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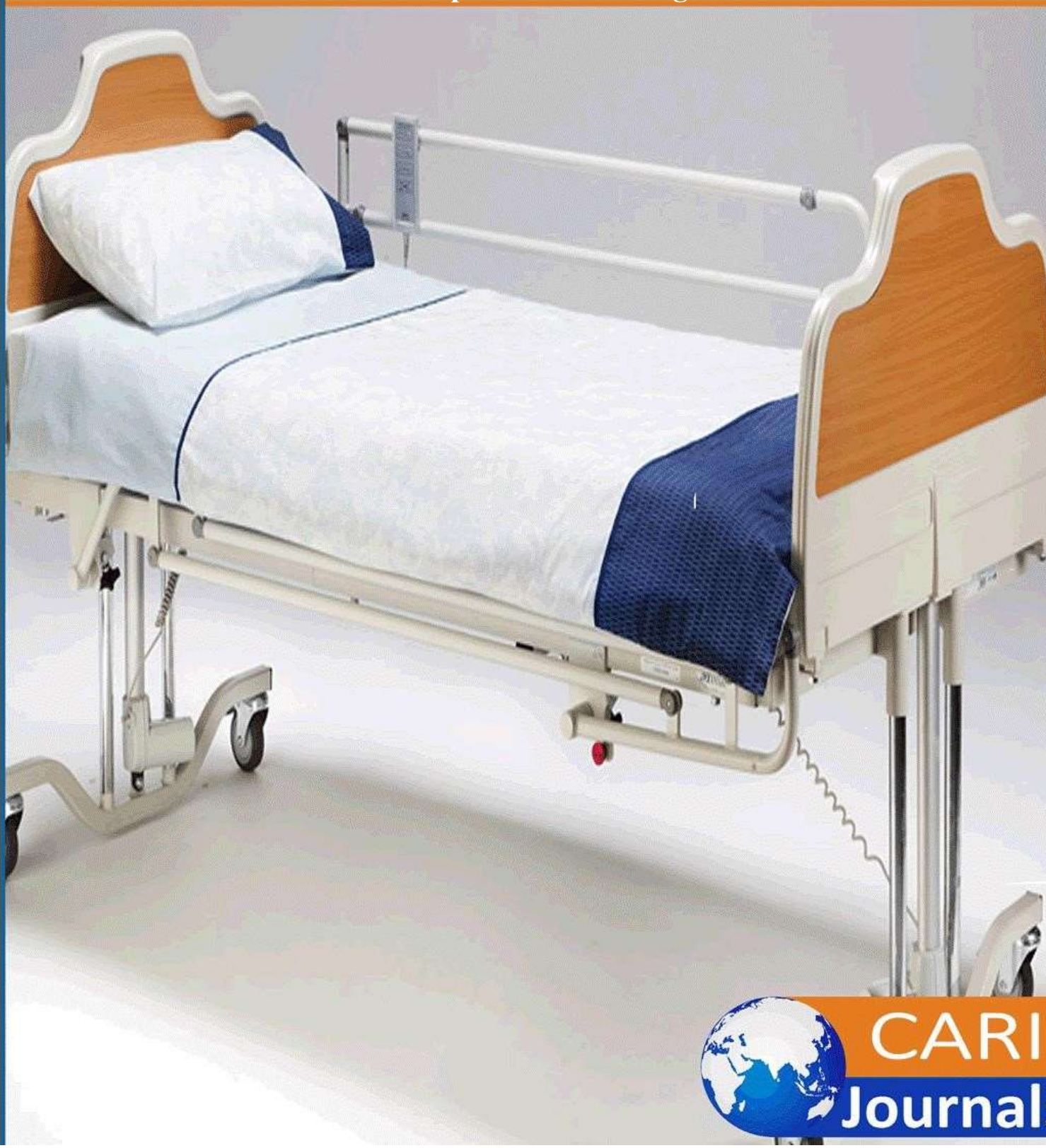

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Serovirological Outcomes and Predictors of Mother-to-Child HIV Transmission in Mbandaka, Democratic Republic of the Congo

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Abstract

Purpose: MTCT of HIV remains high in the DRC due to limited programme coverage, delayed maternal diagnosis, and poor ART adherence. This study evaluated newborn serovirological status in Mbandaka and identified key MTCT determinants.

Methods: A prospective quantitative descriptive and analytical study was conducted at the DREAM Centre of Excellence, including 91 mother–infant pairs. Data were obtained using structured questionnaires complemented by a review of clinical records, and subsequently analysed through logistic regression based on the Wald test. Among the 91 infants included, two cases (2.2%) were found to be HIV-positive, a proportion exceeding the threshold recommended by the World Health Organization.

Results: The results obtained in this study reveal the identification of factors significantly associated with mother-to-child HIV transmission. These include poor adherence to antiretroviral therapy (ART) observed in women, associated with a high risk of HIV transmission (OR = 11.04; 95% CI [3.35-38.68]; p = 0.02). Added to this is the absence of cotrimoxazole prophylaxis (OR = 1.00; 95% CI [0.97-1.04]; p = 0.02). 95% CI [3.35-38.68]; p = 0.02). Added to this is the absence of cotrimoxazole prophylaxis (OR = 5.10; 95% CI [1.14-23.29]; p = 0.03) and the absence of neonatal ARV prophylaxis (OR = 16.11; 95% CI [2.91-89.09]; p < 0.001) were highly associated with high rates of infection. In this regard, home births remain high, as does late diagnosis of maternal HIV infection (OR = 18.32; 95% CI [1.97-170.18]; p = 0.01).

Unique Contribution to Theory, Practice and Policy : These results indicate the need to improve ART adherence, promote early HIV testing during prenatal care, and ensure consistent prophylactic coverage for mothers and infants in order to achieve effective and sustainable reduction of mother-to-child HIV transmission in the city of Mbandaka in Equateur Province.

Keywords*: Mother-to-child transmission, Infants, HIV, Serovirologic, Risk factors, PMTCT, Mbandaka.*

1. Introduction

Mother-to-child transmission (MTCT) of HIV remains a major public health challenge, especially in sub-Saharan Africa, where approximately 330 children aged 0–14 become infected daily, accounting for nearly 9% of new global infections, most of them congenital [1]. In 2018, 37.9 million people were living with HIV worldwide, including 1.7 million children under 15, with young women aged 15–24 disproportionately affected; in the region, four out of five new adolescent infections occur in girls [2].

In the Democratic Republic of the Congo (DRC), HIV prevalence is estimated at 1.1% in the general population and reaches 3.5% among women attending antenatal care. In the absence of appropriate interventions, the risk of mother-to-child transmission ranges from 15% to 30%, and may rise to nearly 45% among breastfed infants [3,4]. In Equateur Province, particularly in Mbandaka, the effectiveness of PMTCT programmes remains constrained by limited access to antenatal services, suboptimal adherence to antiretroviral therapy (ART), and gaps in postnatal follow-up [5].

While the national adoption of the Option B+ strategy ensures lifelong ART and integrated support, evidence on its implementation and outcomes at the local level is still limited. Against this backdrop, the present study examines the serovirological status of infants born to HIV-positive mothers in Mbandaka and explores the determinants of MTCT using Donabedian's model of quality of care [6].

This research focuses on examining women's adherence to antiretroviral treatment at the time of HIV diagnosis, the use of prophylactic interventions such as cotrimoxazole and neonatal antiretrovirals, the place of delivery, and certain operational constraints. Neonatal outcomes reveal a close link to the quality of maternal care and treatment adherence. In this sense, late diagnosis, poor adherence, treatment interruptions, and inconsistent or non-existent prophylaxis remain key factors in increasing the high risk of mother-to-child transmission [5,6].

This research aims to significantly reduce critical epidemiological weaknesses, promote provincial and national decisions on maternal and child health, and improve the sustainable and effective performance of PMTCT, as well as contribute to global efforts to eradicate vertical transmission and ensure HIV-free births [7, 8, 9].

2. Material and Methods

This prospective quantitative study, using a descriptive, analytical, and correlational design, examined the serovirological profile of newborns of HIV-positive mothers through structured questionnaires and systematic extraction of paper and electronic medical records from the DREAM Centre of Excellence under the PMTCT programme between 3 and 17 June 2024, addressing public health priorities related to preventing mother-to-child transmission of HIV.

During this research, the focus was on mother-child pairs who had benefited from routine PMTCT services, identified using a systematic probabilistic approach. The sample size was determined using Fisher's formula (P = 5%, Q = 95%, Z = 1.96, d = 5%), which yielded 73

participants. This number was increased by 25% to include 18 additional pairs, taking into account potential non-responses, for a total of 91 participants selected as the study sample. Participants who met the selection criteria included HIV-positive mothers with infants under 18 months of age enrolled in the PMTCT program, for whom biological test results were available. Those who did not meet these criteria were excluded from the study.

The main outcome variable was the infants' serovirological status. Explanatory variables covered maternal adherence and clinical management under Option B+, prophylactic interventions for both mother and child, biological follow-up up to 18 months, timing of HIV diagnosis, and place of delivery. Data were collected through survey tools and medical record review, with efforts made to ensure data quality by cross-checking the consistency between recorded information and observed variables.

Before data collection, a test was carried out at the Mbandaka University Hospital, which helped to validate the data collection tool and train the investigators. For the processing of quantitative data, we used Excel 2010 and SPSS V.22.0 software, which enabled us to develop descriptive and inferential statistics through multivariate logistic regression. The lack of biological monitoring of partners was the main limitation of the study.

3. Results

Table 1 summarizes the sociodemographic and clinical characteristics of the respondents included in the analysis.

Table 1. **Sociodemographic and Clinical Characteristics of the Respondents**

Variables	Modalities	n (91)	%
Age	24 to 33 years old	20	22.0
	34 to 43 years old	71	78.0
Educational Level	Secondary + Higher	48	52.7
	No formal education + Primary	43	47.3
Occupation of Respondents	Housewife	64	70.3
	Farmer	4	4.4
	Government Employee	4	4.4
	Informal	19	20.9
Marital status	Married	47	51.6
	Unmarried	44	48.4
Occupation of Spouse	Unemployed	8	8.8
	Farmer	44	48.4
	Government Employee	8	8.8
	Informal	31	34.1

Analysis of Table 1 indicates that the most represented age group among the parturients is 33–43 years (78%). Moreover, more than half of the respondents (52.7%) possess an appreciable level of education, while 51.6% are married.

Most HIV-positive pregnant women were in their first five pregnancies, with a notable history of fetal loss. Only about 30% began antenatal care in the first trimester, and nearly half were

newly diagnosed with HIV, predominantly type 1. Most were at stage III of the disease, 58% received cotrimoxazole prophylaxis, and 8% developed opportunistic infections, mainly respiratory. Results revealed also that Candidiasis and cervical dysplasia each affected 6.6% of the women, while 87.9% received tetanus toxoid immunization

Table 2 Immuno-Virological Follow-Up of Pregnant Women

Variables	Modalities	n (91)	%
CD4 Lymphocyte Count			
At the beginning of pregnancy	Less than 350¨µl/mm^3	38	41.8
	More than 350¨µl/mm^3	34	37.4
	Not achieved	19	20.9
During early pregnancy	Less than 350¨µl/mm^3	46	50.5
	More than 350¨µl/mm^3	10	11.0
	Not achieved	35	38.5
At the end of pregnancy	Less than 350¨µl/mm^3	18	19.8
	More than 350¨µl/mm^3	10	11.0
	Not achieved	63	69.2
Other pre-therapeutic assessments	Yes	76	83.5
	No	15	16.5
Assessment performed	Modalities	**n (76)**	**100%**
	CBC and Creatinine	34	44.7
	X-pert (sputum), GOT-GOPT	42	55.3

Regarding Table 2, it was observed that 20.9% of the pregnant women did not undergo CD4 testing at the beginning of pregnancy; 38.5% did not receive CD4 testing during pregnancy, and 69.2% were not tested at the end of pregnancy. Among the remaining laboratory assessments, which accounted for 76% of cases, Xpert (sputum), liver function tests (GOT-GOPT, 55.3%), and complete blood count and creatinine (44.7%) were noted.

Most pregnant women (53.8%) were receiving antiretroviral treatment, the vast majority of whom were undergoing first-line treatment (95.6%), despite reported interruptions (67%). Almost all pregnancies were carried to term (97.8%) and deliveries were mainly normal (92.3%). In this regard, some women (12.1%) gave birth at home, sometimes without effective professional assistance.

More than half of these women breastfed exclusively (72.5%), but it should be noted that throughout the final stages of pregnancy, the vast majority (73.6%) had not undergone viral load testing. Among newborns, boys were the most dominant (59.3%), and among them, a minority (5.5%) had an Apgar score below 7 at birth.

The results highlight that within 72 hours, several infants had not received ARV prophylaxis (63.7%) or cotrimoxazole (26.4%), and at 18 months, only 2.2% tested HIV-positive.

Table 3 revealed that newborns of unmarried mothers had a 70% reduced risk of being HIV-positive compared with those born to married mothers (RR = 0.4, 95% CI [0.1–0.9], $p < 0.01$). A statistically significant association was observed between maternal marital status and the HIV profile of the newborn. No statistically significant differences were found between

maternal age and newborn HIV profile (RR = 1.5, 95% CI [0.6–3.4], p = 0.32), or between maternal education level and the HIV profile of the newborn (RR = 2.0, 95% CI [0.8–4.0], p = 0.08).

Table 3 Sociodemographic Characteristics of the Mother and Profile of the Newborn

Characteristics	Newborn Profile		RR	IC95%	χ^2	p-value
	VIH-	VIH+				
Mother's Age						
24-33 years	19.7	30	1.5	[0.6-3.4]	0.9	0.32
34-43 years	80.3	70				
Mother's Education Level						
Secondary + Higher Education	47.9	70	2.0	[0.8-4.0]	3.0	0.008
No Education + Primary Education	52.1	30				
Marital Status						
Married	57.7	30	0.4	[0.1-0.9]	4.8	0.02
Unmarried	42.3	70				

The risk of HIV transmission to newborns was primarily influenced by the timing of maternal diagnosis. Infants whose mothers were diagnosed only during antenatal care (ANC) had a 2.7-fold higher risk of HIV infection compared with those whose mothers were diagnosed through provider-initiated testing at care points (PITC/DCIP) or voluntary counselling and testing (VCT/CDV) (RR = 2.7, 95% CI [1.1–6.4], p < 0.01).

Otherwise, HIV diagnosis in the mother throughout pregnancy or during delivery was significantly associated with a substantial reduction in the risk of infection in the newborn, estimated at approximately 80% (RR = 0.2; 95% CI [0.1-0.7]; p = 0.03).

Similarly, infants who received cotrimoxazole (CTX) prophylaxis had a low risk of being HIV-positive, with an estimated risk reduction of the same magnitude (RR = 0.2; 95% CI [0.1-0.7]; p < 0.001). These results indicate that maternal antiretroviral and CTX interventions in the prevention of vertical transmission play a decisive role in protecting against mother-to-child HIV transmission.

Similarly, newborns whose mothers received treatment for opportunistic infections had a 60% lower likelihood of HIV infection (RR = 0.4, 95% CI [0.1–0.9], p < 0.01). The highest proportion of HIV-positive cases was observed among newborns whose mothers were classified as WHO clinical stage III, representing 71.4% of infections (χ^2 = 26.1, p < 0.01). No significant associations were found between laboratory assessments and newborn HIV status (RR = 0.5, 95% CI [0.2–1.2], p = 1.2), nor between a history of maternal antiretroviral treatment interruptions and neonatal HIV positivity (RR = 0.5, 95% CI [0.4–1.4], p = 0.48) (Table 4).

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Table 4 Comparison between Diagnostic Modalities, Maternal Care, and Newborn HIV Profile

Characteristics	Newborn profile VIH-	VIH +	RR	IC95%	χ^2	p-Value
Circumstances of diagnosis						
ANC	39.4	70	2.7	[1.1-6.4]	5.8	0.01
DCIP+CDV	70.6	30				
Period of serological diagnosis						
Before pregnancy	62.0	25.0	0.2	[0.1-0.7]	8.5	0.00
During pregnancy and during childbirth	38.0	75.0				
Initiation of cotrimoxazole						
Yes	67.6	25.0	0.2	[0.1-0.6]	11.6	0.00
No	32.4	75.0				
Opportunistic infections during pregnancy (treated)						
No	91.5	75	0.4	[0.1-0.9]	4.0	0.04
Yes	8.5	25				
			0.0	[1.2-3.4]	11.3	0.00
Assessment performed						
Cbc and creatinine	50	30	0.5	[0.2-1.2]	2.3	1.2
X-pert (sputum), got-gopt	50	70				
History of art interruption						
No	35.7	28.6	0.8	[0.4-1.4]	0.4	0.48
Yes	64.3	71.4				
Aids stage at enrollment						
Stage i	8.5	30			10.5	0.005

The analysis of table 5 revealed that 70% of HIV-positive mothers were previously diagnosed cases (AC), while 30% were newly diagnosed (NC).

In relation to infants born to women with a higher risk of infection, estimated to be 2.3 times higher than that observed in infants whose mothers had been recently diagnosed (RR = 2.3; 95% CI [1.0-5.6]; p = 0.03). These results highlight a significant association between maternal serological profile and neonatal infection outcomes ($p<0.05$) (Table 15).

With regard to delivery practices, the performance of an episiotomy was associated with a reduced risk of transmission, with an estimated decrease of about 70% compared to cases where

this procedure was not carried out (RR = 0.3; 95% CI [0.1–0.7]; p = 0.01). This suggests that certain obstetric interventions may play a role in limiting vertical transmission.

To add to this, it should be noted that births in healthcare facilities were significantly associated with a low probability of neonatal infection, with a reduction of approximately 60% (RR = 0.4; 95% CI [0.1-0.9]; p = 0.04), revealing the benefit of hospital deliveries. Thus, neither the duration of labor nor the therapeutic treatment received during pregnancy showed a statistically significant association with neonatal HIV serostatus (p > 0.05).

Table 5 Statistical Comparison between Antiretroviral Therapy (ART) Management and the Neonatal Profile

Caracteristics	Newborn profile		RR	IC95%	χ^2	p-value
	VIH-	VIH+				
RESPONDENT'S HIV-POSITIVE STATUS						
AC	43.7	70	2.3	[1.0-5.6]	4.3	0.03
NC	56.3	30				
Place of delivery						
At the maternity ward	91.5	75.0	0.4	[0.1-0.9]	4.0	0.04
At home with a midwife + unassisted at home	8.5	25.0				
Obstetric procedures						
None	95.8	80	0.3	[0.1-0.7]	5.4	0.01
Episiotomy	4.2	20				
Induction period						
During pregnancy	39.4	30	0.7	[0.3-1.6]	0.5	1.44
After childbirth/during breastfeeding	51.6	70				
Therapeutic line during pregnancy						
Line i	97.2	90.0	2.4	[0.8-6.9]	1.9	0.16
Line ii	2.8	10.0				

The prevalence of HIV infection was higher among female neonates than among male neonates (64.8% vs. 35.2%). Male infants therefore exhibited approximately a 60% lower risk of HIV infection compared with their female counterparts (Table 16; RR = 0.4; 95% CI [0.2–0.6]; p = 0.04).

In light of these results, it appears that the sex of the newborn is relatively associated with the occurrence of HIV infection within the study population. At this stage, infants who received antiretroviral (ARV) prophylaxis within 72 hours of birth have a low risk of infection,

estimated at approximately 90% (RR = 0.1; 95% CI [0.04-0.7]; p < 0.001), indicating a high protective value of early postnatal intervention.

Similarly, feeding practices appear to be factors influencing outcomes for formula-fed infants, who have a low risk of HIV infection (approximately 75% lower) than breastfed infants (RR = 0.1; 95% CI [0.3-0.7]; p < 0.001), thus suggesting that exclusive artificial feeding is appropriate in this context.

On the other hand, no statistically significant association was observed between cotrimoxazole (CTX) prophylaxis, type of breastfeeding, and HIV status of newborns (p > 0.05) (Table 6).

Table **6** Factors Associated with Neonates Born to HIV-Positive Mothers

Caracteristics	**Newborb profil**		**RR**	**IC95%**	**χ^2**	**p-value**
	VIH-	VIH+				
Gender						
Male	64.8	40	0.4	[0.2-0.9]	3.9	0.04
Female	35.2	60				
CTX Prophylaxis						
Yes	73.2	75	1.0	[0.4-2.6]	0.2	0.87
No	26.8	25				
72-hour ARV Prophylaxis						
Yes	43.7	10	0.1	[0.04-0.7]	7.6	0.00
No	56.3	90				
Type of Breastfeeding						
Artificial	28.2	25	1.0	[0.8-1.3]	0.07	0.7
AME	71.8	75				

In the multivariate logistic regression analysis (Table 7), five variables emerged as significant predictors of mother-to-child HIV transmission (Table 18). Poor adherence to antiretroviral therapy among HIV-positive pregnant women increased the likelihood of neonatal HIV infection by 11.04 times compared with mothers who adhered properly to treatment (OR = 11.04; 95% CI [3.35–38.68]; p = 0.02). Neonates whose mothers did not receive cotrimoxazole (CTX) prophylaxis had a 5.1-fold higher risk of infection compared with those whose mothers received prophylaxis (OR = 5.1; 95% CI [1.14–23.29]; p = 0.03).

In the same vein, failure to administer neonatal antiretroviral (ARV) prophylaxis within the first 72 hours after birth was strongly associated with an increased risk of HIV infection, estimated at over sixteen times higher (OR = 16.11; 95% CI [2.91–89.09]; p < 0.001).

The environment in which a baby is delivered is a major factor in the transmission of HIV to infants. In this regard, newborns delivered at home or with the assistance of traditional midwives were much more likely to be infected with HIV than those born in approved health facilities (OR = 32.77; 95% CI [2.70-397.7]; p < 0.001).

In addition, a late maternal HIV diagnosis—whether during pregnancy or at the time of delivery—was associated with a markedly increased risk of transmission to the newborn (OR = 18.32; 95% CI [1.97–170.18]; p = 0.01).

Based on the above, the results show that in order to reduce vertical transmission of HIV, it is essential to combine priority factors such as optimal treatment adherence, early initiation of prophylaxis, and hospital delivery.

Table 7. Logistic Regression on the Sero-Virological Profile of Neonates Born to HIV-Positive Mothers (n = 91)

Variables	**Modality**	**S.E.**	**Wald**	**P**	**OR**	**IC 95%**
reatment Adherence	Yes No	1.017	7.41	0.02	11.04	[3.35-38.68]
Initiation of CTX	Yes No	0.76	4.55	0.03	5.1	[1.14-23.29]
ARV Prophylaxis at 72 hours of Birth	Yes No	0.87	10.14	0.00	16.11	[2.91-89.09]
Place of Delivery	Maternity Nursing home and unassisted home.	1.273	7.510	0.00	32.77	[2.70-397.7]
Diagnostic Period	Before pregnancy During pregnancy and childbirth	1.137	6.541	0.01	18.32	[1.97-170.18]

The discriminatory power of the model was evaluated using Receiver Operating Characteristic (ROC) curve analysis to determine its capacity to accurately distinguish between HIV-positive (HIV^+) and HIV-negative (HIV^-) neonates (Table 8).

The analysis was conducted on a total of 91 participants, including 20 HIV-positive and 71 HIV-negative cases. The model demonstrated a high level of performance, with an Area Under the Curve (AUC) of 0.930 (SE = 0.026; 95% CI [0.879–0.981]; $p < 0.001$), reflecting excellent discriminative ability.

The results of this research show that in the HIV-positive group (group 1), there is a classification probability with an AUC of 0.927 (SE = 0.026; 95% CI [0.876-0.979]; $p < 0.001$). Thus, it appears that the model is capable of distinguishing between an HIV-positive newborn and an HIV-negative newborn in approximately 93% of cases.

Conventional interpretation standards indicate that an AUC value between 0.90 and 1.00 represents exceptional discriminatory power, confirming the robustness, reliability, and predictive power of the logistic regression model used in this study.

Table 8. Area Under the Curve (AUC)

Test Result Variable(s)	Area	Std. Error[a]	p	IC95%	
				Lower Bound	Upper Bound
Predicted probability	0.930	0.026	0.000	0.879	0.981
Probabilities of Membership in Group 1 for Analysis 1	0.927	0.026	0.000	0.876	0.979

4. Discussion

This section presents the sero-virological profile of neonates born to HIV-positive mothers and the main determinants of vertical transmission. Among 91 newborns, two tested HIV-positive (2.2%). Transmission levels vary widely across regions; the rate observed here reflects the profile of patients referred to the DREAM Centre of Excellence for specialised PMTCT care.

Among infants whose mothers had identifiable clinical or behavioral risk factors, two PCR-positive cases were observed. One was a newborn with low birth weight and mixed feeding, who received nevirapine at birth despite the mother's poor adherence to antiretroviral treatment. In the other case, no neonatal prophylaxis was administered to the newborn; it was noted that the mother had been diagnosed too late and had not disclosed her viral load. From this perspective, among mothers who did not start or maintain ART, it was only at WHO stage III that a higher proportion of HIV trans mission was observed.

In this sense, of the two cases previously reported, mother-to-child transmission rates vary considerably from one context to another, ranging from less than 2% in Canada [10] to 12.7% in Lubumbashi under option A [11], and approximately 5.7% under option B+ in other contexts [12], in contrast to high-income countries reporting rates below 1% [13,14]. From this perspective, marital status was strongly linked to transmission (RR = 0.4; $p < 0.01$), corroborating the analyses reported in Togo [15].

According to multivariate analysis, five key factors in mother-to-child transmission were identified. These include cotrimoxazole prophylaxis, which was associated with an 80% reduction in risk (RR = 0.2; $p < 0.001$), in line with WHO recommendations. Similarly, neonatal ARV prophylaxis administered within 72 hours of birth reduced transmission by approximately 90% (RR = 0.1; $p < 0.001$), in line with current guidelines recommending zidovudine alone or in combination, depending on maternal viral load [16,17]. Data from Kinshasa also confirm the additional benefit of triple prophylaxis [18].

Poor adherence to ART remained a major concern, with about one-third of mothers reporting treatment interruption; the highest risk of transmission was observed among those initiating ART at WHO stage III, in agreement with findings from Tuyisingize [19] and Mandelbrot & Faure [20]. Although the place of delivery appeared to influence exposure, this association was not statistically significant. Finally, early maternal HIV diagnosis emerged as

a critical factor, as women diagnosed prior to pregnancy showed lower transmission rates, consistent with studies conducted in Zambia and similar settings [21–23].

Without ART, MTCT ranges from 14–32% in high-income settings and 25–48% in low-resource contexts [24]. Many women recognised PMTCT services as essential for enabling HIV-free births [25].

5. Conclusion and Recommendations

This study examined the sero-virological profile of infants born to HIV-positive mothers and identified the main determinants of mother-to-child HIV transmission within the framework of the DREAM Center's PMTCT program. The results indicate that the main factors influencing the serological status of newborns include: early diagnosis of HIV in the mother, strict adherence to antiretroviral treatment, timely prophylaxis for mothers and newborns, and delivery in a health facility. In this sense, reduction in the mother's viral load and the time to diagnosis are strongly associated with HIV transmission, unlike the following factors: maternal age, obstetric procedures, feeding practices, and the duration of antiretroviral treatment induction are not associated. Ultimately, it should be noted that the low infection rate confirms the effectiveness of the program. It is strongly recommended that HIV testing, support for adherence to antiretroviral treatment, neonatal prophylaxis, and delivery in an approved health facility be strengthened.

Journalism Ethical considerations: Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors

Conflicts of interest: The authors indicate that they do not have any competing interests

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