in the population, and in previously married (divorced or widowed) women in the population (Table 3).

It may thus be possible to estimate population HIV prevalence by accepting the rates for subgroups when they are reasonable, and applying constant adjustments for the other groups. However, any method based on ratios assumes that these are constant between sites and over time, which is not necessarily the case. The differences in HIV prevalence between women in ANC and the population, and between population subgroups, depend on biological and social factors. The biological impact of HIV on fertility may be constant, but may depend on the age at HIV infection and associations with other STD, both of which vary. Social factors, both those influencing fertility and those influencing ANC use, are likely to vary in different places. What is measured in making the comparisons is the sum of all these effects. We identified a few factors that influenced the results seen, and many that were not important, but we could not account for the differences between the sites.

Conclusion

The previously reported finding [7,9,11] that ANC HIV prevalence underestimates the population HIV prevalence for women, and is similar to the combined male and female HIV prevalence in the population was supported by the data from Yaoundé and Ndola (to different degrees), but not that from Kisumu. At each site, few factors influencing the difference in HIV prevalence between ANC and the population were identified, despite the large number of factors studied. This should make adjustments for estimating population HIV prevalence more tractable, but there were no factors identified which, without knowledge of the population HIV prevalence, would suggest that different adjustments should be carried out at different sites. This suggests that standard adjustments will be difficult to develop, although fertility is likely to be the most important factor to incorporate [22]. The estimates of male HIV prevalence based on the age of the father of the child did not provide a good HIV estimate for individual age groups, and was not useful for the youngest age group of men. As an overall measure it may be useful and should be tested at other sites [23].

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Appendix

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