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Prevalence and factors associated with seroconversion among HIV exposed infants receiving care at Lira regional referral hospital in Lira City: a cross-sectional study

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Abstract

Background Human Immunodeficiency Virus (HIV) is a significant public health concern globally, particularly among vulnerable populations such as infants. Mother-to-child transmission (MTCT) of HIV contributes significantly to infant and child HIV-related mortality. In Uganda, up to 3200 children aged 0 to 14 years die due to HIV-related causes annually, which is highly concentrated in areas heavily affected by HIV, like Lira city. Therefore, this study aimed to find out the prevalence of seroconversion and its associated factors among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira City, northern Uganda.

Methods A cross-sectional study design which used a retrospective approach. 217 patient files of infants under 18 months at the Early Infant Diagnosis Clinic of Lira Regional Referral Hospital from February 2021 to February 2024 were systematically selected. Quantitative methods of data collection using a standardized data extraction form were used. Data were analyzed using SPSS version 27 to obtain results. Bivariable and multivariable logistic regression analysis was done considering the p-values of 0.2 and 0.05 respectively as levels of statistical significance and data was presented in form of tables and pie-chart.

Results There were 217 case records reviewed and the results showed that; The seroconversion rate among exposed infants was 7.3% (16/217), and several factors including infants' sex (aOR 36.177; 95%CI:(1.747–749.045), $P=0.020$), Infant's nutrition status (aOR 437.186; 95%CI: (5.248–36,422.893), $P=0.007$), Infants' mode of feeding (aOR 10.565; 95%CI: (1.171–96.990), $P=0.036$) and Maternal viral load suppression status during lactation (aOR 27.971; 95%CI:(1.049–745.899), $P=0.047$) were found to be significantly associated with seroconversion.

Conclusion The seroconversion rates among exposed infants in Lira City are higher than the national estimate of 6.9%. Even now that there has been reduced support towards HIV/AIDs services, stakeholders including midwives, the ministry of health and local leaders should align efforts on strengthening appropriate infant feeding counseling, timely ART initiation for newly tested mothers and adherence counselling for unsuppressed mothers and continuously monitoring PMTCT programs.

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Keywords Seroconversion, HIV exposed infants, Mother to child transmission

Introduction

Human Immunodeficiency Virus (HIV) remains a significant public health concern globally, particularly among vulnerable populations such as infants [1]. Areas with high maternal HIV infection are reported to have the highest HIV prevalence among infants [2]. Despite advancements in prevention and treatment, mother-to-child transmission (MTCT) of HIV, there is significant morbidity and mortality among infants [3].

Globally, 39.9 million people are living with HIV [4]. The global estimate for infants living with HIV is 8.1% [5], while that of sub-Saharan Africa is 15–45% and East Africa being 7.68% [6, 7]. In Uganda, HIV prevalence of seroconversion is estimated to be 2.6% by 6 weeks postpartum and 6.9% by the end of 18 months [8, 9] and in Northern Uganda, Pader District being 7.7% making it higher than the national estimate of 6.9% [10].

Early infant diagnosis (EID) and initiation of antiretroviral therapy (ART) are critical for improving survival rates and reducing MTCT [11–13]. Majority of the infants acquire the virus through vertical transmission [6, 14].

Infants are particularly susceptible to HIV due to their immature immune systems [15]. WHO recommendation on prevention of mother to child transmission of HIV is giving of 6-week postnatal prophylaxis regimen with zidovudine or nevirapine followed by septrin with regular checkups of HIV at 6 weeks, 6 months, 1 year and 18 months [16]. Substantial clinical and programmatic developments have been made on simplification of HIV treatment for pregnant and breastfeeding women through the introduction of a single fixed drug regimen, which can be rolled out on maternal, newborn and child health [17].

Research indicates that the programme focus shifted from PMTCT to eliminating mother-to-child transmission of HIV (eMTCT) [18]. Variability in rates of HIV infection is influenced by several factors, including maternal health, socioeconomic condition, infant feeding, immunological factors and healthcare access [19]. However, continued research from 2019 to 2024 underscores the need for targeted intervention and comprehensive care strategies [2].

However, Lira city, which is one of the districts with the highest HIV infections in Uganda among the women of reproductive age [20], little is known about the prevalence and factors associated with seroconversion among HIV exposed infants under 18 months receiving care at Lira Regional Referral Hospital.

Therefore, the purpose of this study is to assess the prevalence of seroconversion among HIV-exposed

infants receiving care at Lira Regional Referral Hospital in Lira city and to identify the multifactorial influences that contribute to this outcome.

Methods

Study design and setting

This study employed a cross-sectional study design with a retrospective approach to evaluate both the prevalence and factors associated with seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira City. This was because this study design would provide a snapshot of the prevalence of seroconversion at a specific point in time and since retrospective data was available, therefore this approach was more effective compared to a prospective study.

This study was conducted at Lira Regional Referral Hospital particular in the Early Infant Diagnosis unit. The researcher chose Lira Regional Referral Hospital because it serves all the districts in the entire Lango sub region. Lira Regional Referral Hospital is one of the government referral hospitals in the northern part of Uganda, located in Lira City. This hospital serves 9 districts including Alebtong, Lira, Apac, Otuke, Kole, Amolatar, Dokolo, Oyam and Kwanja district (whose population is estimated to be more than 2.5 million people). It has 401 bed capacity.

The wards and clinics of Lira Regional Referral Hospital are the following: medicine ward, surgical ward, emergency unit, labor ward, postnatal ward, eye clinic, OPD, gyn ward, NICU, ART clinic, pediatric ward, PMTCT clinic, family planning clinic, theatre, EID clinic among many others. However, this study involved EID clinic which provides care to HIV-exposed infants below 18 months.

Study population and eligibility

We reviewed all files of HIV-exposed infants who received care at EID at Lira Regional Referral Hospital. The study included those infants between 0–18 months who received care at EID clinic at Lira Regional Referral Hospital who were tested for HIV and had documented results in their medical records between February 2021 to February 2024. The study excluded those exposed infants whose HIV status was not documented by the end of 18 months of prophylactic treatment and those whose HIV exposure status was unclear.

Sample size and sampling procedures

To determine the prevalence and factors associated with seroconversion among HI-exposed infants at Lira Regional Referral Hospital, we used the Krejcie and

Morgan method [21]. We intended to recruit 239 participants assuming a 95% confidence interval, a 5% margin of error, a sampling frame of 500 infant files and a non-response proportion of 10%.

This study used a systematic probability sampling technique to select patient files which were used in the study. The files were arranged and picked according to the n th value calculated as follows:

$$\text{nth value} = N (\text{target population}) / \text{Sample size}$$
$$n = 500 / 239 = 2.09 \text{ approximately } 2$$

The infant files which were to be used in the study were selected by picking the first infant's file randomly and then chose every 2nd file from the infants' files according to the sampling interval of 2.

Recruitment of study participants

Formal permission was sought from the relevant ethical review board of Lira Regional Referral Hospital to access medical records for research purposes. This included assurances of confidentiality of patients' information and adherence to data protection regulations.

Study variables

The outcome variable of the study was the prevalence seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira city.

The independent variables included the factors associated with seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira city which included maternal variables (Maternal viral load, ART adherence, Maternal age, education level and occupation), Infant variables (Birth weight, sex, nutrition

status and mode of feeding) and Delivery variables (Timing of start of HIV prophylaxis, delivery setting, gestational age at delivery and type of delivery).

Data collection tools and procedures

We obtained permission from Lira Regional Referral Hospital review board to access the exposed infant files from February 2021 to February 2024 then created rapport with the health providers and administrative staff which facilitated access to medical records.

We then systematically reviewed the exposed infant files for eligibility infants based on the established inclusion criteria.

A standardized data extraction form was used for the collection of relevant data from the medical records of HIV-exposed Infants. The data extraction form comprised of sections capturing data on Exposed infant variables, maternal variables and delivery variables from the HIV-exposed infants' files.

Once data collection was complete, a final review was conducted daily to ensure that all necessary data had been collected and that forms were fully complete. With an average of 12 infant files per day, 20 working days were used to complete data collection.

Data processing and analysis

The statistical Package for social sciences (SPSS) version 27 was used to analyze the collected data. Univariate analysis was done to obtain frequencies and percentages for categorical variables like sex, and Infant HIV status. Then means and standard deviations for continuous variables like maternal age and birth weight. Bivariable logistic regression analysis was done to obtain the relationship between the dependent and independent variables. All independent variables with a P-value of less than 0.2 at bivariable were carried to the multivariable model where multivariable Logistic regression analysis was done to obtain the factors independently associated with seroconversion among HIV-exposed infants Where Adjusted Odds ratios (aOR) was determined and variables which had P-values of less than 0.05, at a 95% confidence interval were considered significant. The results have been presented in the form of tables, graphs, and pie charts.

Results

Study participants

Out of 500 infant files screened for eligibility to participate in the study in February 2025, 239 were eligible and recruited. A total of 217 files had complete data from the 239 calculated sample size, giving a response rate of 90.8% (217/239) (Fig. 1).

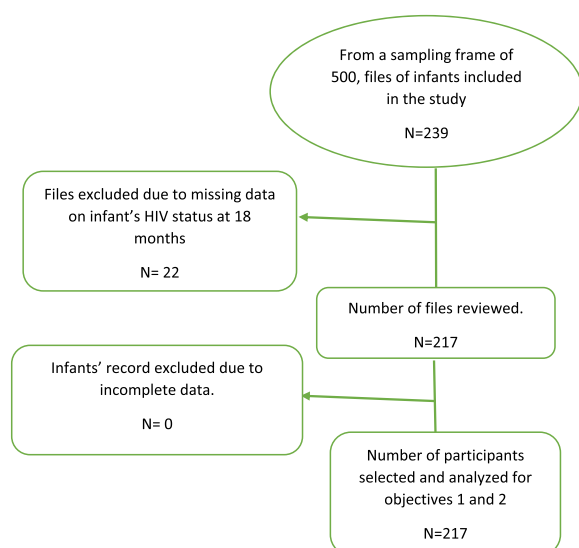


Fig. 1 Flowchart for recruitment of study participants

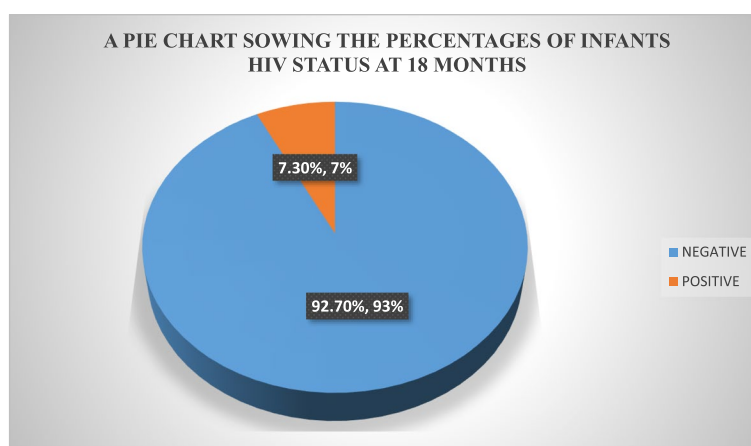


Fig. 2 Pie chart showing the prevalence of seroconversion

Table 1 Infant characteristics

Variable	Frequency	Percentage
Sex		
Female	116	53.7
Male	101	46.3
Birth weight category		
Abnormal birth weight	54	24.8
Normal	163	74.8
MUAC at 6 months category		
Normal	163	84.0
Moderate malnutrition	30	16.0
MUAC at 12 months category		
Normal	159	82.0
Malnourished	35	18.0
MUAC at 18 months category		
Normal	209	96.8
Malnourished	7	3.2
Mode of feeding category		
Recommended feeding	130	59.9
Non recommended feeding	87	40.1

HIV seroconversion rate

The prevalence of seroconversion among the HIV exposed infants receiving care at Lira Regional Referral Hospital from February 2021 to February 2024 was found to be 7.3% by the end of their 18 months in care (Fig. 2).

Infant characteristics

Majority of the infants 116(53.7%) were females with a normal birth weight range(2.5kgs-3.9kgs) (74.8%) with a mean weight of 3.2 kgs, a maximum weight of 4.5kgs and a minimum weight of 1.9kgs. Most of them had a normal MUAC(> 12 cm) value at 6 months (84.0%) with a mean MUAC of 12.8 cm and standard deviation of 0.6668, a normal MUAC value(> 13 cm) at 12 months (82.0%) with mean being 13.6 cm and a standard deviation of 0.6546, a normal MUAC value(> 13 cm) at 18 months (96.8%) with the mean being 14.3 cm and standard deviation of

0.5996. Most of these infants 130(59.9%) were fed as recommended as shown in Tables 1, 2 and 3 below.

Factors associated with seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira city

Factors that were statistically significant at bivariate level and were therefore included in multivariate analysis are; Sex, MUAC at 12 months, MUAC at 18 months, Mode of feeding, time of start of HIV prophylaxis, delivery setting, Maternal age, maternal adherence to ART, maternal viral load suppression status during lactation and maternal occupation.

The findings revealed that the factors associated with seroconversion among these HIV exposed infants were: infants' sex, infant's nutrition status (MUAC at 18 months), infant's mode of feeding and maternal viral load suppression status during lactation. Infant's sex was associated with seroconversion among HIV exposed infants where male infants were 36.177 times more likely to seroconvert; (aOR 36.177; 95%CI:(1.747–749.045), $P=0.020$) than female infants. Infant's nutrition status was found a predictor of seroconversion among these HIV exposed infants where infants with MUAC value of < 13 cm at 18 months were considered malnourished (severely and moderately malnourished) and were 437.186 times more likely to seroconvert (aOR 437.186; 95%CI: (5.248–36,422.893), $P=0.007$) than infants who had a normal nutrition status with the MUAC value of > 13 cm at 18 months. Infants' mode of feeding where infants who were not fed as recommended were 10.565 times more likely to seroconvert (aOR 10.565; 95%CI: (1.171–96.990), $P=0.036$) than those who were fed as recommended (exclusive breast feeding for first 6 months, complementally feeding from 6 months to 1 year and then replacement feeding from 1 year and above). Maternal viral load suppression status during lactation where exposed infants whose mothers' viral load

Table 2 A table showing the Bivariate analysis between factors and seroconversion rate among HIV exposed infants

Variable	Frequency	Percentage	cOR (95% CI)	P-value
Sex				
Female	116	53.7	Ref	
Male	101	46.3	2.713 (0.909–8.095)	0.064*
Birth weight category				
Abnormal birth weight	54	24.8	0.679 (0.186–2.478)	0.204
Normal	163	74.8	Ref	
MUAC at 6 months category				
Normal	163	84.0	Ref	
Moderate malnutrition	30	16.0	0.899 (0.191–4.236)	0.923
MUAC at 12 months category				
Normal	159	82.0	Ref	
Malnourished	35	18.0	2.778 (0.970–8.873)	0.001*
MUAC at 18 months category				
Normal	209	96.8	Ref	
Malnourished	7	3.2	5.571 (0.991–31.338)	0.030*
Mode of feeding category				
Recommended feeding	130	59.9	Ref	
Non recommended feeding	87	40.1	7.437 (2.052–26.954)	0.002*
Start of HIV prophylaxis				
Before 2 weeks	181	83.5	7.944 (2.737–23.052)	< 0.001*
After 2 weeks	36	16.5	Ref	
Delivery setting				
Hospital	191	88.1	Ref	
Home	26	11.9	3.896 (1.234–12.301)	0.014*
Gestational age at delivery categories				
Term	172	79.4	Ref	
Abnormal gestational age at delivery (preterm& post-term)	45	20.7	2.661 (0.524–13.524)	0.438
Type of delivery				
C-Section	45	21.1	0.874 (0.238–3.208)	0.839
Vaginal	172	78.9	Ref	
Maternal age				
Younger mothers < 30	104	47.9	0.281 (0.088–0.902)	0.024*
Older mothers > = 30	113	52.1	Ref	
Adherence to ART				
Good	196	90.4	Ref	
Poor	21	9.6	31.815 (9.609–105.342)	< 0.001*
Viral load suppression status during lactation				
Suppressed	182	83.9	Ref	
Unsuppressed	35	16.1	33.536 (8.884–126.596)	< 0.001*
Occupation				
Employed	197	90.9	Ref	
Unemployed	20	9.2	2.498 (0.647–9.636)	0.156*
Education level				
Lower education	82	37.7	0.732 (0.245–2.187)	0.576
Higher education	135	62.3	Ref	

Ref- Reference category

(*) P-value is significant

cOR Crude Odds ratio

was unsuppressed during lactation were 27.971 times more likely to seroconvert (aOR 27.971; 95%CI:(1.049–745.899), $P=0.047$) than those infants whose mothers had a suppressed viral load during lactation.

Discussion

Prevalence of seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira city

The study found that 7.3% of HIV-exposed infants

Table 3 Multivariate analysis of factors associated with seroconversion among HIV exposed infants at LRRH

Variable	Frequency	%	Bivariate analysis		Multivariate analysis	
			cOR (95% CI)	P-value	aOR (95%CI)	P-value
Sex						
Female	116	53.7	Ref		Ref	
Male	101	46.3	2.713 (0.909–8.095)	0.064*	36.177 (1.747–749.045)	0.020**
MUAC at 12 months category						
Normal	159	82.0	Ref		Ref	
Malnourished	35	18.0	2.778 (0.970–8.873)	0.001*	1.894 (0.211–17.011)	0.569
MUAC at 18 months category						
Normal	209	96.8	Ref		Ref	
Malnourished	7	3.2	5.571 (0.991–31.338)	0.030*	437.186 (5.248–36,422.893)	0.007**
Mode of feeding category						
Recommended feeding	130	59.9	Ref		Ref	
Non recommended feeding	87	40.1	7.437 (2.052–26.954)	0.002*	10.656 (1.171–96.990)	0.036**
Start of HIV prophylaxis						
Before 2 weeks	181	83.5	7.944 (2.737–23.052)	<0.001*	7.126 (0.690–73.566)	0.099
After 2 weeks	36	16.5	Ref		Ref	
Delivery setting						
Hospital	191	88.1	Ref		Ref	
Home	26	11.9	3.896 (1.234–12.301)	0.014*	7.822 (0.680–89.926)	0.099
Maternal age						
Younger mothers < 30	104	47.9	0.281 (0.088–0.902)	0.024*	0.794 (0.096–6.578)	0.831
Older mothers > = 30	113	52.1	Ref		Ref	
Adherence to ART						
Good	196	90.4	Ref		Ref	
Poor	21	9.6	31.815 (9.609–105.342)	<0.001*	4.151 (0.278–62.013)	0.302
Viral load suppression status during lactation						
Suppressed	182	83.9	Ref		Ref	
Unsuppressed	35	16.1	33.536 (8.884–126.596)	<0.001*	27.971 (1.049–745.899)	0.047**
Occupation						
Employed	197	90.9	Ref		Ref	
Unemployed	20	9.2	2.498 (0.647–9.636)	0.156*	1.539 (0.135–17.583)	0.728

Ref- Reference category

(*) P-value is significant bivariable analysis

(**) P-value is significant at multivariable analysis

cOR Crude Odds Ratio, aOR Adjusted Odds Ratio

receiving care at LRRH had seroconverted by 18 months of age. This prevalence is concerning, given the availability of PMTCT (Prevention of Mother-to-Child Transmission) interventions. The finding suggests gaps may still exist in implementation or adherence to care protocols. It also indicates a need for better health education and follow-up systems to reduce the risk of vertical HIV transmission. This relatively moderate prevalence points to progress, but also a reminder that the fight is far from over.

This result is consistent with global estimates, such as the 8.1% reported by Tiruneh & Dagnew, and aligns with findings from East Africa (7.68%) and Pader District, Uganda (7.7%) [5, 7, 10]. However, it differs from studies in Sub-Saharan Africa that reported higher rates (15–45%), those in Kilimanjaro, Santa Catarina [6, 22, 23] and North West Ethiopia [24] that reported lower rates

between 0.5%–2.9%. These variations could reflect differences in study design, geographic contexts, healthcare system efficiency, and cultural practices.

The prevalence in this study was within the mid-range of global estimates, highlighting both progress in HIV prevention efforts and the need for further improvements in care delivery at the facility level.

Factors associated with seroconversion among HIV exposed infants receiving care at Lira Regional Referral Hospital in Lira city

Infants' sex, infant's nutrition status (MUAC at 18 months), infant's mode of feeding and maternal viral load suppression status during lactation were significant determinants for seroconversion among HIV exposed infants with $P < 0.05$. However, infants' birth weight, time of start of prophylaxis, gestational age at delivery,

delivery setting, type of delivery, maternal age, maternal adherence to ART, maternal occupation and level of education were not associated with seroconversion among HIV exposed infants receiving care.

Infant sex

Male infants were significantly more likely to seroconvert than female infants, with an odds ratio of 36.177. This is a striking difference that raises concerns about biological or behavioral vulnerabilities among male infants. One possible explanation could be sex-based differences in immune development. However, such a high odds ratio warrants further investigation to rule out possible confounding or measurement biases. This finding contradicts the results from a study in Mozambique [25], which found higher seroconversion among female infants. Such differences might stem from contextual or methodological variations across the studies, including differing HIV exposure risks or population characteristics.

The association between infant sex and HIV seroconversion in this study underscores the importance of considering biological factors in HIV prevention strategies for infants.

Infant's nutrition status (MUAC at 18 months)

Malnourished infants were 437 times more likely to seroconvert than those with normal nutritional status. This extreme association highlights the critical role of nutrition in immune system function and resistance to HIV. Malnutrition likely compromises an infant's ability to fight infections, making them more vulnerable to seroconversion even with PMTCT interventions. This finding reinforces the interconnectedness of nutrition and disease prevention.

The result aligns with findings from nutrition [26] in Northwest Ethiopia, which also reported a strong link between malnutrition and increased risk of HIV transmission. Studies consistently point to poor nutritional status as a risk factor, suggesting this is a widely relevant concern [23, 27, 28].

Therefore, ensuring good nutrition for HIV-exposed infants should be a key component of HIV prevention strategies, especially in resource-limited settings.

Infant's mode of feeding

Infants who were not fed according to the recommended guidelines of exclusive breast feeding for first 6 months, complementary feeding from 6 months to 1 year and then replacement feeding for infants above 1 year [29] were 10.565 times more likely to seroconvert. Feeding practices are directly linked to postnatal HIV transmission, especially through breastfeeding. Therefore, education on feeding practices remains a vital strategy in preventing HIV transmission among infants.

These findings are consistent with studies from Santa Catarina (USA), Kilimanjaro in Tanzania, Southern Ethiopia and a in Ndejje health Centre, Uganda [22, 23, 30], which also reported higher transmission rates among inappropriately fed infants. However, the result contradicts a study in Kenya [9], which found higher seroconversion in exclusively breastfed infants, a difference possibly due to study design or local healthcare practices.

Therefore, proper feeding practices remain an essential, modifiable factor in reducing HIV transmission risk among exposed infants.

Maternal viral load suppression status during lactation

Infants whose mothers had unsuppressed viral loads during lactation were nearly 28 times more likely to seroconvert. This finding is expected, as unsuppressed maternal viral loads increase the risk of transmission through breast milk. It emphasizes the need for continuous viral load monitoring and adherence to ART during lactation. Ensuring maternal viral suppression should be a cornerstone of PMTCT efforts. This result is consistent with findings from Mozambique [25] which reported increased transmission risks in cases of unsuppressed maternal viral load. These consistent findings across diverse settings highlight the universal importance of maternal health in infant HIV prevention.

Strengthening maternal ART adherence and regular monitoring of viral loads during lactation is critical in preventing seroconversion among HIV-exposed infants.

Conclusion

In conclusion, the ministry of health and the midwives should fight to reduce seroconversion rate among HIV exposed infants through preventing its associated factors that is to say; through health educating mothers about the recommended modes and ways of feeding to prevent malnutrition, encourage mothers to adhere on ART so that they have a suppressed viral load during lactation thus reducing the chances of the infant acquiring HIV through breast milk.

Abbreviations

APR	Adjusted prevalence ratio
CI	Confidence interval
ART	Antiretroviral therapy
Emtct	Elimination of mother to child transmission
EID	Early infant diagnosis
HIV	Human immunodeficiency virus
MTCT	Mother to child transmission
PMTCT	Prevention of mother to child transmission
WHO	World health organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12887-025-06191-6>.

Supplementary Material 1.

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Study category

Clinical trial- not applicable.

Authors' contributions

NPK; conceived the study, collected data, analysed data, and developed the first draft of the Manuscript. RI; supervised protocol development, analyzed data, reviewed results and reviewed manuscript. CJA; supervised protocol development, reviewed results, and reviewed manuscript. All authors reviewed the manuscript.

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Data availability

The datasets generated and analyzed during the current study are not publicly available as no provisions were made to make them publicly available in terms of participants' consent. However, the data is available from the corresponding authors on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Lira University Research Ethics Committee on 4th February, 2025 with a LUREC number of LUREC-2024–334. Permission was obtained from the Lira Regional Referral administration and institutional review board to access patient files and collect data from them. Privacy was observed by using a unique identifier (code numbers) that was anonymous for each patient file without recording their names and patient file numbers.

No permission was obtained from the participants parents or guardians because data was collected from infants' files therefore waiver of consent was obtained from Lira Regional Referral Hospital Review Board.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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