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Risk factors for HIV infection among asymptomatic pregnant women attending an antenatal clinic in western Kenya
ORIGINAL ARTICLE

Risk factors for HIV infection among asymptomatic pregnant women attending an antenatal clinic in western Kenya

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Summary: Our objective was to evaluate HIV prevalence and identify risk factors for HIV infection among women attending the antenatal clinic (ANC) at a large public hospital in Kisumu town, western Kenya. Between June 1996 and November 1997, in the context of a study to determine the effect of placental malaria on mother-to-child transmission of HIV in western Kenya, HIV-1 antibody testing was offered to women with a singleton uncomplicated pregnancy of ≥32 weeks’ gestation attending the ANC. Women were interviewed using a structured questionnaire and had a fingerstick blood sample collected for haemoglobin (Hb), malaria smears, and HIV antibody testing.

Overall HIV seroprevalence was 26.1% (743/2844) (95% confidence interval (CI): 24.5-27.7) and in bivariate evaluation was significantly associated with anaemia (Hb<11 g/dl) (risk ratio (RR) 1.8), malarial parasitaemia (RR 1.6), fever (axillary temperature ≥37.5°C at screening) (RR 1.6), a history of being treated for either vaginal discharge (RR 1.5) or tuberculosis (RR 1.6), reported alcohol consumption (RR 1.6), being an unmarried multigravida (RR 2.2) or a history of the most recent child having died (RR 2.0). Poisson regression analysis for all women identified 5 significant factors independently associated with HIV seropositivity: anaemia (adjusted RR 1.7; 95% CI 1.3-2.0), malarial parasitaemia (adjusted RR 1.7; 95% CI 1.4-2.0), a history of being treated for vaginal discharge (adjusted RR 1.5; 95% CI 1.1-2.0), fever (adjusted RR 2.0; 95% CI 1.3-3.2) and reported alcohol consumption (adjusted RR 1.6; 95% CI 1.1-2.5). Multigravidae women whose most recent child had died were also more likely to be HIV seropositive (adjusted RR 1.9; 95% CI 1.7-2.8). Only 5.5% (156/2844) of the women had none of these risk factors, of whom 12% (18/156) were HIV(+). Even though the model containing the 5 identified factors fitted the data well (goodness-of-fit χ²=18.41, P=0.10), its collective capacity to predict HIV infection was poor; while 74% of the truly positive women were correctly predicted positive by the model, 52% of the truly negative women were misclassified.

Among pregnant women attending the ANC in western Kenya, we were unable to identify a subgroup at risk of HIV infection using non-serological information, indicating that wherever possible universal access to voluntary HIV counselling and testing would be preferable to targeted screening.

Keywords: Risk factors, HIV, pregnancy, antenatal clinic, Kenya, Africa

INTRODUCTION

Human immunodeficiency virus type 1 (HIV) infection has a dramatic impact on the survival of
women and young children in sub-Saharan Africa. In addition to complications of death among women of reproductive age in this region, in sub-Saharan Africa, HIV is mainly spread through heterosexual transmission, and the seroprevalence among child-bearing women is high. Pregnant women serve as an important group to monitor the extent of the HIV infection in the sexually-active general population. The prevalence of HIV infection among pregnant women has increased markedly in some areas of sub-Saharan Africa from less than 10% in 1980s to >30% in 1997/1998 in Zambia, Malawi and Zimbabwe. Kenya is experiencing a growing HIV/AIDS epidemic, and in Nairobi, HIV prevalence among pregnant women increased from 6.5% in 1989 to 13.0% in 1991, and to 16.4% in 1998. A recent study indicated that a short course of zidovudine given in late pregnancy and at delivery decreased vertical transmission of HIV in a non-breastfeeding population by 50%. In addition, HIV transmission through breastfeeding has been clearly documented. The identification of HIV-infected pregnant women through ANC counselling and testing would allow for the targeting of prevention strategies to reduce HIV transmission from mother-to-infant during pregnancy, and in the postpartum period, would permit women to make informed reproductive decisions about future pregnancies, and would facilitate long-range health planning for mothers and infants.

Access to HIV counselling and testing for pregnant women is not common in Kenya or most parts of sub-Saharan Africa. The identification of factors associated with maternal HIV infection may enhance the targeting of the limited resources for counselling and testing in developing countries to sub-populations among the ANC attenders who will most benefit from the services. As part of an on-going study to determine the effect of placental malaria on mother-to-child transmission of HIV in western Kenya, we evaluated HIV prevalence and identified risk factors for HIV seropositivity among women attending the ANC at a large public hospital in Kisumu town.

SUBJECTS AND METHODS

Study site

Kisumu is located on the shores of Lake Victoria in western Kenya with a population of 300,000. The main ethnic groups in this area are the Luo, followed by the Luhya and the Kisi. Malaria is highly endemic in the area around Kisumu municipality, principally infection caused by Plasmodium falciparum, which accounts for 98% of malaria cases (the remaining 2% being P. malariae/ P. ovale). HIV infection is also highly prevalent in the area. Our study was conducted at Nyanza Provincial General Hospital (NPGH), a large government referral hospital with 400 beds, which provides healthcare mostly to the low-income population in this area. On average, about 30 pregnant women present each day for their first antenatal care visit to the ANC service.

Enrolment procedures

Data on risk factors for HIV seropositivity were collected as part of an on-going larger study to assess interactions between HIV infection and malaria during pregnancy and the impact of both infections on maternal and infant health. The objectives and procedures of the larger study were explained in the local languages (Dholuo and Kiswahili). All women who came for regular antenatal follow-up and had undergone their routine ANC care were candidates for the study if they had an uneventful singleton pregnancy of >32 weeks of gestation (based on the fundal height estimation by clinic nurse/midwife), if they resided within the Kisumu municipality, and if they had no known underlying chronic illness. Based on these inclusion criteria, on average, only 10 of the 30 pregnant women making new visits to this ANC per day were eligible for the study each day. The most common reason for ineligibility was residence outside of Kisumu municipality. Upon giving signed informed consent, each woman was interviewed by trained study assistants using a structured questionnaire to obtain information on sociodemographic, health, and obstetric factors. She was then weighed, and a height and axillary temperature obtained. Upon completion of the questionnaire and measurements, each woman was counselled by a trained HIV counsellor in the local languages, and after, an appointment for post-test counselling was made.

After pre-test counselling, a blood sample was taken for HIV antibody testing, HB, and malaria thick blood smear. To ensure confidentiality, post-test counselling was done by the same counsellor who did the pre-test counselling. The counsellor was the only one who had access to the HIV test result and the laboratory personnel did not have access to the study participant names. The woman received the result in a sealed envelope, and during the post-test counselling session, the implications of the results were discussed with her. If the woman requested, more counselling sessions were offered, and all women were encouraged to deliver in Nyanza Provincial General Hospital. As part of the post-test counselling for HIV-seropositive women, the risk of breast milk transmission was discussed. The present Ministry of Health policy is to recommend continued breastfeeding. Access to zidovudine was not standard in Kenya during the study period. The study protocol was approved by the institutional review boards at the Kenya Medical Research Institute (KEMRI) and at the Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, USA.
Laboratory procedures
HIV testing was done using 2 rapid tests: Serostrip HIV-1/2 [Saliva Diagnostic Systems (Singapore) Pte Ltd] and Capillus HIV-1/HIV-2 (Cambridge Diagnostics Ireland Ltd). A woman who tested positive on both tests was counselled and given results as HIV seropositive. We had previously assessed the sequential rapid test algorithm by confirmation with Western blot; when positive blood samples on both tests were confirmed by Western blot, the sensitivity was 99.8%, specificity was 98.9% and the negative and positive predictive values were of the same magnitude, respectively.18 Malaria smears were stained with 10% Giemsa for 10 min and parasites in positive smears were documented using standard methods19. Haemoglobin was measured using a Hemocue® machine (Mission Viejo, California, USA).

Definitions
An uncomplicated pregnancy was defined as a pregnancy without the presence of hypertension, pre-eclampsia, polyhydramnion, an abnormal presentation of the foetus, a history of a previous Caesarean section, haemorrhage, or repeated abortions (>2). Parasitaemia was defined as any plasmoidal asexual form detected on a thick peripheral blood smear. Women with Hb <11 g/dl of blood and <7 g/dl were considered to have anaemia and severe anaemia, respectively20. Fever was defined as an axillary temperature of ≥37.5°C. Any level of parasitaemia in association with an axillary temperature of ≥37.5°C was considered a clinical case of malaria. Women with reactive sera on the 2 rapid tests were considered HIV seropositive. Marriage referred to having 'ever been married', whether or not the husband was deceased, and not being currently divorced. Alcohol consumption referred to present users. Hospitalization was defined as an admission to the ward for at least a day. Employment was defined as any form of occupation where a wage is earned.

Statistical analysis
Bivariate analysis
The relationship between demographic, reproductive, clinical and laboratory parameters and HIV seropositivity was investigated by bivariate analysis. The Chi-square test was used to test for significant differences in proportions. Risk ratios (RR) were computed with their 95% confidence interval (CI) to measure the strength of the associations between the above parameters and HIV infection. Normally distributed continuous data were compared by the Student’s t-test and one-way analysis of variance (ANOVA).

Multivariable analysis
Because many factors associated with HIV seropositivity are interrelated, adjusted RR were estimated by a Poisson regression analysis21 to adjust for the confounding effect of different explanatory risk factors and to assess the independent contributions of each risk factor to the HIV seropositivity. The categories with low prevalence were used as the reference groups in the Poisson regression. Variables were included in the regression model if they were significantly associated with HIV seropositivity in the bivariate analyses or if they are known from prior studies to be associated with HIV seropositivity. Stratified analyses by gravidity were performed to assess potential confounding and effect modification.

Model evaluation
The suitability of the model containing significant factors independently contributing to predicting HIV infection obtained in multivariable analysis was tested by calculating its goodness-of-fit. After the goodness-of-fit statistics, an attempt was made to evaluate (validate) the predictive accuracy of the model in an unbiased manner (i.e. we attempted to test how the model was expected to fare in a different, ‘real’ group of patients a short while after the development of the model, by using the same data set22. This was done by splitting the data set into 2. The first part (75%) of the data set represented the derivation/training set (i.e. the group used for deriving the model). The remaining data set (25%) was used as the test/validation data set to evaluate the derived model21. A person’s predicted probability of being HIV positive is computed based on the individual’s risk factors. Various cut-offs in predicted likelihood of being HIV positive were used to evaluate the sensitivity and specificity of the model. If the predicted probability is below the cut-off, the model classifies the person as being HIV negative; otherwise the person is classified as being HIV positive. The sensitivity and specificity of the model were calculated for each of the specified cut-offs. The cut-off with the best sensitivity and specificity values was then selected as the classification cut-off point. Epi Info 6.01 (Centers for Disease Control and Prevention, Atlanta, Georgia, USA) and Statistical Analysis System (Version 6.12, SAS Institute, Cary, North Carolina, USA) software packages were used. P values < 0.05 were considered statistically significant.

RESULTS
Study population
From June 1996 to November 1997, of the 4308 women residing within the study area who visited the study clinic, 85% (3662/4308) met the study inclusion criteria. Of the women eligible for the study, 80% (2930/3662) accepted HIV counselling and testing. Of the women who accepted, 2.9% (86/2930) had discordant results on the 2 rapid tests and had indeterminate status with Western blot; these women were excluded from further analysis.
Of the remaining women, 26.1% (743/2844) were HIV seropositive (95% CI: 24.5–27.7). The baseline characteristics of the women are given in Table 1. A total of 39.2% (1116/2844) were primigravidae and 60.8% (1728/2844) were multigravidae, of whom 10.2% (176/1728) had 6 or more pregnancies. In addition, 12.7% of the multigravidae had a history of abortion/stillbirth, and 6.7% reported that the abortion or stillbirth had immediately preceded the present pregnancy. Among the multigravidae whose last pregnancy had ended in live birth, 19.8% (319/1613) of the children had died by the time of interview.

The largest occupational group was mainly unemployed/housewives 78.7% (2234/2840). The remaining occupations were unskilled workers/vendors 17.7% (503/2840) and professionals 3.6% (103/2840). The occupational categories most likely to test positive for HIV were unskilled workers/vendors 31.2% (157/503), unemployed/housewives 25.2% (563/2234) and professionals 21.4% (22/103). Of the 602 married HIV-positive women with information about husband’s employment, the largest percentage occupations of their partners were unskilled/vendors 92.4% (556/602), unemployed 6.0% (36/602), and professionals 1.7% (10/602). Of 2146 married women with information about husband’s education available, 85.1% (1846/2146) had partners who had completed at least primary level education (>8 years of schooling).

The prevalence of malarial parasitaemia at the time of enrolment was 20.5%, and 75.8% had third trimester anaemia (Hb <11 g/dl). HIV prevalence was 18.2% among the 13–15-year-olds, reaching peak prevalence (>30%) among the 20–29-year-olds, with the prevalence decreasing to 14.6% among the >35-year-old multigravidae with 6 or more previous pregnancies (Figure 1).

Factors associated with HIV seropositivity

Bivariate analysis

Characteristics of the women’s medical, demographic, and obstetrical history and examination that were associated with HIV seropositivity by bivariate analysis are shown in Table 2. Among the study population as a whole, significant risk factors for HIV seropositivity were history of alcohol consumption; history of treatment for tuberculosis or vaginal discharge; fever at the time of testing; anaemia; malaria parasitaemia and history of being hospitalized in the current pregnancy. Among multigravidae, those who were not married and those whose most recent live-born infant had died by the time of screening were more likely to be HIV seropositive (RR 1.6; 95% CI: 1.2–2.0) and (RR 2.0; 95% CI: 1.7–2.3), respectively. Compared with other women, those whose occupation was unskilled worker/vendor were at a higher risk of testing HIV positive (RR 1.3; 95% CI: 1.1–1.5). However, a history of one or more abortions (induced or spontaneous) or a stillbirth were not associated with an increased risk of HIV (RR 1.2; 95% CI: 0.9–1.5). Low maternal weight (<50 kg), 2 or more weeks of medication use during the current pregnancy, having a positive Venerable Disease Research Laboratory (VDRL), or reporting obstetrical complaints with the current pregnancy were not associated with being HIV infected.

Multivariable analysis

Poisson regression models were performed for the whole study population and separately for primigravid and multigravid women using significant variables from the bivariate analysis. Factors independently associated with HIV seropositivity among our study population were documented as fever at screening, anaemia, malarial parasitaemia, a history of alcohol consumption and history of treatment for vaginal discharge during the current pregnancy (Table 3). A significant interaction was found between parasitaemia and documented fever (P=0.042). Clinical malaria was not associated with increased risk of HIV infection, but parasitaemia without fever was. Similarly, documented fever in the absence of malarial parasitaemia was associated with HIV infection. Compared with women with no risk factor, those with at least one risk factor were at higher risk of HIV-1 infection (RR 2.3, 95% CI: 1.5–3.6). Among the multigravidae, reported death of the most recent
live-born infant was the only risk factor in addition to the above identified factors. Being unmarried and reported hospitalization during the current pregnancy were no longer significant risk factors for HIV infection after adjustment for other variables.

The prevalence, sensitivity, specificity, and positive predictive value for individual factors independently associated with HIV infection are displayed in Table 4. Apart from anaemia, most of the risk factors had low sensitivity but high specificity. Most of the pregnant women had at least one of the significant risk factors; however, the presence of at least one risk factor had high sensitivity but low specificity and low positive predictive value. Only 5.5% (156/2844) of the women had none of the identified risk factors; 12% (18/156) of those were HIV positive. Thus, only a very small proportion (2.4%, 18/743) of the HIV-positive women had none of the identified risk factors.

### Table 2. Risk factors associated with HIV seropositivity among pregnant women attending the antenatal clinic (ANC), Kisumu, western Kenya, June 1996–November 1997

<table>
<thead>
<tr>
<th>Variable</th>
<th>All women (n=2844)</th>
<th>HIV (−) n=2101 (73.9%)</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt;22 years</td>
<td>50.1%</td>
<td>55.4%</td>
<td>1.2 (1.0–1.3)</td>
</tr>
<tr>
<td>Education &gt;6 years*</td>
<td>67.0%</td>
<td>65.6%</td>
<td>1.1 (0.9–1.2)</td>
</tr>
<tr>
<td>Employed*</td>
<td>24.1%</td>
<td>20.4%</td>
<td>1.2 (1.0–1.5)</td>
</tr>
<tr>
<td>Married</td>
<td>82.2%</td>
<td>78.9%</td>
<td>1.2 (0.9–1.4)</td>
</tr>
<tr>
<td>Unmarried multigravidae</td>
<td>8.4% (486)</td>
<td>4.5% (1242)</td>
<td>1.6 (1.2–2.0)</td>
</tr>
<tr>
<td>Last child deceased*</td>
<td>33.0% (449)</td>
<td>14.4% (1165)</td>
<td>2.0 (1.7–2.3)</td>
</tr>
<tr>
<td>Consumes alcohol</td>
<td>3.2%</td>
<td>1.6%</td>
<td>1.6 (1.2–2.2)</td>
</tr>
<tr>
<td>Treated for TB (now/past)</td>
<td>2.2%</td>
<td>1.0%</td>
<td>1.7 (1.2–2.4)</td>
</tr>
<tr>
<td>Vaginal discharge</td>
<td>7.3%</td>
<td>4.3%</td>
<td>1.5 (1.2–1.8)</td>
</tr>
<tr>
<td>Hospitalized*</td>
<td>4.7%</td>
<td>3.0%</td>
<td>1.4 (1.1–1.8)</td>
</tr>
<tr>
<td>History of fever previous week*</td>
<td>28.2%</td>
<td>25.3%</td>
<td>1.1 (0.9–1.3)</td>
</tr>
<tr>
<td>Temperature ≥37.5°C*</td>
<td>5.2%</td>
<td>2.6%</td>
<td>1.6 (1.3–2.1)</td>
</tr>
<tr>
<td>Weight &lt;50kg*</td>
<td>2.6%</td>
<td>2.2%</td>
<td>1.1 (0.8–1.7)</td>
</tr>
<tr>
<td>VDRL(+)</td>
<td>2.8%</td>
<td>2.1%</td>
<td>1.2 (0.8–1.8)</td>
</tr>
<tr>
<td>Haemoglobin &lt;11g/dl*</td>
<td>85.1%</td>
<td>72.5%</td>
<td>1.9 (1.5–2.2)</td>
</tr>
<tr>
<td>Blood smear positive*</td>
<td>29.1%</td>
<td>17.5%</td>
<td>1.6 (1.4–1.8)</td>
</tr>
</tbody>
</table>

*Incomplete data: one woman had no information on education, 4 women on work, one on fever in the previous week, 12 had no temperature measurements, 4 had no weight taken, 281 had no Veneraeal Disease Research Laboratory (VDRL) test results recorded on their ANC card, 96 had no haemoglobin results and 11 had no blood smear.

Multigravidae only. Number studied in parentheses. Hospitalized during the current pregnancy. Treated for vaginal discharge during this pregnancy. RR=risk ratio; CI=confidence interval; TB=tuberculosis

### Table 3. Risk factors associated with HIV seropositivity (multivariable model) among pregnant women attending the antenatal clinic in Kisumu, western Kenya by gravidity, June 1996–November 1997

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever with no parasitaemia</td>
<td>2.0 (1.3–3.2)</td>
</tr>
<tr>
<td>Anaemia</td>
<td>1.7 (1.4–2.1)</td>
</tr>
<tr>
<td>Parasitaemia without fever</td>
<td>1.7 (1.4–2.0)</td>
</tr>
<tr>
<td>Consumes alcohol</td>
<td>1.6 (1.1–2.5)</td>
</tr>
<tr>
<td>Treated for vaginal discharge</td>
<td>1.5 (1.1–2.0)</td>
</tr>
<tr>
<td>Last child deceased*</td>
<td>1.9 (1.5–2.3)</td>
</tr>
</tbody>
</table>

*The model adjusted for ethnicity, age, axillary temperature at screening, peripheral parasitaemia, anaemia, history of treatment for vaginal discharge, history of alcohol consumption and history of treatment for tuberculosis. All were entered as categorical variables.

Multigravidae only (n=1728)

Model evaluation

The suitability of the 5-variable model for all women in predicting HIV infection was tested by calculating its goodness-of-fit. The results showed no evidence of an overall lack of fit of the 5-variable model, (goodness-of-fit χ²=18.41, P=0.10). After the goodness-of-fit statistics, the predictive accuracy of the 5-variable model was evaluated (validated), using 25% of the sample as already explained. Even though the 5 variables in the model contributed independently in predicting HIV seropositivity among pregnant women, their collective capacity to predict seropositivity was poor. When the sensitivity and specificity of the 5-variable model were calculated for various cut-off values for the predicted probability of being HIV positive, the maximum value for sensitivity (74%) and specificity (48%) occurred at a cut-off of 0.20. Using 0.20 as a prediction cut-off point, we calculated the proportion of women correctly classified (i.e. proportion of screened women in the total sample whose observed HIV status (negative or positive)
agreed with predicted HIV status) by the 5-variable model. At this cut-off, while 74% (147/200) of the truly positive women were correctly classified by the model (sensitivity), 52% (266/511) of the truly negative women were misclassified (false positive). However, this model particularly proved useful in predicting HIV-negative women. The proportion of HIV-negative women predicted to be negative was high (negative predictive value, 82%) compared with positive predictive value which was low, 36%.

DISCUSSION

The high prevalence of HIV infection (26.1%) among this population of pregnant women visiting a large government ANC in Kisumu town is consistent with similar studies from sub-Saharan Africa that have reported >20% HIV seroprevalence among women attending the ANCs.16,17,23-28. The acceptance rate for HIV counselling and testing in this public ANC was high (80%), and most women returned for their HIV test results. Whether the prevalence of HIV infection among pregnant women in Kisumu who were eligible to participate in the study but declined to do so is greater or less than the observed 26.1% is unknown. In addition, our study only included women who had attained a gestational age of 32 weeks or more and who had uncomplicated pregnancies. If early foetal loss were more common among HIV-seropositive women, then the true rate among pregnant women would likely be higher than that reported in our study. A recent study from Uganda indicated that HIV-seropositive women may have lower fertility rates, which would also suggest that the high rate reported among pregnant women in our study may actually be an underestimate of the rate among all women of reproductive age. The high prevalence of HIV-1 infection (18.2%) observed among young pregnant women (<16-year-olds) suggests that a sizeable number of women in western Kenya are exposed to HIV almost from the time they became sexually active.

Most pregnant women in Kenya do attend ANC. Results from a survey we conducted in 1994 indicate that more than 95% of pregnant women in western and coastal Kenya have at least one ANC visit, and more than 90% have at least 2 visits.8 Because of the high ANC attendance rate in Kenya, ANCs provide an excellent setting in which to identify HIV-infected pregnant women for interventions to reduce mother-to-infant HIV transmission. Although universal access to HIV counselling and testing for all pregnant women would be optimal, the costs of such a programme may be prohibitive in many areas where most pregnant women receive antenatal care through publicly financed clinics. The identification of risk factors for HIV infection has the potential to allow targeting of ANC counselling and testing services to women with the greatest risk and has the potential for significant cost savings in a resource-poor environment such as western Kenya.

Although access to effective HIV treatment options are limited for pregnant women in most areas of the developing world, those who have accepted counselling and testing and who are found to be seropositive may benefit from advice regarding improved self-care, including adequate hygiene and nutrition, seeking early healthcare at the first sign of illness, and how to prevent the spread of the infection to others. In addition, interventions such as short-course zidovudine or nevirapine, which have been shown to reduce peripartum mother-to-infant transmission, as well as evaluation of strategies to prevent breast milk transmission hold the promise that mother-to-infant HIV transmission can be reduced even in resource-poor settings. Delivery of these control strategies will require a mother’s knowledge of her HIV infection status, since only HIV-infected women would be expected to benefit from these interventions.

In our multivariable analysis, malaria and anaemia were strongly associated with HIV seropositivity. The higher risk of HIV infection among pregnant women with malaria parasitaemia is consistent with previous studies that demonstrated that HIV-infected women are at greater risk of malaria during pregnancy than uninfected women.17,31-33. The markedly higher prevalence of HIV infection among pregnant women with anaemia has also been observed in other studies in this
region\textsuperscript{2,34}. One recent study documented a very high HIV infection among anaemic pregnant women and recommended that HIV be included in the evaluation of the aetiology of anaemia in areas of high prevalence of HIV infection\textsuperscript{35}. In this study, documented fever in the absence of malarial parasitaemia was also associated with HIV infection. Fever per se has been reported to be a marker for HIV seropositivity, and seroprevalence among febrile patients has been found to be higher than that in the general population\textsuperscript{36}.

Reported death of the infant most recently delivered was associated with HIV infection during the current pregnancy. The high prevalence of HIV infection among the pregnant women will inevitably result in an increasing number of children who will be infected with HIV through mother-to-infant transmission. The association of maternal HIV infection with death of the most recent infant among pregnant women has also been observed in other studies\textsuperscript{37} and is likely to be in part due to mother-to-infant transmission of HIV either in the peripartum period or through breastfeeding\textsuperscript{12,13}. The association of higher infant mortality rates with maternal HIV infection have been reported in studies from Brazzaville (39%) and Kinshasa (21%)\textsuperscript{38,39}. The norm in most parts of Africa for women who loose their infants through death is to get another pregnancy to replace the lost child. Access of such women to information about their infection status through ANC counselling and testing may permit them to make better informed reproductive decisions about their future pregnancies and prevent subsequent vertical transmission to susceptible infants.

We observed no association between HIV infection and reported history of one or more abortions (induced or spontaneous) or reported history of stillbirth among women in our study. This is in contrast to an increased rate of spontaneous abortion reported for HIV-infected women elsewhere in Africa\textsuperscript{40}. Our study suggests that unlike women with more advanced disease, asymptomatic HIV infection may not significantly increase the rate of foetal wastage\textsuperscript{41}.

The prevalence of history of treatment for tuberculosis was low in this population (1.4%) and is likely due to the fact that women with known underlying illness were not eligible for enrolment into this study. Despite the fact that only asymptomatic women in apparent good health were included in the study, there was a positive association between HIV infection and history of being treated for tuberculosis in bivariate analysis of the entire study population. This confirms observations by other studies from sub-Saharan Africa, which have demonstrated a high prevalence of tuberculosis and HIV co-infection\textsuperscript{42,43}.

HIV seropositivity was also associated with history of treatment for vaginal discharge. We were unable to collect more information on the aetiologies of vaginal discharge in this population, but studies have observed a high prevalence of vaginal discharge, mostly due to candidiasis, among HIV-seropositive women and particularly among those with immunosuppression\textsuperscript{44-46}. Although few pregnant women reported alcohol use, it was also associated with HIV seropositivity in this population. A study from the Central African Republic showed an association between alcohol use and multiple sex partners, particularly among women\textsuperscript{47}. However, our study was not designed to determine whether such an association exists among pregnant women in western Kenya. Cigarette smoking and blood transfusion was very rarely reported in this population (less than 1% of the women reported either of these factors) and the small numbers made it impossible for us to detect any potential association with HIV seropositivity.

Although risk factors for HIV infection were discernible from our study by Poisson regression, the model containing the 5 identified risk factors had a low positive predictive value for HIV infection. In addition, only 5.5% of the women had none of the identified risk factors. Because of the high prevalence of HIV and high prevalence of factors associated with HIV infection in our entire study population, it was not possible based on our data to identify a well-defined sub-population of women to whom counselling and testing for HIV should be targeted. As a consequence, the overall population of pregnant women attending this ANC must be considered at high risk of HIV infection.

Our study confirms findings of previous studies that were unable to identify asymptomatic HIV-infected women among ANC attenders using non-serological information\textsuperscript{37,48}. Given the high prevalence of asymptomatic HIV infection in our population and elsewhere in sub-Saharan Africa\textsuperscript{6-10,15,22-27} and the new and evolving opportunities for preventing perinatal HIV transmission, it appears that in western Kenya and in similar settings elsewhere, universal access to voluntary HIV counselling and testing would be preferable to targeted screening.

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