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Title: Post Option B+ implementation programme in Nigeria: Determinants of adherence of antiretroviral therapy among pregnant women with HIV

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Abstract: Objective Nigeria has the highest rate of mother to child transmission of HIV (MTCT) in the world. By 2015, all Global Plan priority countries, except Nigeria, had adopted the Option B+ programme. Nigeria finally adopted Option B+ in 2016 with full implementation reported in 2017. We examined adherence to antiretroviral therapy (ART) among pregnant women since the rollout of Option B+ in Nigeria.

Methods A cross sectional approach was adopted that involved dissemination of a survey (Adult AIDS Clinical Trial Groups [AACTG] standardised survey) to HIV positive pregnant women, to assess adherence to ART. This study was conducted from February to June, 2018 in four health care sites in Akwa Ibom State, in the South-South region of Nigeria. Bootstrapping was used to estimate the 95% confidence interval of the prevalence of adherence. Bivariate associations between patient demographic characteristics and medication taking behaviours, and the outcome variable of ART adherence were examined using Chi-square tests. Multivariable logistic regression was used to identify factors independently associated with adherence.

Results Of the 275 women (response rate=92.6%), 32.7% (95% CI: 26.9 to 38.5) self-reported taking all ART doses in the past 96 hours. In the multivariable logistic regression analyses, there were positive associations between an increased education level (OR=1.7, p=0.006) and disclosure of HIV status (OR=2.3, p=0.024), and medication adherence. For women who had previous prevention of MTCT exposure, the odds of medication adherence were 2.5 times higher compared with those with no previous MTCT exposure (OR=2.5, p=0.005).

Conclusion Adherence to ART among pregnant women in Nigeria is low. There is a need to improve adherence during pregnancy under the Option B+ programme in Nigeria.

Responses to reviewer comments

Post Option B+ implementation programme in Nigeria: Determinants of adherence of antiretroviral therapy among pregnant women with HIV (IJID-D-18-00042)

S/N	Reviewers comment	Response and location
1	Highlights: in the highlights it is incorrectly assumed that association is the same as causation. E.g. addressing education and disclosure would not necessarily impact on adherence. Both education and being able to disclose HIV status may be related to socioeconomic status and addressing these in isolation may not have the desired effect. Please revise to state that these were associations. ".... were associated with improved adherence"	We have addressed this comment. The specific response to this comment can be found in the highlights section. • Disclosure of HIV status to anyone was associated with ART adherence during pregnancy. • Among pregnant women, previous prevention of MTCT was associated with ART adherence. • An increased level of education among pregnant women was associated with ART adherence.
2	Abstract: Sites are referred to as "services" please correct.	The specific response to this comment can be found in the method section of the abstract. This study was conducted from February to June, 2018 in four health care sites in Akwa Ibom State, in the South-South region of Nigeria
3	Abstract: Please correct the statement about prevalence calculated by bootstrapping. Bootstrapping was used to estimate the confidence interval of the prevalence and not the observed prevalence.	We have corrected this statement. The correction can be found in the method section of the abstract. Bootstrapping was used to estimate the 95% confidence interval of the prevalence of adherence.
4	Please replace term "adherences" used in text with "adherence"; the use of this plural term is not appropriate.	We have replaced the term ‘’adherences” with ‘’adherence.’’ The correction can be found under the method section, sub-heading “Data collection” on page 7, paragraph 1 in the text. Section one measures adherence based on a four-day recall method, with sections two and three assessing adherence to the medication regimen and special instructions on how to take ART.
5	Please provide details about which fixed dose combination tablets were used in this population.	We have included the details of the fixed dose combination tablets used in this population in the results section of the text (page 8, paragraph 1). Details are stated below. An overwhelming majority of the women (274 out of 275) were

		on a fixed dose combination of Tenofovir 300mg (TDF) +Lamivudine 300mg (3TC) +Efavirenz 600mg (EFV) taken once a day at night. One woman was on a fixed dose combination of Zidovudine (300mg) (ZDV)+Lamivudine 150mg (3TC)+ Nevirapine 200mg (NVP) taken twice daily (12 hourly).
6	Stepwise backwards regression was used for model selection; using this approach the order of variable removal could influence the final model selected. Please rather use criterion-based model selection using either BIC or AIC; and assess if this impacts on the final model.	Both AIC and BIC were also considered for the model selection process and the results remained unchanged. The model selection criteria in the methods has been revised accordingly on page 8, paragraph 1. Table 3 now contains a footnote that explains the multivariable logistic model has been edited to reflect this modification. Thus, the specific response to this comment can found in the following locations: Method section, page 8, paragraph 1: In addition the Akaike information criterion (AIC) and the Bayes information criterion (BIC) were compared between the nested models and the model with optimal (i.e. smaller) goodness of fit index was selected as the final multivariable model.[20] Table 3 (foot note): * AIC and BIC for initial model included all factors significant at 0.1, and were 254.2 and 312.1 respectively. These indexes changed to 84.8 and 102.9 in the final selected model.
7	Last line of results: Please correct language "having a treatment supporter had a borderline significant trend with adherence to ART (OR=2, 95% CI: [1.0 to 4.4], p=0.084)." e.g. there was a trend towards a significant association between having a treatment supporter and adherence to ART …	We have addressed this comment. The specific response can be found in the last line of the results (page 10, paragraph 2). In the final logistic regression model, there was a trend towards a significant association between having a treatment supporter and adherence to ART (OR=2, 95% CI: [1.0 to 4.4], p=0.084).
8	The 95% adherence threshold is not relevant to NNRTI based regimens. Please seehttps://academic.oup.com/cid/article/43/7/939/372031 and other recent publications and correct this statement.	We have addressed this comment by replacing this statement: ‘’It is well established that a high adherence level of 95% or greater is required to achieve consistent viral load suppression in order to maximize the benefits of ART.’’ The new statement in the discussion section reads as follows (page 10, paragraph 1): “Current evidence involving general patients situated in developed countries suggests that an adherence level lower than 95% may be sufficient for viral load suppression in populations using the newer non-nucleoside

		reverse transcriptase inhibitors (NNRTI) formulations,[21,22] as compared with the near perfect adherence of 95% or greater required when using the early ART regimens.[23,24] However, health care professionals must continue to support patients to achieve perfect adherence. This is" This is because……
9	Tables 1 and 2: Please remove the "dose non-adherent" column as this does not add any information in addition to the "dose adherent" column.	We have addressed this comment by removing the ''dose non-adherent column in tables 1 and 2. This can be verified by viewing tables 1 and 2.
10	Please clarify whether the completed questionnaires, collected, were anonymous. Please also comment on whether the anonymous collection of adherence information may improve accurate reporting by eliminating social desirability bias and whether this may be a strength of this study.	The questionnaires were completed anonymously. We have included this statement under the method section, sub-heading (recruitment) in the text (page 6, paragraph1): Women completed the AACTG standardised survey anonymously and placed it in a secured box positioned on the pharmacy counter. The completion of the adherence survey anonymously may also be a strength of this study. Hence, we have included the following statement in the discussion section (page 12, paragraph 5): The anonymous collection of adherence information may have improved accurate reporting by eliminating social desirability bias.

12 February 2019

Eskild Petersen, MD, DMSc, MBA

Editor-in-Chief

International Journal of Infectious Diseases

Dear Dr Eskild Petersen,

RE: Major Revisions requested IJID-D-18-00042

Thank you for the opportunity to revise the manuscript "Post Option B+ implementation programme in Nigeria: Determinants of adherence of antiretroviral therapy among pregnant women with HIV" that is being considered for publication in *International Journal of Infectious Diseases.*

The suggestions and comments of the reviewer were highly insightful and helped to greatly improve the quality of the manuscript. We have included the revised manuscript with changed text identified using yellow highlighter. We have also enclosed the point-by-point responses to each of the comments of the reviewer.

Thank you for considering this revised manuscript for review. Your time is appreciated and we look forward to your response.

Sincerely,

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Highlights

- Of surveyed pregnant women in Nigeria, about one-third self-reported taking all their ART doses in the past 96 hours.
- Disclosure of HIV status to anyone was associated with ART adherence during pregnancy.
- Among pregnant women, previous prevention of MTCT was associated with ART adherence.
- An increased level of education among pregnant women was associated with ART adherence.

*Manuscript (Please include all author details)
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Post Option B+ implementation programme in Nigeria: Determinants of adherence of antiretroviral therapy among pregnant women with HIV

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Introduction

Globally, Nigeria has the highest burden of mother to child transmission (MTCT) of the human immunodeficiency virus (HIV).[1] This country is therefore an important target in current global efforts towards eliminating MTCT of HIV. Approximately 180,000 HIV-positive pregnant women require prevention of MTCT services every year in Nigeria,[1] with 37,000 new paediatric HIV infections reported in 2016.[2] The Global Plan towards the elimination of new HIV infections among children by 2015 and keeping their mothers alive (Global Plan) prioritised 22 countries that, in 2009, accounted for 90 percent of the global number of pregnant women living with HIV who were in need of services to prevent MTCT.[3] Nigeria is at the top of this list of high-HIV burden priority countries in sub-Saharan Africa.[3] Based on the Joint United Nations Programme on HIV/AIDS (UNAIDS) final accountability report of the Global Plan that was released in 2016, some countries still face significant challenges, which includes Nigeria. This is because between 2009 and 2015, only 21 percent reduction in new pediatric HIV infection in Nigeria has been achieved compared with other priority countries such as Uganda, South Africa, Burundi, Swaziland, Namibia and Mozambique, which have achieved 86 percent, (Burundi and South Africa-84 percent), 80 percent, 79 percent and 75 percent reductions within the same time frame respectively.[3]

Prior to 2010, the Nigerian national guidelines on preventing MTCT recommended the Option A regimen to the World Health Organization (WHO), which included administration of maternal zidovudine during pregnancy, and short-term single-dose of nevirapine, zidovudine, and lamivudine at delivery and at one week postpartum.[4] In 2010, the revised guidelines recommended antiretroviral therapy (ART) for pregnant

women in compliance with the WHO Option B regimen.[5] This regimen involved continuing postpartum maternal ART until one week after cessation of breastfeeding for women who did not meet eligibility criteria for CD4 count and WHO clinical staging, as detailed under Option B.[5] However, healthcare facilities, such as primary health care centres with low technical capability for implementing Option B, were required to continue implementation of Option A.[5] The 2014 Nigerian national guidelines endorsed Option B for preventing MTCT and expanded this treatment option to all healthcare facilities.[6] This endorsement was in contrast to the 2013 WHO consolidated guidelines, which recommended life-long ART for all HIV-infected women after delivery, using the Option B+ regimen.[7] By 2015, all Global Plan priority countries, except Nigeria, had adopted Option B+. Under this treatment regimen, pregnant women are offered lifelong ART from the time of HIV diagnosis, regardless of the gestational age, and irrespective of their WHO HIV clinical staging and CD4 cell count. [8] Nigeria finally adopted Option B+ in the 2016 with full implementation in 2017.[9]

Extensive evidence demonstrates the importance of medication adherence, and its crucial role in influencing treatment outcomes in the general population.[10] In the face of high MTCT burden in Nigeria, there has been a dearth of research specifically examining whether Nigerian women take their medications during pregnancy, and the complex factors that influence their decision to take ART. This study is the first to examine adherence to ART among pregnant women since the rollout of Option B+ in Nigeria.

Methods

Study design and participants

A cross sectional approach was adopted that involved dissemination of the Adult AIDS Clinical Trial Groups [AACTG] standardised survey[11] to HIV positive pregnant women, to assess adherence to ART. Information about their health behaviours and practices associated with this treatment was also obtained. This survey has been widely used in assessing adherence to ART among the general adult HIV positive population in sub-Saharan Africa, such as South Africa and Uganda [12,13] and in particular among HIV positive pregnant women in Zambia.[14] This study was conducted from February to June of 2018 in Akwa Ibom State, in the South-South region of Nigeria. Among the six regions of Nigeria, the South-South region has the highest HIV prevalence rate (5.5%) with the prevalence of HIV reported to be 6.5% in the Akwa Ibom State, which is higher than the national HIV prevalence (3.4%).[15] The study was conducted in four health facilities, which are among the highest volume of HIV/AIDS treatment centres in the state, with over 2,000 patients on ART including adult and children. These health facilities offer free comprehensive HIV/AIDS services, including prevention of MTCT. Following status determination, every HIV positive pregnant and breastfeeding woman is started on lifelong ART (same-day ART initiation) with a single fixed-dose combination tablet, regardless of their clinical status or CD4 count. HIV positive pregnant women receive at least one viral load estimate prior to delivery of their baby to determine whether the resultant HIV exposed infant is high risk and eligible for enhanced ART prophylaxis.[9] Prior to ART commencement, HIV positive pregnant women undergo adherence counseling, provided by nurses and midwives in the

antenatal clinic. Subsequently, ongoing group and individualised adherence counseling is provided at every refill visit (usually every month) by doctors, nurses, midwives, trained adherence counselors and pharmacy personnel before ART is dispensed.

Sample size estimation

The minimum sample size (N) was determined by using the WHO statistical formula of estimating population proportion with absolute precision in health studies.[16]

$N = Z^2_{1-\alpha/2} P (1-p)/d^2$

The following parameters were used to calculate the sample size for the prevalence of adherence to ART: Z = Normal deviant at the portion of 95% confidence interval = 1.96, (P) proportion of adherence among HIV positive pregnant women based on two previous studies conducted in Nigeria[17,18] (i.e. mean value of 79.6%), an absolute precision (d) of 5% and the 95% confidence interval level. This calculation gave a sample size of 250. The sample size was adjusted by 10% to compensate for a potential non-response rate of 10%, which increased the sample size to approximately 275.

Eligibility criteria

HIV positive pregnant women were eligible to participate if they were aged 18 years or older, had received ART for at least one month and could provide informed consent. HIV positive pregnant women who were judged by clinic health professionals to be too ill to participate were excluded.

Recruitment

In each of the four health facilities, HIV positive pregnant women received their ART refill monthly on specific clinic days and recruitment occurred while women were seated

in the pharmacy waiting area before receiving their ART refills. Hence, all women available on each of the clinic days had an equal chance of being selected to participate. Information about the study was placed on a notice board within the dispensing area. Additionally, during the group adherence session facilitated by the nurses and adherence counselors in the pharmacy waiting area, information about the study and the potential benefits and risks of participating were provided. Once women indicated their willingness to participate to the nurse in the clinic, they were approached by a researcher who sought written informed consent. Women completed the AACTG standardised survey anonymously and placed it in a secured box positioned on the pharmacy counter.

A record was kept reflecting the number of women scheduled to attend the clinic, the ones who did not attend and those who attended. These numbers were used to determine the response rate for the study. Ethical approval for this study was granted by the Akwa Ibom State Ministry of Health, Nigeria and Deakin University Human Research Ethics Committee.

Data collection

A questionnaire with two parts was used to collect data about adherence to ART. Part one of the questionnaire was used to collect socio-demographic and pregnancy details, and HIV and treatment related characteristics of participants. If a consented woman was unable to provide HIV and treatment related information, one of the researchers, together with the medical record staff in the hospital, obtained this information from the woman's medical record by using the patient identification number provided on the questionnaire. Part two included the AACTG standardised survey[11] comprising six

sections. Section one measures adherence based on a four-day recall method, with sections two and three assessing adherence to the medication regimen, and special instructions on how to take ART. Sections four and five assess whether the ART medication was not taken in the previous weekend and when the medication was last missed, with section six exploring the reasons for missed dosages.

Definition of the study outcome

This study examined adherence to ART (dose adherence) as the primary outcome. The prevalence of self-reported 100% adherence to ART doses in the previous four days was estimated using the AACTG standardised survey. Dose adherence has been found to be the best predictor of recent and durable viral suppression.[19] Therefore, a respondent was considered adherent if she had not missed taking any doses over the four-day period. Missing at least one dose over the four-day period prior to the day of a survey was considered as non-adherent.

Statistical analysis

Survey data were entered into an IBM SPSS software database (Version 25, Chicago). Means and standard deviations, or medians and inter-quartile ranges were used to describe continuous variables. Categorical variables were described using summary counts and percentages. The prevalence estimation method was used to determine adherence prevalence. The ART adherence prevalence proportion was calculated and the bootstrap technique was used to calculate prevalence at 95% confidence intervals. Bivariate associations between patient characteristics and medication-taking behaviours, and the outcome variable of ART adherence were examined using Chi-square tests. Multivariable logistic regression was used to identify factors independently

associated with adherence, using a backward elimination variable selection strategy with $p < 0.10$ inclusion and $p < 0.05$ retention criteria. In addition the Akaike information criterion (AIC) and the Bayes information criterion (BIC) were compared between the nested models and the model with optimal (i.e. smaller) goodness of fit index was selected as the final multivariable model.[20] Model adjusted odds ratios (adjusted OR) and 95% confidence intervals (CI) were reported.

Role of the funding source

The funder had no role in the design, collection of data, data analysis, interpretation, or writing of the report. The corresponding author had full access to all data in the study and had final responsibility for the decision to submit the manuscript for publication.

Results

Of 297 women who attended the health facilities, 275 women responded to the survey, resulting in a response rate of 92.6% (Figure 1). The demographic profile of women who did not respond to the survey was similar to those who participated. An overwhelming majority of the women (274 out of 275) were on a fixed dose combination of Tenofovir 300mg (TDF) + Lamivudine 300mg (3TC) + Efavirenz 600mg (EFV), taken once a day at night. One woman was on a fixed dose combination of Zidovudine (300mg) (ZDV) + Lamivudine 150mg (3TC) + Nevirapine 200mg (NVP), taken twice daily (12 hourly). The median age of responding women was 27 years (interquartile range [IQR] 24-29). In all, 117 (42.5%) had completed primary school education, and 239 (86.9%) were married and living with a spouse or a partner (Table 1). More than half (54.5%) of the women lived in a rural area and 178 (64.7%) of the women reported that it takes less than an hour for them to get to the health facility (Table 1). More than half of the women (53.5%)

had not disclosed their HIV infection status to anyone. With respect to timing of diagnosis, 65.8% of the women were newly diagnosed as HIV positive in the current pregnancy. Of all the women, 199 (72.4%) reported not having a treatment supporter (who was a family member or friend nominated by the women to support medication adherence) with 57.1% stating they did not know the HIV status of their spouse or partner (Table 2). Just over one-third of women (36.4%) commenced ART during the second trimester of their current pregnancy, while 209 women (76%) had not previously received preventive MTCT therapy (Tables 1 and 2).

Of the women, 32.7% (95% CI: 26.9 to 38.5) self-reported taking all ART doses in the past 96 hours, while during the same time frame, 67.3% (95% CI: 61.5 to 73.1) did not take all their ART doses. In the bivariate analyses, there were significant associations between the women's educational level ($p<0.001$) and place of residence ($p<0.001$), to adherence to ART during pregnancy (Table 1). In addition, pregnancy and HIV related treatment, care and support characteristics, such as disclosure of HIV status, HIV status of partner and treatment supporter, demonstrated a significant association with adherence to ART (Table 2). Furthermore, couple/partner HIV counseling and testing, previous prevention of MTCT experience, and timing of ART initiation all showed a significant relationship with ART adherence among the pregnant women (Table 2). In the multivariable logistic regression analyses, education and place of residence were significantly associated with medication adherence among the women. For every level increase in education status, there was 70% increase in odds of medication adherence (OR=1.7, $p=0.006$). The odds of medication adherence were two times higher in women living in rural areas compared with urban regions (OR=2.0,

p=0.019) (Table 3). In addition, disclosure of HIV infection status and previous prevention of MTCT experience were significantly associated with adherence to ART in the multivariable analyses. The odds of medication adherence were 2.3 times higher for participants who disclosed their HIV status compared with those with no HIV status disclosure (OR=2.3, p=0.024). For the women who had previous PMTCT exposure, the odds of medication adherence was 2.5 times higher compared with those with no previous MTCT exposure (OR=2.5, p=0.005) (Table 3). In the final logistic regression model, there was a trend towards a significant association between having a treatment supporter and adherence to ART (OR=2, 95% CI: [1.0 to 4.4], p=0.084).

Discussion

In this study, 32.7% of the HIV positive pregnant women self-reported 100% dose adherence to ART over a recall period of four days, whereas 67.3% had missed at least one dose within the same time frame. These results show a poor level of adherence to ART during pregnancy in this study population. Current evidence involving general patients situated in developed countries suggests that an adherence level lower than 95% may be sufficient for viral load suppression in populations using the newer non-nucleoside reverse transcriptase inhibitors (NNRTI) formulations,[21,22] as compared with the near perfect adherence of 95% or greater required when using the early ART regimens.[23,24] However, health care professionals must continue to support patients to achieve perfect adherence. This is because missed ART in pregnancy may lead to virologic failure, increased risk of MTCT, and potential transmission of drug resistant virus to the unborn child.[25] The results of this study underscore the recent report from the United Nations Joint Programme on HIV/AIDS (UNAIDS), which showed that

Nigeria has the highest rate of MTCT among the Global Plan priority countries compared to other Global Plan countries, including South Africa, Uganda, Swaziland, Mozambique and Malawi, with MTCT rates that vary between 2 and 7%.[26] The MTCT rate in Nigeria is 13% at the first six weeks following childbirth and increases to 23% at the end of breastfeeding.[26] A major contributing factor to this high MTCT rate in Nigeria, particularly in the first six weeks of life, could be poor medication adherence during pregnancy, as exemplified in this study. The level of ART adherence during pregnancy has implications for HIV transmission in-utero, during delivery and in the early postpartum period. Additionally, our results showed that 65.5% of the women commenced ART after conception with more than half initiating ART for the first time during the second trimester of their current pregnancy. This result could also be another contributing factor to the high MTCT rate in Nigeria, as research has shown that ART started before conception, and continued throughout pregnancy, is linked with exceptionally low rates of MTCT.[27]

In multivariable analyses, disclosure of HIV status to anyone was significantly associated with an increased level of adherence. Past studies conducted in other sub-Saharan African countries showed that disclosure of HIV infection status to partners, family and friends was associated with good maternal adherence[8,28,29] while non-disclosure was linked with non-adherence as shown by a study conducted in Rwanda.[2] A previous study conducted in Nigeria reported a relationship between disclosure of a partner's HIV status and women's adherence to medication, especially if the spouse was also HIV positive.[17]

Our results also showed that previous prevention of MTCT exposure was independently associated with adherence to ART during pregnancy. A qualitative study in Kenya, using in-depth interviews, found that women who gave birth previously, had successfully accessed prevention of MTCT services. These women lived a healthy life with children who were HIV negative and were better equipped and more compliant with taking ART in their current pregnancy.[30]

The findings from this study allude to two important areas where urgent attention is needed. First, the issues surrounding the disclosure of HIV status by women should be addressed. As shown in this study, more than half of women had not disclosed their HIV infection status to anyone. According to the WHO, pregnant women in sub-Saharan Africa have the lowest rate of HIV status disclosure to their partners in the world.[31] As shown in our study, women who had disclosed their HIV status to someone were more than two times likely to adhere to ART than women who had not disclosed their HIV status. Without partner support, it is often challenging for women to adhere to ART.[32] There is a need for government and non-government organisations supporting HIV service implementation in Nigeria to ensure the active implementation of the WHO recommended voluntary assisted partner notification services[33] at all health care facilities providing HIV treatment. These voluntary assisted partner notification services should be offered as part of a comprehensive package for pregnant women during HIV testing and counseling in antenatal clinics, to facilitate safe and comfortable disclosure of HIV status to partners. Second, late initiation of ART by pregnant women should also be addressed. About two-thirds of women were made aware of their HIV status during an antenatal care visit and were required to commence ART. It is therefore pertinent

that Nigeria works towards the attainment of the 90-90-90 UNAIDS target, particularly in this case to reach the first 90 goal, that is, diagnosing 90% of people with HIV who do not know their HIV status. According to the UNAIDS, only 3 out of every 10 pregnant women living with HIV in Nigeria access ART to prevent MTCT.[26] Early diagnosis may help to facilitate early initiation of ART in women of reproductive age, thus, increasing the likelihood of HIV positive women commencing ART before conception and improving adherence during pregnancy.

The strengths of this study include utilisation of a tool with proven validity and reliability to assess adherence. Many previous studies on adherence in pregnant women in sub-Saharan Africa used self-reporting measures to assess medication adherence without identifying the tools used.[34] The anonymous collection of adherence information may have improved accurate reporting by eliminating social desirability bias. Our study was a multicentre study with a relatively high sample size. A key limitation of the study was inability to correlate the level of adherence with the viral load of women. Viral load coverage for patients in most health facilities in Nigeria remains very low, the turnaround time for viral load test results also remains unacceptably high, and significant viral load results released by the laboratories are not filed in the patients' medical records.

In summary, the proportion of women who were adherent to ART was low. The factors relating to women's education level, living in a rural area, having a previous experience with prevention of MTCT and disclosing HIV status to someone were significantly associated with improved adherence. It is crucial that ART adherence is

improved among pregnant women in Nigeria, for the country to be well positioned for elimination of MTCT of HIV.

Contributors

O.O., S.K., P.N. and EM conceptulised and designed the study. O.O., M.M, S.K, P.N., E.M. analysed and interpreted data. O.O., M.M and E.M. did the statistical analysis. O.O. wrote the first and second draft of the manuscript with input from S.K., P.N., M.M. and EM. All authors read and approved the final manuscript.

Declaration of interests

We declare no competing interests.

Acknowledgement

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Figure

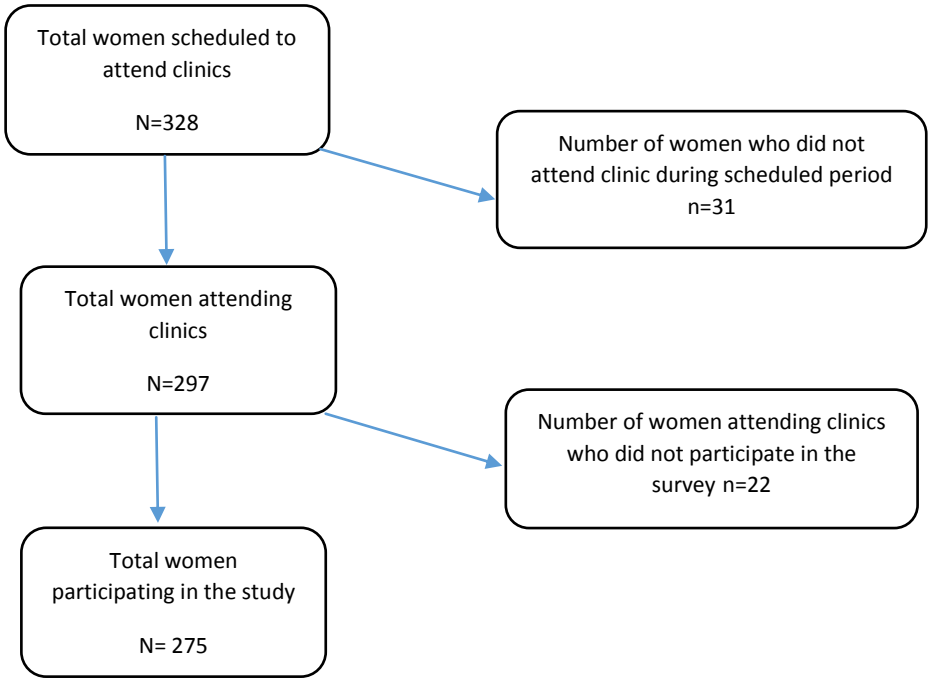
Total women scheduled to attend clinics
N=328
Number of women who did not attend clinic during scheduled period n=31
Total women attending clinics
N=297
Number of women attending clinics who did not participate in the survey n=22
Total women participating in the study
N= 275

Figure 1

Study flow chart

Table

Table 1

Socio-demographic characteristics of HIV positive pregnant women by adherence status

	Overall(N=275) N (%)	Dose adherent (n=90; 32.7%) 95% CI: (26.9-38.5)			
		n	%	95% CI	P-value*
Age (Median, IQR[a])	27 (24-29)				
18-24	115 (41.8)	38	33	24.3 to 42.6	0.746
25-29	109 (39.6)	35	32.1	22.9 to 41.3	
30-34	43 (15.6)	13	30.2	16.3 to 44.2	
35+	8 (2.9)	4	50	12.5 to 87.2	
Marital status					
Married and living with spouse	182 (66.2)	59	32.4	24.7 to 39.0	0.848
Married not living with spouse	23 (8.4)	6	26.1	8.7 to 43.5	
Single but living with partner	57 (20.7)	20	35.1	22.8 to 47.4	
Others	13 (4.7)	5	38.5	15.4 to 69.2	
Educational level completed					
None	24 (8.7)	5	20.8	8.3 to 37.5	<0.001
Primary school	117 (42.5)	19	16.2	10.3 to 23.1	
Secondary school	100 (36.4)	44	44	35.0 to 54.0	
Tertiary	34 (12.4)	22	64.7	47.1 to 79.4	
Place of residence					
Rural	150 (54.5)	33	22	15.3 to 28.7	<0.001
Urban	125 (45.5)	57	45.6	37.6 to 54.4	
Occupation					
Full time house wife	35 (12.7)	9	25.7	11.4 to 42.9	0.072
Trader	71 (25.8)	20	28.2	18.3 to 39.3	
Civil servant	18 (6.5)	11	61.1	38.9 to 83.3	
Self employed	71 (25.8)	23	32.4	21.1 to 43.7	
Unemployed	79 (28.7)	26	32.9	22.8 to 44.3	
Travel time to hospital					
Less than one hour	178 (64.7)	59	33.1	26.4 to 40.4	0.841
More than one hour	97 (35.3)	31	32	22.7 to 41.2	

*p-value for chi-square test, [a]IQR: interquartile range

Table

Table 2

Pregnancy and HIV related treatment, care and support characteristics by adherence status

	Overall(N=275) N (%)	Dose adherent (n=90; 32.7%) 95% CI: (26.9 to 38.5)			
		n	%	95% CI	P-value*
Disclosure of HIV status					
Disclosure to someone(spouse, partner, family, friend, religious leader)	128 (46.5)	64	50.0	41.4 to 58.6	<0.001
Disclosure to no one all	147 (53.5)	26	17.7	11.6 to 24.5	
HIV status of partner					
HIV positive	40 (14.5)	20	50	35.0 to 65.0	0.001
HIV negative	78 (28.4)	33	42.3	30.8 to 53.8	
Unknown	157 (57.1)	37	23.6	16.6 to 29.9	
Treatment supporter					<0.001
Yes	76 (27.6)	47	61.8	51.3 to 72.4	
No	199 (72.4)	43	21.6	16.1 to 27.6	
WHO clinical stage					
Clinical stage 1	244 (88.7)	82	33.6	27.9 to 39.8	0.383
Clinical stage 2	31 (11.3)	8	25.8	12.9 to 41.9	
Timing of HIV diagnosis					
Before getting pregnant	94 (34.2)	49	52.1	42.6 to 62.8	<0.001
During this pregnancy	181 (65.8)	41	22.7	17.1 to 28.7	
Couple/partner HIV testing and counseling					
Received	25 (9.1)	16	64	44.0 to 80.0	<0.001
Never received	250 (90.9)	74	29.6	24.4 to 35.6	
Number of living children					
0	22 (8.0)	9	40.9	18.2 to 59.1	0.551
1-2	212 (77.1)	66	31.1	25.0 to 37.7	
More than 2	41 (14.9)	15	36.6	22.0 to 51.2	

Number of children that have died					
0	220 (80.0)	75	34.1	28.2 to 40.0	0.443
1-2	53 (19.3)	15	28.3	17.0 to 41.5	
More than 2	2 (0.7)	0			
Previous PMTCT experience					
Yes	66 (24.0)	42	63.6	51.5 to 74.2	<0.001
No	209 (76.0)	48	23.0	17.7 to 29.2	
Timing of ART initiation					
Before conception	94 (34.2)	48	51.1	41.5 to 60.6	<0.001
First trimester	68 (24.7)	21	30.9	20.6 to 42.6	
Second trimester	100 (36.4)	19	19.0	12.0 to 28.0	
Third trimester	13 (4.7)	2	15.4	0 to 38.5	

*p-value for chi-square test

Table

Table 3

Determinants of adherence in multivariable logistic regression model

Determinants	Adjusted OR	95% C.I	Wald (df)	P-value
Education completed (ordinal strata)	1.7	1.1 to 2.5	7.6 (1)	0.006
Having previous PMTCT exposure	2.5	1.2 to 5.1	6.6 (1)	0.010
Disclosure of HIV status to anyone	2.3	1.1 to 4.6	5.1 (1)	0.024
Place of residence (rural)	2.0	0.3 to 0.9	5.5 (1)	0.019

*AIC and BIC for initial model included all factors significant at 0.1, and were 254.2 and 312.1 respectively. These indexes changed to 84.8 and 102.9 in the final selected model.