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Postnatal HIV transmission determinants among mothers on antiretroviral therapy in Kwekwe District, Zimbabwe

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Abstract

Introduction: Mother-to-child HIV transmission (MTCT) remains the primary way children acquire HIV. In 2022, Midlands Province, Zimbabwe, had an MTCT rate of 10.6%, an increase from 9.4% in 2020. The MTCT rate in Midlands province remains high above the expected target of 5%. In 2024, Kwekwe district, Midlands province, contributed 26.7% of all new HIV infections in the 0-4 years age group, an increase from 22.5% in 2022, with most of the infants sero-converting during the postnatal period. We conducted the study to determine determinants of postnatal MTCT in Kwekwe district, 2024.

Methods: We conducted a 1:2 unmatched case-control study. A case was an HIV-positive mother with an HIV-positive baby (0-2 years) attending the PMTCT clinic in the Kwekwe district in 2024. Systematic random sampling was used to select 47 cases and 94 controls from the PMTCT registers. An interviewer-administered questionnaire, a key informant guide and a focus group discussion guide were used to collect data. Mental health status was assessed using the Shona symptom questionnaire. We generated proportions and odds ratios at a 95% confidence interval. Backward elimination logistic regression was carried out to identify independent risk factors for postnatal MTCT. Thematic analysis was used to analyse qualitative data.

Results: A total of 47 cases and 94 controls were enrolled. Having a maternal viral load of > 50 copies/ml in the post-delivery (AOR=7.38; 95%CI:1.65-33.04, p =0.009) and infants who suffered from oral candidiasis/sores/thrush during breastfeeding (AOR=5.21; 95%CI:1.30-20.81, p =0.02) were independent risk factors for postnatal MTCT. Maternal HIV diagnosis before delivery (AOR=0.06; 95%CI:0.02-0.19, p <0.0001), good maternal mental health status (AOR=0.20; 95%CI:0.06-0.65, p =0.007), and receiving HIV counselling 6 weeks post-delivery (AOR=0.04; 95%CI: 0.007-0.23, p = 0.0003), were protective. More statistically significant risk factors and protective factors are in the main document. However, qualitative findings showed mothers had a lack of knowledge on exclusive breastfeeding as a protective factor for maternal HIV transmission to the infant.

Conclusions: Receiving an HIV diagnosis during pregnancy and counselling in the post-delivery period could lead to better adherence to treatment, hence a reduced viral load resulting in reduced MTCT. We therefore recommend psychosocial and emotional support, health education and routine mental health screening and counselling during the post-natal period.

Keywords: Determinants, mother-to-child HIV transmission, postnatal, Midlands

Citation

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Introduction

Maternal Human Immunodeficiency virus (HIV) transmission remains a significant public health concern, particularly in regions with high HIV prevalence. Infants born to HIV-positive mothers are a vulnerable population at risk of acquiring HIV infection. Maternal HIV transmission, also known as vertical transmission or mother-to-child transmission, refers to the passage of the human immunodeficiency virus (HIV) from mother to her child, and this is the primary way children acquire HIV. This transmission can occur during pregnancy (in utero), childbirth (intrapartum), or breastfeeding (postpartum) [1-3]. Without intervention, the risk of an HIV-positive mother transmitting the virus to her child ranges from 15-45% [4]. During postnatal, breastfeeding contributes to pediatric HIV infections, accounting for an estimated 5-15% of mother-to-child HIV transmission for women not receiving ART [5]. However, with the implementation of prevention of mother-to-child HIV transmission (PMTCT) programs, this risk can be significantly reduced.

Globally in 2022, there were 130,000 new infections among children 0-14 years, showing a 58% decline from 2010. Mother-to-child HIV transmission (MTCT) has dropped from 23% in 2010 to 11% in 2022 [1]. In 2022, 82% of pregnant women living with HIV were receiving effective antiretroviral therapy (ART) drugs for the Prevention of mother-to-child HIV transmission (PMTCT), globally up from 48% in 2010 [4]. A decline in MTCT transmission rate has been noted in sub-Saharan Africa from 27.2% in 2010 to 16.9% in 2019. Mother-to-child HIV transmission accounts for more than 90% of new childhood infections. This can be reduced to 5% in breastfeeding countries and 2% in non-breastfeeding countries by providing an HIV-positive mother access to effective antiretroviral therapy [5]. Globally, the number of new HIV infections and AIDS-related deaths has continued to decrease, bringing the AIDS response closer to achieving Sustainable Development Goal (SDG) 3.3 of ending AIDS as a public health threat by 2030 [6]. However, in 2022, Zimbabwe had a cumulative 4200 new HIV infections among children 0-14 years, and Midlands Province contributed the highest number of new infections in this age band of 784. Midlands Province has a mother-to-child HIV transmission rate of 10.6%, an increase from 9.4% in 2020 and far above the national rate of 8.1%, although both rates are still above the minimum target of 5% since Zimbabwe is a breastfeeding country [7].

Early-stage HIV infection in the post-partum phase is characterised by an elevated risk of mother-to-child HIV transmission during breastfeeding. In Mozambique (2014), a neighbouring country to Zimbabwe, the HIV incidence in postpartum women was estimated at 3.2 per 100 women with a mother-to-child HIV transmission rate of 21% among the newly HIV-infected women. HIV-uninfected breastfeeding women remain a crucial population in the elimination of pediatric HIV/AIDS in Africa. Breastfeeding women are rarely tested for HIV after receiving an HIV-negative result at their first antenatal clinic visit. However, pregnancy and breastfeeding are high-risk periods for HIV acquisition [8].

Prevention of maternal HIV transmission involves a combination of strategies known as the PMTCT approach. Zimbabwe adopted the prevention of mother-to-child HIV transmission (PMTCT) option B+ program in 2013. The PMTCT option B+ services include; routine HIV testing and counseling for pregnant women and male partners, comprehensive antenatal care, lifelong antiretroviral therapy for HIV-positive pregnant and breastfeeding women, safe delivery practices, postpartum care for mothers and infants, Antiretroviral and Cotrimoxazole prophylaxis for HIV-exposed infants, counseling for safe infant feeding practices, early infant diagnosis and treatment for HIV infected infants, and male partner and family involvement [3. 9, 10]. The PMTCT program follows four prongs set by the WHO. The first prong focuses on preventing HIV infection among women of childbearing age, the second prong focuses on preventing unintended pregnancies among women living with HIV, the third prong focuses on PMTCT service delivery, which aims to prevent HIV transmission from mother to child, and the fourth prong aims to offer treatment, care and support to women living with HIV, their children and families [11]. Elimination of new HIV infections averts an estimated USD$360,000 cost of providing lifetime HIV treatment per person, resulting in significant cost savings for the healthcare systems [12]. PMTCT programs during pregnancy, birth, and breastfeeding have averted an estimated 3.4 million infections in children 0-14 years since 2000 [7].

Maternal HIV transmission continues to be a significant global health challenge, particularly in the postnatal period when infants are at risk of acquiring the virus through breastfeeding. The postnatal period presents a unique set of challenges regarding mother-to-child HIV transmission. Studies have shown that acute infection with HIV in the post-partum period results in a high risk of mother-to-child HIV transmission during breastfeeding [8, 13]. HIV-uninfected breastfeeding women remain a crucial population in the elimination of pediatric HIV/AIDS in Africa. Breastfeeding women are rarely tested for HIV after receiving an HIV-negative result at their first antenatal clinic visit. However, pregnancy and breastfeeding are high-risk periods for HIV acquisition [8].

Several factors, such as a high maternal HIV viral load, mastitis during breastfeeding, and mixed feeding in the first 6 months of the baby's life had been found in several studies to be significantly associated with mother-to-child HIV transmission [2, 13-19]. However, there is limited literature on the contribution of maternal mental health as a

determinant of MTCT. Maternal mental health can affect several PMTCT services, including ART adherence and infant feeding practices. Good maternal mental health is key to caring for the baby, feeding the baby, and implementing PMTCT strategies.

In 2022, Zimbabwe had a mother-to-child HIV transmission rate of 8.1% and a total of 4200 new infections among the 0-14 years children [7]. The Midlands Province, Zimbabwe, in 2022 contributed the highest proportion of new child infections nationally, recording an MTCT rate of 10.6% an increase from 9.4% in 2020. This is far from the 5% path to elimination thresholds [7]. In 2023, the Kwekwe district of Midlands province contributed 26.7% of all new HIV infections in the 0-4 years, with most of the infants sero-converting during postnatal. We investigated determinants of postnatal MTCT among HIV-exposed infants of mothers on antiretroviral therapy in the Kwekwe district.

HIV-exposed infants face substantial challenges and are at risk of developing HIV-related complications and ongoing healthcare challenges throughout their lives. However, understanding the determinants of maternal HIV transmission during the postnatal period is essential for the development of targeted PMTCT interventions. With comprehensive prevention strategies coupled with early diagnosis and treatment, the goal of eliminating mother-to-child HIV transmission can be achieved by 2030, and also, a healthier future for the children born to HIV-infected mothers. Also, the elimination of new HIV infections averts an estimated USD$360,000 cost of providing lifetime HIV treatment per person, resulting in significant cost savings for the healthcare systems [12].

Methods

Study setting

The study was carried out in Kwekwe district. Kwekwe district is one of the eight administrative districts in Midlands Province, with 33 administrative wards and is 215 Km from Harare and 66 Km from Gweru. It has thirty-eight (38) health facilities carrying HIV services, particularly prevention of mother-to-child HIV transmission services. According to the 2022 population and housing census report, Kwekwe houses a population of 197 062 people, 35 701 are living with HIV, and those aged between 15-49 years contribute 26 964 of the people living with HIV [7]. The district is the second-highest in terms of its total population in the Province. The people in Kwekwe District economically rely on mining and farming activities. Males engage in underground mining and ploughing while females participate in surface mining activities, farm weeding, and crop harvesting. Their mining activities occur throughout the year for both males and females. However, farming is seasonal and occurs only during the rainy season (October to May).

Study design and population

A 1:2 unmatched case-control study was conducted. This study design is most appropriate for determining multiple exposures (factors) to a single outcome (disease) variable. The study population comprised mother-baby pairs enrolled in the PMTCT program with children (0-2) years in Kwekwe district from 1 January 2022 to 30 March 2024. Cases were defined as HIV-positive mothers with HIV-positive babies (0-2 years) attending the PMTCT clinic in Kwekwe district, 2024. Controls were defined as HIV-positive mothers with HIV-negative babies (0-2 years) attending the PMTCT clinic in Kwekwe district in 2024. HIV-positive mothers who consented to the study and have children from 0-2 years of age attending PMTCT clinic in the Kwekwe district in 2024 were included. HIV-positive mothers attending PMTCT clinic in Kwekwe district, 2024, with a child who is above 18 months with no final HIV status outcome were excluded. The nurse in charge of the PMTCT clinic and community health workers were our key informants.

Sample size calculation and sampling procedure

The sample size was calculated using the Fleiss formula.

Number of cases (n)

$$n = \frac{\left[z_{\alpha/2}\sqrt{(r+1)\bar{p}\bar{q}} + z_{(1-\beta)}\sqrt{rp_1q_1 + p_2q_2}\right]^2}{r(p_1 - p_2)^2}$$

where:

$z_{\alpha/2}$ = z value for a two-tailed test based on the desired confidence level,

r = ratio of cases to controls,

p_1 = proportion of cases with the exposure,

p_2 = proportion of controls with the exposure,

$q_1 = 1 - p_1$, $q_2 = 1 - p_2$ and

$z_{(1-\beta)}$ = desired power of the study.

The sample size was calculated using the Fleiss formula embedded in the Stat Cal function, Epi info 7, based on a study by Duri et al, (2022) where having a viral load > 1000 copies/ ml was a risk factor for mother-to-child HIV transmission with an odds ratio of 5.4 at 95% confidence interval using 80% power. The proportion of cases with viral load > 1000 copies/ ml was 22.1%, and the proportion of controls was 5%. The case-to-control ratio was 1:2. The calculated minimum sample size was 43 cases and 85 controls, with a 10% non-response rate. Our minimum sample size was 47 cases and 94 controls [13]. The PMTCT register at each health facility was used to select

cases and controls using a systematic random sampling method. Eight Key informants (PMTCT nurse in charge) and eight key informants (community health workers) were purposively selected, one per each facility visited. The district hospital and the referral hospital were purposefully selected for the study. Simple random sampling was conducted to choose three urban facilities and three rural facilities.

Data collection

A pre-tested interviewer-administered questionnaire was used to collect data from the study cases and controls on demographic characteristics, maternal factors, infant factors, socio-cultural factors, and health system factors. PMTCT Knowledge and awareness were assessed using a 3-point Likert scale, where a set of five questions was asked, scored, and marked out of five. Scores (0-1) were classified as poor knowledge and awareness, (2-3) moderate knowledge and awareness, and (4-5) good knowledge and awareness. Mental health status was assessed using the Shona symptom questionnaire for mental health disorders, which has a set of 14 questions [20]. ART adherence was assessed using self-reporting where study participants were asked how many doses they had missed in 30 doses. Missing 0-1 doses in 30 doses was categorized as good adherence and missing 2-5 doses in 30 doses was categorized as poor adherence [21]. Semi-structured interview guides were used to collect qualitative data from key informants (nurses) and community health workers. A focus group discussion was conducted at the district hospital, referral hospital, one urban facility, and one rural facility with HIV-positive mothers to understand the challenges faced by postnatal mothers and their perceptions of determinants of MTCT. Each focus group had 5-15 people. The patients' green OI booklets, mother-baby pair register, and PMTCT registers were reviewed to collect clinical data for both cases and controls, as well as to validate responses from the mothers. Drug availability was verified with the pharmacy department.

Dependent variable

Infant HIV status was ascertained using an early infant diagnostic test. This test is a virological test to detect viral DNA through a polymerase chain reaction (PCR). The EID DNA/PCR test is performed at birth, 6 weeks and at 9 months using a point-of-care machine (Genexpert and M-PIMA machines were used). However, the EID DNA/PCR test can also be performed at any other time before breastfeeding cessation when seroconversion is suspected. Three months post-weaning, an HIV antibody test was performed to determine the infant's HIV status.

Independent variables

Independent variables were categorized into demographic characteristics (Age, sex, level of education, marital status, religion, occupation, family monthly income), maternal factors (Mastitis/cracked nipples/ nipple bleeding, viral load, breastfeeding practices, ART adherence post-delivery, Unprotected sex, History of sexually transmitted infections (STIs), Substance use, Lack of HIV knowledge and awareness, Poor maternal mental health post-delivery), infant factors (duration of breastfeeding, infant oral candidiasis, adherence to nevirapine and zidovudine (NVP/AZT), prematurity), socio-cultural factors (Partner support, intimate partner violence, partner's willingness to use HIV preventive measures, partner HIV status, sex, and sexuality), and health system factors (HIV counseling and follow-up post-delivery, HIV diagnosis post-delivery, drug availability).

Data analysis

Data was captured and analyzed using Epi info version 7.2.5 to generate frequencies, proportions, medians, and means. Chi-square was used to compare cases and controls. Bivariate analysis was done to generate odds ratios at a 95% confidence interval. Backward elimination logistic regression was carried out to identify statistically significant independent risk factors leading to postnatal mother-to-child HIV transmission in the Kwekwe district while simultaneously controlling for confounding. Variables with a p-value < 0.25 were included in the multivariate logistic regression. Variables with a p-value of < 0.05 were considered statistically significant. Data was cleaned before analysis.

Qualitative data were analysed using thematic analysis, where the researcher closely examined text data to identify themes and patterns of its meaning. Focus group discussions were transcribed into text format and thematically analysed. The process started with the text familiarisation phase, and initial codes were generated by manually highlighting and labelling meaningful phrases in the text. The codes were grouped into potential themes, which were reviewed and refined through an iterative process of checking against the initial codes. Finally, clear names of each theme were established, and compelling extracts were selected to illustrate the thematic structure in the reporting phase.

Ethical considerations

Ethical approval was obtained from the Joint Research and Ethical Council (JREC) (JREC Ref: 375/2024). Permission to carry out the study was obtained from the Provincial Medical Director, Midlands (PMD), the District Medical Officer (DMO) Kwekwe district, the Medical Superintendent for Kwekwe General Hospital, and the

Director of Kwekwe City Health. The study was conducted in an ethical manner where principles of confidentiality, informed consent, anonymity, and harm to participants were addressed. Participant names were not captured during data collection. Informants were fully informed about the study, and written consent was obtained before responding to interview questions.

Results

Socio-demographic and contextual characteristics of young people who participated in the study

A total of 141 study participants (47 cases and 94 controls) were recruited into the study and the minimum sample size was achieved. The response rate was 100%.

Sociodemographics of breastfeeding mothers living with HIV and their exposed infants in Kwekwe district

The median age of the mother in years among cases was 26, with a (Q1=22; Q3=29) years, whilst among controls was 30 with a (Q1=26; Q3=36) years. There were more cases in the 25-29 age group, 20(42.55%), while more controls were in the 35+ age group 32(34.04%). The median age of the baby in months was 20 (Q1=15; Q3=24) months among cases and 9(Q1=4; Q3=14) months among controls. The majority of the infants in the cases were diagnosed with HIV between 1-3 months of age, 19(40.43%), compared to 7(14.89%) at birth and 10(21.28%) after 12 months of age. Cases and controls were comparable with respect to marital status, religion, occupation, and average monthly family income (Table 1).

Maternal factors associated with postnatal mother-to-child HIV transmission in Kwekwe district

Having a maternal viral load of > 50 copies/ml in the post-delivery [COR 4.10; 95% CI (1.56-10.78); p =0.004], unprotected sex in the post-delivery [COR 2.28; 95% CI (1.10-4.69); p = 0.03], and a history of suffering from an STI [COR 3.51; 95% CI (1.67-7.36); p = 0.0009] were significantly associated with postnatal mother to child HIV transmission. Mothers diagnosed with HIV before delivery [COR 0.05; 95% CI (0.02-0.14); p <0.0001], good mental health status [COR 0.18; 95% CI (0.08-0.38); p <0.0001], and those that exclusively breast/bottle feed their infants [COR 0.36; 95%CI (0.18-0.75); p = 0.006] were less likely to transmit HIV to their infants. Both cases and controls had multiple sexual partners, however, stratifying the data by age group, the 25-29 years (9/18) among cases and the 35+ years (5/10) had the bigger proportions (Table 2).

Focus group discussion findings confirmed that more than 50% of cases and controls had ever used an HIV prevention method before diagnosis. The community health workers indicated that most of the mothers both HIV-infected and uninfected are practicing unprotected sex with their intimate partners' post-delivery despite not knowing their partners' HIV status. Furthermore, mothers during the FGDs clearly outlined that their husbands did not like the use of condoms despite the knowledge of their partners' HIV-positive status. Some women also indicated that they did not like using Prep as an HIV prevention method.

"Duration for taking prep is too long during pregnancy to after breastfeeding, which is close to 3 years hence where do we differ with taking ART drugs? It is better to rely on constant HIV testing for early ART initiation." (35-year-old, married woman, urban facility).

"Our husbands do not like the use of condoms despite knowing that we are HIV positive, especially among us married women." (33-year-old, married women, rural facility)

Focus group discussion responses supported the quantitative results, in which over 50% of cases were diagnosed with HIV after delivery suggesting a pattern of underutilization of post-delivery HIV testing and counselling services. One of the PMTCT nurses in charge explained that there is underutilization of postnatal HIV testing and counselling services hence most of the mothers show up at the health facility with an ill baby when both the mother and baby are already infected.

"Mothers utilize postnatal HIV testing and counseling services up to 6 weeks post-delivery, since then they do not show up for the 6 monthly HIV testing for breastfeeding mothers." (PMTCT nurse in charge, urban facility)

Discussions with mothers across facilities revealed that less than 50% of the cases practiced exclusive breastfeeding for the first 6 months of the infant's life. Discussions with the mothers indicated that exclusive breastfeeding was known for nutritional benefits and not for HIV prevention. Also, the mothers listed other measures taken to reduce postnatal mother-to-child HIV transmission and exclusive breastfeeding was not one of the measures. However, on further probing the mothers revealed a lack of knowledge of exclusive breastfeeding as an HIV prevention method. Commenting on exclusive breastfeeding as an HIV prevention method, the mothers expressed the following sentiments;

"We produce less milk hence we end up complementing with other feeds, however, if the baby has diarrhea we stop but if the baby is fine we continue giving the complementary feed mainly maize meal." (29-year-old, single mother, rural facility)

"Adherence to ART, use of condoms and giving infant HIV prophylaxis are measures to reduce postnatal

Table 1. Socio-demographics of breastfeeding mothers living with HIV and their exposed infants in Kwekwe district, 2024

Variable	Case n (%)	Control n (%)	p-value (chi-square)
Age of mother (years)			0.01
15–19	4 (8.51)	6 (6.38)	
20–24	13 (27.66)	12 (12.77)	
25–29	20 (42.55)	28 (29.79)	
30–34	4 (8.51)	16 (17.02)	
35+	6 (12.77)	32 (34.04)	
Median Age of mother (years)	28 (Q1=22; Q3=29)	30 (Q1=26; Q3=36)	0.24
Age of baby(s) in months			< 0.0001
0–5	0	31 (32.98)	
6–11	11 (23.40)	28 (29.79)	
12–17	4 (8.51)	18 (19.15)	
18–24	32 (68.09)	17 (18.09)	
Median Age of baby(s) in months	20 (Q1=15; Q3=24)	9 (Q1=4; Q3=14)	0.98
Age of baby on HIV diagnosis (months)			
At birth	7 (14.89)		
6 weeks	1 (2.13)		
1–3	19 (40.43)		
4–6	3 (6.38)		
7–12	7 (14.89)		
> 12	10 (21.28)		
Level of education			0.0005
Primary	16 (34.04)	8 (8.51)	
Secondary	27 (57.45)	80 (85.11)	
Tertiary	0	1 (1.06)	
None	4 (8.51)	5 (5.32)	
Marital status			0.44
Single	3 (6.38)	4 (4.26)	
Married	33 (70.21)	72 (76.60)	
Divorced	11 (23.40)	15 (15.96)	
Widow	0	3 (3.19)	
Religion			0.89
Christian	19 (40.43)	40 (42.55)	
Apostolic sector	3 (6.38)	8 (8.51)	
Pentecostal	23 (48.94)	6 (6.38)	
None	2 (4.26)	40 (42.55)	
Occupation			0.96
Formal	2 (4.26)	6 (6.38)	
Informal	14 (29.79)	29 (30.85)	
Unemployed	31 (65.96)	59 (62.77)	
Residential place			< 0.0001
Peri-urban	3 (6.38)	4 (4.26)	
Urban	16 (34.04)	68 (72.34)	
Rural	28 (59.57)	22 (23.40)	
Average monthly family income			0.06
< $200	30 (63.83)	41 (43.62)	
$200–$500	17 (36.17)	50 (53.19)	

mother-to-child HIV transmission. Exclusive breastfeeding, I am not sure." (32-year-old, divorced mother, urban facility)

Infants who suffered from oral candidiasis/sores/thrush during breastfeeding [COR 2.72; 95% CI (1.19-6.16); p = 0.02], and those breastfed for more than 12 months [COR 6.67; 95% CI (1.62-27.38); p = 0.0085] were significantly more likely to contract HIV from their mothers (Table 3).

Socio-cultural factors associated with mother-to-child HIV transmission in Kwekwe district

Mothers who experienced intimate partner physical and sexual violence [COR 4.21; 95% CI (2.00-8.85); p = 0.0001], and those who denied their partners' sex in the post-natal [COR 3.72; 95% CI (1.76-7.83); p =0.0006] were significantly more likely to transmit HIV to their infants. Having your partner escort, you to PMTCT appointment [COR 0.11; 95% CI (0.01-0.89); p = 0.04],

Table 2. Shows bivariate analysis of the maternal factors associated with postnatal mother-to-child HIV transmission in Kwekwe district, 2024

Variable	Cases n (%)	Controls n (%)	cOR	95% CI	P-value
HIV diagnosed					
Before delivery	20 (42.55)	88 (93.62)	0.05	0.02–0.14	< 0.0001
After delivery	27 (57.45)	6 (6.38)	Ref		
Current maternal viral load (copies/ml)					
> 50	13 (27.66)	8 (8.51)	4.10	1.56–10.78	0.004
≤ 50	34 (72.34)	86 (91.49)	Ref		
Suffered from mastitis/cracked nipple/nipple bleeding during breastfeeding					
Yes	3 (6.38)	3 (3.19)	2.07	0.40–10.66	0.39
No	44 (93.62)	91 (96.81)	Ref		
Adherence to ART post-delivery (missed < 2 doses in 30 doses)					
Yes	36 (76.60)	83 (88.30)	0.43	0.17–1.09	0.08
No	11 (23.40)	11 (11.70)	Ref		
Had unprotected sex post-delivery					
Yes	30 (63.83)	41 (43.62)	2.28	1.10–4.69	0.03
No	17 (36.17)	53 (56.38)	Ref		
Number of sexual partners					
One	29 (61.70)	75 (79.79)	0.21	0.09–0.52	0.0006
Multiple	18 (38.30)	10 (10.64)	Ref		
None	0	9 (9.57)	NC		
History of suffering from an STI					
Yes	25 (53.19)	23 (24.47)	3.51	1.67–7.36	0.0009
No	22 (46.81)	71 (75.53)	Ref		
Substance use post-delivery					
Yes	4 (8.51)	6 (6.38)	1.36	0.37–5.09	0.64
No	43 (91.49)	88 (93.62)	Ref		
Ever used HIV prevention measures before HIV diagnosis					
Yes (Condoms)	15 (31.91)	37 (39.36)	0.71	0.34–1.49	0.36
Yes (PrEP)	0	1 (1.06)	NC		
No	32 (68.09)	56 (59.57)	Ref		
Maternal mental health status					
Good	15 (31.91)	68 (72.34)	0.18	0.08–0.38	< 0.0001
Poor	32 (68.09)	26 (27.66)	Ref		
HIV-PMTCT knowledge and awareness					
Good	23 (48.94)	73 (77.66)	0.28	0.13–0.58	0.0008
Moderate	24 (51.06)	21 (22.34)	Ref		
Breastfeeding practices (in the first 6 months of life)					
Exclusive breastfeeding or bottle-feeding	20 (42.55)	60 (65.93)	0.36	0.18–0.75	0.006
Mixed breast and complementary feeding	27 (57.45)	31 (34.07)	Ref		

*Bold p-values are statistically significant; **NC** = not calculable

knowing intimate partner HIV status [COR 0.31; 95% CI (0.14-0.67); p = 0.003], partner willing to use condoms during sex in the post-delivery [COR 0.06; 95% CI (0.03-0.15); p<0.0001], receiving HIV counseling as a couple in the post-delivery [COR 0.15; 95% CI (0.03-0.65); p=0.01], and discussing safe sex practices with intimate partner [COR 0.15; 95% CI (0.07-0.35); p<0.0001] were protective factors significantly associated with mother to child HIV transmission (Table 4).

The majority of the mothers from both the cases and controls suggested that their male partners made the final decision on when, where and how sex should be done. During FGDs, the mothers pointed out that it was very difficult to educate their husbands of the safe sex practices taught at the health facility in their absence.

"It is very difficult to convince our husbands to adhere to the practices we are taught during HIV counseling since most of the sessions are done in their absence and also, some of the teachings deviate from the routine practices before HIV infection." (22-year-old, married woman, rural facility)

Focus group discussions showed that most of intimate partner violence among both the cases and controls were due to misunderstandings that emanated from being denied sex. The mothers' further shared that some of these misunderstandings arise as women try to educate their husbands on safe sex practices such as the use of condoms and this often resulted in exchange of harsh words with their intimate partners.

"If we have a misunderstanding with my husband I deny him sex because I will be very angry however we end up getting into a fight over sex most of the time." (28-year-old,

Table 3. Bivariate analysis of the infant factors associated with mother-to-child HIV transmission in Kwekwe district, 2024

Variable	Case n (%)	Control n (%)	COR	95% CI	p-value
Baby born before 37 weeks (premature baby)					
Yes	2 (4.26)	5 (5.32)	0.79	0.15–4.24	0.78
No	45 (95.74)	89 (94.68)	Ref		
Baby suffered from oral candidiasis/ sores/ thrush					
Yes	16 (34.04)	15 (15.96)	2.72	1.19–6.16	**0.02**
No	31 (65.96)	79 (84.04)	Ref		
Baby Given NVP/AZT					
Yes	14 (29.79)	94 (100)	NC		
No	33 (70.21)	0			
Given NVP/AZT for					
<6 weeks	7 (50)	0			
6 weeks	7 (50)	94 (100)	NC		
Adherence to NVP/AZT					
Yes	11 (78.57)	94 (100)	NC		
No	3 (21.43)	0			
Breastfeeding period					
12 months	4 (10.53)	21 (55.26)	0.38	0.07–1.90	0.24
>12 months	30 (78.95)	9 (23.68)	6.67	1.62–27.38	**0.0085**
<12 months	4 (10.53)	8 (21.05)	Ref		

NC = not calculable. Bold p-values are statistically significant

married, rural facility)

"It is very difficult to teach our spouses safe sex because they end up telling us that you should have intercourse with your nurses who are telling you that we should use condoms even if we are married." (25-year-old, married, rural facility)

The PMTCT nurse also reiterated the fact that the patriarchal culture does not allow women to negotiate for sex.

"Our culture is very tight, it doesn't allow women to negotiate for sex with their intimate partners; rather, they have to follow what the male partners want since they are considered the head of the family." (PMTCT nurse in charge, urban facility)

The community health workers shared the same sentiments, arguing that in our culture, it is unacceptable to negotiate for safe sex with our intimate partners, nor deny them sex for whatever reason.

"Intimate partner violence is due to denying partner sex. Most of the male partners will be out in the mines carrying out mining activities, hence they do not come for HIV testing and counselling. Later in the night, when the mothers try to educate their spouse and they do not want to listen the women retaliate by denying partner sex. The partners will then start beating the wife, accusing him of being intimate with other men during the day in his absence." (Community health worker #1, rural facility)

Community members further clarified that women give complementary feeds because of cultural beliefs that infants need complementary food, as a baby's crying was a sign of hunger.

"Culturally people in our community believe that when the babies cry a lot, it is due to hunger, showing that the baby needs complementary feeds; breastmilk is not enough in the first six months of life." (community health worker # 2, rural facility)

Healthcare-related factors associated with mother-to-child HIV transmission in Kwekwe district Mothers who received HIV counselling 6 weeks post-delivery were 10% less likely to transmit HIV to their infants [COR 0.10; 95% CI (0.04-0.32); p = 0.0003]. More than 90% of the infants among cases and controls did not fail to receive NVP/AZT due to stock unavailability. The PMTCT nurse in charge during an interview alluded that at any given time the health facilities had adequate supplies of NVP/AZT and adult ART drugs except for private facilities, which then refer patients to the nearest health facility for the infant's NVP/AZT administration and Early infant HIV diagnosis using a point-of-care MPIMA NAT diagnostic machine. Mothers confirmed the constant availability of HIV drugs at the health facilities. A health care worker and a mother stated the following:

"Nevirapine, Zidovudine and adult ART drugs are always adequate. Also, we are a referral hospital, mostly from private facilities, for EID testing and administering NVP/AZT to HIV-exposed infants. We have a point-of-care MPIMA machine to run EID-NAT, therefore early infant diagnosis is timely." (PMTCT nurse in charge, referral hospital).

Table 4. Bivariate analysis of the Sociocultural factors associated with mother-to-child HIV transmission in Kwekwe district, 2024

Variable	Cases n (%)	Control n (%)	COR	95% CI	p-value
Partner support- escorting you to PMTCT appointments					
Yes	1 (2.13)	15 (15.96)	0.11	0.01–0.89	**0.04**
No	46 (97.87)	79 (84.04)	Ref		
Partner reminding you to take drugs (ART)					
Yes	12 (25.53)	39 (41.49)	0.48	0.22–1.05	0.06
No	35 (74.47)	55 (58.51)	Ref		
Know your intimate partner's HIV status					
Yes	11 (23.40)	47 (50.00)	0.31	0.14–0.67	**0.003**
No	36 (76.60)	47 (50.00)	Ref		
Experienced intimate partner violence					
Yes	29 (61.70)	26 (27.66)	4.21	2.00–8.85	**0.001**
No	18 (38.30)	68 (72.34)	Ref		
A partner willing to use condoms post-delivery					
Yes	9 (19.15)	75 (79.79)	0.06	0.03–0.15	< 0.001
No	38 (80.85)	19 (20.21)	Ref		
Received HIV counseling as a couple in the postnatal period					
Yes	2 (4.26)	22 (23.40)	0.15	0.03–0.65	**0.01**
No	45 (95.74)	72 (76.60)	Ref		
Ever denied intimate partner sex					
Yes	25 (53.19)	22 (23.40)	3.72	1.76–7.83	**0.0006**
No	22 (46.81)	72 (76.60)	Ref		
Discuss safe sex practices with intimate partner					
Yes	9 (19.15)	57 (60.64)	0.15	0.07–0.35	< 0.001
No	38 (80.85)	37 (39.36)	Ref		
Makes sex-related decisions					
Yes	3 (6.38)	18 (19.15)	0.29	0.08–1.03	0.06
No	44 (93.62)	76 (80.85)	Ref		
Makes final decisions on when, where, and how to have sex					
Male partner	45 (95.74)	89 (94.68)	1.26	0.24–6.77	0.78
Female partner	2 (4.26)	5 (5.32)	Ref		
Average monthly family income					
< $200	30 (63.83)	41 (43.62)	2.15	1.04–4.44	**0.04**
$200–$500	17 (36.17)	50 (53.19)	Ref		
> $500	0	3 (3.19)	NC		

*Bold p-values are statistically significant. NC = not calculable

"We never got short of infant drugs (NVP/AZT) and Cotrimoxazole, however, in the past few months we had to buy Cotrimoxazole syrup since the health facility was supplying us with Cotrimoxazole pills, which are difficult to administer to our small babies." (22-year-old, married mother, urban facility)

Independent factors associated with mother-to-child HIV transmission in Kwekwe district

Backward elimination logistic regression was conducted to determine independent factors associated with postnatal mother-to-child HIV transmission, while simultaneously controlling for confounding. All variables with a p-value<0.25 in the bivariate analysis were included in the logistic regression model. Adjusted odds ratios, 95% confidence interval, and p-values from the final model are presented in Table 5. The results from this multi-variate analysis indicate that in Kwekwe district maternal HIV diagnosis before delivery [AOR 0.06; 95% CI (0.02-0.19); p<0.0001], good maternal mental health status (AOR= 0.20; 95%CI:0.06-0.65, p =0.007), breastfeeding for 12 months [AOR 0.03; 95% CI (0.001-0.87); p =0.04], exclusive breast/bottle feeding for the first 6 months of baby's life [AOR 0.24; 95% CI (0.07-0.78); p =0.02], a partner willing to use condoms during sex in the post-delivery [AOR 0.06; 95% CI (0.02-0.21); p<0.0001], receiving HIV counseling 6 weeks post-delivery [AOR 0.04; 95% CI (0.007-0.23); p = 0.0003], and discussing safe sex practices with an intimate partner [AOR 0.19; 95% CI (0.05-0.64); p =0.008] were independent factors associated with mothers being less likely to transmit HIV to their infants in Kwekwe district. Maternal viral load > 50 copies/ml in the post-delivery [AOR 7.38; 95% CI (1.65-33.04); p =0.009], having a history of suffering from an STI [AOR 3.44; 95% CI (1.06-11.15); p =0.04], Infants who suffered from oral candidiasis/sores/thrush during breastfeeding [AOR 5.21; 95% CI (1.30-20.81); p =0.02], and denying partner sex in the post-natal [AOR 10.82; 95% CI (2.93-39.88)p =0.0003] were independent factors associated with mothers being more likely to transmit HIV to their infants in Kwekwe district.

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Table 5. A multivariate analysis of the factors associated with mother-to-child HIV transmission in Kwekwe district, 2024

Variable	COR	AOR	95% CI	p-value
HIV diagnosed before delivery	0.05	0.06	0.02–0.19	< 0.0001
Current maternal viral load of > 50 copies/ml	4.10	7.38	1.65–33.04	0.009
Having a history of suffering from an STI	3.51	3.44	1.06–11.15	0.04
Exclusive bottle feeding or breastfeeding	0.36	0.24	0.07–0.78	0.02
Good mental health status	0.18	0.20	0.06–0.65	0.007
Baby developing oral thrush/sores during breastfeeding	2.72	5.21	1.30–20.81	0.02
Breastfeeding for 12 months	0.38	0.03	0.001–0.87	0.04
An intimate partner willing to use condoms during sex	0.06	0.06	0.02–0.21	< 0.0001
Receiving HIV counselling 6 weeks post-delivery	0.10	0.04	0.007–0.23	0.0003
Denying intimate partner sexual intercourse	3.72	10.82	2.93–39.88	0.0003
Discussing safe sex practices with intimate partner	0.15	0.19	0.05–0.64	0.008

Discussion

The main objective of this study was to identify determinants of postnatal mother-to-child HIV transmission among HIV-exposed infants in Kwekwe district. Maternal HIV diagnosis before delivery, good maternal mental health status, breastfeeding for 12 months, exclusive breast/bottle feeding for the first 6 months of baby's life, a partner willing to use condoms during sex in the post-delivery, receiving HIV counseling 6 weeks post-delivery, and discussing safe sex practices with an intimate partner were found to be independent factors associated with mothers being less likely to transmit HIV to their infants. Maternal viral load > 50 copies/ml in the post-delivery, having a history of suffering from an STI, and infants who suffered from oral candidiasis/sores/thrush during breastfeeding were independent factors associated with mother-to-child HIV transmission.

In this study, mothers with a viral load > 50 copies/ml during the postnatal period were 7 times more likely to transmit HIV to their infants than those with a viral load < 50 copies/ml. A higher viral load may increase the risk of HIV transmission from mother to child during breastfeeding. These findings are similar to those by Osorio and others, where 90% of the mothers with a viral load > 1000 copies/ml transmitted HIV to their infants (16). This is also, supported by a study by Duri and others, where women with a viral load > 1000 copies/ml late in pregnancy were 9.3 times more likely to transmit HIV to their infants in the postnatal period (13). Recently a policy change stated that a viral load > 50 copies/ml is an unsuppressed viral load. Viral suppression can be achieved through adherence to antiretroviral therapy (ARV) for one month or more. However, unsuppressed viral load during the postnatal period may be due to enrollment in ART late in pregnancy or during breastfeeding. In this study ART adherence was statistically insignificant this may be due to late ART enrolment when both the mother and baby are already infected. Hence this factor becomes less significant even when it contributes more towards a reduced viral load.

Mental health is key to properly caring for a baby. In this study, mental health status was assessed using the Shona symptom questionnaire. Women with a good mental health status were less likely to transmit HIV to their infants than those with a poor mental health status. Mental health affects multiple interventions in the PMTCT program. Mental health disorders include stress, and this leads to an increase in hormones such as cortisol, adrenaline, and dopamine. These hormones suppress the synthesis of prolactin and oxytocin, which are essential for the generation and release of breastmilk resulting in depleted production and secretion of breastmilk [21]. This is consistent with a study by Fernandez-Tunas and colleagues [22]. Depleted production of breastmilk may result in most mothers resorting to mixed feeding which is a risk factor in mother-to-child HIV transmission.

Findings from this study showed that more than 50% of the infants who acquired HIV from their mothers were mixed-fed and more than half of the mothers who transmitted HIV to their infants had poor mental health status. The provision of psychosocial support and emotional support may reduce maternal stress during the postnatal. However, in this study community key informants and the focus group discussions provided information that was in agreement with the patients on the unavailability of psychosocial, emotional, and partner support in PMTCT. This confirms that the unavailability of these services can ruin efforts made towards the elimination of mother-to-child HIV transmission.

Findings from this study showed that women diagnosed with HIV before delivery were less likely to transmit HIV to their infants than those diagnosed with HIV after

delivery. Diagnosis with HIV before delivery allows for ample time for viral suppression before breastfeeding the baby. Viral suppression can be achieved within one to three months of treatment with good adherence to ART drugs. This reduces the risk of transmitting HIV to the infant during breastfeeding. In this study, more than half of the women who transmitted HIV to their infants were diagnosed with HIV after delivery. These findings are congruent with those obtained in Brazil and Zimbabwe, where mothers who transmitted HIV to their infants were diagnosed during breastfeeding [22, 23]. An increased HIV seroconversion during post-delivery and transmission to their infants may be due to the unavailability of the preferred HIV prevention methods among mothers. In this study, the majority of the mothers who transmitted HIV to their infants reported that they had never used any HIV prevention method before HIV diagnosis.

This finding agrees with the responses from the community key informants and focus group discussion where community health workers clearly outlined that mothers are indulging in unprotected sex post-delivery. During the focus group discussion mothers aired out their concerns about the long duration of taking prep which is discouraging them from using it. Also, their intimate partners do not agree with the use of condoms during sex. This leaves both the HIV-infected and uninfected mothers in the postnatal with an increased risk of maternal HIV infection and re-infections during breastfeeding. If we are to effectively decrease the incidence of new pediatric infections, there is a need to speed up the use of cabotegravir (prep-injectable) to accommodate HIV uninfected lactating mothers. Improve health education to increase understanding and utilization of the available combination HIV prevention methods among mothers during the postnatal.

In this study exclusively breastfed or bottle-fed infants were less likely to acquire HIV from their mothers during breastfeeding. This is in agreement with findings from various research conducted in Nigeria; Northwest Ethiopia; the United States of America; Tanzania and Zimbabwe [2, 15, 21, 22]. Breastfeeding approximately doubles the risk of mother-to-child HIV transmission. High levels of HIV in breastmilk cells may correlate with an increased risk of transmission, however, exclusive breastfeeding may reduce the risk. In this study, more than 40% of new HIV infections in infants occurred between 6 weeks and 6 months of life, the same period mothers are expected to be exclusively breastfeeding. This is similar to the finding by Duri and others [13]. Exclusive breastfeeding in the first 6 months of life may promote early health infant gut development as well as providing resistance to infectious microbial agents including HIV.

However, mixed feeding in the first 6 months of life poses a risk of poor gut mucosal development exposing the infants to maternal HIV during breastfeeding [22]. Mixed feeding can also pose a risk to the infants of developing sores in the mouth creating a passage for transmission. Findings from this study showed that infants who develop thrush/sores/candidiasis in the mouth during breastfeeding were three times more likely to acquire HIV from their mothers. Mixed feeding of infants may be due to the production of less breastmilk due to the effects of maternal stress in the postnatal. On the other hand, this might be because of a lack of knowledge on the benefits of exclusive breastfeeding in PMTCT.

In this study mothers who received HIV counseling 6 weeks post-delivery were less likely to transmit HIV to their infants. Counseling sessions create time for mothers to learn good practices for preventing MTCT. Lack of HIV counseling, support, and follow-up services for both HIV-infected and uninfected mothers may result in poor PMTCT scale-up. However, nurse key informants outlined the underutilization of postnatal HIV testing and counseling among HIV-uninfected mothers after 6 weeks post-delivery. This may result in unnoticed maternal seroconversion thereby transmitting to their infants. Poor knowledge of PMTCT may affect the utilization of postnatal HIV testing and counseling services [24]. In this study, most of the mothers who transmitted HIV to their infants had moderate knowledge of PMTCT. These findings are similar to those by Masaka and colleagues where 17% of the mothers were not aware of transmission during breastfeeding and one-third of the study participants had incorrect knowledge of mother-to-child HIV transmission and its prevention [25].

Having a good male partner involvement in the fight against mother-to-child HIV transmission helps reduce pediatric transmission rates. In this study mothers who discussed safe sex practices with their intimate partners as well as having a partner who is willing to use condoms during sex were less likely to transmit HIV to their infants. Partner support among HIV uninfected women helps in the choice of the HIV prevention method to adopt during the high-risk period of HIV acquisition during breastfeeding. Among HIV-infected women, partner support helps in making the best choices to prevent mother-to-child HIV transmission. More than 50% of the mothers who transmitted HIV to their infants had unprotected sex during the postnatal period and had a history of suffering from an STI. Protected sex protects against sexually transmitted infections which creates passage for HIV infection among HIV-negative mothers as well as advancing the HIV diseases among already HIV-positive mothers. Good male partner involvement creates good emotional and psychosocial support for the mother. This support creates room for a good mental health state for the mother, which is good for properly taking care of the child thereby preventing mother-to-child HIV transmission [22].

Limitations

Since interviews were being carried out inside the hospital setting, some study participants may not have been open enough to some sensitive questions introducing social desirability bias. Due to the nature of the study design there might also be recall bias, information bias and temporal ambiguity bias, Data triangulation were done to reduce their effects.

Conclusions

Receiving HIV diagnosis during pregnancy and counselling in the post-delivery could lead to better adherence to treatment and reduced viral load resulting in reduced MTCT. We therefore recommend HIV-related health education, psychosocial and emotional support, and routine mental health screening and counselling during the postnatal period to improve maternal mental health. Infants who were mixed-fed in the first 6 months of life and those who developed oral thrush/sores/candidiasis during breastfeeding were more likely to acquire HIV from their mothers during breastfeeding. Hence paediatric HIV prophylaxis should be made available in public institutions for HIV exposed infants, as this will also reduce transmission in children with other predisposing factors, such as candidiasis /sores/thrush.

Recommendations

Recommendations for healthcare workers

- Improving health education through innovative strategies such as educational campaigns in the community and morning health education sessions in the antenatal clinic to improve mothers' knowledge of postnatal mother-to-child HIV transmission and its prevention
- Create differentiated service delivery models for lactating mothers
- Improve male involvement in the PMTCT program by encouraging mothers to bring spouses during Antenatal and postnatal care visits
- Encourage HIV testing and counseling before delivery and routinely in the post-delivery

Recommendations for community health workers

- Improve community health education sessions during outreach services
- Creates and follows-up support groups for pregnant and breastfeeding HIV-positive women

Recommendations for mothers

- Identify suitable HIV prevention methods to use as a couple so that they reduce HIV infections and re-infections during breastfeeding
- Convince male partners involvement in PMTCT program
- Create enabling environments to negotiate for safer sex without introducing intimate partner violence
- Take up all the health education given towards prevention of mother-to-child HIV prevention and practices

Recommendations for the Ministry of health and child care

- Create IEC materials such as charts, posters, and videos for the prevention of postnatal mother-to-child transmission
- Speed up piloting the cabotegravir injectable prep so that it can be used by all populations
- Revise the lactating mothers' HIV testing algorithm so that it aligns with routine immunization schedules to reduce hospital visits and improve postnatal HIV testing and counseling service utilization
- Incorporate routine mental health screening and counseling among mothers during the postnatal period

What is Already Known About this Topic

- High maternal viral load is associated with postnatal MTCT
- Mixed-fed infants in the first 6 months of life are more likely to acquire HIV from their mothers.

What This Study Adds

- Good maternal mental health reduces the risk of MTCT.
- Maternal education/counselling post-delivery reduces the risk of MTCT

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Authors' Contributions

Plassey Ropafadzo Chinove and Mary Muchekeza did the conception and design of the study, data collection, analysis and interpretation, and manuscript writing. Tsitsi Juru, Notion Gombe, Gerald Shambira, Addmore Chadambuka, Gibson Mandozana, and Mufuta Tshimanga did the conception, design, data analysis, interpretation, critical revision, and final approval of the study. All authors read and agreed to the final manuscript.

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Conflict of Interest Statement

Addmore Chadambuka is an Associate Editor at the Journal of Interventional Epidemiology and Public Health (JIEPH) and a co-author of this manuscript. In line with the journal's conflict-of-interest policy, he was fully recused from the peer-review process and had no involvement in the editorial handling or decision-making for this submission. An independent editor oversaw the review and decision-making process.

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