

Evaluating the Effectiveness of Prevention of Mother-to-Child Transmission (PMTCT) programs: A case study of Federal Medical Centre, Asaba

International Journal of STD & AIDS

2025, Vol. 0(0) 1–8

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DOI: 10.1177/09564624251377214

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Abstract

Background: Mother-to-Child Transmission (MTCT) of HIV continues to be a critical public health issue, particularly in high-prevalence regions. This study examines the rates of MTCT in relation to antenatal booking, parity, antiretroviral (ARV) use, delivery mode, CD4 counts, and infant feeding practices.

Methods: A retrospective cross-sectional study was conducted at the Federal Medical Centre, Asaba, Nigeria, involving pregnant women living with HIV attending the Prevention of Mother-to-Child Transmission (PMTCT) program. Data on demographics, antenatal booking, ARV use, delivery mode, CD4 count, and infant feeding were collected. Ethical approval was obtained from the hospital's ethics committee. MTCT rates were analysed based on these variables.

Results: MTCT rates dropped from 1.2% in 2018 to 0% in 2019, with an overall rate of 0.7%. Early antenatal booking and ARV adherence were critical in reducing MTCT. Vaginal delivery with ARV use showed lower MTCT rates than emergency caesarean sections. Higher MTCT rates were associated with CD4 counts below 200 cells/mm³, emphasizing the importance of early ART initiation. Exclusive breastfeeding with ARV prophylaxis was the most effective practice.

Conclusion: The PMTCT program at FMC Asaba significantly reduced MTCT rates, highlighting the importance of early booking, ARV adherence, and appropriate delivery methods in improving maternal-child health in high HIV prevalence areas.

Keywords

Prevention of mother-to-child transmission (PMTCT), HIV, antenatal care, exclusive breastfeeding, public health, maternal health

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Introduction

The transmission of Human Immunodeficiency Virus (HIV) has posed a significant global health challenge, with both horizontal and vertical modes of transmission contributing to the spread of the infection.¹ This study focuses on the vertical transmission of HIV, commonly known as Mother-to-Child Transmission (MTCT) or vertical transmission, which occurs during pregnancy, childbirth, or breastfeeding. Understanding the dynamics of MTCT is crucial, especially in regions like Nigeria, which bears a substantial burden of new HIV infections among children. HIV transmission occurs through horizontal and vertical routes.² Horizontal transmission involves transmission between two individuals through various routes such as unprotected sex, blood transfusion, and sharing contaminated needles.³ Vertical transmission, on the other hand, refers to the transmission of HIV from an infected mother to her child during pregnancy, labour, delivery, or breastfeeding.^{4,5}

Mother-to-Child Transmission of HIV accounts for over 90% of HIV infections in children, with Nigeria having the highest number of new HIV infections among children.^{6,7} PMTCT programs play a crucial role in reducing vertical transmission, involving antiretroviral treatment (ART) for mothers, ARV drugs for infants, measures to prevent HIV acquisition in pregnant women, and safe breastfeeding practices.⁴ Despite significant progress, challenges persist in PMTCT programs. In 2017, approximately half of the 180,000 new HIV infections in children occurred during breastfeeding.⁸ Retaining women in care, ensuring effective ART coverage, and managing new infections during pregnancy or breastfeeding are ongoing challenges.⁸ The effectiveness of PMTCT interventions varies across regions, with disparities in access to testing, treatment, and adherence to interventions.

Globally, efforts to prevent new infections among children have shown progress, with 1.4 million infections averted between 2010 and 2018.⁹ However, challenges persist, especially in sub-Saharan Africa, where the majority of high-priority PMTCT countries are located.⁸ In Nigeria, a densely populated country with high HIV prevalence, concerns arise due to slow progress and rising numbers of new infections among children.⁹ Efforts to integrate family planning services into HIV care aim to enhance accessibility for women and couples living with HIV. While progress has been made, a systematic review in 2017 highlighted limitations in meeting unmet family planning needs.¹⁰ The integration of services remains a critical aspect of comprehensive healthcare for people living with HIV (PLWH). Western and central Africa face considerable challenges, with lower ART coverage for pregnant women living with HIV. Alarming, one in five children born to mothers living with HIV in this region

became HIV positive during childbirth or breastfeeding in 2017.⁹ Nigeria's specific challenges, including low testing rates among pregnant women and increasing numbers of infected children, underscore the urgency of addressing gaps in PMTCT programs.⁹

This review reveals significant gaps in knowledge, including variations in knowledge levels, acceptability of PMTCT, and challenges in implementing effective interventions.¹¹ Studies emphasize the need for tailored approaches to address region-specific barriers, such as stigma and discrimination, impacting the acceptability of PMTCT services.^{12,13}

The high prevalence of MTCT in Nigeria, coupled with slow progress in implementing effective PMTCT measures, necessitates a closer examination of the factors contributing to this persistent challenge. A study by Ikpeazu et al. identified a progressive decline in the number of pregnant women living with HIV (WLWH) identified and put on treatment in Nigeria.¹⁴ Nevertheless, among women identified as living with HIV during pregnancy, the percentage initiated on ART increased from 71% in 2018 to 88% in 2020. The increasing number of children acquiring HIV, despite PMTCT interventions, signals the need for a detailed investigation into the effectiveness of these programs at Federal Medical Centre, Asaba.

The rising incidence of children acquiring HIV, even with mothers accessing PMTCT and on Highly Active Antiretroviral Therapy (HAART), raises concerns. Interviews with mothers and a thorough literature review indicate that this specific topic has not been extensively studied at the Federal Medical Centre, Asaba. This study aims to fill this research gap and provide insights into the effectiveness of PMTCT programs in this setting. It aims to describe MTCT rates of HIV to antenatal booking and parity, compare maternal antiretroviral (ARV) use and mode of delivery with MTCT rates, describe MTCT rates to CD4 categories, and assess MTCT rates concerning infant feeding methods. This study's findings are essential for healthcare providers, policymakers, and researchers involved in HIV prevention and care. Understanding the factors influencing MTCT rates in this specific setting can inform tailored interventions to improve the effectiveness of PMTCT programs, ultimately reducing the burden of paediatric HIV.

Methods

Study design

A retrospective, cross-sectional approach was employed, spanning 2 years. Folders containing information on pregnant women were selected for the study.

Study population and sampling. The study included pregnant women and their infants registered in the PMTCT program

at the Federal Medical Centre, Asaba, between January 1, 2018, and December 31, 2019. The sample size of 144 was calculated using Slovin's formula, with a total population of 227 pregnant women from the antenatal register and a margin of error set at 0.05. All eligible pregnant WLWH attending the centre during this period were included, ensuring comprehensive representation.

Inclusion and exclusion criteria

Eligible participants encompassed pregnant WLWH who registered and delivered at the facility, with or without comorbidities. This also included patients accessing the clinic for HAART drug refills, children born to mothers living with HIV at the facility, and HIV-exposed babies with co-morbidities. Cases that met the inclusion criteria but could not be analyzed were excluded. Reasons for exclusion included incomplete or missing key records in the hospital database, absence of documented infant HIV test results, transfer of care to another facility before delivery or follow-up, and duplicate or inconsistent records that could not be verified.

Method of data collection and study duration

Data collection involved retrieving records of pregnant WLWH who registered and delivered at the hospital, along with their HIV-exposed babies up to 6 weeks old. Information was gathered from folders, including CD4 counts, maternal age, viral load, mode of delivery, PMTCT commencement time, ARV drug combinations, gestation age at booking, and infant formula practices.

Variables

The study assessed the rate of MTCT of HIV, defined as the proportion of infants born to pregnant WLWH who were diagnosed with HIV at specific intervals postpartum using infant HIV testing. The exposures examined included the type of antiretroviral therapy (ART) regimen administered to the mothers during pregnancy, the timing of the first antenatal care visit, and the mode of delivery (e.g., vaginal or caesarean section). Key predictors analysed in the study were maternal CD4 count, adherence to ART, maternal age, and the infant's feeding method (e.g., breastfeeding vs formula feeding). The study also considered the potential confounding effect of maternal socioeconomic status, as it could influence both the likelihood of accessing timely and adequate healthcare (exposure) and the risk of MTCT (outcome). Additionally, maternal age was identified as an effect modifier, with the impact of ART on reducing MTCT potentially varying between younger and older mothers.

Data sources/measurement

The study measured the primary outcome of MTCT of HIV through infant HIV testing using PCR at various postpartum intervals. Data sources included medical records and self-reports, with consistent assessment methods applied across the study population to ensure comparability.

Bias

To address potential sources of bias in the study, several measures were implemented. Selection bias was minimized by including all eligible pregnant women who attended the healthcare centre during the study period. Information bias was addressed by using standardized methods for data collection, including medical record reviews. To reduce recall bias, recent data on ART adherence and other predictors were obtained directly from patient records.

Data analysis

Descriptive data were recorded for nominal and categorical variables, employing frequencies and percentages to characterize categorical variables. SPSS (Version 26) was utilized for data analysis. Inferential analyses were conducted using the Mann-Whitney test to assess differences in antenatal booking age and maternal ARV regimens, and the Kruskal-Wallis test to explore variations in MTCT rates relative to parity, delivery mode, CD4 count categories, and infant feeding methods.

Ethical approval

Ethical clearance was obtained from the Federal Medical Centre's ethics and research committee in Asaba. The ethical certificate number is FMC/ASB/A81. Authorization from the Health Information Management Department facilitated access to patients' folders, ensuring confidentiality during and after the study.

Results

The demographic characteristics of the 144 pregnant women living with HIV show that the majority fall within the age range of 30–39 years (66.0%), attained tertiary education (56.9%), and are employed (70.8%) (Table 1).

From 2018 to 2019, a total of 31,318 pregnant women were tested for HIV, out of which 227 were positive. Among these, 189 mothers living with HIV delivered at the Centre. This study focused on 144 mother-infant pairs that were followed from antenatal booking through birth until 6 weeks and beyond, when the infants' HIV status was determined by DNA PCR testing. The analysis over the 2 years reveals a consistent decrease in the MTCT rate of HIV. In 2018, the

MTCT rate among mothers who booked and delivered at the Centre was 1.2%. By 2019, this rate had effectively reduced to 0% (Figure 1).

Table 2 presents the results of the investigation into the relationships between various factors of MTCT of HIV,

Table 1. Demographic Characteristics of Pregnant Women who have acquired HIV.

Characteristics	Number of patients	Percentage (%)
Maternal age (years)		
20–29	39	27.1
30–39	95	66.0
40–49	10	6.9
Total	144	100.0
Marital status		
Single mothers	18	12.5
Married women	126	87.5
Total	144	100
Educational status		
No formal education	22	15.3
Primary education	15	10.4
Secondary education	25	17.4
Tertiary education	82	56.9
Total	144	100
Employment status		
Unemployed	14	9.7
Employed	102	70.8
Self-employed	28	19.5
Total	144	100

analysing the influence of antenatal booking age, parity, CD4 count category, maternal antiretroviral (ARV) drug regimen, mode of delivery, and infant feeding method on the HIV status of infants. The MTCT rate was 0.7% for mothers who booked their antenatal care in the first trimester, with no transmissions observed among those who booked in the second or third trimesters.

Among the parity groups, mothers with no previous pregnancies (P0), as well as those with two (P2) or three (P3) previous pregnancies, showed no MTCT. However, there was a slight increase in transmission among mothers with one previous pregnancy (P1), where the MTCT rate was 1.1%. A significant observation was made in the CD4 count category.

No transmissions occurred among mothers with CD4 counts between 201–500 cells/mm³, 501–1000 cells/mm³, or above 1000 cells/mm³. However, an MTCT rate of 0% was recorded among mothers with CD4 counts below 200 cells/mm³, though only one positive case was noted in this group.

The type of ARV drug regimen used by the mothers also influenced MTCT rates. The overall MTCT rate was 0.7% among mothers on triple combination ARV therapy. Specifically, those on TDF/3TC/EFV had a slightly higher MTCT rate of 1%, whereas no transmissions were observed in mothers on AZT/3TC/NVP. Mode of delivery played a critical role in MTCT. No transmissions were observed among mothers who had elective caesarean sections (CS) or vaginal deliveries. However, an emergency CS was

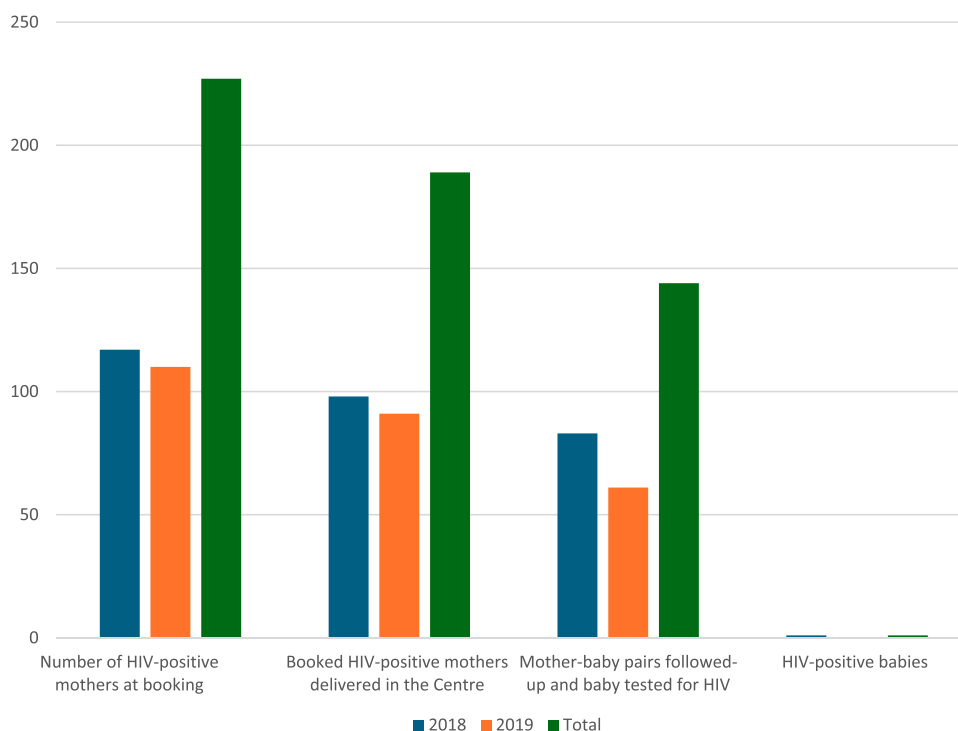


Figure 1. Mtct rate in relationship to year of antenatal booking.

Table 2. Relationships between various factors and MTCT of HIV.

Infant HIV status	Negative	Positive	MTCT rate (%)
MTCT rate in relationship to antenatal booking age			
First trimester	141	1	0.7
Second trimester	2	0	0
Third trimester	0	0	0
MTCT rate in relationship to parity			
P0	22	0	0
P1	88	1	1.1
P2	31	0	0
P3	2	0	0
MTCT rate in relationship to CD4 category			
<200 cells/mm ³	0	1	0
201–500 cells/mm ³	60	0	0
501–1000 cells/mm ³	77	0	0
>1000 cells/mm ³	6	0	0
MTCT rate in relationship to maternal ARV drug used			
Triple combination ARV	143	1	0.7
TDF/3 TC/EFV	101	1	1
AZT/3 TC/NVP	42	0	0
MTCT rate in relationship to mode of delivery			
Elective CS	13	0	0
Emergency CS	8	1	12.5
Vaginal	122	0	0
MTCT rate in relationship to infant feeding method			
EBF	135	1	0.7
EFF	6	0	0
MF	2	0	0

associated with a significant increase in the MTCT rate to 12.5%. Regarding infant feeding methods, the MTCT rate was 0.7% among exclusively breastfed (EBF) infants. No transmissions were observed in infants who were exclusively formula-fed (EFF) or mixed-fed (MF).

The Mann-Whitney test (Table 3) was employed to assess whether antenatal booking age and maternal antiretroviral regimens significantly affected MTCT rates. Results revealed no significant differences in booking age between women who booked in the first versus second trimester ($p = .906$), with mean ranks of 72.51 and 70.00, respectively. Similarly, MTCT rates did not significantly differ across different maternal antiretroviral regimens ($p = .521$), with mean ranks of 72.71 for TDF/3TC/EFV and 72.00 for AZT/3TC/NVP.

Additionally, the Kruskal-Wallis test explored MTCT rates relative to parity, delivery mode, CD4 count categories, and infant feeding methods. No significant differences were found in MTCT rates across parity groups ($p = .892$), with mean ranks ranging from 72.00 to 72.81. However, significant variations were observed based on delivery mode ($p = .001$), where mean ranks were 72.00 for elective caesarean section, 80.00 for emergency caesarean section, and 72.00 for spontaneous vaginal delivery. Similarly,

significant differences were noted across CD4 count categories ($p < .001$), with mean ranks ranging from 72.00 to 144.00. Conversely, no significant difference was found in MTCT rates based on infant feeding methods ($p = .971$), with mean ranks of 72.53 for exclusive breastfeeding, and 72.00 for both exclusive formula feeding and mixed feeding.

Discussion

This study provides a comprehensive analysis of mother-to-child transmission (MTCT) rates among pregnant WLWH attending a healthcare centre, focusing on various demographic, clinical, and behavioural factors. The MTCT rate observed in this study is noteworthy, exhibiting favourable outcomes compared to reports from various centres within the country and developed nations where similar interventions are the standard care for WLWH, albeit with some variations.^{6,15,16}

Demographic data reveal that most of the women were within the 30–39 age range, had attained tertiary education, and were employed. These findings align with the United Nations report that highlights similar demographic characteristics among pregnant WLWH in different regions.¹⁷

Table 3. Mann whitney test for antenatal booking age.

Antenatal booking	Number	Mean rank	Sum of ranks	Asymp. Sig (2-tailed)
First trimester	142	72.51	10,296.00	
Second trimester	2	70.00	144.00	
Total	144			0.906

Additionally, the study found that the majority of PMTCT registrants were married women, which shows the potential influence of spousal support on adherence to the PMTCT program. Marital status serves as a proxy indicator for the availability of a support structure, which is crucial in preventing MTCT of HIV infection.¹⁸

The overall HIV MTCT rate observed in the Federal Medical Centre, Asaba, was 0.7%, meeting the World Health Organization's goal of reducing MTCT rates to below 5%.¹⁹ The gradual reduction from 1.2% in 2018 to 0% in 2019 aligns with findings from Ghoma Linguissi *et al.*, indicating the effectiveness of PMTCT interventions in progressively lowering transmission rates.²⁰ The analysis of antenatal booking age showed that early booking in the first trimester was associated with a lower MTCT rate. This finding is consistent with existing literature that emphasizes the importance of early antenatal care initiation for better health outcomes and reduced MTCT rates.¹⁶ However, the lack of significant difference in MTCT rates between the first and second trimesters in our Mann-Whitney test ($p = .906$) suggests that while early booking is beneficial, the provision of timely and adequate care in later trimesters can still effectively reduce MTCT risks.

Parity did not show a significant impact on MTCT rates in this study. Interestingly, mothers with one previous pregnancy (P1) exhibited a slightly higher MTCT rate (1.1%), but this difference was not statistically significant. Previous studies have reported mixed findings on the influence of parity on MTCT, with some indicating higher risks among multiparous women and others showing no significant differences.^{21,22}

The CD4 count, a crucial indicator of immune status, showed significant differences in MTCT rates. Notably, no MTCT occurred among mothers with CD4 counts above 200 cells/mm³, highlighting the effectiveness of ART in maintaining immune function and reducing transmission risks.²³ The Kruskal-Wallis test confirmed the significance of CD4 count categories on MTCT rates ($p < .001$). These results underscore the importance of maintaining adequate CD4 levels through continuous and effective ART.⁶

Maternal antiretroviral regimens played a significant role in MTCT outcomes. The study found a slightly higher MTCT rate (1%) among mothers on the TDF/3TC/EFV regimen compared to no transmissions in those on AZT/3 TC/NVP. While the Mann-Whitney test did not show a significant

difference ($p = .521$), the observed variation aligns with some studies suggesting that certain ART regimens may be more effective in preventing MTCT.²⁴ Continuous monitoring and optimization of ART regimens are essential to ensure the best outcomes for both mothers and infants.

Mode of delivery significantly influenced MTCT rates, with no transmissions in elective caesarean sections (EL CS) and vaginal deliveries, but a substantial increase in MTCT (12.5%) in emergency caesarean sections (EM CS). This finding is consistent with literature that identifies emergency caesarean sections as a higher-risk factor for MTCT due to potential complications and increased viral exposure during the procedure.²⁵ The significant p -value (.001) from the Kruskal-Wallis test supports this conclusion, reinforcing the need for planned elective caesarean deliveries in pregnant WLWH to minimize MTCT risks.

Infant feeding methods also showed interesting trends, with exclusive breastfeeding (EBF) associated with a 0.7% MTCT rate and no transmissions observed with exclusive formula feeding (EFF) or mixed feeding (MF). While the Kruskal-Wallis test indicated no significant difference ($p = .971$), the observed MTCT rates align with WHO recommendations, which advocate for exclusive breastfeeding with maternal ART to minimize transmission risks in resource-limited settings.²⁶ However, in contexts where safe and reliable formula feeding is accessible, it may be preferred to further reduce MTCT risks.²⁷

Overall, this study highlights the many aspects of MTCT prevention, demonstrating that a combination of early antenatal booking, effective ART, appropriate delivery methods, and careful infant feeding choices can significantly reduce transmission rates. The findings are consistent with global PMTCT strategies that advocate for integrated care approaches to achieve and maintain low MTCT rates.^{6,20,28,29}

Despite the encouraging results, this study has some limitations. The relatively small sample size, especially in some subgroups such as those with emergency caesarean sections, may limit the generalizability of the findings. Additionally, the observational nature of the study means that causality cannot be definitively established. Future research with larger cohorts and randomized controlled trials would be beneficial to further elucidate the factors influencing MTCT and to refine PMTCT strategies.

Conclusion

This study revealed a commendable MTCT rate of 0.7% in the PMTCT program at the Federal Medical Centre, Asaba, which substantiates the effectiveness of interventions. Timely antenatal booking and ART adherence are related to lower MTCT rates. Marital status indicated potential support structure, while delivery mode is associated with MTCT. Although most mothers are on exclusive breastfeeding, it doesn't significantly impact MTCT rates. The findings contribute to the growing body of evidence supporting integrated and multi-pronged approaches to HIV prevention in mother-infant pairs, ultimately aiming to achieve the global goal of eliminating paediatric HIV.

Acknowledgements

The authors express their sincere gratitude to the management and staff of the Federal Medical Centre, Asaba, particularly the Centre for Communicable Diseases Control and Research, the Department of Obstetrics and Gynaecology, the Paediatrics Department, and the Health Information Management Department, for their invaluable support in facilitating data access and providing the necessary logistics for this study. We are also grateful to the patients whose records contributed to this research.

Author contributions

I.J.A.: Conceptualization (lead); Methodology (equal); formal analysis (lead); data collection (lead); A.O.J., E.D.A., B.A., K.A., F.U., S.I.O., E.N.E., and J.E.O.: formal analysis (equal); A.O.J.: writing, original draft; writing, review and editing (equal); A.Q.A., V.O., E.O., S.O.I.; U.M.O.: supervision and final approval of the version to be published. I.J.A., A.O.J. contributed to statistical analysis and data interpretation. I.J.A. and K.A. assisted with literature review and background contextualization. All authors contributed to reviewing, editing, and approving the final version of the manuscript. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the study are appropriately investigated and resolved.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical considerations

Ethical clearance was obtained from the Federal Medical Centre's ethics and research committee in Asaba. The ethical certificate number is FMC/ASB/A81. Authorization from the Health Information Management Department facilitated access to patients' folders, ensuring confidentiality during and after the study.

Consent to participate

All patient information was de-identified and patient consent was not required. Patient data will not be shared with third parties.

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Data Availability Statement

The dataset underlying this article will be made available upon reasonable request to the corresponding author.

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