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SPECIAL ARTICLE

HIV infection among pregnant women in Nigeria

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Abstract

Objectives: To determine risk factors for HIV among pregnant women ($N = 2657$) receiving antenatal services in Jos, Plateau state, Nigeria. *Methods:* Information about potential risk factors was obtained at interview. Biological samples were collected for detection of HIV and other sexually transmitted infections (STIs). *Results:* The prevalence of HIV was 8.2%. Women aged 20—29 years had more than 4-fold increased risk of HIV. Women of Catholic (adjusted odds ratio (AOR) = 1.72, 95% CI = 1.01—2.95) and Pentecostal (AOR = 2.57, 95% CI = 1.46—4.52) denominations were more likely to be HIV-infected when compared to Moslem women. The risk of HIV was also increased among women with multiple marriages and in women married to a banker/accountant. Other predictors of HIV were having a husband with other partners, perceived risk of HIV, STIs, candidiasis and bacterial vaginosis. *Conclusions:* Development of effective interventions, including behavioral change, expansion of perinatal HIV prevention services and STI control, should be given the highest priority.

1. Introduction

Since the first cases of AIDS were reported in Nigeria in 1986 [1,2], HIV has become a major public health problem. Based on the national sentinel surveys, the prevalence of HIV among

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adults in Nigeria increased from 1.8% in 1991 to 5.8% in 2001 [3,4]. With more than 3.5 million people estimated to be living with HIV by the end of 2003 [5], Nigeria has the largest number of HIV/AIDS cases in West Africa. Improved knowledge of the factors contributing to the continued expansion of the HIV epidemic is important in the design of effective intervention programs. In most African countries, data from women participating in the programs for prevention of mother-to-child transmission of HIV has been used to determine the prevalence and risk factors for HIV infection. Because of relatively high background fertility and antenatal services coverage, results from such studies may be applicable to other women of reproductive age in the general population. In this report, we present results of a study we conducted to examine factors contributing to the expansion of the HIV epidemic among pregnant women participating in the program for prevention of mother-to-child transmission of HIV at Jos University Teaching Hospital (JUTH) in Nigeria. This is a referral center for 2 million people in the Plateau State.

2. Methods

2.1. Study population and procedures

As part of a national program for prevention of mother-to-child transmission of HIV, the AIDS Prevention Initiative in Nigeria developed HIV voluntary counseling and testing services at JUTH antenatal clinic in October 2001. Between April 2002 and November 2003, we conducted a research study to determine risk factors for HIV among women participating in this program at JUTH. During this period, all pregnant women waiting to receive antenatal services at the clinic were given information about the research and were invited to participate. Women who agreed to participate in the study signed a written informed consent form. On each clinic day, about 10 interviews were conducted in a private room to obtain information about socio-demographic characteristics, sexual behaviors, pregnancy history, knowledge about HIV and other sexually transmitted infections (STIs), HIV risk perception and history of STIs-related symptoms.

After pre-test counseling, 5—10 ml of blood was collected from women who agreed to be tested for HIV and syphilis. Later, we performed gynecological examination to collect genital samples. Vaginal fluid pH was measured by using a pH paper on a vaginal swab obtained from the lateral and posterior fornices. Later, we collected a swab from the posterial fornix for preparation of a wet mount, a vaginal swab for detection of *Candida* species, and an endocervical swab for *Neisseria gonorrhea* isolation. Women were given an appointment to return to the clinic after 7 days for post-test counseling. HIV positive mothers and their babies were given nevirapine for prevention of mother-to-child transmission of HIV following the HIVNET 012 regimen [6]. Subjects with STIs symptoms and laboratory confirmed infections received free treatment. The study protocol was approved by the Ethics Committee of JUTH and the Institutional Review Board of the Harvard School of Public Health, Boston, USA.

2.2. Laboratory methods

Blood samples were centrifuged and plasma was screened for HIV with the Determine rapid test (Abbott Laboratories, IL, USA). Reactive samples were confirmed by Western blot test in Nigeria using strips for HIV-1 and 2 prepared in the laboratory of one of the authors (PK). Active or recent syphilis was diagnosed if plasma was reactive on both the Rapid Plasma Reagin (RPR) card test (Newmarket Laboratories Ltd, Kentford, UK) and the Treponema Pallidum Hemagglutination assay (TPHA) (Newmarket Laboratories Ltd, Kentford, UK). A positive TPHA test alone was interpreted as evidence of a past infection.

A wet mount of the vaginal swab was prepared in normal saline immediately after collection and examined microscopically for the presence of clue cells, motile *Trichomonas vaginalis* and yeast cells. Direct microscopy on Gram-stained genital swabs was performed for the detection of leukocytes and Gram-negative diplococci. Isolation of *N. gonorrhea* was performed by inoculation of the genital swab on modified Thayer Martin media followed by incubation in a candle extinction jar at 36 °C for 24—48 h. Isolates were identified on the basis of colony morphology, visualization of Gram-negative diplococci, positive oxidase reaction and sugar fermentation tests. Candidiasis was diagnosed by isolation of the Gram-positive yeast-like cells on Saboraud's dextrose agar and confirmed by a positive germ tube test. Bacterial vaginosis was diagnosed according to Amsel criteria [7].

2.3. Data analysis

The prevalence of HIV in each category of the predictor variables was determined, and the associations between HIV infection and predictor variables were summarized by using odds ratios (OR) and corresponding 95% confidence intervals (CI). To

Table 1 The associations between selected potential risk factors and HIV-1 infection among pregnant women in Jos, Plateau State, Nigeria

Predictors	*N* (%)	% HIV positive	Crude OR (95% CI)[a]	Adjusted OR (95% CI)[b]
Age (years completed)				
<19	182 (6.8)	2.2	1.00	1.00
20–24	618 (23.3)	8.3	4.00 (1.43–11.22)	4.57 (1.35–15.46)
25–29	887 (33.4)	10.9	5.46 (1.98–15.03)	4.44 (1.32–14.88)
30–34	607 (22.8)	7.7	3.73 (1.33–10.50)	3.00 (0.86–10.40)
35–39	276 (10.4)	5.4	2.56 (0.83–7.82)	1.69 (0.44–6.43)
>40	54 (2.0)	1.9	0.84 (0.09–7.67)	0.47 (0.04–5.38)
Don't know	33 (1.2)	6.1	2.87 (0.50–16.34)	1.05 (0.01–11.39)
Religion				
Moslem	802 (30.2)	5.1	1.00	1.00
Catholic	477 (18.0)	9.6	1.98 (1.28–3.07)	1.72 (1.01–2.95)
Pentecostal	383 (14.4)	10.2	2.10 (1.33–3.32)	2.57 (1.46–4.52)
Protestant	953 (35.9)	9.3	1.91 (1.30–2.80)	1.50 (0.93–2.44)
Traditional/other	15 (0.6)	0.0	–	–
Missing	27 (1.0)	0.9	1.48 (0.34–6.48)	–
Do you drink alcohol?				
No	2491 (93.8)	7.9	1.00	
Yes	125 (4.7)	13.6	1.82 (1.07–3.10)	
Missing	41 (1.5)	4.9	0.59 (0.14–2.48)	
Marital status				
Married only once	2429 (91.4)	7.4	1.00	1.00
Married more than once	161 (6.1)	16.1	2.41 (1.54–3.76)	3.06 (1.74–5.39)
Not married (single/div/sep)	39 (1.5)	23.1	3.75 (1.75–8.02)	2.08 (0.67–6.47)
Missing	28 (1.1)	7.1	0.96 (0.23–4.08)	–
Occupation of husband/cohabiting partner				
Civil servant	830 (31.2)	8.6	1.00	1.00
Banker/accountant	72 (2.7)	20.8	2.81 (1.51–5.22)	2.88 (1.28–6.45)
Business	858 (32.3)	6.9	0.79 (0.55–1.13)	1.10 (0.71–1.70)
Drivers (truck, taxi, motorcycle)	181 (6.8)	5.5	0.63 (0.32–1.24)	0.87 (0.40–1.91)
Other	557 (21.0)	7.4	0.85 (0.57–1.27)	0.97 (0.60–1.57)
Missing	120 (4.5)	10.0	1.19 (0.62–2.26)	–
Not married	39 (1.5)	23.1	3.21 (1.46–7.02)	–
Number of sex partners during the last 5 years				
1	2003 (75.4)	5.7	1.00	
2	349 (13.1)	13.2	2.49 (1.73–3.58)	
>3	128 (4.8)	19.5	3.98 (2.48–6.41)	
Missing	177 (6.7)	17.5	3.49 (2.27–5.36)	
p-value, test for linear trend			0.001	
Last male partner has other partners?				
No	1680 (63.2)	5.8	1.00	1.00
Yes	162 (6.1)	22.8	4.83 (3.17–7.35)	2.20 (1.23–3.94)
Don't know	815 (30.7)	10.2	1.85 (1.36–2.51)	1.39 (0.94–2.04)
What are your chances of contracting HIV/AIDS?[c]				
No risk at all	1607 (61.7)	4.1	1.00	1.00
Minimal/small risk	388 (14.9)	7.2	1.82 (1.15–2.87)	1.59 (0.96–2.63)
Moderate risk	68 (2.6)	17.6	5.00 (2.56–9.78)	3.56 (1.64–7.71)
Great risk	25 (0.9)	20.0	5.84 (2.12–16.03)	4.83 (1.52–15.30)
Don't know	518 (19.9)	11.0	2.89 (1.99–4.18)	2.56 (1.68–3.90)
p-value, test for linear trend			<0.001	<0.001
Had abnormal genital discharge during the last 12 months				
No	1866 (70.2)	6.3	1.00	
Yes	661 (24.9)	14.1	2.45 (1.83–3.26)	
Don't know	130 (4.9)	5.4	0.85 (0.39–1.86)	

(continued on next page)

Table 1 (*continued*)

Predictors	*N* (%)	% HIV positive	Crude OR (95% CI)[a]	Adjusted OR (95% CI)[b]
Had genital ulcer during the last 12 months or at the time of examination				
No	2422 (91.2)	7.0	1.00	1.00
Yes	132 (5.0)	28.8	5.39 (3.58–8.10)	3.35 (2.00–5.61)
Don't know or not examined	103 (3.9)	9.7	1.43 (0.73–2.80)	–
Candida albicans				
Negative	2226 (83.8)	7.3	1.00	1.00
Positive	391 (14.7)	13.0	1.91 (1.37–2.67)	2.23 (1.49–3.36)
Samples not provided[d]	40 (1.5)	10.0	1.41 (0.50–4.03)	–
Trichomonas vaginalis				
Negative	2575 (96.9)	8.0	1.00	
Positive	41 (1.5)	14.6	1.97 (0.82–4.74)	
Samples not provided[d]	41 (1.5)	12.2	1.60 (0.62–4.11)	
Active (recent) syphilis[e]				
Negative	2627 (98.8)	8.0	1.00	1.00
Positive	7 (0.3)	42.9	8.63 (1.92–38.82)	16.88 (2.88–98.76)
Samples not provided[d]	23 (0.9)	17.4	2.42 (0.82–7.19)	–
Disturbance of vaginal flora				
Normal flora	185 (7.0)	7.6	1.00	1.00
Mild disturbances	1677 (63.2)	6.5	0.85 (0.48–1.51)	1.68 (0.78–3.62)
Moderate disturbances	288 (10.8)	10.4	1.42 (0.73–2.76)	2.40 (1.03–5.60)
Severe disturbances (Bacterial vaginosis)	466 (17.5)	12.7	1.77 (0.96–3.26)	2.77 (1.25–6.13)
Samples not provided[d]	41 (1.5)	12.2	1.70 (0.57–5.01)	–

[a] Crude odds ratio (OR) and 95% confidence interval (CI).
[b] Odds ratio (OR) and 95% confidence interval (CI) adjusted for age, religion, occupation of the husband/cohabiting male partner, marital status, sex behavior of the last male partner, perceived risk of HIV, genital ulcer in the past year or at the time of examination, candidiasis, active (recent) syphilis, and disturbance of vaginal flora.
[c] Excludes 51 women who knew that they had HIV/AIDS.
[d] Samples not provided because they were not examined or did not want to be tested.
[e] Based on positive Rapid Plasma Reagin (RPR) card test and Treponema Pallidum Hemagglutination assay (TPHA) tests.

adjust for multiple risk factors simultaneously, multivariate analyses were performed by using logistic regression models [8]. All significant variables in the univariate analyses ($p<0.05$) and others that were thought to be important based on previous reports were included in a list of candidate variables for multivariate logistic regression models. Stepwise procedures, using both forward selection and backward elimination procedures, were used to determine the final logistic regression model. For ordinal variables, the linear trend was tested by entering the variable as a continuous predictor. After the final models were obtained from the stepwise procedures, we assessed potential confounding of the variables not retained in these models. The fitness of the final model was assessed by using the Hosmer–Lemeshow test [8].

3. Results

Of 2931 women we interviewed, 2676 (91.3%) provided blood samples for HIV and syphilis testing. Nineteen of 2676 women who provided blood samples had indeterminate HIV test results, and were excluded from the analysis. Of 2657 women with definite HIV test results, 217 were HIV seropositive. Thus, the prevalence of HIV in this population was estimated at 8.2% (95% confidence interval (CI), 7.1–9.2%). In Table 1, we present the associations between HIV and selected potential risk factors. The prevalence of HIV increased from 2.2% among women below 20 years of age to 10.9% in subjects aged 25–29 years, and then decreased to 1.9% in women aged 40 years and above. Compared to women who reported to be Moslems, women of all Christian denominations had significantly increased risk of HIV. Moslem women were less likely to have STIs, multiple sex partners, and to be unmarried when compared to other women (data not shown).

Only 125 (4.7%) women reported drinking alcohol in this population. These women had significantly increased risk of HIV (odds ratio (OR) = 1.82, 95% confidence interval (CI) = 1.07–3.10). Compared to women who were married only once, the risk of HIV was increased among women who

reported multiple marriages (OR=2.41, 95% CI=1.54—3.76), and in unmarried women (OR=3.75, 95% CI=1.75—8.02). The risk of HIV was also increased among women whose husbands were bankers/accountants.

The risk of HIV increased with increasing number of sex partners in the past 5 years (p-value, test for linear trend=0.001). However, most women (75.4%) reported only one sex partner during the last 5 years. Women who were aware that their last male partner had other sex partners were at increased risk of HIV (OR=4.83, 95% CI=3.17—7.35). About 65% of women did not use condoms in the last 5 years and most women (61.7%) did not perceive themselves to be at risk of HIV. Compared to women who perceived themselves to be at no risk of HIV, the risk of HIV was significantly increased in all other women.

Women who had genital symptoms and STIs during the last 12 months had increased risk of HIV. Candidiasis was the most common genital infection in this population, with a prevalence of 14.9% among women who provided genital samples. Women with candidiasis and recent and past syphilis had a significantly increased risk of HIV. The majority of women (93%) had abnormal vaginal flora. The prevalence of HIV increased as the degree of disturbance of vaginal flora increased (p-value, test for linear trend <0.001).

After adjusting for potential confounding, the risk of HIV remained significantly increased among women aged between 20 and 29 years when compared to women aged 19 years and younger. Other independent predictors of HIV were religion, marital status, perception of HIV risk, genital ulcers, candidiasis, active or recent syphilis, disturbances of vaginal flora and occupation and sex behavior of husband or cohabiting male partner.

4. Discussion

The relatively high prevalence of HIV among pregnant women in Jos indicates that this population is experiencing a generalized epidemic. The prevalence of HIV in this population was substantially higher than the average national prevalence of about 5.0% [5]. In a previous study involving 11,059 pregnant women in Jos, the prevalence of HIV was 0.25% in 1989 and 3.29% in 1998 [2]. Results from the current study indicate a substantial increase in the prevalence of HIV among pregnant women in Jos between 1998 and 2003. This increase is a reflection of the rising trend of HIV infection in the general population and confirms that HIV is a major public health problem in Nigeria.

As observed in other studies in Nigeria [9], the rate of HIV increased with age among women below 30 years of age, with the highest prevalence among women aged between 25 and 29 years. The increased risk of HIV among relatively young women has been associated with increased biological vulnerability [10], and relatively prevalent asymptomatic and untreated STIs [10,11]. In addition, young women tend to have sexual relationships with relatively older men who have been exposed to the risk of HIV for many years [12].

Women who reported multiple marriages had a significantly increased risk of HIV. Women with multiple marriages may be at high risk of HIV because of exposure to multiple male partners. Moslem women have relatively lower risk of HIV when compared to Christian women. This is consistent with other studies that have reported relatively low HIV prevalence in the predominantly Moslem communities in northern Nigeria [9]. In our study, Moslem women were less likely to be unmarried and to report multiple sexual partners. They were also less likely to have STIs. These behavioral and biological factors might account for the relatively low risk of HIV in these women.

The finding of an increased risk of HIV among women whose husband/partner was a banker/accountant confirms results from a previous study [2], and underlines the socio-economic implications of the HIV epidemic in Africa. Similar findings have been reported in other studies in sub-Saharan Africa [13—15]. The banking sector is the fastest growing sub-sector in the liberalized economy of Nigeria, and men working in this sector have relatively high socio-economic status and disposable income that may be used to acquire or support multiple sex partners [15]. Thus, they may be at increased risk of contracting HIV and transmitting the infection to their partners. Since a relatively high rate of HIV infection among men working as bankers/accountants is likely to have negative impact on the growing financial institutions in Nigeria, development of comprehensive workplace HIV/AIDS prevention programs in these places should be given the highest priority.

Only few women in this population experiencing a generalized HIV epidemic reported multiple sex partners and perceived themselves at risk of HIV. Misreporting and social desirability bias are common in the interview settings and might have affected the validity of the self-reported sexual behaviors [16]. Nevertheless, only a small proportion of women we interviewed reported to have used condoms. Thus, promotion of safer sexual

practices, including condom use, remains an important strategy for HIV prevention in this population. The risk of HIV was increased among women whose male partner's had other sex partners. These results highlight the critical role of the male partner's sexual behavior as a predictor of HIV infection among women, and underscore the importance of involving men in HIV prevention programs.

Other independent risk factors for HIV infection were active (or recent) syphilis and genital ulcer disease. Syphilis is one of the most common causes of genital ulcers in Africa. Genital ulcer increases the risk of HIV by providing an easy portal of entry for HIV and increased presence and activation of HIV susceptible cells [17]. In addition, genital ulcers may be a complication of HIV disease and a marker of high-risk sexual exposure. HIV was also associated with candidiasis and disturbance of vaginal flora and bacterial vaginosis. Candidiasis is associated with genital inflammation which could weaken the epithelial integrity and increase the risk of HIV. There are a number of mechanisms by which disturbance of vaginal flora and bacterial vaginosis might be associated with HIV. The concentration of hydrogen peroxide (H_2O_2) producing lactobacilli is reduced in women with this condition. Hydrogen peroxide plays an important role in the vaginal ecosystem and is toxic to a number of organisms including HIV [18]. In addition, bacterial vaginosis might increase the levels of endocervical interleukin-10 and other inflammatory cytokines that increase susceptibility of macrophages to HIV [19].

Overall, the HIV epidemic is evolving rapidly among women in Jos and effective intervention programs are urgently needed. Our findings provide strong justification for expansion of prevention of mother-to-child transmission of HIV services in Nigeria. Given the strong associations between STIs and HIV, control of other STIs is likely to have a significant impact on the HIV epidemic in this population. We also highlight the urgent need for concerted prevention efforts targeting women below 30 years of age who have the highest rate of infection. In addition, innovative strategies involving men in promotion of safer sexual practices and consistent condom use might help to reduce the risk of HIV among women. Finally, we contribute to the growing literature showing that bacterial vaginosis is a significant risk factor for HIV. Since bacterial vaginosis has been shown to be associated with other STIs and adverse reproductive outcomes [20], control of this condition might contribute in reducing the burden of HIV/STIs and improved reproductive outcomes. Such efforts could include regular screening and treatment of symptomatic infections, and improved genital hygienic practices.

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References

[1] Chikwem JO, Modammed I, Bawa HG, Oyebode OT. Human immunodeficiency virus (HIV) infection in a patient attending sexually transmitted disease clinic in Borno State of Nigeria. Trop Geogr Med 1990;42:17–21.
[2] Sagay AS, Imade GE, Nwokedi EE. Human immunodeficiency virus infection in pregnant women in Nigeria. Int J Gynecol Obstet 1999;66:183–4.
[3] Report of 1995/96 HIV Sentinel Sero-surveillance in Nigeria. Federal Ministry of Health, National AIDS/STD Control Programme. May 1997, Abuja, Nigeria.
[4] A Technical report on the 2001 National HIV/Syhpilis Sentinel Survey among pregnant women attending Antenatal clinics in Nigeria. Federal Ministry of Health, National AIDS/STD Control Programme. December 2001, Abuja Nigeria.
[5] 2003 National HIV Sero-prevalence Sentinel Survey. Federal Ministry of Health, National AIDS/STD Control Programme. April 2004, Abuja, Nigeria.
[6] Guay LA, Musoke P, Fleming T, Bagenda D, Allen M, Nakabiito C, et al. Intrapartum and neonatal single-dose nevirapine compared with zidovudine for prevention of mother-to-child transmission of HIV-1 in Kampala, Uganda: HIVNET 012 randomised trial. Lancet 1999;354:795–802.
[7] Amsel R, Totten PA, Spiegel CA, Chen KC, Eschenbach D, Holmes KK. Non-specific vaginitis: diagnostic criteria and microbial and epidemiological associations. Am J Med 1983;74:14–22.
[8] Hosmer DW, Lemeshow S. Applied logistic regression. New York: John Wiley & Sons; 1989.
[9] Esu-Williams E, Mulanga-Kabeya C, Takena H, Zwandor A, Aminu K, Adamu I, et al. Seroprevalence of HIV-1, HIV-2, and HIV-1 group O in Nigeria: evidence for a growing increase of HIV infection. J Acquir Immune Defic Syndr Human Retrovirol 1997;16:204–10.
[10] Laga M, Schwartlander B, Pisani E, Sow PS, Carael M. To stem HIV in Africa, prevent transmission to young women. AIDS 2001;15:931–4.
[11] Auvert B, Ballard R, Campbell C, Carael M, Carton M, Fehler G, et al. HIV infection among youth in a South African mining town is associated with HSV-2 seropositivity and sexual behavior. AIDS 2001;15:885–98.
[12] Boerma JT, Gregson S, Nyamukapa C, Urassa M. Understanding the uneven spread of HIV within Africa: compar-

ative study of biologic, behavioral, and contextual factors in rural populations in Tanzania and Zimbabwe. Sex Transm Dis 2003;30:779–87.

[13] Fylkesnes K, Musonda RM, Kasumba K, Ndhlovu Z, Mluanda F, Kaetano L, et al. The HIV epidemic in Zambia: socio-demographic prevalence patterns and indications of trends among childbearing women. AIDS 1997;11:339–45.

[14] Dallabetta GA, Miotti PG, Chiphangwi JD, Saah AJ, Liomba G, Odaka N, et al. High socio-economic status is a risk factor for human immunodeficiency virus type 1 (HIV-1) infection but not sexually transmitted diseases in women in Malawi: implications for HIV-1 control. J Infect Dis 1993; 167:36–42.

[15] Ryder RW, Ndilu M, Hassig SE, Kamenga M, Sequeira D, Kashamuka M, et al. Heterosexual transmission of HIV-1 among employees and their spouses at two large businesses in Zaire. AIDS 1990;4:725–32.

[16] Gregson S, Zhuwau T, Ndlovu J, Nyamukapa CA. Methods to reduce social desirability bias in sex surveys in low-development settings: experience in Zimbabwe. Sex Transm Dis 2002;29:568–75.

[17] Flemming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV-1 infection. Sex Transm Infect 1999;75:3–17.

[18] Klebanoff SL, Coombs RW. Virucidal effect of *Lactobacillus acidophilus* on human immunodeficiency virus type-1; possible role in heterosexual transmission. J Exp Med 1991;174:289–92.

[19] Hillier SL. The vaginal microbial ecosystem and resistance to HIV. AIDS Res Hum Retroviruses 1998;14(Suppl 1):S17–21.

[20] Morris M, Nicoll A, Simms I, Wilson J, Catchpole M. Bacterial vaginosis: a public health review. Br J Obstet Gynaecol 2001;108:439–50.