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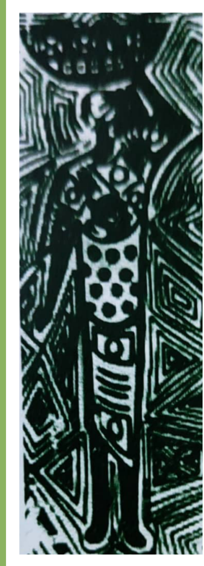

VOLUME 52
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REVIEW

Advocacy by Paediatricians: A Potential Strategy for Ending the Menace of Childhood Malnutrition in Nigeria
Ubesie Agozie C.

Understanding Antimicrobial Stewardship in Paediatric Practice: A Conceptual Framework
Ogunbosi Babatunde O.

ORIGINAL ARTICLE

The Pattern of Orofacial Lymphoma and Their Histopathologic Subtypes Among Children in a Tertiary Hospital in Southern Nigeria
Ehizonaga Jovana I, Okoh Dickson S, Ogordi Philip U, Omoregie Osawe F.

Birthweight Discordance Among Twins Born in Lagos, Nigeria
Kehinde Omolara A, Ubuane Peter O, Olutekunbi Adenike O, Alaje Ekaette O, Ogunleye Grace A, Akinola Ayodeji O, *et al.*

Awareness, Acceptability and Outcome of Newborn Screening for Sickle Cell Disease in Benue State, Nigeria
Michael Aondoaseer, Mokuolu Olugbenga A.

Determinants of Zero Dose Immunization Among Children Aged 12–23 Months in Abuja, Nigeria: A Cross-Sectional Survey
Nwaze Eric, Nwaze Kate N, Okoude Uchechi E.

Strengthening Hospital-Based Paediatric AMS in Nigeria: A Multi-Centre Baseline Survey and Intervention Overview
Ogunbosi Babatunde O, Ebruke Bernard E, Oladokun Regina E, Sadoh Ayebo E, Obaro Stephen K.

Socio-Clinical Predictors of Treatment Outcomes Among Human Immunodeficiency Virus-exposed Infants in Southwest Nigeria
Olagunju Funso A, Oninla Samuel O, Odeyemi Abimbola O, Ayeni Temitope O, Afolabi Adegboyega S, Awodele Kehinde, *et al.*

CASE REPORT

Mucopolysaccharidosis IVa (Morquio Syndrome Type A): A Case Report on Challenges of Management of a Rare Disease in a Resource Constrained Setting
Babatunde Funmilayo O, Oyenusi Elizabeth E, Idemudia Rita O, Oladipo Oluwadamilola M, Oduwole Abiola O.

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ORIGINAL RESEARCH

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A Facility-Based Study of Socio-clinical Predictors of Treatment Outcomes Among Human Immunodeficiency Virus-Exposed Nigerian Infants

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Abstract

Background: Despite global achievements in lowering mother-to-child transmission of human immunodeficiency virus, Nigeria still accounts for 14% of the global trend. Therefore, it is imperative to assess prevention of mother-to-child transmission (PMTCT) treatment outcomes and their socio-clinical determinants.

Objectives: To determine the treatment outcomes and socio-clinical predictors of outcomes of HIV-exposed infants.

Methods: The medical records of 409 HIV-exposed infants who received PMTCT care over eight years were assessed. A purpose-designed proforma was used to collect the necessary data, including sociodemographic information, clinical variables, and treatment outcomes: non-infected, infected, and loss to follow-up (LTFU).

Results: Out of the 409 records assessed, 338 (82.64%) infants were non-infected, 12 (2.93%) were infected, and 59 (14.43%) were LTFU. The identified predictors of infection outcomes were the age of first ART clinic attendance (>6 weeks), polygamous family setting, maternal HAART-naïve status, paternal non-awareness of maternal HIV status, and antenatal care outside the tertiary health facility. Other predictors of HIV-infection as an outcome included the gestation age at birth (preterm), mixed-feeding options, non-ART prophylaxis usage, <5 times clinic attendance, low socioeconomic status, and the occurrence of comorbidities like pneumonia.

Conclusions: The HIV infection rate in the cohort was 2.9%. Socio-clinical predictors of treatment outcomes were identified. Health workers and caregivers should pay particular attention to the socio-clinical predictors of infection outcomes to mitigate mother-to-child transmission of HIV.

Keywords:* *Antenatal care, HIV-exposed infants, Prevention-of-Mother-To-Child-Transmission, Socioeconomic status, Treatment outcomes.

Introduction

Mother-to-child transmission (MTCT) of Human Immunodeficiency Virus (HIV), otherwise called vertical transmission, can occur during pregnancy, delivery, and breastfeeding. It is the most common mode of childhood HIV infection transmission, and a newborn delivered by an infected mother is referred to as an HIV-exposed baby. [1] The trend of MTCT among antiretroviral therapy (ART) naïve mothers is as follows: for every 100 newborns delivered and breastfed by infected mothers without any intervention, 25 to 40 children will be infected. Among the 25 to 40 newborns, 5 to 10 will acquire HIV infection during pregnancy, 15 during labour and delivery, and 5 to 15 during breastfeeding. [2] Globally, there has been a drastic reduction in the rate of new HIV infection among children from 310,000 cases in 2010 to 120,000 cases in 2023, and approximately 22,000 of the 120,000 new cases (approximately 14% of the global total) were from Nigeria. [3, 4] Thus, the gain of this tremendous effort is yet to be fully felt in Nigeria, with 24% of HAART-naïve pregnant women living with the virus worldwide being Nigerians.[5] In addition, one out of seven children delivered by HIV-infected pregnant women worldwide is a Nigerian baby. [4]

In a bid to halt the transmission of HIV from infected pregnant mothers to children, the Joint United Nations Programme on HIV/AIDS (UNAIDS) introduced the prevention of mother-to-child transmission (PMTCT) package of care to be administered to every HIV-infected pregnant woman, her family, and the community at large. Judicious administration of the package of care and adherence to the tenets of care by all concerned stakeholders are expected to significantly reduce the percentage of MTCT to a minimal value of less than 5%. [3] PMTCT operates on four pillars: 1) primary prevention of HIV in women of reproductive age and partners; 2) prevention of unintended pregnancy among HIV-infected women; 3) prevention of HIV transmission from the infected mothers to the children; and 4) provision of appropriate treatment, care and support to HIV-infected mothers, children and families. [6]

The success of the PMTCT programme in the HIV Treatment facility can be evaluated by assessing the treatment outcomes and comparing them to the <5% infection rate among HIV-exposed children advocated for by the UNAIDS [3] and reports from similar studies. Ugochukwu *et al.* [1] in a study in Southeast Nigeria reported that the percentages of infected children, non-infected children, and lost-to-follow-up (LTFU) children were 8.1%, 81.2%, and 10.7%, respectively. Additionally, Oluwayemi *et al.* [7] in Ado-Ekiti, southwest Nigeria, reported that 6.3% were infected, 93.7% were non-infected, and none were LTFU. However, there is still a paucity of recent information on how treatment facilities are faring in the mandate to reduce MTCT and identify socio-clinical predictors of the treatment outcome of HIV-exposed children. Therefore, this retrospective study aimed to review the hospital records of HIV-exposed children managed between 2013 and 2021 in a tertiary hospital in southwest Nigeria to determine the treatment outcomes of the PMTCT programme and their socio-clinical predictors.

Methods

Study setting

This study was conducted at the Paediatric Antiretroviral Therapy (ART) Clinic of Osun State University Teaching Hospital, Osogbo Nigeria. The hospital is one of the 16 centres providing HIV care services in Osun State. In accordance with the National Guidelines for HIV Prevention, Treatment and Care, HIV-exposed children are enrolled at the Paediatric ART Clinic for PMTCT from six weeks of life until 18 months of age and then discharged from the clinic if they are HIV-uninfected.

Study designs

The study was a retrospective, descriptive study.

Ethical considerations

Ethical approval for the study was obtained from the hospital's Research Ethics Committee on 2nd October 2023, with the following protocol number: UTH/REC/2023/10/0195. Furthermore, all ethical principles guiding the conduct of research on retrospective studies involving human subjects were strictly adhered to, in accordance with the Declaration of Helsinki (1975), as revised in 2013.

Study population, including inclusion and exclusion criteria

The study population comprised all children enrolled at the Paediatric ART Clinic for PMTCT care who were born to HIV-positive mothers. The HIV-exposed infants included in this study were those enrolled for PMTCT from January 2013 and had completed 18-month PMTCT care by June 2021, over eight years of care. During this period, 424 HIV-exposed children were enrolled on the care programme. Medical records of these 424 children were sought, but only those of 409 children were obtained. The remaining 15 children, whose records could not be traced, were excluded from the study, as depicted in Figure 1.

Data collection

A purpose-designed proforma was used to extract information from the children's case records. The extracted data included sociodemographic characteristics, age at enrolment, gestational age, mode of delivery, birth weight, and place of birth. Other information retrieved included pregnancy, labour and delivery histories, post-delivery events, feeding options, ART prophylaxis usage, clinic attendance, and the occurrence of comorbidities and patterns. Additionally, extracted were parents' HIV statuses, educational and occupational statuses, family structure, maternal HAART experience, fathers' awareness of mothers' HIV status, and HIV-exposed infant treatment outcomes. The parental educational qualification and occupations were used to determine the socioeconomic background of the children as described by Oyedeji. [8] The outcome of care of HIV-exposed infants was classified as HIV-infected based on the results of two HIV antigen-based tests (DNA PCR, performed at Paediatric ART clinic six weeks of life and between six and eight weeks after cessation of breastmilk feeding), and one HIV antibody-based test. A positive result from any of these three tests classified the baby as infected. Treatment outcome was defined as non-infected, infected or lost to follow-up (LTFU) when the children reached 18 months of age.[1,7] The data for this study were collected between October 2023 and June 2024.

Data management

The data obtained were input into a computer and analysed with version 23 of the IBM SPSS Software Package (SPSS Inc., Chicago, IL, USA). Categorical variables such as age at presentation of the HIV-exposed children at the Paediatric ART clinic, ART prophylaxis usage, maternal HAART experience, antenatal clinic (ANC) venue, and feeding options were summarised and expressed as percentages. These were compared using Pearson's Chi-Square test. Continuous variables, such as age at enrolment, gestational age, and birth weight, were summarised using the mean ± standard deviation (SD) for normally distributed variables. Non-normally distributed data were summarised using median and IQR. The associations between treatment outcomes (non-infected, infected or lost to follow-up) and potential socio-clinical events were determined via bivariate analysis. The potential social and clinical events that could predict treatment outcomes with p-values ≤ 0.25 were further evaluated via multivariate analysis (multinomial logistic regression). Statistical significance was set at a p-value <0.05.

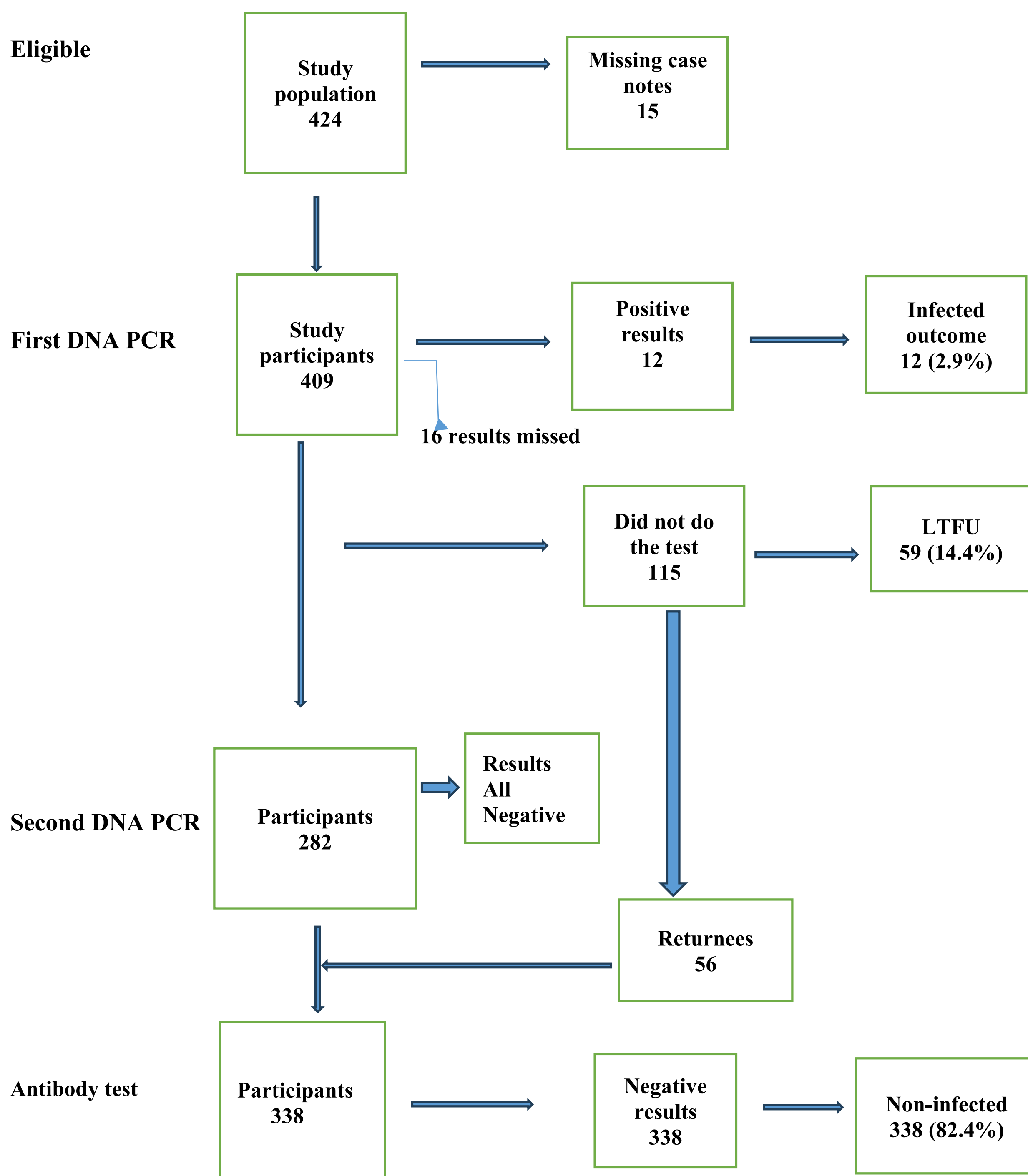

Figure 1: PMTCT laboratory tests, results and treatment outcomes of the study participants

Results

Demographic and socioeconomic characteristics

Among the 409 HIV-exposed children studied, 210 (51.30%) were males. The mean (±SD) birth weight was 2.96 (±0.54) kg, and the median (IQR) age at first presentation at paediatric ART Clinic was 6.0 (1.0) weeks. The mean ages of the fathers and mothers were 40.47 ± 6.21 years and 33.61 ± 4.85 years, respectively. Table I shows the children's demographic characteristics and the parents' socioeconomic characteristics.

Table Ia: Demographic characteristics of children

Variables	Frequency (%)
Age at presentation (weeks)	
< 6	7 (0.7)
6	264 (63.9)
7 – 12	83 (20.2)
> 12	55 (15.2)
Sex	
Male	210 (51.3)
Female	199 (48.7)
Birth Weight	
Low birth weight	56 (13.7)
Normal weight	345 (84.4)
Macrosomia	8 (2.0)

Table Ib: Demographic characteristics of parents

Variables	Frequency (%)
Father's educational qualification	
Primary	67 (16.4)
Secondary	147 (35.9)
Tertiary	187 (45.7)
Informal	8 (2.0)
Mother's educational qualification	
Primary	89 (21.8)
Secondary	154 (37.7)
Tertiary	154 (37.7
Informal	12 (2.9)
Father's occupation	
Trading	138 (33.7)
Artisan	135 (33.0)
Civil servant	134 (32.8)
Unemployed	2 (0.5)
Mother's occupation	
Trading	121 (29.6)
Artisan	166 (40.6)
Civil servant	117 (28.6)
Unemployed	5 (1.2)
Socioeconomic class	
Low	252 (61.6)
Middle	79 (19.3)
High	78 (19.1)

Participants' parental HIV profile

Two hundred and eighty-five (69.70%) fathers of the study participants were HIV seronegative, 65 (15.90%) were infected, and the statuses of 59 fathers (14.40%) were unknown. Two hundred and forty-eight fathers (60.60%) were aware of the mothers' HIV status. Among the 409 mothers, 326 (79.70%) were aware of their status before pregnancy, 72 (17.60%) during pregnancy, 5 (1.2%) at delivery, and 6 (1.5%) post-delivery.

Pregnancy, delivery and post-delivery events

During pregnancy, 251 (61.40%) mothers received antenatal care at the study health facility (tertiary), and 402 (98.3%) received HAART, while 7 (1.7%) were naïve to it. One hundred seventy mothers (41.56%) had deliveries at the study facility. The majority (394; 96.30%) of the HIV-exposed children were delivered at term. Similarly, most of the deliveries (344; 84.10%) involved spontaneous vertex delivery, and 65 (15.90%) by caesarean section.

Four hundred and one (98.04%) of the children received antiretroviral prophylactic drugs, and 384 (95.76%) received nevirapine only, one (0.25%) received zidovudine only, and 16 (3.99%) received the nevirapine-zidovudine combination. Three hundred and eighty-three (93.60%) children commenced prophylaxis within 72 hours of birth, 18 (4.40%) after 72 hours, and 8 (2.0%) did not receive prophylactic therapy. During the first six months of life, 380 (92.90%) of the children were exclusively breastfed, 17 (4.20%) received breastmilk substitute only, while 12 (2.90%) had mixed feeds (a combination of breastfeeding and a breastmilk substitute). Twenty-nine (7.10%) mothers stopped breastfeeding their children before one year of age, 300 (73.30%) at one year, and 28 (6.80%) after one year. The breastfeeding cessation period of 52 (12.70%) mothers was not documented.

Treatment outcomes

The median (IQR) age at presentation for the first antigen-based test at the Paediatric ART Clinic was 6.0 (0.0) weeks, and 381 (93.20%) of the 409 children brought for the first antigen-based test during the period of this study had negative results, 12 (2.90%) had positive results, and 16 (3.90%) test results were missing. The mean age at presentation for the second DNA PCR test (usually performed at least 6-8 weeks after cessation of breastmilk,

usually at the age of 12 months) was 14.02±0.14 months. Among the 397 exposed children expected to undergo a second DNA PCR test, 282 (71.03%) children were tested; all the results were negative.

Table II: Relationship between socio-clinical characteristics and treatment outcomes

Variables	Treatment Outcomes n (%)					
	Non-infected	*Infected*	*Lost to follow up*	*Total*	X^2	p-value
Age at the first ART clinic presentation (weeks)						
< 6	4 (66.66)	1 (16.67)	1 (16.67)	6 (100.0)	25.514	<0.001*
6	232 (87.88)	2 (0.76)	30 (11.36)	264 (100.0)		
7-12	65 (78.31)	4 (4.82)	14 (16.87)	83 (100.0)		
≥ 13	37 (66.07)	5 (8.93)	14 (25)	56 (100.0)		
Total	338 (82.64)	12 (2.93)	59 (14.43)	409 (100.0)		
ART prophylaxis usage (the children)						
Received	338 (84.50)	4 (1.00)	58 (14.50)		239.409	<0.001*
Not received	0 (0.00)	8 (88.89)	1 (11.11)			
Maternal HAART Status						
Experienced	336 (83.58)	8 (1.99)	58 (14.43)		73.85	<0.001*
Naïve	2 (28.57)	4 (57.14)	1 (14.29)			
Place of ANC						
Study centre	218 (86.85)	2 (0.80)	31 (12.35)		13.449	0.001*
Outside the study centre	120 (75.95)	10 (6.33)	28 (17.72)			
Place of Birth						
Study centre	146 (85.88)	4 (2.35)	20 (11.77)		2.132	0.344
Outside the study centre	192 (80.33)	8 (3.35)	39 (16.32)			
Feeding Options						
Breastfeeding	323 (85.00)	5 (1.32)	52 (13.68)		138.122	<0.001*
Breastmilk substitute	13 (76.47)	0 (0.00)	4 (23.53)			
Mixed feeding	2 (16.67)	7 (58.33)	3 (25.00)			
Number of ART Clinic Attendances						
< 5 times	62 (49.21)	9 (7.14)	55 (43.65)		143.446	<0.001*
≥ 5 times	276 (97.53)	3 (1.06)	4 (1.41)			

HAART – Highly-Active Antiretroviral Treatment; ART – Antiretroviral Therapy; ANC – Antenatal Care.

In contrast, 115 (28.97%) children were not subjected to the test because their parents did not bring them to the clinic. The mean age at presentation for the antibody test was 18.21±0.87 months; 338 HIV-exposed children were tested, and all (100%) had negative results. Fifty-nine children (14.86%, 59/397) were excluded from the antibody test because their parents failed to present them for the test.

Association between socio-clinical events and treatment outcomes

The details of the bivariate analyses of the association of socio-clinical events with treatment outcomes among the study participants were categorised into (a) clinical events related to parental decisions /actions, (b) family background and (c) characteristics specific to the children.

Table III: Relationship between family socio-clinical characteristics and treatment outcomes

Variables	Treatment outcomes n (%)					
	Non-infected	*Infected*	*Lost to follow up*	*Total*	χ^2	*p-value*
Family setting						
Monogamous	287 (82.95)	7 (2.02)	52 (15.03)		6.945	0.031*
Polygamous	51 (80.95)	5 (7.94)	7 (11.11)			
Fathers' Awareness of Mothers' HIV Status						
Yes	214 (86.29)	3 (1.21)	31 (12.50)		9.019	0.011*
No	124 (77.02)	9 (5.59)	28 (17.39)			
Socioeconomic class						
Low	207 (82.14)	11 (4.37)	34 (13.49)		5.69	0.224
Middle	67 (84.81)	1 (1.27)	11 (13.92)			
High	64 (82.05)	0 (0.00)	14 (17.95)			

Table IV: Socio-clinical associations with treatment outcome among study participants in relation to the children's peculiar characteristics

Variables	Treatment outcomes n (%)					
	Non-infected	*Infected*	*Lost to follow up*	*Total*	χ^2	*p-value*
Gestation age						
Term	330 (83.76)	9 (2.28)	55 (13.96)		18.693	**<0.001***
Preterm	8 (53.33)	3 (20.00)	4 (26.67)			
Mode of Delivery						
Caesarean section	56 (86.15)	0 (0.00)	9 (13.85)		2.401	0.301
SVD	282 (81.98)	12 (3.49)	50 (14.53)			
Birth Weight Group						
Low birth weight	44 (78.57)	5 (8.93)	7 (12.50)		9.02	0.061
Normal	288 (83.48)	7 (2.03)	50 (14.49)			
Macrosomia	6 (75.00)	0 (0.00)	2 (25.00)			
Sex						
Male	181 (86.19)	3 (1.43)	26 (12.38)		5.243	0.073
Female	157 (78.90)	9 (4.52)	33 (16.58)			
Comorbidity occurrence and patterns during PMTCT care for the children						
Malaria	19 (95.00)	0 (0.00)	1 (5.00)		84.619	**<0.001***
Pneumonia	7 (53.85)	5 (38.46)	1 (7.69)			
URTI	61 (88.41)	0 (0.00)	8 (11.59)			
Septicaemia	8 (61.54)	3 (23.08)	2 (15.38)			
Congenital anomalies	2 (100.00)	0 (0.00)	0 (0.00)			
None	241 (82.53)	4 (1.37)	47 (16.10)			

SVD – Spontaneous Vertex Delivery; URTI – Upper Respiratory Tract Infections

The analysis revealed that the age at presentation of the HIV-exposed children at the Paediatric ART Clinic, children's ART prophylaxis usage, maternal HAART experience, antenatal clinic (ANC) venue, feeding options and number of Paediatric ART follow-up clinic visits were associated with infective outcome (Table II). Other factors that were related to infectious outcome were family setting and fathers' non-awareness of maternal HIV status (Table III), gestation age and the occurrence of comorbidity in children during PMTCT care (Table IV).

Socio-clinical predictors of HIV treatment outcomes

The multinomial logistic regression model estimates for socio-clinical predictive variables against treatment outcomes of the HIV-exposed participants were also grouped into (a) clinical events related to parental decisions /actions, (b) family background and (c) characteristics specific to the children. As shown in Table V, the exposed child who presented at the Paediatric ART Clinic for enrolment at six weeks of age had a 2.926 increased odds ratio of being non-infected relative to one lost to follow-up, compared with a baby aged 13 weeks or more. A HAART-experienced mother had a 0.034 lower odds ratio of having an infected child relative to a mother who had a child lost to follow-up than a mother who was HAART-naïve. Maternal antenatal care attendance at the study centre (tertiary healthcare facility) was associated with 0.181 decreased odds of having an infected child relative to a child lost to follow-up whose mother had ANC outside the study centre.

In addition, Table V shows that the breastfeeding option is associated with 9.317 times the increased odds of having a child with a non-infected treatment outcome relative to those lost to follow-up, among mothers who practised a mixed feeding option. Additionally, breastfeeding had 0.041 decreased odds of having a child with an infection treatment outcome relative to one lost to follow-up who had mixed feeding. For a child with fewer than five clinic attendances during the PMTCT, there was a 0.016 decrease in the odds of being non-infected relative to a baby lost to follow-up who had five or more clinic attendances.

Table VI suggests that a child from a monogamous family had 0.188 fewer odds of being infected relative to a child lost to follow-up than a child from a polygamous family. A child from a low socioeconomic class had 9.812 times increased odds of being infected relative to a child lost to follow-up who was from a high socioeconomic background. Furthermore, Table VII shows that a low-birth-weight child had 2.136 times the odds of being infected relative to a child lost to follow-up who had macrosomia. HIV-exposed children with pneumonia had 24.583 times the increased odds of being infected relative to one lost to follow-up, who had a congenital anomaly.

Discussion

This study evaluated the success and effectiveness of the PMTCT programme and elucidated the socio-clinical predictors or determinants influencing the treatment outcomes. In the present study, the 82.6% non-infected outcome is similar to the 81.2% and 84.1% reported by Adelekan *et al.*[9] and Sagay *et al.*,[10] respectively. Additionally, a 2.9% HIV-infected outcome was recorded among the study participants, and it is comparable to the 2.8% reported by Adelekan *et al.* in a multistate retrospective study conducted in Nigeria. [9] However, this figure is higher than the 0.7% and 1.0% infection rates reported in Jos [10] and Enugu, [11] respectively, in other parts of Nigeria. The number of years covered (1-2 years) by the studies, as mentioned earlier, [10,11], compared with that of the present study (8½ years), could have accounted for the rate differences. In addition, the relatively low infected outcome could be because all the mothers of the HIV-exposed children in the two studies, [10,11], had their antenatal care and deliveries in the teaching hospitals – the study facilities.

Table V: Socio-clinical predictors of treatment outcome among study participants in relation to the parental decisions/actions (multinomial logistic regression)

Variables	Treatment outcome a*			
	Non-infected (OR, p-value)	*95% CI* Lower – upper bound	*Infected (OR, p-value)*	*95% CI* Lower – upper bound
Age at first Presentation at Paediatric ART clinic (weeks)				
<6	(1.514, 0.721)	0.155 – 14,738	(2.800, 0.495)	0.146 - 53.706
6	(2.926, 0.004*)	1.420 – 6.030	(0.187, 0.061)	0.032 – 1.083
7 – 12	(1.756, 0.191)	0.756 – 4.084	(0.800, 0.772)	0.177 – 3.618
≥ 13 (b)	b	b	b	b
Maternal HAART Status				
Experienced	(2.897, 0.388)	0.258– 32.463	(0.034, 0.004*)	0.003 – 0.348
Naïve (b)	b	b	b	b
ANC Venue				
Within the study centre	(1.641, 0.082)	0.940 – 2.865	(0.181, 0.036*)	0.036 – 0.896
Outside the study centre (b)	b	b	b	b
Feeding Options				
Breastfeeding	(9.317, 0.016*)	1.520 – 7.104	(0.041, 0.000*)	0.008 – 0.211
Breastmilk substitute	(4.875, 0.141)	0.590 – 0.258	(0.010, 0.064)	0.001 – 0.043
Mixed feeding (b)	b	b	b	b
ART Prophylaxis usage by HIV-exposed children				
Received	(2.198, 0.968)	1.244 – 4.622	(0.007, 0.129)	0.001- 0.214
Not received (b)	b	b	b	b
Number of Paed ART Clinic Attendance				
< 5	(0.016, 0.000*)	0.006 – 0.047	(0.218, 0.071)	0.042 – 1.141
≥ 5 (b)	b	b	b	b

a* - Reference category (Lost-To-Follow-Up), b - Parameter set at zero because it is redundant; OR - Odd Ratio, ANC -Antenatal care, HAART - Highly active antiretroviral therapy, ART - Antiretroviral therapy, CI - Confidence Interval

This was contrary to the present study, in which only 61.4% and 41.6% of the mothers had ANC and deliveries, respectively, at the study centre, a teaching hospital. Furthermore, Oluwayemi *et al.* reported a higher prevalence (6.3%) of infection in Ado-Ekiti [7] compared with the present study. This might be because there was a greater percentage (8.9%) of HIV-infected mothers who were not on HAART before or during pregnancy,[7] than the 1.7% reported in the present study. The infectious outcome in this study was also lower compared to the findings of Menbere *et al.* in an Ethiopian study. [12] The difference could have resulted from a higher percentage (7.3%) of mixed feeding and a higher percentage (4.9%) of exposed children who did not receive ART prophylaxis in the study. [12]

Table VI: Socio-clinical predictors of treatment outcome among study participants in relation to the family background (multinomial logistic regression)

Variables	Treatment outcome [a*]			
	Non-infected (OR, p-value)	*95% CI* *Lower – upper bound*	*Infected* *(OR, p-value)*	*95% CI* *lower – upper bound*
Family Setting				
Monogamous	(0.758, 0.519)	0.326 – 1.761	(0.188, **0.019***)	0.047 – 0.759
Polygamous (b)	b	b	b	b
Fathers' Awareness of Mothers' HIV Status				
Aware	(1.559, 0.118)	0.893 – 2.720	(0.301, 0.099)	0.074 – 1.225
Not aware (b)	b	b	b	b
Socioeconomic Class				
Low	(1.332, 0.411)	0.673 – 2.636	(9.812, **0.000***)	113.491 – 848.352
Middle	(1.332, 0.513)	0.563 – 3.151	(2.757, 0.074)	2.757 – 4.324
High (b)	b	b	b	b

a* - Reference Category (Lost-To-Follow-Up), b - Parameter set at zero because it is redundant

These points buttress the assertion that maternal HAART-naïve, mixed feeding and lack of ART prophylaxis for exposed infants predispose and increase MTCT. Fourteen-point-four per cent (14.4%) of LTFUs in the present study is comparable to 14.1% [10] and 14.9% [12] reported in some previous studies. However, the observed 14.4% LTFU in this present study was higher than the 10.7% reported by Ugochuckwu *et al.*[1] from Nnewi, southeastern Nigeria. The relatively lower proportion of LTFU in this study may be attributed to the electronic documentation and abstraction of the subjects' medical records for the study. This was contrary to the present study, in which the medical records of all study participants were retrieved from the medical records department, and data extraction was performed manually. Furthermore, the predominant (61.6%) low socioeconomic background of the study participants in the present study may also have contributed to the higher proportion of LTFU. It has been documented that a low socioeconomic background can negatively impact clinic attendance and adherence to prescribed guidelines. [13] Loss to follow-up is a significant impediment to the success of PMTCT, especially in sub-Saharan Africa. It does not allow HIV-exposed infants to receive complete care and ultimately increases the rate of new infections. [14]

The enrolment of HIV-exposed infants at six weeks of age for PMTCT care at the Paediatric ART Clinic was associated with reduced infection outcomes.[1] Early enrolments offered the mothers support and counselling, especially against mixed-feeding and unhygienic behaviours, [15,16] and provided an opportunity to reinforce maternal antiretroviral drug usage and ARV prophylaxis usage and completion for high-risk children.[16] Likewise, the commencement or continued attendance of the routine immunisation clinic will be encouraged. [15]

The family setting of the exposed infants was found to influence treatment outcomes, with monogamous families having lower rates of infection. A small family size may offer better communication, understanding, health-seeking behaviours and support. The contrary is true of polygamous family settings with larger family

sizes, limited financial resources and unhealthy rivalry. On the other hand, a lack of paternal awareness of mothers' HIV-infected status was associated with increased HIV-infected outcomes. Paternal awareness and acceptance of the mother's HIV status would provide necessary support to the duo. [17-19] In addition, socioeconomic disadvantage is reported to be a strong determinant of poorer HIV treatment outcomes. [20]

Table VII: Socio-clinical predictors of treatment outcome among study participants in relation to the children's characteristics (multinomial logistic regression)

Variables	Treatment outcome [a*]			
	Non-infected (OR, p-value)	*95% CI Lower – upper bound*	*Infected (OR, p-value)*	*95% CI lower – upper bound*
Gestation age				
Term	(3.000, 0.080)	0.874– 10.302	(0.218, 0.071)	0.042 – 1.141
Preterm (b)	b	b	b	b
Birth Weight				
Low birth weight	(2.095, 0.417)	0.351 – 12.525	(2.136, **0.000***)	53.022 – 86.118
Normal weight	(1.920, 0.432)	0.377 – 9.782	(4.188, 0.456)	4.188– 8.163
Macrosomia (b)	b	b	b	b
Sex				
Male	(1.463, 0.180)	0.838 – 2.553	(0.423, 0.230)	0.104 – 1.723
Female (b)	b	b	b	b
Comorbidity occurrence and Patterns During PMTCT Care				
Malaria	(0.007, 0.941)	0.000 – 0.061	(0.008, 0.995)	0.000 – 0.026
Pneumonia	(0.002, 0.925)	0.000 – 0.045	(24.583, **0.025***)	1.503 – 402.172
URTI	(0.003, 0.900)	0.000 – 0.052	(0.003, 0.991)	0.000 – 0.456
None	(0.002, 0.965)	0.000 – 0.081	(0.418, 0.407)	0.053 – 3.283
Septicaemia	(0.002, 0.911)	0.000 – 0.016	(7.375, 0.945)	3.142 – 9.146
Congenital anomalies (b)	b	b	b	b

a* - Reference Category (Lost-To-Follow-Up), b - Parameter set at zero because it is redundant; PMTCT – Prevention of Mother To Child Transmission; URTI – Upper Respiratory Tract Infection

This fact was established in this study, as 11 out of the 12 infected infants were from low socioeconomic backgrounds. Low socioeconomic status has been documented to cause limited access to quality healthcare, prevention services, and poor education, which increases engagement in riskier behaviours like transactional sex because of economic necessity. [21] In this study, maternal HAART usage and good adherence before pregnancy and delivery were linked to a reduced tendency of mothers to transmit the virus to their children. This is because mothers are more likely to experience viral suppression, which is a crucial factor in preventing mother-to-child transmission. This finding is consistent with a study in Malawi, [22] where maternal HAART usage was associated with a 46% reduction in mother-to-child HIV transmission in comparison to that in infants of HAART-naïve

mothers. Additionally, mothers who received antenatal care at the study health facility (Teaching Hospital) demonstrated good adherence to HAART usage, the chosen feeding option and early presentation of children at the ART clinic. Hence, there are fewer HIV-infected infants from these mothers.

The feeding options adopted by mothers significantly affected the risk of infection. Exclusive breastfeeding for the first six months of life and cessation by 12 months were found to be associated with a reduced risk of infection, which is consistent with earlier reports. [8,10,11] In agreement with previous studies, [23-25] the present study found mixed feeding for the children in the first six months of life to increase mother-to-child HIV transmission. Maternal breastmilk could contain a variable amount of the HIV virus, depending on the mother's viral load, and the exposure of the children's immature and vulnerable gastrointestinal tract (GIT) could aid MTCT. [12] The simultaneous administration of breastmilk and breastmilk substitutes to HIV-exposed infants aged less than six months can cause GIT mucosal inflammation and erosion, thereby causing diarrheal diseases and severe malnutrition, [26,27] factors that increase MTCT.

Regular attendance at ART clinics was observed to be an important determinant of treatment outcome. An attendance of at least five times throughout the PMTCT programme was associated with an increased tendency of having a non-infected treatment outcome, thus reiterating the need for regular clinic attendance. Punctual and regular clinic attendance provides continuous health education related to PMTCT, monitoring and evaluating infants' health status, and implementing key interventions to achieve a successful treatment outcome. [28] In addition, mothers are also followed up for HAART adherence and viral load monitoring, with the goal of viral suppression. [28]

Gestational age, ARV prophylaxis usage and the presence or absence of comorbidities were also found to be factors associated with treatment outcome. Preterm children are more prone to MTCT because of their weak immune system,[29] coupled with their delicate and fragile innate barriers, which increase the risk of transmission when exposed to conditions such as chorioamnionitis, prolonged rupture of membranes or vaginal birth. [30,31] In addition, increasing the performance of invasive procedures further increases transmission in children. [32] ARV prophylaxis usage in HIV-exposed infants was observed to be a strong determinant of treatment outcome, with 8 out of 9 children who did not receive prophylaxis in this series being HIV-infected. The presence of comorbid illnesses was associated with a higher likelihood of achieving a positive treatment outcome. Comorbid illnesses, such as pneumonia and other invasive bacterial infections, further weaken the already fragile immune system, increasing vulnerability. [12]

Limitations

Like any other retrospective study, data loss is a common phenomenon, and this study is no exception. For one reason or another, 15 out of 424 HIV-exposed infants' case records could not be found and were excluded from the study. Additionally, some information needed from the medical records of some of the study participants could not be found and might have affected the overall treatment outcome.

Conclusion

This study revealed that PMTCT intervention is an indispensable strategy for reducing the HIV infection rate among children born to HIV-infected mothers. With a 2.9% MTCT rate, the study centre achieved less than the 5% benchmark set by UNAIDS. Key socio-clinical predictors of infection outcome in the PMTCT programme include delayed first ART clinic attendance (>6 weeks), polygamous family setting, maternal HAART-naïve status, lack of paternal awareness of maternal HIV status, and antenatal care received outside HIV-treatment facilities. Additional factors associated with HIV infection outcomes are preterm gestation,

mixed feeding practices, absence of ART prophylaxis, fewer than five clinic visits, low socioeconomic status, and the presence of comorbidities. Therefore, all healthcare providers, especially in HIV programmes, should work assiduously to mitigate these identified predictors of infectious outcome to continue to decrease MTCT rates in their practice locality.

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