

# Population-based survey of HIV sero-status and vertical transmission among naive pregnant women in Sokoto, Nigeria

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## ABSTRACT

**Background:** This study aims at investigating the seroprevalence of HIV infection among status naive pregnant women and probable vertical transmission in Sokoto, Nigeria. **Materials and Methods:** This cross-sectional study examined 13,026 apparently healthy pregnant women aged between 14 and 45 years and 312 mother-baby pairs in 4 different hospital settings in Sokoto State, North West, Nigeria between March, 2011 and February, 2013. The babies were aged between 8 and 16 months. HIV screening was performed using qualitative rapid tests and ELISA and HIV-DNA polymerase chain reaction (PCR) techniques. Measurement of CD4+ T-lymphocytes was carried out by the BD FACScout System. All seropositive pregnant women were immediately placed on triple antiretroviral therapy (ART) throughout the duration of the pregnancy and beyond. **Results:** An overall 2.4% prevalence of HIV-1 infection among the pregnant women and 20.5% incident of mother-to-child transmission were found. Of the seropositive pregnant women, 75.0% were full-time house wives, 13.8% and 11.2% were traders and civil servants respectively; of which, 70.2% were within the ages of 14 and 27 years (youthful predominance). Pearson's  $\chi^2$  analysis did not show any statistically significant difference in the Mean values in the 4 health facilities ( $\chi^2 = 2.084$ ,  $df = 3$ ,  $P\text{-value} = 0.555$ ). Similarly, no significant difference in HIV seropositivity in the demographic data of the pregnant women were observed ( $P > 0.05$ ). Infection was recorded in all age groups but there was no statistical significance between age groups and infection ( $P = 0.833$ ). Of the 64 seropositive babies, 62 (92.5%) contracted HIV from antiretroviral therapy non-adherence mothers ( $\chi^2 = 271.457$ ,  $df = 1$ ,  $P < 0.01$ ),  $OR = 1506.6$  (95%CI = 285.5-7950.4). **Conclusion:** This study found high prevalence of vertical transmission due to ART non-adherence. Intervention initiatives should, therefore, focus seriously on ART non-adherence.

**Key words:** HIV-naive pregnant women, Vertical transmission, Nigeria

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## INTRODUCTION

The greatest health problem threatening the human race in our time is the HIV/AIDS pandemic where the burden is greatest in sub-Saharan Africa.<sup>1</sup> Epidemiologic data indicates that heterosexual and vertical transmissions constitute 80-95% of HIV infections in Nigeria.<sup>2</sup> This is largely influenced by lack of sexual health information and education, ignorance of one's HIV status, socio-cultural

practices, poor healthcare system, general poverty, low levels of condom use and high levels of sexually transmitted infections (STIs).<sup>3</sup> Since the first case of HIV was reported in a 13-year old girl in 1986 in Nigeria,<sup>4</sup> it is estimated that approximately 3.5 million people are currently living with HIV making Nigeria with the second highest burden of HIV in the world, only after South Africa.<sup>1</sup> With this figure, it is estimated that the current National HIV seroprevalence in Nigeria as at the end of 2012 is 3.4%.<sup>2</sup>

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This unfortunate epidemic, which was once dominated by infected males, has become progressively feminized and in sub-Saharan Africa (Nigeria inclusive) approximately 60% of adults living with HIV are women.<sup>1</sup> As HIV prevalence increases among women in sub-Saharan Africa and the world in general, the risks of mother-to-child transmission (MTCT) of HIV also increases. MTCT accounts for 90% of HIV infection among children less than 15 years.<sup>1,3</sup> With an estimated 260,000 children infected with HIV as at the end of 2011, Nigeria accounts for more than 10% of the global paediatric HIV burden.<sup>5</sup> Consequently, a burden has been placed on women and children, who in many settings continue to experience high rates of new HIV infections and of HIV-related illnesses and death (3). The high burden of MTCT in Nigeria is due to high viral load, mode of delivery, prolonged rupture of membranes, prematurity, higher prevalence of HIV in women of reproductive age, high total fertility rate, characteristically prolonged breastfeeding culture, as well as poor access to prevention of mother-to-child transmission (PMTCT) interventions. In the absence of MTCT interventions 20-45% of infants born to HIV positive women will become positive during pregnancy, delivery, or through breastfeeding.<sup>6</sup> And childhood HIV has become a critical health problem that threatens to undermine the positive impact of child survival strategies in the African continent.

The possibility that both the pregnant woman and her child could be HIV-infected calls for concerted efforts at establishing the magnitude of the problem in order to achieve the main objective of antenatal care. To promote maternal good health that will lead her to produce live healthy baby at the end of the pregnancy. Any pregnant woman screened positive for HIV will be effectively managed during the antenatal, intrapartum and post-natal periods to help reduce the MTCT rate of HIV. In addition, early diagnosis of HIV infection in pregnancy will make it possible for HIV-exposed and HIV-infected infants to receive early prophylaxis for opportunistic infections and antiretroviral therapy (ART).<sup>7</sup> If left untreated, HIV infection in children is associated with high morbidity and mortality rates.<sup>8</sup> Furthermore, a review of the HIV test results in a PMTCT programme will provide a unique opportunity for evaluating the success of the PMTCT programme.<sup>7</sup> HIV testing in pregnancy is the gate way to accessing care for the mother and child. The interventions in prevention of mother to child transmission (PMTCT) of HIV can only be applied to a woman whose HIV status is known<sup>9</sup> through laboratory screening during ante-natal visit. Against this background, this study aims at investigating the seroprevalence of HIV infection among status naive pregnant women and the probable vertical transmission of HIV in four ante-natal clinics in Sokoto State, North West, Nigeria.

## MATERIALS AND METHODS

### Study design

This was a cross-sectional study conducted among antenatal attendees who had counselling on HIV infection and antiretroviral therapy (ART).

### Setting

This study was conducted at four (4) different hospital settings in Sokoto State, Nigeria which include Usman Dan Fodio University Teaching Hospital (UDUTH), a tertiary healthcare institution located in Sokoto, the state capital with 1400 bed capacity; Specialist Hospital Sokoto, a secondary healthcare institution with a bed capacity of 620 also located in the state capital; Dogon-Daji General Hospital, a primary health centre located in Dogon-Daji Local Government area of Sokoto state. It is a rural health centre with 200 bed capacity; and Holy-Family Health Centre, another a primary health centre located in WAMACO Local Government Area of Sokoto state with 100 bed capacity. The 4 hospitals were chosen because they offer free prevention of mother-to-child transmission (PMTCT) of HIV services.

### Study population

A total of 13,026 apparently healthy pregnant women aged between 14 and 45 years who were attending the Antenatal Clinics for the very first time in this their current pregnancy of the above four (4) different hospital settings in Sokoto State were consecutively recruited for this study. Exclusion criteria were history of HIV and knowledge of HIV status. A nurse/midwife counsellor obtained the information on bio-data and socio-demographic parameters.

### Informed consent and ethical clearance

Informed consent was obtained from each pregnant woman prior to sample collection. Ethical approval was obtained from the Medical Ethics Committee of the Hospitals.

### Sample collection and analyses

Two millimetres (2 ml) of venous blood was collected from each participant into EDTA bottles and mixed properly to avoid clotting. All the pregnant women and the mother-infant pairs of the HIV seropositive mothers were screened for human immunodeficiency virus (HIV) antibodies, CD4 count and viral load. All analyses were carried out according to standard procedures. The mothers HIV screening was carried out using Abbott Determine™ HIV 1/2 test kit (Abbot Laboratories, Illinois, USA), STAT- PAK™ HIV-1/2 (CHEMBIO Diagnostic System Inc. USA) and Clinotech Diagnostic Enzyme-Linked Immunosorbent Assay (ELISA) test kits (Clinotech Laboratories, USA). The Manufacturers' Standard Operating Procedures (SOPs)

were strictly followed. Briefly, each pregnant woman's serum was tested for the presence of HIV antibodies using Determine™ HIV-1/2 and STAT-PAK™ HIV-1/2. If both kits tested positive, the result was considered positive for HIV infection. These methods which are immunochromatographic and qualitative in nature, detect the presence of antibodies to HIV-1 and HIV-2 in human blood with a sensitivity of more than 99.9% and specificity of 99.75%. If the results were discordant, ELISA was used as tie breaker. HIV-seropositivity was defined as a reactive result on two of the test systems. Subjects not reactive were considered HIV-seronegative.

All the HIV exposed infants born to the HIV positive pregnant women were screened for HIV using HIV-DNA Polymerase Chain Reaction (PCR) technique on Dried Blood Spot (DBS) samples taken from them using Q1Amp DNA Mini kit.

#### Criteria for the pregnant women eligibility for ART initiation (treatment)

The national PMTCT guidelines for pregnant women eligibility for ART initiation was used after adherence counselling. Only those who tested positive for HIV and at or over 14 weeks of gestation and irrespective of their CD4 cell counts were placed on triple antiretroviral cocktail consisted of Zidovudine (AZT) or Stavudine (D4T) plus Lamivudine (3TC) plus either Nevirapine (NVP) or Efavirenz (EFZ) throughout the duration of the pregnancy and beyond. All the pregnant women who tested positive for HIV were included for the treatment to prevent HIV transmission to their infants.<sup>10</sup> The entire HIV positive mothers exclusively breastfed their babies until the baby was sampled for screening.

#### HIV-exposed babies ART regimen

The HIV-exposed babies (babies born to HIV positive women) were given nevirapine (NVP) and septrin (cotrimoxazole) prophylaxis within the first three days of life up to six weeks. The HIV-exposed infants were thereafter screened for HIV according to the National Early Infant Diagnosis algorithm which stipulates that a DNA

PCR test should be carried out on all HIV-exposed infants at age six weeks. Mothers of infants with a positive HIV result were counselled to enrol the infant into HIV care and treatment services, while those who breastfed and whose babies have a negative HIV results were advised to return six weeks after the complete cessation of breastfeeding for a repeat DNA PCR test. If the HIV-PCR test was negative the initial treatment was suspended, but if the HIV-PCR test was positive they were given a combination dose of zidovudine (AZT), lamivudine (3TC) and nevirapine (NVP).<sup>10</sup> Combination drug regimens are considered the standard of care for treatment of HIV infection and for prevention of perinatal HIV transmission.<sup>10</sup>

#### Data analysis

The data analysis was carried out using Statistical Package for Social Science (SPSS) software (version 17.0, SPSS, Chicago, USA). The level of significance was set at  $P < 0.05$ . Percentages mean and standard deviations were used for the descriptive data. The results of human immunodeficiency virus (HIV) test were expressed as either positive or negative as the case may be.

## RESULTS

Out of the 13,026 antenatal attendees screened for HIV infection, 12,714 (97.6%) were HIV sero-negative and 312 (2.4%) were HIV sero-positive (all were HIV type-1). Initially, it was 324 out of the 13,026 pregnant women (2.5%) who tested positive for HIV infection but 12 (3.7%) relocated their residency and were lost to follow-up. Those 312 HIV positive pregnant women constituted the sub-study population, of which 64 (20.5%) transmitted the infection to their babies while the remaining 248 (79.5%) did not transmit the infection to their babies. Of the 4 health facilities, the antenatal attendees of Dogon-Daji Health Centre had the highest prevalence rate of 5.57%. HIV seropositivity among the babies was also the highest in this health facility. However, analysis of variants (ANOVA) did not show any statistically significant difference among the 4 health facilities ( $\chi^2 = 2.084$ ,  $df = 3$ ,  $P\text{-value} = 0.555$ ) (Table 1).

**Table 1: Frequency distribution of HIV status of the pregnant women and their newborn babies according to health facilities**

Health facility	Total	HIV status of Mothers (%)		HIV status of children of HIV positive Mothers (%)	
		Pos.	Neg.	Pos.	Neg.
Specialist Hospital Sokoto	4506	100 (2.22)	4406 (97.78)	20 (20.00)	80 (80.00)
UDUTH	5500	100 (1.82)	5400 (98.18)	17 (17.00)	83 (83.00)
Holy Family HC	1520	30 (1.97)	1490 (98.03)	6 (20.00)	24 (80.00)
Dogon-Daji HC	1500	82 (5.57)	1418 (94.53)	21 (25.61)	61 (74.39)
Total	13026	312 (2.40)	12714 (97.6)	64 (20.51)	248 (79.49)

$\chi^2 = 2.084$ ,  $df = 3$ ,  $P\text{ value} = 0.555$ . HIV, human immunodeficiency virus

Analysis of the demographic data of the pregnant women positive for HIV-1 infection (Table 2a) shows that the majority, 251 (80.4%) were Muslims and 61 (19.6%) were Christians. Cross Tabulation Analysis of Religion versus HIV Status indicated that 14 (23.0%) of the HIV-1 seropositive pregnant women were Christians and 50 (19.9%) were Muslims; whereas, 47 (77.0%) and 201 (80.1%) were seronegative, respectively. All the pregnant women positive for HIV infection had formal or Qu'ranic education with 40.7% of them with secondary education; 75.0% were house wives while 13.8% and 11.2% were traders and civil servants respectively (Tables 2b, c and d). Analysis of variants (ANOVA) did not show any significant difference among the demographic data ( $P>0.05$ ) of the HIV seropositive mothers.

**Table 2a: Frequency distribution of the demographic data of the pregnant women positive for HIV infection**

Demographic data	Frequency (%)
Religion	
Christians	61 (19.6)
Muslims	251 (80.4)
Total	312 (100.0)
Education	
Higher institution	21 (6.7)
Secondary education	127 (40.7)
Primary education	91 (29.2)
Qu'ranic education	73 (23.4)
Total	312 (100.0)
Occupation	
Civil servant	35 (11.2)
House wife	234 (75.0)
Trading	43 (13.8)
Total	312 (100.0)

**Table 2b: Cross tabulation analysis of religion versus HIV status**

Religion	HIV status		Total
	+	-	
Christian	14 (23.0)	47 (77.0)	61
Muslim	50 (19.9)	201 (80.1)	251
Total	64 (20.5)	248 (79.5)	312

$\chi^2=0.276$ ,  $df=1$ ,  $P$  value=0.599. HIV, human immunodeficiency virus

**Table 2c: Cross tabulation analysis of education versus HIV status**

Education	HIV status		Total
	+	-	
Higher institution	1 (4.8)	20 (95.2)	21
Secondary education	26 (20.5)	101 (79.5)	127
Primary education	20 (22.0)	71 (78.0)	91
Qu'ranic education	17 (23.3)	56 (76.7)	73
Total	64 (20.5)	248 (79.5)	312

$\chi^2=3.660$ ,  $df=3$ ,  $P$  value=0.301. HIV, human immunodeficiency virus

As shown in Tables 3 and 4, of the 312 HIV-1 seropositive pregnant women studied, 219 (70.2%) were within the ages of 14 and 27 years; of which 46 (21.0%) were seropositive for HIV-1 and 173 (79.0%) were seronegative. The remaining 93 (29.8%) were 28 years and above; of which 18 (19.4%) were seropositive for HIV-1 and 75 (80.6%) were seronegative; making a total of 64 (20.5%) seropositive for HIV-1 and 248 (79.5%) seronegative. No maternal age group was free from HIV infection. The babies' sex distribution consisted of 158 (50.6%) males and 154 (49.4%) females. Of the 158 (50.6%) males, 33 (20.9%) were HIV-1 positive and 125 (79.1%) were HIV-1 negative. Of the 154 (49.4%) females, 31 (20.1%) were HIV-1 positive and 123 (79.9%) were HIV-1 negative. Pearson's  $\chi^2$  analysis revealed no statistically significant difference between the babies' sex and HIV seropositivity ( $\chi^2=0.027$ ,  $df=1$ ,  $P$ -value=0.869).

Table 5 shows the frequency distribution of the babies' age groups versus HIV status. Nearly one-third (30.1%) were aged 8 – 10 months, 46.2% were aged 11 – 13 months, and 23.7% were aged 14 – 16 months. The HIV seropositivity cut across all the age groups and there were no statistically significant differences in the proportions ( $\chi^2=1.729$ ,  $df=2$ ,  $P$ -value=0.440).

Table 6 summarizes the cross tabulation analysis of adherence and non-adherence versus HIV Status. Of the 312 pregnant women positive for HIV-1 infection, 245 (78.5%) adhered to their antiretroviral therapy regimen and the remaining 67 (21.5%) did not adhere. Of the 67 non-adherence cases 62 (92.5%) transmitted the HIV-1

**Table 2d: Cross tabulation analysis of Occupation versus HIV status**

Occupation	HIV status		Total
	+	-	
Civil servant	4 (11.4)	31 (88.6)	35
House wife	50 (21.4)	184 (78.6)	234
Trading	10 (23.3)	33 (76.7)	43
Total	64 (20.5)	248 (79.5)	312

$\chi^2=2.075$ ,  $df=2$ ,  $P$  value=0.354. HIV, human immunodeficiency virus

**Table 3: Frequency distribution of HIV sero-positivity according to mothers' age groups**

Mothers' age group (years)	Frequency (%)
14 – 20	91 (29.2)
21 – 27	128 (41.0)
28 – 34	61 (19.6)
35 – 41	25 (8.0)
41 and above	7 (2.2)
Total	312

HIV, human immunodeficiency virus

**Table 4: Frequency distribution of the babies' HIV status according to sex and their mothers' age groups**

Mothers age group (years)	HIV status		Total	Baby sex	HIV status		Total
	+	-			+	-	
14 – 20	22 (24.2)	69 (75.8)	91	Male	33 (20.9)	125 (79.1)	158
21 – 27	24 (18.8)	104 (81.3)	128	Female	31 (20.1)	123 (79.9)	154
28 – 34	11 (18.0)	50 (82.0)	61	Total	64 (20.5)	248 (79.5)	312
35 – 41	5 (20.0)	20 (80.0)	25				
41 and above	2 (28.6)	5 (71.4)	7				
Total	64 (20.5)	248 (79.5)	312				

$\chi^2=1.506$ ,  $df=4$ ,  $P$  value= $0.833$ ,  $\chi^2=0.027$ ,  $df=1$ ,  $P$  value= $0.869$ . HIV, human immunodeficiency virus

**Table 5: Frequency distribution of the babies' HIV status according to age groups (in months)**

Babies' age group (in months)	HIV status		Total (%)
	+	-	
8 – 10	15 (16.0)	79 (84.0)	94 (30.1)
11 – 13	32 (22.2)	112 (77.8)	144 (46.2)
14 – 16	17 (23.0)	57 (77.0)	74 (23.7)
Total	64 (20.5)	248 (79.5)	312

$\chi^2=1.729$ ,  $df=2$ ,  $P$  value= $0.440$ . Abbreviation: HIV, human immunodeficiency virus

**Table 6: Cross tabulation analysis of adherence and non-adherence versus HIV status**

ART	HIV status		Total
	+	-	
Non-adherence	62 (92.5)	5 (7.5)	67
Adherence	2 (0.8)	243 (99.2)	245
Total	64 (20.5)	248 (79.5)	312

$\chi^2=271.457$ ,  $df=1$ ,  $P$  value= $<0.01$ ;  $OR=1506.6$  ( $95\%CI=285.5-7950.4$ ). HIV, human immunodeficiency virus

infection to their babies while 5 (7.5%) did not transmit the HIV infection to their babies. Pearson's  $\chi^2$  analysis revealed a significant difference ( $P<0.05$ ) in the transmission rate between those who adhered to their antiretroviral therapy regimen and those who did not adhere. The babies of the HIV positive mothers that did not adhere to their antiretroviral therapy regimen are 1,506.6 times more likely to have HIV infection than the children of the HIV positive mothers that adhered (*Odd Ratio*=1506.6 ( $95\%CI=285.5-7950.4$ )). Whereas, of the 245 HIV-1 positive pregnant women who adhered to their antiretroviral therapy regimen, only 2 (0.8%) transmitted the HIV-1 infection to their babies; while the remaining 243 (99.2%) did not transmit the HIV infection to their babies ( $\chi^2=271.457$ ,  $df=1$ ,  $P$ -value= $<0.01$ )  $OR=1506.6$  ( $95\%CI=285.5-7950.4$ ). In the overall, 64 (20.5%) of the babies were positive for HIV infection and 248 (79.5%) were negative.

Table 7 shows the frequency distribution of the HIV-1 positive pregnant women in relation to adherence and non-adherence versus mother's age groups. Analysis of variants (ANOVA) revealed that maternal age group

**Table 7: Frequency distribution of the HIV positive pregnant women in relation to non-adherence and adherence and mother's age groups**

Mother's age group	ART (%)		Total
	Non compliance	Compliance	
14 – 20	23 (25.3)	68 (74.7)	91
21 – 27	26 (20.3)	102 (79.7)	128
28 – 34	10 (16.4)	51 (83.6)	61
35 – 41	6 (24.0)	19 (76.0)	25
41 and above	2 (28.6)	5 (71.4)	7
Total	67 (21.5)	245 (78.5)	312

$\chi^2=2.119$ ,  $df=4$ ,  $P$  value= $0.735$ . HIV, human immunodeficiency virus

did not influence the transmissibility of the HIV-1 infection in relation to adherence and non-adherence to their antiretroviral therapy regimen ( $\chi^2=2.119$ ,  $df=4$ ,  $P$ -value= $0.735$ ).

## DISCUSSION

This study found 2.4% overall prevalence of HIV-1 infection among the pregnant women and 20.5% prevalence rate of mother-to-child transmission, which could serve as a baseline data and subsequently be used to monitor the trend of the disease. No woman was seropositive to HIV-2, which may suggest that HIV-2 is not common in this locality. Reasons for this current seroprevalence rates include high prevalence of low level of national and individual awareness, low perception to risk, and poverty in the community, and non-adherence. Our findings indicate that HIV infection is still a major public health problem among women of reproductive age and paediatrics in Sokoto, Nigeria. This relatively low 2.4% seroprevalence obtained in this current study was not very surprising as compared with the 6.4% prevalence found in the National HIV seroprevalence sentinel survey report of 2012 among the general population of antenatal clinic attendees in Sokoto State.<sup>11</sup>

Our seroprevalence rate in this study is similar to some earlier reports conducted in Nigeria such as the 3.0% found in Jos, North-Central Nigeria<sup>12</sup> and the 2.83% reported by Ajoge *et al.*<sup>13</sup> in Okene. However, the 2.4% seroprevalence rate in

this study is lower than the 3.5% seroprevalence found in another related study carried out at the University of Port Harcourt Teaching Hospital, Port Harcourt, South-South Nigeria;<sup>14</sup> the 4.1% in Yenagoa City, Bayelsa State.<sup>9</sup> Similar studies in other parts of Nigeria such as the 5.2% reported at the Federal Medical Centre, Yola, North-eastern Nigeria,<sup>15</sup> the 28.6% reported at University College Hospital, Ibadan, Nigeria<sup>16</sup> and the 7.8% at the General Hospital, Minna, Nigeria<sup>17</sup> all reported higher rates. The 2.4% seroprevalence in this study is also lower than some similar studies reported from other African countries like in Kenya (6.7%)<sup>18</sup> and Tanzania (10.6%).<sup>19</sup> This lower rate may suggest a steady decline in HIV-1 infection among pregnant women in general. However, the existence of 2.4% HIV-1 prevalence still presents a serious public health problem in this state. It poses a special risk in transmitting the infection to their fetuses or infants during pregnancy, labour or breast feeding.

In contrast, the finding in this study is higher than the 0.8% seroprevalence found in a Missionary Hospital, Nsukka, Nigeria;<sup>20</sup> whereas, Sahaf *et al.*<sup>21</sup> and Todd *et al.*,<sup>22</sup> found no cases of HIV infection in Malekan and Kabul, respectively. Those various findings succinctly indicate that there is a wide geographical variation in the seroprevalence of HIV infection amongst pregnant women within and outside Nigeria. This corroborates the importance of establishing our own institution based values. The variations may be a reflection of the differences in socio-cultural practices, low perception to risk, and poverty in the community.

The study subjects' demographic data did not affect or influence their HIV status in this our study (occupations:  $\chi^2 = 2.075$ ,  $df=2$ ,  $P\text{-value}=0.354$ ; religion:  $\chi^2 = 0.276$ ,  $df=1$ ,  $P\text{-value}=0.599$  and education:  $\chi^2 = 3.660$ ,  $df=3$ ,  $P\text{-value}=0.301$ ) [Tables 2b, c and d]. The house wives, civil servants and traders all had their fair share of the HIV infection and the differences were not statistically significant ( $P>0.05$ ). Both the Christians and Muslims of the study subjects (pregnant women) were seropositive for HIV-1; it is therefore important to mount a sensitization campaign on the need for voluntary counselling and testing of the spouses to reduce the spread of HIV/AIDS in the general population. The entire pregnant women positive for HIV-1 infection have some level of formal or Qu'ranic education with 40.7% of them with secondary education. None of the women was an illiterate. This finding is in consonance with the findings of Imade *et al.*,<sup>23</sup> who reported that literate women had a higher prevalence of HIV infection compared to their illiterate counterparts.

Maternal age groups distribution did not affect HIV seropositivity in our study. All the maternal age groups experienced HIV infection. However, 70.2% were within the ages of 14 and 27 years. This corroborates the reported

higher incidence of sexual activities among the youths (age <30 years). Maternal age group did not also affect or influence the seropositivity of HIV among the babies in this study ( $\chi^2 = 1.506$ ,  $df=4$ ,  $P\text{-value}=0.833$ ) [Tables 3 and 4]. This is in concert with the findings of Imade *et al.*<sup>23</sup>

Our current study observed a relatively high incidence/prevalence of 20.5% (64/312) mother-to-child transmission (MTCT) of HIV among exclusively breastfed HIV-exposed newborn babies. This corroborates the fact that mother to child transmission of HIV still remains one of the most efficient and prominent ways of paediatric HIV transmission in Nigeria. This finding also gives credence to the need to offer routine screening to all HIV-exposed newborn babies as provided in the WHO guideline<sup>24</sup> as well as the need to intensify efforts to get MTCT service to the large numbers of Nigerian women needing it. According to the UNGASS Country Progress Report for Nigeria,<sup>25</sup> there are about 57,000 babies born with HIV each year and an estimated 360,000 children are living with HIV in Nigeria, most of whom became infected from their mothers.<sup>26</sup> The MTCT rate in this study is comparable to the 18.5% at the Nnamdi Azikiwe University Teaching Hospital, Nnewi<sup>27</sup> and the 22% reported at the Nigerian Institute of Medical Research, Yaba, Lagos, Nigeria.<sup>28</sup> It is, however, higher than the 13.6% reported at the Imo State University Teaching Hospital, Orlu, Imo State<sup>29</sup> and the 2.54% at the Amino Kano University Teaching Hospital, Kano.<sup>30</sup> It is also higher than the 4.9% and 12.1% obtained from Brazil<sup>31</sup> and Cuba<sup>32</sup> respectively. Our MTCT rate is lower than the 45.0% and 93.3% at the University College Hospital, Ibadan, Southwestern Nigeria by Odaibo *et al.*,<sup>33</sup> and Ogubosi *et al.*,<sup>34</sup> respectively.

Though the finding of 20.5% in this study is considered high it falls below the often quoted 25-45% estimated rate of MTCT of HIV without intervention.<sup>35</sup> It is difficult to ascertain the level of success without control group and there were no previously established baselines in the four healthcare facilities to compare outcomes. This study has provided for the very first time a platform to compare or monitor the efficiency of the antiretroviral therapy (ART) regimens and the general prevention of mother-to-child transmission (PMTCT) of HIV services in the study sites. This notwithstanding, we call for more concerted efforts to improve the services or methodologies to reduce it further to at least less than one per cent (<1%). Studies have shown that when HIV-infected women are treated with antiretroviral therapy and their infants receive antiretroviral (ARV) prophylaxis, mother-to-child transmission of HIV (MTCT) occurs in less than 1% of pregnancies.<sup>36,37</sup>

Some infants became infected despite treatment probably because (a) the HIV transmission occurred before treatment,

(b) inefficient suppression of maternal viral replication by zidovudine, (c) non-adherence to the treatment regimen, or (d) unique characteristics of the infecting maternal strain of HIV, such as decreased susceptibility to zidovudine. Susceptibility testing of isolates from these mother-infant pairs was not performed. High-level resistance to zidovudine was unlikely, considering the relatively short duration of the maternal treatment, the lack of previous maternal exposure to zidovudine before now, and the relatively high median CD4+ T-lymphocyte count of the mothers at entry. Non-adherence to the treatment regimen is a very strong factor. Of the 67 non-adherence cases, 62 (92.5%) transmitted the HIV infection to their babies.

This study recorded a non-adherence rate of 21.5% among the HIV-positive pregnant women. This is in consonance with the 21.7% reported by Igwegbe *et al.*<sup>38</sup> in a similar study at Nnewi, Nigeria and the 19.4% reported by Ekama *et al.*<sup>39</sup> in Lagos, Nigeria. It is, however, higher than the 16.3% reported in Zambia,<sup>40</sup> but lower than the 37.1% and 37.4% reported by Oloowokere *et al.*<sup>41</sup> and Shaahu *et al.*,<sup>42</sup> respectively in Ibadan, Southwestern Nigeria. The 21.5% non adherence rate found in this study is considered high in spite of the fact that all the women had adherence counseling prior to the initiation of ART. This may indicate a need to review pre commencement adherence counseling practice in the area in terms of organization, content and delivery. It may be important to survey the knowledge of the trained counselors and possibly organize periodic re-training. Proper evaluation of the clients for beliefs and attitudes is central to effective counseling as studies have shown that clarification of clients' beliefs and attitudes during adherence counseling significantly improve their level of adherence to ART.<sup>38,43</sup>

We did not examine the likely causes of the non-adherence and would suggest further research in this direction. But whatever are the likely reasons HIV-positive pregnant women should realize that antiretroviral therapy in pregnancy is not solely for preventing/controlling maternal disease but also to prevent mother-to-child transmission of HIV. Of the 67 non-compliance cases, 62 (92.5%) transmitted the HIV infection to their babies while 5 (7.5%) did not transmit the HIV infection to their babies. Pearson's  $\chi^2$  analysis revealed a significant difference ( $P < 0.05$ ) between those who adhered to and those who did not adhere to their antiretroviral therapy regimen. The non-adherence HIV-positive mothers had 1,506.6-fold increase rate of MTCT of HIV in this study ( $\chi^2 = 271.457$ ,  $df = 1$ ,  $P\text{-value} = < 0.01$ ;  $OR = 1506.6$  ( $95\% CI = 285.5-7950.4$ ), whereas, Galli *et al.*<sup>44</sup> in their cohort study reported that temporary discontinuation led to a 10-fold increase in the rate of MTCT, overcoming all other risk factors, except for the independent factor of high plasma viral RNA load at

delivery. It is important, therefore, to note that temporary discontinuation of ART after commencement or non-adherence is both detrimental to the maternal health.

Adequate adherence to the prescribed antiretroviral medications is essential to achieving maximal viral suppression necessary to prevent MTCT.<sup>38</sup> Adherence rates exceeding 95% are necessary, in order to maximize the benefits of antiretroviral therapy. Higher levels of drug adherence are associated with improved virological, immunological, and clinical outcome.<sup>45</sup> Poor adherence to antiretroviral drugs during pregnancy can lead to suboptimal viral suppression, development of viral resistance, higher risk of mother-to-child transmission, and mother-to-child transmission of resistant HIV strains.<sup>46</sup> Interrupting medication permits the virus to resume rapid replication and as many as 1010 viral particles will be produced per day. This allows resistant mutant strains to be generated which are no longer responsive to available antiretroviral drugs, posing a public health danger. Adherence to antiretroviral drugs poses unique challenges to HIV infected persons particularly among pregnant women.<sup>47</sup> Improving adherence among pregnant women therefore requires knowledge of the factors that influence adherence.

The HIV seropositivity among the babies in this study cut across all the age groups in months (Table 7) and there were no statistically significant differences in the proportions in the age groups ( $\chi^2 = 1.729$ ,  $df = 2$ ,  $P\text{-value} = 0.440$ ) even though those in groups 14-16 months old and 11-13 months old were higher than those in group 8-10 months old, 23%, 22.2% and 16% respectively. This is likely to be due to the length of time the babies were exposed to breast feeding as all the mothers were exclusively breast feeding their babies. However, Shaffer *et al.*<sup>48</sup> reported a statistically significant difference in children less than 6 months of age who had higher rate of HIV (12.6%) than children 6-11 months old (1.9%) and children 1-13 years old (4.1%).

## CONCLUSIONS

In conclusion, this study has shown a significant incidence of mother to child transmission (MTCT) of HIV, which could now serve as baseline data for subsequent monitoring of MTCT among HIV seropositive antenatal women on ART in Sokoto State. The greatest challenge was non-adherence by some of the seropositive mothers on antiretroviral therapy. Adherence to antiretroviral therapy is a principal predictor for the success of prevention of mother to child transmission of HIV. It is to be recommended that intervention initiatives should focus seriously on ART non-adherence among

seropositive antenatal attendees. Timely detection of non-adherence behaviours and appropriate monitoring of patients' difficulties with ART could potentially help seropositive antenatal attendees on anti-retroviral therapy to maintain adherence and therefore improve the treatment outcomes. There was no relationship between demographic variables like gender and age range with HIV seropositivity in the babies. It is to be recommended that assess to PMTCT services be scaled up to arrest any chances of mother-to-child-transmission. More so, paediatric HIV treatment services and support should be scaled up to ensure the achievement of a HIV free generation in the nearest future.

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**Authors Contribution:**

FI - Buseri conceived the idea, design the study, collected and analyzed data and wrote the initial and final drafts of the paper. CN - Okonkwo supported FI Buseri in data collection and analysis and contributed to initial and final drafts.

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