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Barriers To Elimination Of Mother To Child Transmission Of HIV In Machakos County, Kenya

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Abstract
Background: Despite progress in Kenya's PMTCT program, mother-to-child transmission (MTCT) rates remain above the national target, with Machakos County recording 9.1%. This study examined barriers to elimination of MTCT in Machakos County. Methods: A facility- based cross-sectional study was conducted among HIV-positive mothers and their HIV- exposed infants enrolled between 2019 and 2021. Quantitative data were collected from clinic records and structured questionnaires, while qualitative data were gathered through key informant interviews with nurses. Analysis included descriptive statistics and logistic regression. Results: Sociodemographic factors were not strong predictors, but HIV-positive partners and multiparity significantly increased risk of MTCT. Clinical barriers included late ANC attendance, high maternal viral load, and delayed infant prophylaxis. Health system barriers included drug stock-outs, staff shortages, high workload, and long waiting times.
Stigma, intimate partner violence, and lack of male partner involvement negatively influenced adherence. Conclusion: MTCT persists due to psychosocial, clinical, and health system barriers. Strengthening early ANC attendance, promoting male involvement, ensuring uninterrupted ART supply, and addressing stigma are essential for achieving elimination targets.

Materials and Methods
This study employed a cross-sectional mixed-methods design in 14 high-volume PMTCT facilities in Machakos County. A sample of 287 HIV-positive mothers and their HIV-exposed infants was proportionately drawn. Data were collected from medical records, structured questionnaires, and key informant interviews with 21 nurses. Quantitative data were analyzed using SPSS v25 with regression models, while qualitative data were thematically analyzed. Ethical approval was obtained from Kenyatta University ERB, NACOSTI, and Machakos County authorities.

Results
MTCT prevalence among study participants was consistent with county trends (9.1%). Sociodemographic variables such as maternal age and education were not significant predictors. However, having an HIV-positive partner (AOR=0.34, p=0.006) and multiparity (AOR=0.47, p=0.017) increased risk. Clinical factors strongly associated with MTCT included late ANC initiation (p=0.039), unsuppressed maternal viral load (>1000 copies/ml, p=0.008), delayed infant prophylaxis (p=0.007), and poor retention in care (p<0.001).
Vaginal delivery carried higher transmission risk compared to cesarean section. Health system challenges included drug and reagent stock-outs, understaffing, outdated training, and long waiting times. Psychosocial factors such as stigma, IPV, and lack of male involvement hindered adherence and retention.

Discussion
This study highlights that beyond ART access, psychosocial and systemic barriers drive persistent MTCT. Findings align with studies in Kenya and Sub-Saharan Africa showing stigma, poor adherence, and health system weaknesses as key determinants. Male partner involvement remains a protective factor but is underutilized. The high impact of late ANC and unsuppressed viral load underscores the need for early testing and adherence support. Addressing stock-outs, strengthening staff capacity, and integrating PMTCT with MNCH services are critical steps. Limitations include reliance on facility-based sampling and self- reported psychosocial data, which may underrepresent community-level barriers.

Conclusion
Persistent MTCT in Machakos County is driven by clinical, psychosocial, and health system barriers. Elimination requires strengthening early ANC engagement, promoting male partner involvement, addressing stigma, and ensuring consistent ART supply and healthcare workforce support.

Keywords: *Mother-to-Child Transmission; HIV; PMTCT; Barriers; Machakos County; Kenya*

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I. Introduction

Mother-to-child transmission (MTCT) of HIV remains a major contributor to pediatric HIV in Sub-Saharan Africa. Globally, 120,000 children were newly infected in 2024, with Eastern and Southern Africa bearing the greatest burden. In Kenya, national MTCT stands at 7.3%, while Machakos County reports a higher prevalence at 9.1%. Despite high ART coverage, gaps persist due to stigma, poor adherence, late ANC initiation, and health system weaknesses. This study aimed to identify barriers to elimination of MTCT in Machakos County to inform targeted interventions.

II. Materials And Methods

Cross-sectional study design was used in the research to gather data on the obstacles to PMTCT in Machakos County PMTCT facilities. In order to better address the research objectives, the study collected both qualitative and quantitative data and used both analytical and descriptive analysis

Study Design: Cross-sectional study design

Study Location: The study was done in Machakos County. Machakos County is one of the 47 counties of Kenya. Machakos County has 9 sub counties namely Machakos, Yatta, Masinga, Mwala, Kalama, Athi River (Mavoko), Kangundo, Kathiani and Matungulu with 70 facilities offering PMTCT services

Study Duration: June 2019 and June 2021

Sample Size: 286 mother and HEI pairs

Sample size calculation: Yaman's formula, $n=N/(1+N(e)^2)$. The study had the following assumption:

n- Desired Sample size

N=Targeted population for the study (1267)

e= the margin of error (0.05) Thus $n=1003/(1+1003(0.05)^2)$ n=286.5

Subjects and selection method:

A proportional allocation method was used to distribute the sample across 14 high- volume health facilities, selected based on their high PMTCT client load. Within facilities, mothers were randomly selected from PMTCT clinic registries, ensuring inclusion of both HEI-positive and HEI-negative cases to reflect the study's objectives. The samples were then distributed proportionally in the health facilities depending on the number of mothers enrolled in PMTCT clinic within the selected period who had EID sample and have at least two HEI Pos using the formula:

a=b/c*y Where

a=sample for the facility b=EID per facility

c=total PMCT mothers with EID done y=calculated sample size.

Inclusion criteria:

1. A HIV-positive mother and her child who were enrolled in PMTCT clinics between June 2019 and June 2021
2. A HEI who had a final HIV test result at the age of 24 months
3. Nurses working in MCH clinics who gave consent to participate were included in the study as key informants to provide information on health system factors.

Exclusion Criteria:

1. Mothers who were critically ill or their babies
2. Any mother who was no longer active in the clinic

Procedure methodology

The study used a structured questionnaire to gather information from the MCH registers, the mother's CCC records, HEI card, and HEI register about the mother's and the infant's clinical factors. A semi-structured questionnaire was used to gather information on socioeconomic and psychosocial aspects. Additionally, the Key Informant Interview guide (KII) was used to gather information on health system factors from the nurses in MCH clinics.

Quantitative data from the registers and patient files on maternal and infant clinical factors was collected using a structured questionnaire while a semi structured questionnaire was used to collect qualitative data on social economic and psychosocial factors from the mothers. Key Informant Interview guide (KII) was used to

data on collect health system factors from nurses in MCH. All the questionnaires were in the format of ODK/kobo collect tool.

Statistical analysis

Quantitative data from structured questionnaires was cleaned and coded in Microsoft Excel, and double-checked for accuracy. Data was then imported into SPSS version 27.0 for analysis. Descriptive statistics, including frequencies and percentages for categorical variables (e.g., sociodemographic factors, clinical characteristics) were calculated to summarize participant characteristics. Chi- square test was used to assess associations between independent variables (sociodemographic, clinical, and health system factors) and the outcome variable (child HIV test result). Variables with $p < 0.05$ in univariate analyses were included in a multivariable logistic regression model to identify predictors of MTCT. Collinearity was assessed using variance inflation factors (VIF < 5), and confounders (e.g., maternal age, education) were included based on literature and study objectives. Adjusted odds ratios (AORs) with 95% confidence intervals were reported.

Qualitative data from semi-structured interviews with 21 nurses was transcribed verbatim and analyzed using deductive thematic analysis in NVivo 12. Themes were triangulated with quantitative findings to provide a comprehensive understanding of MTCT barriers. Results were presented using tables, bar graphs, and narrative summaries.

III. Result

The study was guided by the study objectives: assessing the sociodemographic and psychosocial aspects of motherhood, the maternal-infant clinical characteristics, and health system factors influencing MTCT of HIV. Results are organized thematically, with basic frequencies presented first, followed by statistical analyses, and triangulation with qualitative findings.

Sociodemographic Characteristics of Mothers by Child HIV Status

This study included 286 mothers of which 47.9% who were aged 25 -34 years, 65.4% were married, and 55.2% had secondary education (Table no 1). Most of them, 48.6%, relied on business as their income source, with 45.1% earning less than Kshs 5,000 monthly.

Chi-square test was used to assess the association between sociodemographic factors and child HIV status (Table 4.1). Most variables; age category ($\chi^2 = 0.047$, $p = 0.977$), marital status ($\chi^2 = 6$, $p = 0.573$), education level ($\chi^2 = 7$, $p = 0.08$), religion ($\chi^2 = 0.569$, $p = 0.451$), income source ($\chi^2 = 1.229$, $p = 0.476$), and monthly income ($\chi^2 = 0.79$, $p = 0.674$) showed no significant association with MTCT ($p > 0.05$). This indicates that these factors may not directly drive MTCT but could affect access to care or adherence indirectly.

Partner HIV status and number of children (parity) were significantly associated with MTCT ($p<0.05$). Children of mothers with HIV-positive partners had a higher HIV- positive rate, 40% compared to those with HIV-negative partners, 15.57% or unknown partner status 20.18%. Mothers with three or more children had a higher proportion of HIV-positive children, 33.7% compared to those with one or two children 16.49% ($\chi^2 = 10.75$, $p = 0.001$).

Table no 1: Sociodemographic Characteristics of Mothers by Child's HIV Status

Variable	HIV Status of Child		Total	χ^2	P Value
	Negative (n=223, 78%)	Positive (n=63, 22%)	(N=286, 100%)		
Age category(years)					
19-24	12(80)	3(20)	15(5.2)	0.047	0.977
25-34	107(78.1)	30(21.9)	137(47.9)		
>35	104(77.6)	30(22.4)	134(46.9)		
Marital Status					
Single	51(82.3)	11(17.7)	62(21.7)	1.997	0.573
In a relationship	8(72.7)	3(27.3)	11(3.9)		
Married	146(78.1)	41(21.9)	187(65.4)		
Separated/widowed	18(69.2)	8(30.77)	26(9.1)		
Education Level					
Primary	44(77.2)	13(22.8)	57(19.9)	5.05	0.08
Secondary	117(74.1)	41(25.9)	158(55.2)		
Tertiary	62(87.3)	9(12.7)	71(24.8)		
Religion					
Muslim	2(100)	0	2(0.7)	0.569	0.451
Christian	221(77.8)	63(22.2)	284(99.3)		
Income Source					
None	33(82.5)	7(17.5)	40(14.0)	1.229	0.476
Employment	33(75)	11(25)	44(15.4)		

Business	110(79.1)	29(20.9)	139(48.6)		
Farming	47(74.6)	16(25.4)	63(22.0)		
Monthly Income					
0-5000	98(76.0)	31(24.0)	129(45.1)	0.79	0.674
5001-10000	68(78.2)	19(21.8)	87(30.5)		
>10000	57(81.4)	13(18.6)	70(24.5)		
HIV Status of Partner					
Positive	33(60)	22(40)	55(19.2)	13.517	0.001
Negative	103(84.4)	19(15.6)	122(42.7)		
Don't know	87(79.8)	22(20.2)	109(38.1)		
Number of children					
3-5	61(66.3)	31(33.7)	92(32.2)	10.75	0.001
1-2	162(83.5)	32(16.5)	194(67.8)		

Multivariate analysis confirmed the significance of partner HIV status and parity (Table no 2). Mothers with HIV-negative partners had 66% lower odds of MTCT compared to those with HIV-positive partners (AOR = 0.34, 95% CI: 0.16–0.73, p = 0.006). Mothers with 1–2 children had 53% lower odds compared to those with 3–5 children (AOR = 0.47, 95% CI: 0.26–0.87, p = 0.017).

Table no 2: Regression Analysis of Sociodemographic Factors Associated with MTCT of HIV

Variables	HIV Status of Child (n, %)		COR (95%CI)	P Value	AOR (95%CI)	P Value
	Negative	Positive				
HIV Status of Partner						
Positive	33(60)	22(40)	Ref		Ref	
Negative	103(84.4)	19(15.6)	0.27(0.13-0.57)	<0.001	0.34(0.16-0.73)	0.006
Don't know	87(79.8)	22(20.2)	0.37(0.18-0.77)	0.008	0.48(0.23-1.03)	0.061
Number of children						
3-5	61(66.3)	31(33.7)	Ref		Ref	
1-2	162(83.5)	32(16.5)	0.38(0.21-0.69)	<0.001	0.47(0.26-0.87)	0.017

Psychosocial Factors Associated with Mother to Child Transmission of HIV

Out of the 286 mothers, 37.4% reported partners attending clinic visits, 61.9% noted partner care, 4.9% experienced physical violence, and 2.4% faced partner threats. Self-stigma affected 15.7%, and 32.2% of mothers felt sad/unhappy as their child was tested HIV-positive.

Bivariate analysis showed some psychosocial factors associated with MTCT, though significance diminished in multivariate models (Table no 3). Partner clinic attendance was associated with lower MTCT (15.9% vs. 25.7%; COR = 0.54, 95% CI: 0.29–1.01, p= 0.055), but not significant after adjustment (AOR = 0.65, 95% CI: 0.32–1.30, p = 0.225). Caring partners showed a similar trend (18.6% vs. 27.5%; COR = 0.60, 95% CI:0.34–1.06, p = 0.08; AOR = 0.76, 95% CI: 0.40–1.44, p = 0.405). Physical violence significantly increased MTCT risk in bivariate analysis (50.0% vs. 20.6%; COR = 3.85, 95% CI: 1.29–11.45, p = 0.015), but not in multivariate analysis (AOR = 2.68, 95% CI: 0.57–12.49, p = 0.209). Partner threats followed a similar pattern (57.1% vs. 21.1%; COR= 4.97, 95% CI: 1.08–22.82, p = 0.039; AOR = 1.68, 95% CI: 0.19–14.24, p = 0.632). Sadness (32.2% MTCT rate) and stigma (12.7%) were not significant (p > 0.05).

Table no 3: Psychosocial Factors Associated with MTCT of HIV

Variables	HIV Status of Child (n, %)		COR (95% CI)	P Value	AOR (95% CI)	P Value
	Negative	Positive				
Partner attended any clinic with you						
No	133(74.3)	46(25.7)	Ref		Ref	
Yes	90(84.1)	17(15.9)	0.54(0.29-1.01)	0.055	0.65(0.32-1.30)	0.225
Partner cares for you and your baby						
No	75(72.5)	30(27.5)	Ref		Ref	
Yes	144(81.4)	33(18.6)	0.60(0.34-1.06)	0.08	0.76(0.40-1.44)	0.405
Partner ever kicked, slapped or otherwise physically hurt you						
No	216(79.4)	56(20.6)	Ref		Ref	
Yes	7(50)	7(50)	3.85(1.29-11.45)	**0.015**	2.68(0.57-12.49)	0.209
Partner ever threatened to hurt you						
No	220(78.9)	59(21.1)	Ref		Ref	
Yes	3(42.9)	4(57.1)	4.97(1.08-22.82)	**0.039**	1.68(0.19-14.24)	0.632
Partner ever forced you to do something sexually that made you feel uncomfortable						
No	221(78.1)	62(21.9)	Ref			

Yes	1(50)	1(50)	3.56(0.21-57.80)	0.371		
Feeling if someone knows my status						
Worried	13(86.7)	2(13.3)	Ref			
Sad/unhappy	59(67.8)	28(32.2)	3.08(0.65-14.60)	0.156		
Bad/stigmatized	103(87.3)	15(12.7)	0.94(0.19-4.61)	0.946		
Disappointed	11(91.7)	1(8.3)	0.59(0.04-7.42)	0.684		
Uncomfortable/ insecure	24(72.7)	9(27.3)	2.43(0.45-13.0)	0.297		
Nothing/ok with my status	13(61.9)	8(12.7)	4(0.70-22.55)	0.116		

Perceptions and Knowledge on HIV among HIV Positive Mothers

Knowledge gaps were significant (Table no 4). Only 1.4% had adequate information on disclosure, transmission modes, safe delivery, and ART adherence, while 98.6% lacked such knowledge. Self-stigma affected 15.7%, and 13.6% reported differential treatment due to HIV status.

Table no 4: Perceptions and Knowledge on HIV among HIV Positive Mothers (n=286)

Factor	Yes	No	Not sure
People treat me differently because I am HIV positive	13.6 %	75.1%	11.2%
Feel bad/hate myself because I am HIV positive	15.7 %	81.8%	2.4%
Lost friends/isolated by my family when they knew my HIV status	3.5%	96.5%	-
Adequate information on importance of disclosure and partner testing	1.4%	98.6%	-
Adequate information on modes of transmission of HIV from mother to child	1.4%	98.6%	-
Adequate information on safe delivery options	1.4%	98.6%	-
Adequate information on recommended feeding options	1%	98.9%	-
Adequate information on ART and prophylaxis adherence	1.4%	98.6%	-

Maternal and Infant Clinical Factors Associated with MTCT of HIV Bivariate analysis identified several maternal and child characteristics significantly associated with MTCT as shown below:

Uptake of ANC Services

Antenatal clinic attendance was protective (COR = 0.20, 95% CI: 0.04-0.92, p = 0.039), with non-attendees having a 57.14% MTCT rate versus 21.15% for attendees. Attendance of 5–6 ANC visits reduced risk (COR = 0.34, 95% CI: 0.12-0.97, p = 0.044). High maternal viral load (more than 1000 copies/mL) at first ANC strongly predicted MTCT (COR = 7.32, 95% CI: 1.66-32.18, p = 0.008).

Mothers Gestation at entry into PMTCT Care

Late PMTCT entry during labor and delivery (COR = 17.5, 95% CI: 1.88-162.36, p = 0.012) or postnatally (COR = 5.83, 95% CI: 1.23-27.47, p = 0.026) increased risk.

ART uptake and adherence to treatment

Loss-to-follow-up (COR = 9.01, 95% CI: 2.77-29.27, p < 0.0001), and defaulting (COR = 8.32, 95% CI: 1.61-42.94, p = 0.011) was strongly associated with MTCT. Poor retention has a strong link to MTCT (LTFU: COR = 9.01, p < 0.0001)

Mode of Delivery

Vaginal delivery increased risk compared to cesarean (COR = 2.25, 95% CI: 1.0-5.01, p = 0.047). However, in multivariate analysis, these factors lost significance possibly due to confounding (Table 4.5).

Maternal Viral Load

There was a strong association of high viral load with MTCT (COR = 7.32, p = 0.008). Mothers with viral loads >1,000 copies/mL had a markedly higher proportion of HIV- positive children compared to those with viral loads ≤1,000 copies/ml. The association between maternal viral load and MTCT was statistically significant (p < 0.05). After adjusting for other variables in the model, high maternal viral load (>1,000 copies/ml) remained significantly associated with increased odds of MTCT.

Feeding options

In multivariate analysis, exclusive breastfeeding remained significantly protective against MTCT. Infants who were exclusively breastfed for the first six months had lower adjusted odds of HIV infection

compared to those who received mixed feeding.

Infant Prophylaxis

Multivariate analysis showed that timely infant prophylaxis was independently associated with reduced MTCT. Infants who received prophylaxis within the recommended time after birth had markedly lower adjusted odds of HIV infection than those who received it late or not at all.

Table no 5: Maternal and Infant Clinical Factors Associated with MTCT of HIV

Variables	HIV Status of Child (n, %)		Bivariate Analysis		Multivariate Analysis	
	Negative	Positive	COR (95%CI)	P Value	AOR (95%CI)	P Value
Year HIV diagnosed						
2018 and above	90(81.8)	20(18.2)	Ref			
2017 and below	133(75.6)	43(24.4)	1.45(0.80-2.63)	0.216		
Mother attended ANC clinic						
No	3(42.86)	4(57.14)	Ref			
Yes	220(78.85)	59(21.15)	0.20(0.04-0.92)	**0.039**		
Number of ANC visits						
1-2	17(68)	8(32)	Ref			
3-4	114(77)	34(23)	0.63(0.25-1.59)	0.333		
5-6	79(85.9)	13(14.1)	0.34(0.12-0.97)	**0.044**		
7+	10(71.4)	4(28.6)	0.85(0.20-3.55)	0.824		
Mother HIV status at entry into ANC						
Known Positive	141(80.57)	34(19.43)	Ref		**Ref**	
Newly diagnosed	80(76.19)	25(23.81)	1.29(0.72-2.32)	0.385	0.7(0.07-6.46)	0.753
Negative	2(33.33)	4(66.67)	8.29(1.45-47.16)	**0.017**		
Mothers Viral load at first ANC contact for Known Positives						
Below 1000	145(81.5)	33(18.5)	Ref			
Above 1000	3(37.5)	5(62.5)	7.32(1.66-32.18)	**0.008**		
Mothers Gestation at entry into PMTCT Care						
before 14 weeks	49(77.8)	14(22.2)	Ref		**Ref**	
14-28 weeks	143(82.7)	30(17.3)	0.73(0.36-1.49)	0.396	1.57(0.55-4.43)	0.395
29-36 weeks	22(84.6)	4(15.4)	0.63(0.18-2.15)	0.468	0.98(0.04-20.33)	0.992
Above 36 weeks	4(44.4)	5(55.6)	4.37(1.03-18.51)	**0.045**	0.35(0.0-18.39)	0.607
Labor and delivery	1(16.7)	5(83.3)	17.5(1.88-162.36)	**0.012**	1(empty)	
Postnatal	3(37.5)	5(62.5)	5.83(1.23-27.47)	**0.026**	1(empty)	
Time Mother was initiated on ART						
Before ANC	92(76.7)	28(23.3)	Ref		**Ref**	
Before 14 weeks	15(68.2)	7(31.8)	1.53(0.56-4.13)	0.398	3.80(0.37-38.99)	0.26
14-28 weeks	95(84.8)	17(15.2)	0.58(0.30-1.14)	0.119	0.68(0.11-3.98)	0.671
29-36 weeks	14(77.8)	4(22.2)	0.93(0.28-3.08)	0.917	1(empty)	
Postnatal	4(66.7)	2(33.3)	1.64(0.28-9.44)	0.578	1(empty)	
Labor and delivery	1(20)	4(80)	13.14(1.41-122.44)	**0.024**		
Mother adherence Status after diagnosis						
Active	111(73.51)	40(26.49)	Ref		**Ref**	
LTFU	4(23.53)	13(76.47)	9.01(2.77_29.27)	**<0.0001**	3.03(0.5-18.14)	0.224
Defaulter	2(25)	6(75)	8.32(1.61-42.94)	**0.011**	3.76(0.3-46.39)	0.301
Place of delivery						
Home	7(77.78)	2(22.22)	Ref			
Hospital	216(77.98)	61(22.02)	0.98(0.20-4.88)	0.989		
Mode of delivery						
CS	55(87.30)	8(12.70)	Ref		**Ref**	
SVD	168(75.34)	55(24.66)	2.25(1.0-5.01)	**0.047**	0.22(0.01-2.70)	0.237
Age when Infant Prophylaxis was initiated						
At birth	215(80.83)	51(19.17)	Ref			
Below 8 weeks	6(75)	2(25)	1.40(0.27-7.16)	0.682		
8 weeks - 6 months	2(50)	2(50)	4.21(0.57-30.64)	0.155		
6 months-1 year	0	2(100)	1(empty)			
Above 18 months	0	1(100)	1(empty)			
Infant feeding below 6 months						
Exclusive breastfeeding	221(78.37)	61(21.63)	Ref			

Exclusive replacement feeding	1(50)	1(50)	3.62(0.22-58.76)	0.365		
Mixed Feeding	1(50)	1(50)	3.62(0.22-58.76)	0.365		

Health System Factors Associated with Mother to Child Transmission of HIV Health system factors were assessed through key informant interviews (KIIs) with 21 nurses from three healthcare facilities; Kangundo (8), Nguluni (7), and Mlolongo (6) using a questionnaire. They were asked their views on health system factors contributing to MTCT of HIV.

Table no 6: Healthcare Worker Characteristics and PMTCT-service Practices (n=21)

Variable	Category	Frequency (n)	Percentage (%)
Facility	Kangundo	8	38.1
	Nguluni	7	33.3
	Mlolongo	6	28.6
Year of Work Experience	>10 years	3	14.3
	<10 years	18	85.7
Duration in MCH Department	>10 years	3	14.3
	<10 years	18	85.7
Sensitized on Current PMTCT Guidelines	Yes	16	76.2
	No	5	23.8
Mode of Sensitization	Training	5	23.8
	Continuing Medical Education	5	23.8
	Both	6	28.6
Confidence in Offering PMTCT Services	Strongly Agree	11	52.4
	Agree	4	19
	Neutral	4	19
	Disagree	2	9.5
Organization of Health Education Talks	Always	17	81
	Often	1	4.8
	Sometimes	2	9.5
	Rarely	1	4.8

Staffing and Training gaps

Table no 6 presents the demographic characteristics and PMTCT-related practices of healthcare workers across three facilities. Most respondents had less than 10 years of work and MCH experience, with 76.2% having received sensitization on current PMTCT guidelines through training, CME, or both. Over half (52.4%) strongly agreed they were confident in providing PMTCT services, and the majority (81%) reported always organizing health education talks.

Stock-Outs and Resource Constraints

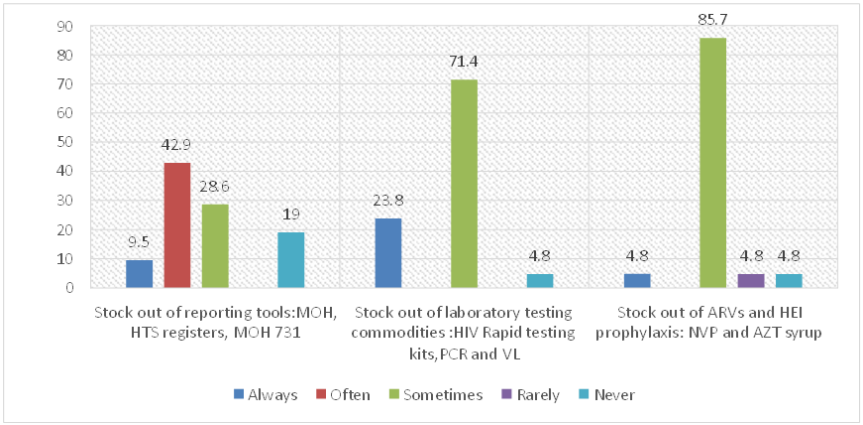

Figure no 1: Stock out of PMTCT tools and commodities in the past 3 months

In the past three months, 85.7% of providers reported ARV and HEI prophylaxis stock outs, 71.4% noted frequent shortages of HIV test commodities, and 42.9% reported missing reporting tools such as MOH registers and HTS forms (Figure no 1).

Infrastructure and other Resources

Most providers reported having adequate infrastructure to support PMTCT service delivery. Adequate space was the most frequently cited (71.4%), followed by sufficient staffing (66.7%) and 61.9% had availability of materials on HIV/AIDS and PMTCT (Figure no 2).

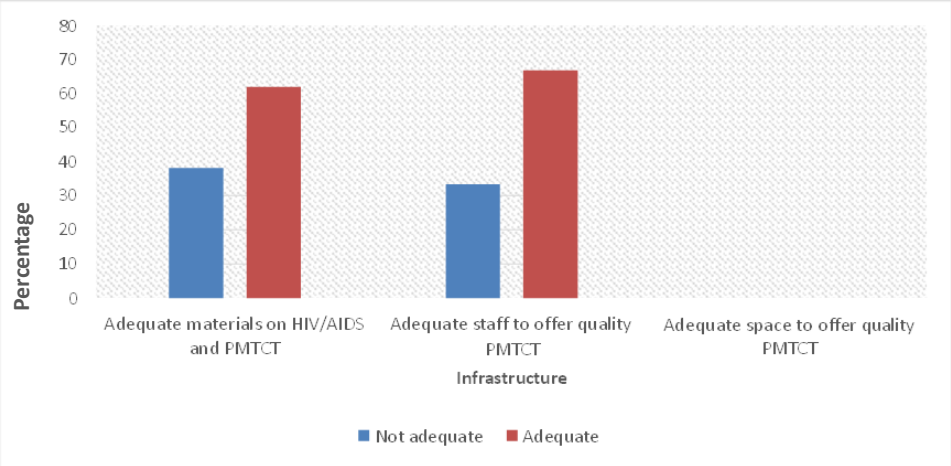

Figure no 2: Infrastructure and other resources

Health Provider Perspective on Drug Adherence and Clinic Appointment Follow-Up

Only 19% of mothers always honored their clinic appointments. Drug adherence was also suboptimal, only 14.3% of mothers consistently adhered to ART (Figure no 3).

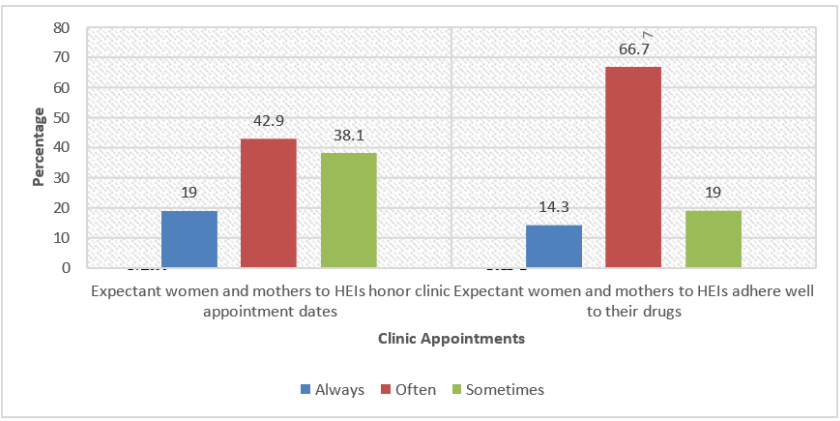

Figure no 3: Adherence to Clinic Appointments and drugs by HIV Infected mothers Maternal Reported Health service delivery challenges

The HIV positive mothers also noted challenges during hospital visits. These included long waiting hours (58.7%), frequent clinic appointments (48.3%), distance to health facility (37.1%), negative staff attitude (17.4%), confidentiality breech (2.8%) and the least reported (1%) being poor quality services (Figure no 4).

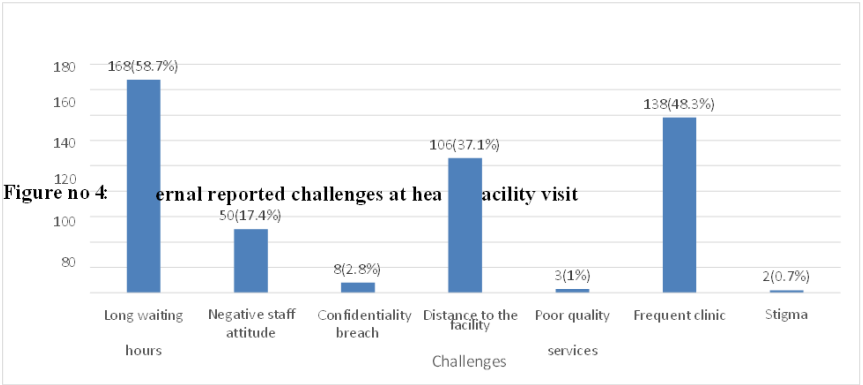

Figure no 4: ernal reported challenges at hea acility visit

IV. Discussion

The study suggest a predominantly young, married, moderately educated, and low- income population. The elevated MTCT rates observed among mothers in sero- concordant relationships align with Kenyan and regional evidence. Non-disclosure of maternal HIV status to partners has been associated with nearly a tenfold increase in infant infection risk (aOR = 9.8). Studies also indicate that high parity is linked to incomplete PMTCT engagement and higher transmission rates (Nyandat & van Rensburg, 2017; van Lettow et al., 2018).

Higher parity may reflect cumulative challenges affecting PMTCT engagement. Although direct empirical evidence is limited, studies have identified structural and psychosocial barriers such as increasing childcare demands, economic constraints, and healthcare fatigue that disproportionately affect multiparous women (Gourlay et al., 2015; Ngarina et al., 2014; Nyondo-Mipando et al., 2018).

The non-significant associations of age, marital status, education, and income with MTCT align with Onono et al. (2015), who found that sociodemographic factors have limited predictive power when clinical and service delivery factors are controlled.

These variables may influence health behaviors indirectly, but their lack of direct impact suggests that structural and clinical determinants are more critical. The significant association of partner HIV status with MTCT (AOR = 0.34, p = 0.006) points towards the role of male partner influence. A study by Aluisio et al. (2011) noted that sero-concordant couples face stigma and lower ART adherence, increasing MTCT risk. HIV-negative partners likely provide emotional and practical support, enhancing maternal adherence, as evidenced by the lower MTCT rate (15.6%). This finding supports the need for couple-based interventions, such as joint counseling and partner testing, to improve PMTCT outcomes.

Higher parity's association with MTCT (AOR = 0.47, p = 0.017) is consistent with Kim et al. (2015), who reported that multiparous women face caregiver fatigue, financial strain, and reduced vigilance in care-seeking. The qualitative insight about missed appointments due to family responsibilities further explains this link, suggesting that multiparous mothers require targeted support like peer counseling or home-based care. These findings align with the study objective of identifying sociodemographic barriers, highlighting the need for interventions tailored to sero- concordant couples and multiparous mothers to reduce MTCT in Machakos County.

The bivariate associations of intimate partner violence (IPV) and partner threats with MTCT suggest that IPV may disrupt ART adherence and clinic attendance. This finding is consistent with Hatcher et al. (2014), who demonstrated that IPV reduces PMTCT engagement by increasing emotional distress and fear of disclosure. In this study, however, the lack of significance in multivariate analysis indicates that these effects may be mediated through clinical or structural factors. The observed trend of lower MTCT rates among mothers with supportive partners supports Ngarina et al.

(2014), who emphasized the role of male involvement in improving PMTCT outcomes. The findings demonstrate that stigma reduction campaigns, IPV counseling, and education on disclosure could enhance adherence and reduce MTCT.

The study found major knowledge gaps, with only 1.4% of mothers having adequate information on disclosure, transmission modes, safe delivery, and ART adherence.

Such limited awareness is a known barrier to PMTCT uptake and adherence (Sibanda et al., 2019). Self-stigma (15.7%) and reports of differential treatment (13.6%) further hinder service use, consistent with Abbamonte et al. (2020) and Turan et al. (2017). The qualitative account from a Kangundo nurse "lack of disclosure to spouses leads to poor adherence and defaulting" echoes findings by Onono et al. (2015), highlighting the importance of disclosure in improving adherence and partner support.

The findings of this study highlight key maternal and health system factors influencing the risk of mother-to-child transmission (MTCT) of HIV. The study shows that early and consistent maternal engagement in HIV care plays a key role in preventing mother-to-child transmission. Mothers who attended antenatal care (ANC), initiated ART early, and had suppressed viral loads were more likely to have HIV-negative children.

Antenatal care attendance was protective, a finding consistent with Ngarina et al. (2014), who emphasized ANC's role in early HIV testing and ART initiation. The high MTCT rate among non-attendees underscores the need for community outreach to encourage early engagement.

Delayed entry into PMTCT services, poor adherence, and high maternal viral load were associated with higher child infection rates. Late PMTCT entry is impactful and reflects missed opportunities for ART, consistent with Yotebieng et al. (2016).

Fear of stigma and potential rejection remained a barrier to adherence and retention in care. Many HIV-positive women hesitated to disclose their status, leading to poor adherence. A provider from Kangundo noted, *"Lack of disclosure to their spouses leads to poor adherence and defaulting."* This aligned with the report by (Nordberg et al., 2020), that showed that anxiety about HIV status disclosure to partners and relatives correlated with higher odds of disengagement from PMTCT care.

The strong association of high maternal viral load with MTCT mirrors UNAIDS (2022) evidence that

viral suppression is critical in prevention. Mothers with viral loads above 1,000 copies/mL were significantly more likely to transmit HIV to their infants, even after controlling for other clinical and demographic factors. This aligns with global evidence that maternal viraemia is the strongest biological predictor of vertical transmission (UNAIDS, 2022; World Health Organization [WHO], 2021).

High viral loads during pregnancy often reflect late ART initiation, poor adherence, or treatment failure (Gourlay et al., 2015). Without early suppression, the virus can cross the placenta during pregnancy, be transmitted during delivery, or through breastfeeding (Kim et al., 2012). These findings highlight the importance of early HIV diagnosis, prompt ART initiation, regular viral load monitoring, and adherence support throughout the PMTCT cascade.

Late PMTCT entry, particularly during labor or postnatally, reflects missed opportunities for ART initiation, consistent with Yotebieng et al. (2016). Qualitative insights reinforced these findings. A Mlolongo nurse stated, *"High viral load PMTCT clients risk transmission."*

Poor retention in care, including loss-to-follow-up and defaulting, was strongly linked to MTCT. This aligns with Kim et al. (2012), who noted that interruptions in ART lead to viral rebound and higher transmission risk. Qualitative findings from a nurse at who reported that, *"Late clinic attendance is a challenge."* showed that adherence was a significant gap.

Although vaginal delivery was associated with higher MTCT rates in bivariate analysis, this association disappeared in multivariate analysis, suggesting possible confounding. WHO (2021) recommends vaginal delivery for virally suppressed mothers, indicating that delivery mode alone may not be the determining factor when viral load is controlled.

Exclusive breastfeeding remained protective against MTCT, consistent with WHO (2021) guidance. Recent Kenyan data show women living with HIV, are 26% more likely to exclusively breastfeed for six months than HIV-negative mothers (International Breastfeeding Journal, 2024). With effective ART, the risk of transmission is minimal (PubMed, 2023).

Timely prophylaxis was independently protective, echoing 2024 findings from Uganda where most infants who missed Nevirapine were HIV positive (BMC Pediatrics, 2024a) and Ethiopian data linking absence of prophylaxis to higher MTCT (BMC Pediatrics, 2024b). Administering within 72 hours remains critical.

These results highlight the importance of early HIV diagnosis, prompt treatment, and continuous follow-up throughout pregnancy and postpartum.

While majority of providers (66.7%) reported adequate staffing for PMTCT services, high workloads (1 nurse: 40–50 clients) were noted on clinic days. A nurse from Mlolongo noted*, "There is too much workload versus one nurse for each MCH section."* This was Also, some respondents reported knowledge gaps due to lack of refresher training. A nurse from Mlolongo stated, *"I feel I have limited information on PMTCT because it's been long since I was updated on the current guidelines."*

Similar findings in Kenya show that targeted PMTCT training greatly improves adherence to guidelines (Ulalo, 2016), while structured health talks enhance retention in care (BMC Health Services Research, 2017). This suggests that continuous sensitization and regular community education are key to strengthening PMTCT service delivery.

Lack of essential IEC materials, including current HIV testing algorithm guidelines, flip charts, and posters was noted. A provider from Kangundo observed, *"There are no HIV testing algorithm on current guidelines, flip charts on current guidelines, or posters in MCH rooms."* This finding supports the study by Olaniran et al. (2022) which reported that only a small proportion of healthcare providers demonstrated adequate knowledge of the national guidelines on opt out testing suggesting limited internal dissemination and reinforcement of protocols, the posting of standard operating procedures (SOPs) and HIV testing algorithms.

In this study, 85.7% of providers reported ARV and HEI prophylaxis stock-outs, 71.4% cited HIV test kit shortages, and 42.9% lacked reporting tools. One provider from Nguluni stated, *"We sometimes have to turn mothers away due to drug shortages."* Such gaps reflect supply chain weaknesses that threaten PMTCT service continuity. UNAIDS (2025) notes that nearly half of countries face HIV commodity supply chain challenges, while a Ugandan study linked ARV shortages to poor forecasting and delayed orders (Lule, 2024). These disruptions risk treatment interruptions, delayed diagnosis, and compromised program monitoring.

Although 71.4% of respondents deemed space adequate for PMTCT services, qualitative reports suggested otherwise(Figure 4.2), noted congestion and a lack of privacy in PMTCT rooms. One provider from Nguluni noted, *"No space for ANC services at the PMTCT room... there is need for integration."* Similarly, a nurse Mlolongo emphasized, *"The PMTCT room is too squeezed with no privacy and the furniture is not enough."* This is because all mothers coming for antenatal services including those who are HIV positive are seen in one room, which is not partitioned and has only one table. The room has an uncomfortable bench where the mothers in line wait and can only accommodate 3 mothers at a go. This echoed the findings by Mburu et al. (2017), who noted similar constraints in Tanzanian PMTCT clinics.

Adherence to PMTCT care was inconsistent. Defaulting from care was frequently mentioned, with one

provider from Kangundo stating, *"Some women decline care, and poor adherence leads to high viral loads for those on treatment."* Another provider from Nguluni echoed this, saying, *"Defaulting of PMTCT clients is a major challenge."* Low appointment keeping and drug adherence compromise viral suppression and elevate MTCT risk. Similar trends have been observed in East Africa, where missed visits correlate with higher maternal viral loads and delayed infant diagnosis (Lule, 2024; UNAIDS, 2025)

Long waiting hours (58.7%), frequent clinic appointments (48.3%), and distance to the facility (37.1%) were the main barriers to PMTCT service use. Long waits and travel distance have been shown to reduce retention and adherence in HIV care (UNAIDS, 2025; Lule, 2024), while frequent visits can be addressed through differentiated service delivery models (WHO, 2023; Mburu et al., 2024). Less common but still relevant were negative staff attitude (17.4%), poor service quality (11%), and stigma (0.7%), which may undermine patient trust (International Breastfeeding Journal, 2024).

V. Conclusion

The study draws the following conclusions based on the analysis and objectives:

While socio-economic factors such as place of delivery or maternal education were not strongly predictive of MTCT, mothers with HIV-positive partners and those with higher parity showed increased risk. Psychological barriers, including stigma and lack of partner involvement, though not statistically significant, were frequently reported and may hinder timely PMTCT service uptake and adherence.

Maternal clinical factors played a more prominent role. High maternal viral load was a key predictor with 62.5% of mothers with >1000 copies/mL had HIV-positive infants, compared to 18.5% with <1000 (COR 7.32, 95% CI 1.66–32.18, p=0.008).

Late PMTCT initiation, particularly at labor or postpartum, further elevated risk. For instance, mothers initiated during labor had an 80% infant positivity rate (COR 13.14, p=0.024). Infant-related factors such as mixed feeding and delayed prophylaxis past 6 months were also linked to higher MTCT.

Significant health system weaknesses undermined PMTCT outcomes. Only 21.2% of mothers attended the recommended 5–6 ANC visits, yet this group had the lowest MTCT rate (14.1%). Loss to follow-up (LTFU) was highly correlated with infant infection, with 76.5% of HIV-positive infants born to mothers who had dropped out of care (COR 9.01, p<0.0001). Qualitative findings revealed recurring issues such as stock-outs of HIV commodities, inadequate staffing, outdated training, and breaches in confidentiality—factors that eroded patient trust and disrupted the PMTCT cascade.

In summary, reducing MTCT in Machakos County will require not only clinical interventions but also psychosocial support and urgent systemic health reforms.

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