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The progress of mother-to-child transmission of Human Immunodeficiency Virus (HIV) after Dolutegravir (DTG) optimization program: evidence from a multicenter cohort study in Ethiopia

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Abstract

Background Ethiopia aims to eliminate mother-to-child transmission (MTCT) of HIV by 2030. In 2020, Dolutegravir-based antiretroviral treatment (ART) regimen optimization was done for the Prevention of Mother-to-Child Transmission (PMTCT). However, data tracking progress, particularly post-rollout of the Dolutegravir (DTG)-based regimen, and the real-world effectiveness of the new regimen are unavailable.

Methods A multicenter retrospective cohort study was conducted among HIV-infected mothers and their HIV-exposed infants visiting the selected hospitals for routine care. Eligible participants were HIV-exposed infants enrolled in the PMTCT care from 2017 to 2022. However, only the 2021 and 2022 birth cohorts were considered post-DTG optimization considering 2020 a year of optimization. The cumulative incidence of perinatal MTCT tested at 6–8 weeks of infant age, and end of care MTCT tested at 18 months of age was assessed. The exposures of the study were the infant birth cohort years and the different ART regimens used for PMTCT of HIV.

Results Among a total of 2,643 routine care enrolled participants, 2521 (95.4%) HIV-exposed infants were included in the analysis. Of these, 210 were on follow-up and excluded from the breastfeeding MTCT analysis. A total of 30/2521(1.2%) [95% confidence interval (CI): 0.8-1.7%] were positive for HIV at 6–8 weeks. Additionally, 11 /2281 (0.50%) (95% CI: 0.3-0.9%) were positive during breastfeeding. At the end of the care, 41/2311 (1.8%) (95% CI: 1.3-2.4%) infants were HIV-positive. The highest end-of-care MTCT was reported in 2019 and 2022 birth cohorts while the lowest was in 2018 (P-value > 0.3). However, after adjusting for baseline characteristics, the trend showed a decrease in transmission rates following the rollout of DTG-based regimen, although statistical significance was not reached. The adjusted odds ratios (AORs) for perinatal, breastfeeding, and end-of-care transmission rates were 0.34 (95%CI: 0.08–1.39), 0.29(95%CI: 0.03–3.05), and 0.38(95%CI: 0.11–1.26) respectively. Compared with the Efavirenz (EFV)-based

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regimen, the DTG-based regimen was associated with a lower risk of MTCT in both the perinatal (AOR 0.23, 95% CI: 0.06–0.85) and at the end of care (AOR 0.27, 95% CI: 0.09–0.82). Pregnant women who started ART at late gestation had the highest transmission rate regardless of ART regimens (P-value < 0.001).

Conclusions In the studied cohort population, we observed less than 3% MTCT rate at the end of PMTCT care. The findings might suggest the achievement of MTCT elimination at the hospital level. Although the DTG-based regimen demonstrated a lower risk of transmission, other contributing factors, such as late ART initiation, should be urgently addressed. Future research should focus on prospective designs, interventions targeting late ART initiation, and understanding regional disparities to further advance efforts to eliminate MTCT by 2030.

Keywords PMTCT, Pregnancy, Dolutegravir, Ethiopia

Background

Human Immunodeficiency Virus (HIV) is transmitted from mother-to- child during pregnancy, delivery, and breastfeeding [1, 2]. Mother-to-child transmission (MTCT) is the primary route of HIV infection in people under fifteen years of age [3]. In the absence of intervention, the rate of transmission ranges from 15–45% [3]. However, the transmission rate can be less than 2% if a comprehensive prevention of mother–to–child transmission (PMTCT) program is implemented [4]. Globally, with the implementation of the PMTCT program, approximately 1.4 million HIV transmissions were prevented between 2010 and 2018 [5]. Nevertheless, approximately 130,000, in ranges (90,000-210,000) new HIV infections among children under five years of age occurred in 2022 [6]. Sub-Saharan Africa, including Ethiopia, accounts for nearly 90% of all these new infections worldwide [6].

Different PMTCT programs have been implemented in Ethiopia since 2001 [7–11]. The 4-pronged WHO PMTCT approach has long been adopted by the Ministry of Health (MOH) of Ethiopia [12]. The option B+treatment approach started in 2013 when ART started immediately after HIV diagnosis, irrespective of the CD4 count [13]. In 2016, lifelong triple ART was recommended for all HIV-positive pregnant and breastfeeding women [13]. These implemented programs have led to remarkable achievements in the last two decades. The proportion of pregnant women living with HIV receiving lifelong antiretroviral treatment (ART) increased from 24.3% in 2010 to 85.9% in 2022 [14]. According to model-based estimation, the rate of MTCT for HIV decreased by 63% from 2000 (43%) to 2019 (16%) [14]. The 2017 national guidelines were revised and implemented in 2021. Key updates included the optimization of a dolutegravir (DTG)-based ART regimen, enhanced postnatal prophylaxis (with zidovudine (AZT) twice daily plus nevirapine (NVP) once daily for the first six weeks, followed by NVP once daily for an additional six weeks for the newborn), and Multi-Month Dispensing (3MMD) of ART. The guidelines also incorporated Point-of-Care (POC) testing for infant diagnosis and maternal viral load testing. However, these latter measures were not fully realized during the study period [11].

Dolutegravir (DTG) has been found to have more rapid viral suppression, lower potential for drug-drug interactions, and a greater genetic barrier to developing drug resistance than the previously used efavirenz (EFV)-based regimen [15]. These advantages are considered for the optimization of the regimen for HIV treatment, including for pregnant and breastfeeding women [11, 16]. However, the real-world effectiveness of DTG-based ART regimen for PMTCT of HIV is limited. The majority of the available evidences are from clinical trials [17–20]. A large-scale study conducted in Botswana showed no difference in the overall MTCT risk between DTG and EFV-based ART [21]. However, the evidence from Botswana might not be applicable to Ethiopia, where new HIV infections and late ART initiation during pregnancy and in the postpartum period are relatively common [22].

Although the PMTCT ART regimen in Ethiopia has been optimized, recent evidence regarding the progress of PMTCT is lacking. The available pieces of evidence include the following: (1) the majority of studies were conducted before the DTG roll-out and did not evaluate its effectiveness [23]; (2) the perinatal, breastfeeding and end of care MTCT rate was not addressed separately [24]; and (3) the studies were conducted in a small-scale limited area with a small sample size [25]. To our knowledge, this is the first study in sub-Saharan Africa to investigate recent progress in MTCT of HIV following the optimization of a DTG-based ART regimen, as well as the real-world effectiveness of this new regimen.

Method

Study design, area and period

A multicenter retrospective cohort study using the routine PMTCT of HIV care registration log books and medical charts was conducted among HIV-exposed infants in Ethiopia. Ethiopia is located in the north-eastern part of Africa and has an estimated population of 110 million in 2020. According to reports from the 2023 Joint United Nations AIDS Program (UNAIDS), 84% of people living with HIV know their status, 83% receive ART, and 81%

experience viral load suppression. Moreover, antenatal care HIV testing coverage was more than 95%, and 14,200 (82%) HIV-infected pregnant women received lifelong ART in 2022 [26].

HIV-infected pregnant mothers or mother-infant pairs after delivery visiting the selected hospitals for routine PMTCT care from the 1st of July 2017 to 30 June 2022 were considered for the study. The study periods were selected based on the Ethiopia annual reporting fiscal calendar from July to June. Fourteen hospitals located in central and southern Ethiopia were selected from four administrative regions, namely, the Oromia, Addis Ababa, Southern Nation, Nationalities and People (SNNP), and Sidama. The study hospitals had 30-46.5 million estimated catchment population coverage (Fig. 1). The Northern Ethiopia hospitals were excluded from the study due to security concerns, making it impractical to collect data from those locations [27, 28]. The hospital selection criteria were primarily based on their ability to offer PMTCT services and their substantial number of eligible participants. The required variables from the routine paper-based registration logbooks and medical charts were transferred to a validated Excel checklist form over 2 month's period, from the 1st of January to the end of February 2023. Repeated data collection sessions were conducted from January 1st to January 30th, 2024. The purpose of these additional sessions was to assess the transmission of HIV through breastfeeding among those who were on follow-up during the first data collection period.

Study participants

The study population was HIV-infected pregnant mothers or mother-HIV-exposed infant pairs enrolled in the routine PMTCT of HIV care. However, the eligible participants were all HIV-exposed infants who were born alive and at risk of vertical HIV transmission during the study period. HIV-exposed live infants at birth were followed to assess perinatal MTCT outcomes at 6 to 8 weeks of age. Infants infected with HIV at 6–8 weeks of age were linked to a paediatric HIV care clinic for the initiation of ART and other HIV care. However, HIV-negative infants at 6–8 weeks of test were followed to determine the outcome of breastfeeding MTCT at the age of 18 months or after cessation of breastfeeding, whichever came first. Infants who were still on follow-up during the second data collection period were excluded from the breastfeeding and end-of-care MTCT outcome evaluation. For mothers with twin pregnancies, only the MTCT outcome of the first birth infant was included considering the greater likelihood of the first born being infected [29]. If a woman had more than one birth during

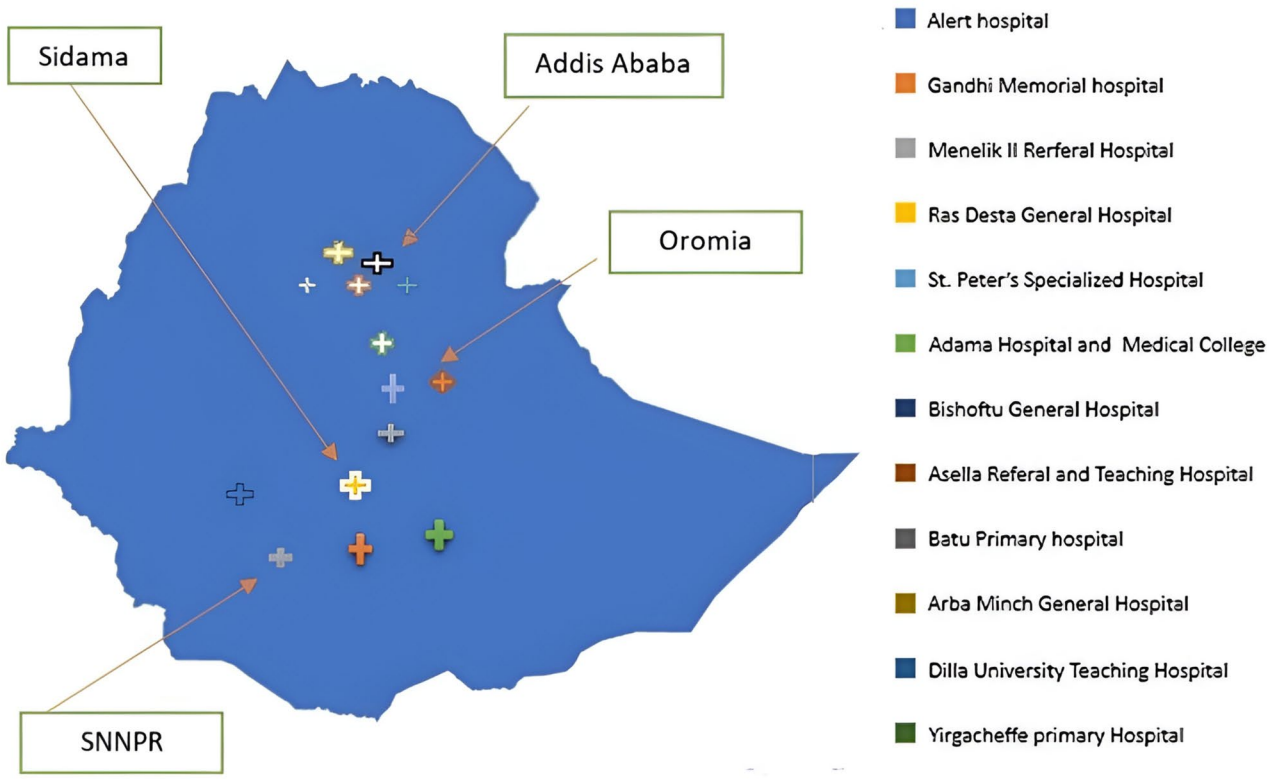

Fig. 1 Geographic locations of the study hospitals. Figure 1 shows the geographic locations of the study hospitals in central and southern Ethiopia, N [14]

the study period, each outcome was treated as a separate participant. However, we did not differentiate how many participants experienced sibling births during this period.

Outcomes/exposures of the study

The primary outcomes of the study were cumulative incidence of (1) perinatal MTCT of HIV determined at 6–8 weeks of infant age, (2) breastfeeding MTCT assessed at 18 months of age among HIV-negative infants during the 6–8 week test, and (3) end-of-care MTCT outcome evaluated at the end of PMTCT care among those eligible infants who completed the care. We measured the outcome at 6–8 weeks and 18 months since these were the documented HIV testing periods in the cohort population. The cumulative incidence of perinatal MTCT was defined as the proportion of HIV-positive infants at 6–8 weeks test among HIV-exposed infants at birth. Similarly, the breastfeeding MTCT incidence was the proportion of HIV-positive infants tested at the age of 18 months among HIV-negative infants at 6–8 weeks. The end-of-care MTCT rate was defined as the proportion of all HIV-positive infants among the eligible infants who completed the PMTCT. The secondary outcomes included the differences in MTCT outcomes among the various ART regimens and the trend differences before and after the optimization of the DTG-based ART regimen. Among the total birth cohorts, only the 2021 and 2022 cohorts were considered post-DTG optimization, taking into account the 2020 year for optimization. The exposures of the study were the infant birth cohort years and the different ART regimens used for PMTCT of HIV. To avoid the effects of multiple regimen use on MTCT outcomes, women who switched between ART regimens were excluded from the analysis.

Study variables/covariates

Before analysing the differences in the MTCT outcomes of the ART regimens, differences in the baseline characteristics of the participants during enrolment in PMTCT care, labor and delivery, and breastfeeding characteristics were assessed. The enrolment cohort years were derived from the pregnant mother or the mother–infant pairs' first PMTCT care registration date, while the birth cohort year was considered the year of infant birth. The study sites were the locations of the hospitals in terms of the administration region. The level of hospitals were categorized based on the Ethiopia health care level tire system. Primary hospitals with health centers and health posts have the lowest level of care. General and tertiary hospitals are the second and tertiary levels of care, respectively. We used the WHO clinical staging system to assess the status of the woman at enrolment. Partner HIV status was categorized as tested and positive, tested and negative, and unknown for those untested or whose status was not documented. The woman's mode of delivery was categorized into a vaginal, elective or emergency caesarean delivery, or instrumental vaginal delivery. The place of delivery was assessed based on whether the mother delivered at the same PMTCT care hospital, a different healthcare facility, or at home. The types of breastfeeding practices during the first six months of life were categorized into exclusive breastfeeding, exclusive formula feeding, and mixed feeding, which involved a combination of both.

The duration of ART use before birth and gestational age at PMTCT care enrolment were categorized depending on the trimester of pregnancy. Preconception refers to a woman who started ART before her current pregnancy. The first, second, and third trimesters included conception to 11 weeks and 6 days, 12 to 27 weeks and 6 days, and after 28 weeks and before the onset of labour respectively. The labour and delivery initiation period refers to one day before or after birth, while the initiation of postpartum ART refers to the initiation of ART at least two days after birth. The first-line ART regimen before the DTG rolled out was the EFV-based regimen. DTG-based ART regimens include a fixed-dose combination of tenofovir disoproxil fumarate (TDF)+lamivudine (3TC)+dolutegravir (DTG), while EFV-based regimens include a fixed-dose combination of TDF+3TC+efavirenz (EFV). 'Other ART "regimens were mainly older regimens even before EFV-based regimens and were used as second-line ART regimens due to adverse events or treatment failure. Gestational age at PMTCT enrolment or ART initiation was assessed based on the last normal menstrual period (LNMP), ultrasound results or clinical assessment, whichever was available.

Study procedures

Routine PMTCT care services before and after the rollout of the DTG-based ART regimen

HIV-infected pregnant mothers or mother-HIV-exposed infant pairs are regularly monitored during routine PMTCT care visits until the final documented mother-infant status visit. All study hospitals adhere to national guidelines for PMTCT care provision, which is offered at no cost to women attending antenatal, delivery, and postpartum services. Provider-initiated routine counselling and HIV testing, utilizing the opt-out approach, are conducted at each service delivery point [30]. Positive HIV tests prompted immediate initiation of the "Option B+" treatment approach, involving triple ART upon diagnosis confirmation. Negative test results during early pregnancy warranted retesting in late pregnancy, labor, and postpartum stages. Pregnant HIV-positive women already on ART continued with the same regimen as per national guidelines [10, 13, 30]. Following PMTCT ART optimization in April 2020, the initial regimen shifted to

a DTG-based one. Women previously on EFV-based or "Other" ART regimens were transitioned to DTG-based regimen at varying optimization rates across the study hospitals [11]. Women with relatively high viral loads (>1,000 copies/ml) were encouraged to undergo elective cesarean sections (CS) [10, 11]. However, we didn't differentiated how many of them were underwent CS for high viral load.

Infants born to HIV-positive women start daily nevirapine prophylaxis for six weeks, starting immediately at birth [10]. However, the 2021 revised guideline included enhanced postnatal prophylaxis using both NVP and AZT [11]. All HIV-exposed infants start Cotrimoxazole prophylaxis at 4–6 weeks of age and continue until HIV-negative status is confirmed [10]. HIV-exposed infants recommended to exclusively breastfed for 6 months according to the WHO recommendation [10]. During the study period, the national guidelines were changed only once—in 2021 [11]—from the previous 2017 guidelines [10]. The major changes were in the first-line treatment regimen, and high-risk infant prophylaxis was changed to dual prophylaxis using NVP and AZT [11]. There was no change in the healthcare providers' capacity.

HIV testing of infants born to HIV-positive mothers

All infants born to HIV-positive mothers recommended to undergo DNA PCR testing at the age of 6 weeks. However, the documented testing age in the cohort population ranges from 6 to 8 weeks. If the infant is diagnosed with HIV, ART treatment will be initiated and linked to the Paediatrics ART clinic. However, if the infant is negative at the 6–8 weeks test, HIV retesting will be performed with an HIV antibody test at the age of 18 months or at least 6 weeks after cessation of breastfeeding [10].

Data source and measurement

We extracted data from routine PMTCT registration logbooks and medical charts, which was paper-based during the data collection. The data collection phases were closely supervised by the principal investigator. The data registration logbooks and their contents were prepared at the national level and were similar to those of all the study hospitals. The extracted data included baseline demographic and reproductive characteristics during enrolment, infant characteristics (types of breastfeeding, infant HIV status at 6–8 weeks and 18 months of age). The maternal ART treatment characteristics (date and type of ART regimen initiated, any ART regimen change) were also extracted from the maternal medical records.

Statistical analysis

All collected variable data in Excel format were checked and imported to the Statistical Package for the Social Sciences (SPSS) version 26 for analysis. Descriptive summary statistics were used to present the participants' baseline characteristics categorized by birth cohort years or ART regimens. Chi-square or Fisher exact tests ($n<5$) when appropriate, were used to assess baseline difference. The cumulative incidence of MTCT outcomes was calculated based on the proportion of HIV-positive infants out of the total number of HIV-exposed infants at risk. The lost-to-follow-up participants were included in the denominator of at-risk participants considering the lost were only less than 5%. The perinatal MTCT at-risk population included HIV-exposed alive infants at birth. The breastfeeding MTCT at-risk population comprised HIV-exposed infants who tested negative at 6–8 weeks, excluding those already under follow-up. The final MTCT at-risk population included all HIV-exposed alive infants at birth, with the exception of those under follow-up.

The 95% confidence intervals for the incidence were calculated using the Clopper-Pearson (exact) test. The difference in MTCT outcome after DTG-optimization was assessed using logistic regression. To control the effects of differences in baseline characteristics among the regimens and birth cohort years, multivariate logistic regression was conducted, including variables with significant baseline differences at a p-value less than 0.05.

Ethical consideration

The study was reviewed and approved by the Institutional Review Board (IRB) of the College of Medicine and Health Sciences, Hawassa University, with reference number (IRB/076/2022, dated December 10/2022). The need to obtain informed consent from individual participants was waived due to the use of anonymized data from routine healthcare records.

Results

Study cohort population characteristics

A total of 2643 pregnant mothers or mother-infant pairs were enrolled in the PMTCT care. Among these, 2521 (95.4%) HIV-exposed infants were eligible for perinatal MTCT analysis. A total of 210 HIV-exposed infants were on PMTCT care and excluded from breastfeeding and end-of-care outcome analysis (Fig. 2).

Demographics, pregnancy history, and ART treatment characteristics of the study participants among the study birth cohort years

The mean and median ages of the mothers at enrolment were similar at 29 years. The baseline characteristics of the participants for age, study hospital location, levels of hospitals, PMTCT care initiation gestation, ART initiation period, partner HIV status, place and mode of delivery were statistically different among the cohort years at P-value<0.001 (Table 1).

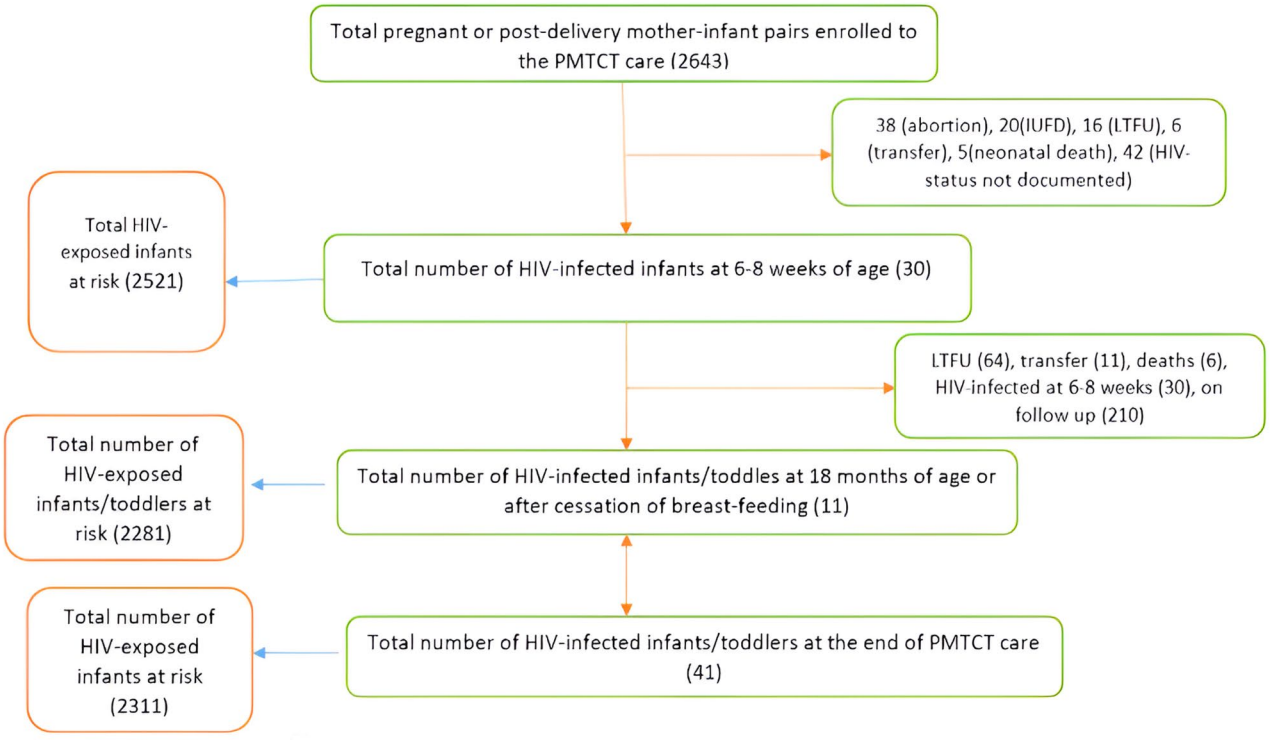

Fig. 2 Study participants flow diagram. Figure 2 shows the study participants flow diagram from enrolment to end of care. It shows the number of HIV-exposed infants at birth, 6–8 weeks of age and 18 months of infants age as well as the number of HIV-infected infants

Characteristics of the study hospitals and their MTCT outcomes

All the study hospitals included in the cohort achieved a cumulative MTCT rate of less than 3% at the end of care. However, the MTCT rates varied among the studied hospitals. Each hospital had a transmission rate of less than 10% at the end of care, as determined by the 95% confidence interval. However, only 6 out of 14 hospitals (42.9%), primarily located in Addis Ababa and Oromia, achieved MTCT rate of less than 5%, with 95% confidence in accordance with WHO recommendations (Table 2).

Participants from Addis Ababa had the lowest MTCT rate at the end of care, 0.4% (95% CI: 0.1-1.2%), followed by those from Oromia, 1.8% (95% CI: 1.0-3.0%), the SNNPR, 2.8% (95% CI: 1.6-4.3%), and Sidama, 3.6% (95% CI: 1.3-7.7%), $P=0.01$. However, we did not observe a difference in the MTCT rate based on hospital level ($P=0.566$): primary hospitals, 2.7% (95% CI: 0.9-6.2%); general hospitals, 1.4% (95% CI: 0.5-3.3%); and tertiary hospitals, 1.4% (95% CI: 1.2-2.5%).

Cumulative incidence of MTCT and trends among the 2017–2022 birth cohorts

The cumulative incidence of perinatal MTCT in infants aged 6–8 weeks was 30/2521 (1.2%), 95% CI (0.8-1.7%). An additional 11/2281 (0.5%), 95% CI (0.2-0.9%) infants were HIV-infected during breastfeeding. At the end of PMTCT care, 41/2311 (1.8%), 95% CI (1.3-2.4%) were HIV positive. The highest end-of-care MTCT rates were reported in 2019 and 2022, while the lowest rates occurred in 2018, with no statistically significant difference (P-value>0.3) (Fig. 3a-c). However, after adjusting for baseline characteristics, the trend indicates a potential decrease in transmission rates following the rollout of Dolutegravir (DTG) in the 2021 and 2022 birth cohorts compared to the pre-rollout cohorts from 2017 to 2020, although statistical significance was not achieved. The adjusted odds ratios (AORs) for perinatal, breastfeeding, and end-of-care transmission rates were 0.34 (95%CI: 0.08–1.39), 0.29(95%CI: 0.03–3.05), and 0.38(95%CI: 0.11–1.26) respectively.

Cumulative incidence of MTCT outcomes categorized by the duration of ART use before birth among the 2017–2022 birth cohorts

We found a statistically significant difference in the risks of perinatal and end-of-care MTCT based on the duration of ART used before birth, with a P-value<0.000. The perinatal MTCT rate was less than 1% (0.4%, 95% CI: 0.2-0.8%), while the end-of-care MTCT rate was less than 2% (0.8%, 95% CI: 0.5-1.4%) for mothers who started ART before conception. In contrast, mothers who initiated ART during labor and delivery exhibited the highest

Table 1 Demographic, pregnancy history and ART treatment characteristics of the study participants

Variables	Category	Birth cohort year							P-value
		2017	2018	2019	2020	2021	2022	Total	
Age (years) *N* = 1734	15–24	18(32.7)	68(18.2)	72(18)	58(19)	76(22.2)	46(18)	338(19.5)	**0.001**
	25–29	15(27.3)	154(41.2)	136(33.9)	96(31.4)	99(28.9)	83(32.4)	583(33.6)	
	30–34	14(25.5)	95(25.4)	133(33.2)	98(32)	93(27.2)	63(24.6)	496(28.6)	
	>=35	8(14.5)	57(15.2)	60(15)	54(17.6)	74(21.6)	64(25)	317(18.3)	
Study hospital location	Addis Ababa	41(47.1)	181(34.4)	193(32.5)	141(29.3)	147(31.2)	112(30.9)	815(32.3)	**0.000**
	Oromia	23(26.4)	192(36.5)	204(34.4)	162(33.6)	159(33.8)	108(29.8)	848(33.6)	
	SNNPR	20(23)	103(19.6)	145(24.5)	154(32)	136(28.9)	134(37)	692(27.4)	
	Sidama	3(3.4)	50(9.5)	51(8.6)	25(5.2)	29(6.2)	8(2.2)	166(6.6)	
levels of hospital care	Primary	0(0)	20(3.8)	58(9.8)	43(8.9)	32(6.8)	40(11)	193(7.7)	**0.000**
	General	11(12.6)	64(12.2)	69(11.6)	74(15.4)	92(19.5)	84(23.2)	394(15.6)	
	Tertiary	76(87.4)	442(84)	466(78.6)	365(75.7)	347(73.7)	238(65.7)	1934(76.7)	
Gravidity *N* = 1928	1	16(29.1)	66(17.4)	91(19.8)	71(18.5)	76(21.1)	62(21.3)	382(19.8)	0.691
	2–4	35(63.6)	277(72.9)	319(69.5)	279(72.8)	250(69.4)	198(68)	1358(70.4)	
	>=5	4(7.3)	37(9.7)	49(10.7)	33(8.6)	34(9.4)	31(10.7)	188(9.8)	
Parity *N* = 1928	0	19(34.5)	77(20.3)	98(21.4)	88(23)	85(23.6)	72(24.7)	439(22.8)	0.539
	1	18(32.7)	126(33.2)	154(33.6)	118(30.8)	127(35.3)	90(30.9)	633(32.8)	
	2–4	18(32.7)	170(44.7)	194(42.3)	171(44.6)	139(38.6)	124(42.6)	816(42.3)	
	>=5	0(0)	7(1.8)	13(2.8)	6(1.6)	9(2.5)	5(1.7)	40(2.1)	
PMTCT care enrolment gestation	1st trimester	10(11.5)	50(9.5)	67(11.3)	72(14.9)	47(10)	48(13.3)	294(11.7)	**0.000**
	2nd trimester	21(24.1)	305(58)	344(58)	277(57.5)	239(50.7)	199(55)	1385(54.9)	
	3rd trimester	22(25.3)	76(14.4)	94(15.9)	63(13.1)	97(20.6)	58(16.0)	410(16.3)	
	Term pregnancy	6(6.9)	21(4)	22(3.7)	19(3.9)	20(4.2)	11(3)	99(3.9)	
	Labor and delivery	15(17.2)	31(5.9)	28(4.7)	27(5.6)	32(6.8)	20(5.5)	153(6.1)	
	Postpartum	13(14.9)	43(8.2)	38(6.4)	24(5)	36(7.6)	26(7.2)	180(7.1)	
WHO stage during enrolment	1	84(96.6)	510(97)	575(97)	473(98.1)	449(95.3)	351(97)	2442(96.9)	0.053
	2	3(3.4)	10(1.9)	10(1.7)	4(0.8)	19(4)	10(2.8)	56(2.2)	
	3	0(0)	3(0.6)	7(1.2)	5(1)	3(0.6)	1(0.3)	19(0.8)	
	4	0(0)	3(0.6)	1(0.2)	0(0)	0(0)	0(0)	4(0.4)	
Partner HIV status	Positive	61(70.1)	398(75.7)	474(79.9)	386(80.1)	381(80.9)	275(76)	1975(78.3)	**0.002**
	Negative	7(8)	47(8.9)	57(9.6)	55(11.4)	44(9.3)	47(13.0)	257(10.2)	
	Unknown	19(21.8)	81(15.4)	62(10.5)	41(8.5)	46(9.8)	40(11)	289(11.5)	
ART regimens during the PMTCT care	TDF + 3TC + EFV only	63(72.4)	388(73.8)	484(81.6)	263(54.6)	22(4.7)	10(2.8)	1230(48.8)	
	TDF + 3TC + EFV Switched to DTG	0(0)	0(0)	0(0)	75(15.6)	37(7.9)	1(0.3)	113(4.5)	**0.000**
	TDF + 3TC + DTG only	0(0)	0(0)	0(0)	89(18.5)	392(83.2)	342(94.5)	823(32.6)	
	Other ART regimens switched to DTG	0(0)	0(0)	0(0)	8(1.7)	0(0)	0(0)	8(0.3)	
	Other ART regimens only	22(25.3)	135(25.7)	105(17.7)	45(9.3)	20(4.2)	9(2.5)	336(13.3)	
	Other ART regimens switched to EFV	2(2.3)	3(0.6)	4(0.7)	2(0.4)	0(0)	0(0)	11(0.4)	
ART initiation period	Pre-conception	60(69)	399(75.9)	472(79.6)	396(82.2)	376(79.8)	279(77.1)	1982(78.6)	**0.02**
	1st trimester	2(2.3)	29(5.5)	25(4.2)	15(3.1)	10(2.1)	18(5)	99(3.9)	
	2nd trimester	7(8)	49(9.3)	45(7.6)	36(7.5)	34(7.2)	33(9.1)	204(8.1)	
	3rd trimester	5(5.7)	16(3)	15(2.5)	12(2.5)	23(4.9)	12(3.3)	83(3.3)	
	Labor and delivery	12(13.8)	18(3.4)	22(3.7)	17(3.5)	17(3.6)	11(3)	97(3.8)	
	Postpartum	1(1.1)	15(2.9)	14(2.4)	6(1.2)	11(2.3)	9(2.5)	56(2.2)	
Mode of delivery	Vaginal delivery	74(85.1)	465(88.4)	505(85.2)	412(85.5)	398(84.5)	304(84)	2158(85.6)	**0.034**
	Emergency CS*	5(5.7)	51(9.7)	66(11.1)	55(11.4)	58(12.3)	40(11)	275(10.9)	
	Elective CS	8(9.2)	10(1.9)	22(3.7)	15(3.1)	14(3)	16(4.4)	85(3.4)	
	Instrumental	0(0)	0(0)	0(0)	0(0)	1(0.2)	2(0.6)	3(0.1)	
Place of delivery	Study site hospital	76(87.4)	466(88.6)	517(87.2)	428(88.8)	424(90)	328(90.6)	2239(88.8)	**0.009**
	Other healthcare facility	6(6.9)	51(9.7)	66(11.1)	52(10.8)	43(9.1)	32(8.8)	250(9.9)	
	Home delivery	5(5.7)	9(1.7)	10(1.7)	2(0.4)	4(0.8)	2(0.6)	32(1.3)	

Table 1 (continued)

Variables	Category	Birth cohort year							P-value
		2017	2018	2019	2020	2021	2022	Total	
Infant feeding types *N*=2516	Exclusive breastfeeding	85(98.8)	510(97.1)	569(96.1)	458(95.2)	448(95.1)	351(97.2)	2421(96.2)	0.628
	Exclusive formula feeding	1(1.2)	14(2.7)	20(3.4)	21(4.4)	22(4.7)	9(2.5)	87(3.5)	
	Mixed-feeding	0(0)	1(0.2)	3(0.5)	2(0.4)	1(0.2)	1(0.3)	8(0.3)	

Table 1 showed the demographic, pregnancy history and ART treatment characteristics of the study participants categorized by the birth cohort years in the selected hospitals in Ethiopia from 2017 to 2022, *N*=2521. Bold letters are significant value at P-value of less than 0.05. * CS means caesarean section.

Table 2 Study hospitals' locations, levels of hospital, catchment populations, and MTCT outcome rates, N [14]

Study hospitals	Administrative Region	Hospitals level	Catchment population (in million)	Total enrolled *N* (%)	Perinatal MTCT *N* (%)	Breastfeeding MTCT *N* (%)	End of care MTCT *N* (%), 95% CI
Alert hospital	Addis Ababa	Tertiary	3–5	382(15.2)	1(0.3)	2(0.6)	**3(0.9): 0.2–2.6**
Gandhi Memorial hospital	Addis Ababa	Tertiary	3–5	145(5.8)	0(0)	0(0)	**0(0): 0.0-2.8**
Menelik II Referral Hospital	Addis Ababa	Tertiary	3–5	86(3.4)	0(0)	0(0)	0(0): 0.0-5.7
Ras Desta General Hospital	Addis Ababa	General	1-1.5	59(2.3)	0(0)	0(0)	0(0): 0.0-7.3
St. Peter's Specialized Hospital	Addis Ababa	Tertiary	3–5	143(5.7)	0(0)	0(0)	**0(0): 0.0–3.0**
Adama Hospital and Medical College	Oromia	Tertiary	3–5	499(19.8)	8(1.6)	2(0.5)	**10(2.2): 1.1–4.1**
Bishoftu General Hospital	Oromia	General	1-1.5	166(6.6)	0(0)	1(0.6)	**1(0.6): 0.0-3.3**
Asella Referral and Teaching hospital	Oromia	Tertiary	3–5	138(5.5)	3(2.2)	0(0)	3(2.2): 0.5–6.2
Batu Primary hospital	Oromia	Primary	0.1-1	45(1.8)	0(0)	0(0)	0(0): 0.0-9.7
Arba Minch *General* Hospital	SNNP*	General	1-1.5	169(6.7)	3(1.8)	1(0.8)	4(3.1): 0.8–7.7
Dilla University *Teaching* Hospital	SNNP	Tertiary	3–5	230(9.1)	5(2.2)	3(1.3)	8(3.5):1.5–6.7
Yirgacheffe primary Hospital	SNNP	Primary	0.1-1	148(5.9)	4(2.7)	1(0.7)	5(3.4):1.1–7.7
Wolaita Sodo University Teaching Referral Hospital	SNNP	Tertiary	3–5	145(5.8)	1(0.7)	0(0)	**1(0.7): 0.0-3.8**
Hawassa University Comprehensive Specialized Hospital	Sidama	Tertiary	3–5	166(6.6)	5(3.0)	1(0.6)	6(3.6): 1.3–7.7
Total			30.2–46.5	2521(100)	30(1.2)	11(0.5)	**41(1.8): 1.3–2.4**

Table 2 shows list of Hospitals with location, level, catchment population, and MTCT outcome rate. Hospitals with an MTCT outcome rate below 5% are highlighted in bold. N represents the number, and % indicates the percentage. *SNNPR means Southern Nation and nationality and People.

risk of perinatal MTCT, at 8.2% (95% CI: 3.6-15.6%), and postpartum, at 12.5% (95% CI: 5.2-24.1%). Similarly, the highest risk of MTCT at the end of care was observed in mothers who began ART during labor and delivery, at 10.8% (95% CI: 5.3-18.9%), and postpartum, at 13% (95% CI: 5.4-24.9%) (Fig. 4a-c). However, we did not observe a statistically significant difference in the mode of delivery, with a P-value of 0.164 for perinatal MTCT and 0.345 for end-of-care MTCT.

Differences in the rates of MTCT outcomes between DTG and EFV-based ART regimens used for PMTCT care

Compared to those who used DTG-based ART regimens, mothers who used EFV-Based regimens were younger (P-value 0.000), from Addis Ababa (P-value 0.000) and tertiary hospitals (p-value 0.000), had advanced WHO staging during care enrolment (P-value 0.011), and were more likely to give birth in other facilities or at home (p-value 0.013) (Table 3).

Those women who used the DTG-based ART regimen had a lower risk of perinatal (P-value, 0.471), breastfeeding (P-value, 0.463) and end-of-care MTCT (P-value, 0.684) than did those who used the EFV-based regimens, although these differences did not reach statistical significance (Fig. 5a-c). These findings were consistent when the regimens used were categorized by the duration of ART use before birth (Supplementary Fig. 1a-c). However, after adjustment for differences in baseline characteristics, DTG-based ART regimens were associated with an approximately 77% lower risk of perinatal transmission, an adjusted odds ratio (AOR) of 0.23 (95% CI: 0.06–0.85) and an end-of-care transmission, with an AOR of 0.27 (95% CI: 0.09: 0.82). Nevertheless, we did not observe a significant difference in the incidence of breastfeeding transmission, with an AOR of 0.18 (95% CI: 0.02–1.95) **(**Table 4**).**

Discussion

The WHO considers the elimination of mother-to-child transmission of HIV to be successful when the population-level MTCT rate is less than 5% in a breastfeeding population such as Ethiopia. Although our study assessed facility-level MTCT, we found less than 3% transmission rate at the end of care. When compared to prior reports, our findings show remarkable improvement. A systematic review of more than 4000 HIV-exposed

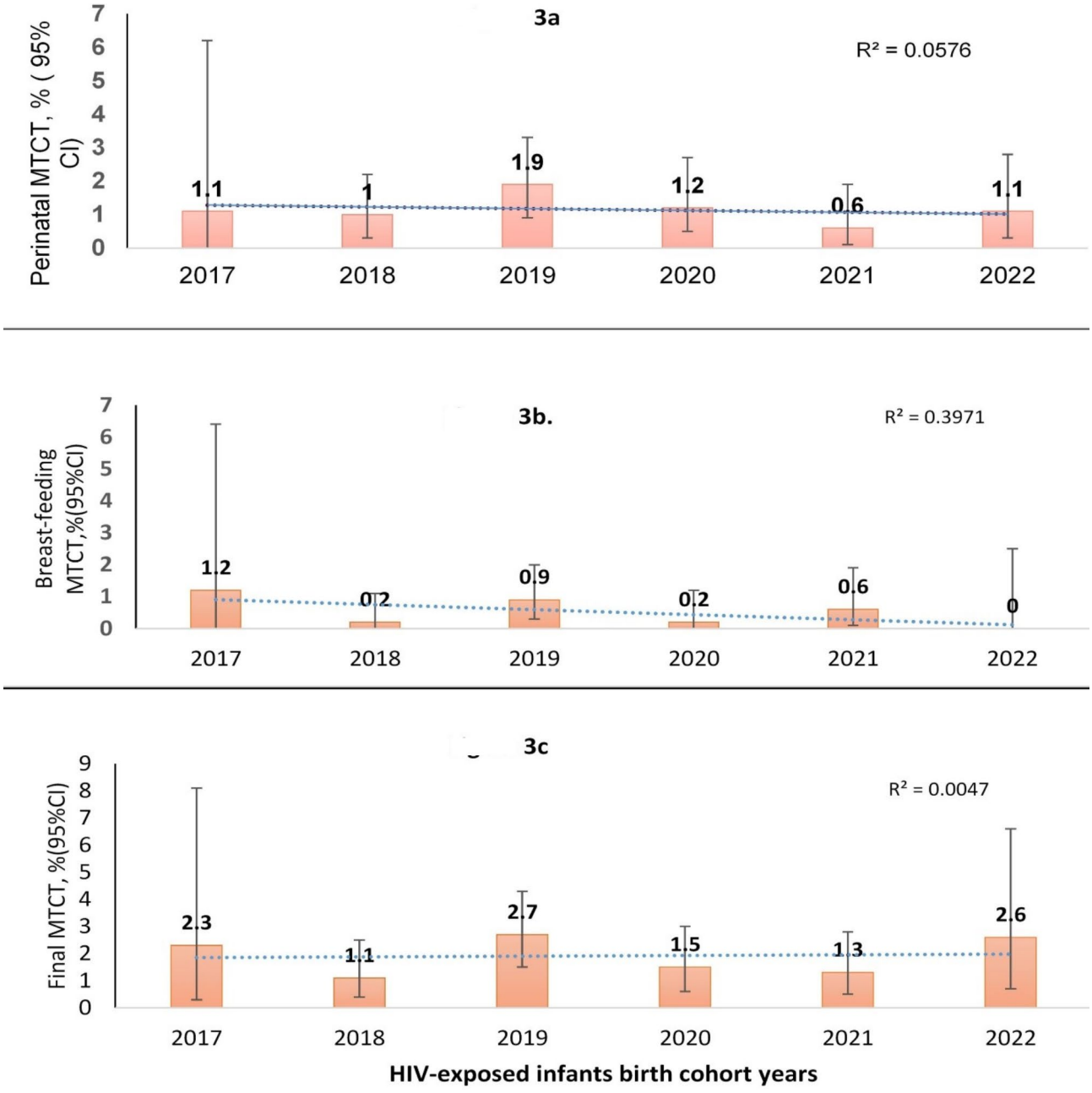

Fig. 3 Cumulative incidence and trends of MTCT with 95% CI among HIV-exposed birth cohorts from 2017–2022 in selected hospitals in Ethiopia. Figure 3a–c shows cumulative incidence and trends of MTCT with 95% Confidence Intervals among 2017–2022 birth cohorts in selected Hospitals in Ethiopia ; 3a) Perinatal MTCT (*N* = 2521), 3b) Breastfeeding MTCT (*N* = 2281), and 3c) end of care MTCT (*N* = 2311)

infants published in 2018 revealed an 11.4% prevalence of MTCT at the end of care [23]. Other relatively recent data involving 5,679 participants between 2016 and 2020 also showed a 2.6% perinatal MTCT rate, which is higher than that of our perinatal MTCT findings [24].

Achieving MTCT rates below 3% indicates that Ethiopian hospital level facilities are approaching the WHO's goal of eliminating mother-to-child transmission. This outcome underscores the effectiveness of recent efforts in optimizing PMTCT services, which could potentially lead to MTCT elimination at a population level if the hospital-level PMTCT services are expanded to lower healthcare facilities such as health centers. Our study's finding suggests that PMTCT interventions are being effectively implemented and that the elimination target is attainable at the hospital level. This trend also highlights the positive impact of recently implemented interventions, including the adoption of dolutegravir-based

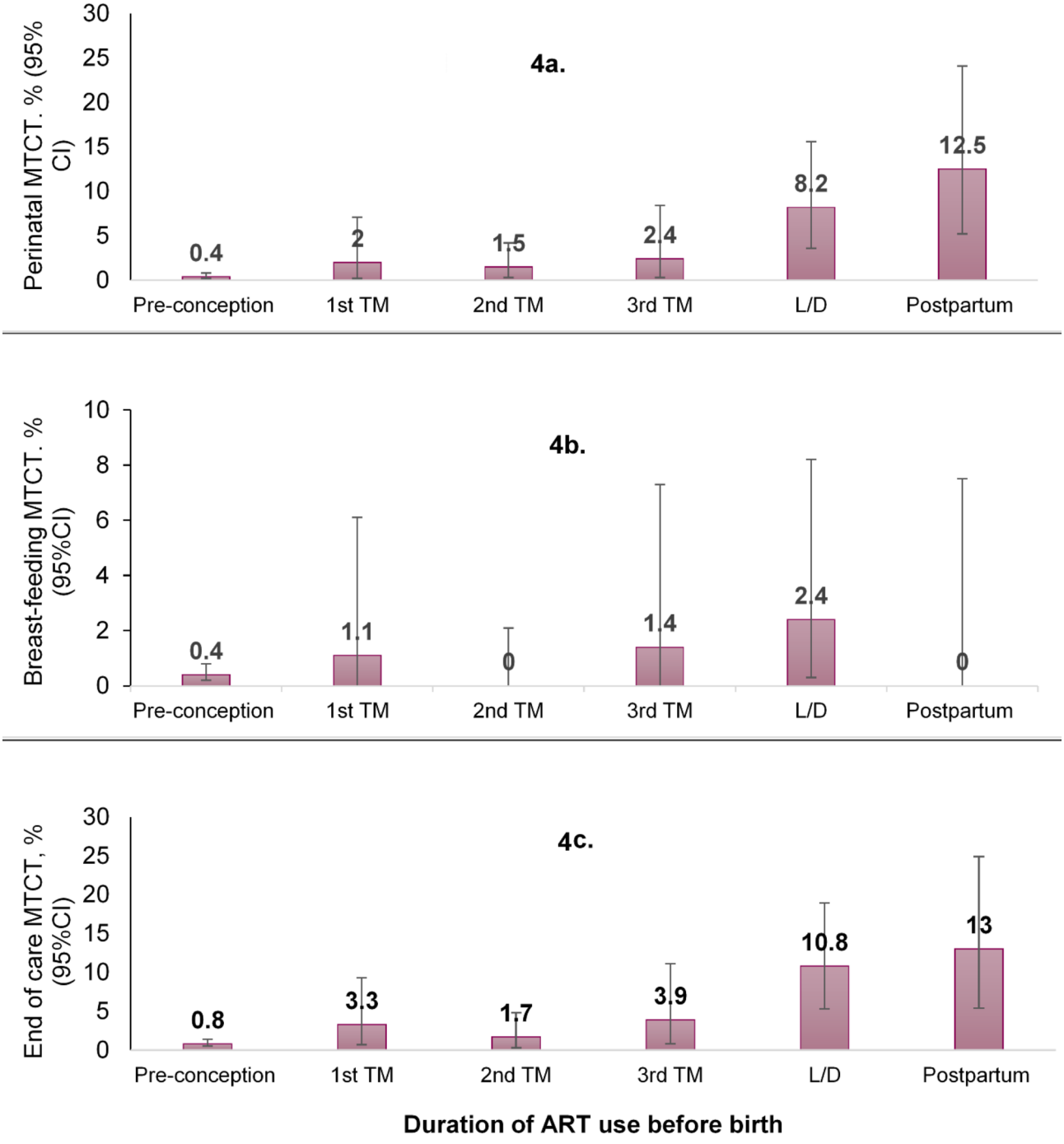

Fig. 4 Cumulative incidence of MTCT with 95% among HIV-exposed infants by maternal ART duration. Figure 4a–c shows the cumulative incidence of MTCT among HIV-exposed infants by maternal ART duration during PMTCT Care (2017–2022 Birth Cohorts) in selected hospitals in Ethiopia ; 4a) Perinatal MTCT (*N* = 2521), 4b) Breastfeeding MTCT (*N* = 2281), and 4c) end of care MTCT (2311)

regimens and enhanced postnatal prophylaxis, which are likely to contribute to improved outcomes and further reductions in MTCT rates.

Our findings are similar to those in a recent large cohort of Tanzania patients with a low risk of MTCT findings, which were 1.4% (1.2–1.6) [31] and 2.7% in Uganda [32]. However, these findings are lower than those from other African countries, such as Malawi (5·3%, 95% CI 4·7–5·9) [33] and Mozambique (4·1%, 3·1–5·1) [34]. The differences in MTCT rates among the aforementioned countries may be attributed to several factors, including variations in the prevalence of new HIV infections among pregnant and breastfeeding women, the timing of DTG-based ART regimen optimization, and differences in the

Table 3 Baseline demographics, pregnancy history, and HIV-Related characteristics of study participants using DTG- or EFV-only containing ART regimens for PMTCT Care (2017–2022) in selected hospitals in Ethiopia ($N = 2053$)

Baseline characteristics	Category	TDF + 3TC + EFV	TDF + 3TC + DTG	Total	*P*-value
Birth cohort year	2017	63(5.1)	0(0)	63(3.1)	**0.000**
	2018	388(31.5)	0(0)	388(18.9)	
	2019	484(39.3)	0(0)	484(23.6)	
	2020	263(21.4)	89(10.8)	352(17.1)	
	2021	22(1.8)	392(47.6)	414(20.2)	
	2022	10(0.8)	342(41.6))	352(17.1)	
Age	Median (IQR)	28(25,32)	29(25,34)	28(25,33)	**0.000**
Age in category	15–24	159(19.3)	127(21.9)	286(20.4)	
	25–29	304(36.8)	179(30.9)	483(34.4)	
	30–34	245(29.7)	140(24.2)	385(27.4)	
	>=35	117(14.2)	133(23.0)	250(17.8)	
Study hospital region	Addis Ababa	408(33.2)	227(27.6)	635(30.9)	**0.000**
	Oromia	401(32.6)	288(35.0)	689(33.6)	
	SNNPR	330(26.8)	273(33.2)	603(29.4)	
	Sidama	91(7.4)	35(4.3)	126(6.1)	
Hospital levels	Primary	92(7.5)	78(9.5)	170(8.3)	**0.000**
	General [1]	139(11.3)	194(23.6)	333(16.2)	
	Tertiary	999(81.2)	551(67.0)	1550(76.5)	
Partner HIV status	Positive	959(78.0)	649(78.9)	1606(78.3)	0.532
	Negative	119(9.7)	85(10.3)	204(9.9)	
	Unknown	152(12.4)	89(10.8)	241(11.7)	
WHO staging	1	1197(97.3)	791(96.1)	1988(96.8)	**0.011**
	2	19(1.5)	28(3.4)	47(2.3)	
	3	10(0.8)	4(0.5)	14(0.7)	
	4	4(0.3)	0(0)	4(0.2)	
Gravidity	1	200(21.4)	140(21.2)	340(21.3)	0.955
	2–4	655(70.0)	460(69.7)	1115(69.9)	
	>=5	81(8.7)	60(9.1)	141(8.8)	
Parity	0	229(24.5)	160(24.2)	389(24.4)	0.693
	1	297(31.7)	226(34.2)	523(32.8)	
	2–4	394(42.1)	261(39.5)	655(41.0)	
	>=5	16(1.7)	13(2.0)	29(1.8)	
Enrolment gestation	1st trimester	141(11.5)	87(10.6)	228(11.1)	0.439
	2nd trimester	682(55.4)	426(51.8)	1108(54.0)	
	3rd trimester	194(15.8)	146(17.7)	340(16.6)	
	Term pregnancy and before labor	40(3.3)	34(4.1)	74(3.6)	
	Labor and delivery	82(6.7)	61(7.4)	143(7.0)	
	Postpartum	91(7.4)	69(8.4)	160(7.8)	
Mode of delivery	Vaginal delivery	1062(86.3)	697(84.7)	1759(85.7)	0.470
	Emergency CS[2]	127(10.3)	99(12.0)	226(11)	
	Elective CS	40(3.2)	25(3.0)	65(3.1)	
	Instrumental	1(0.1)	2(0.2)	3(0.1)	
Delivery site	Study site hospital	1067(86.7)	746(90.6)	1813(88.3)	**0.013**
	Other healthcare facility	144(11.7)	72(8.7)	216(10.5)	
	Home delivery	19(1.5)	5(0.6)	24(1.2)	
Type of breastfeeding	Exclusive breastfeeding	1180(96.1)	791(96.5)	1971(96.2)	0.679
	Exclusive formula-feeding	42(3.4)	27(3.3)	69(3.4)	
	Mixed-feeding	6(0.5)	2(0.2)	8(0.4)	

Table 3 (continued)

Baseline characteristics	Category	TDF + 3TC + EFV	TDF + 3TC + DTG	Total	*P*-value
ART initiation	Pre-conception	930(75.6)	617(75.0)	1547(75.4)	0.298
	1st trimester	62(5.0)	29(3.5)	91(4.4)	
	2nd trimester	112(9.1)	72(8.7)	184(9.0)	
	3rd trimester and before labor	41(3.3)	39(4.7)	80(3.9)	
	Labor and delivery	55(4.5)	41(5.0)	96(4.7)	
	Postpartum	30(2.4)	25(3.0)	55(2.7)	

Foot note: "1" general hospital in Ethiopia setting is equivalent to secondary hospital. "2" means caesarean section

Table 3 summarizes the baseline demographics, pregnancy history, and HIV-related characteristics of study participants who used either DTG- or EFV-containing ART regimens for routine PMTCT care from 2017 to 2022 in selected hospitals in Ethiopia ($N=2053$). Significant differences, highlighted in bold, correspond to a P-value of less than 0.05.

initiation of ART during pregnancy. Additionally, disparities in the accessibility of antenatal and postnatal care, as well as the effectiveness of the implemented PMTCT programs, can significantly impact transmission rates. To reach a definitive explanation, a systematic investigation into the causes of these differences is necessary, considering these potential factors.

In this study, consistent with previous reports [35, 36], we found a high risk of HIV transmission among women who initiated ART after the second trimester of pregnancy, underscoring the critical importance of achieving viral load suppression to reduce vertical transmission. Notably, women who began ART during labor and delivery or postpartum had more than six times the risk of transmission compared to those who were enrolled before the third trimester. The delayed initiation of ART increased the risk of vertical transmission due to elevated maternal viral loads during pregnancy, labor, and breastfeeding.

The late initiation of ART during pregnancy might be related to the late antenatal care enrolment practice in Ethiopia [37]. It could also be related to missed opportunities of HIV screening despite the women attending antenatal care [37]. However, our study found that one-third (33.4%) of women enrolled in PMTCT care after 28 weeks of gestation or postpartum, highlighting a common challenge of delayed antenatal care (ANC) enrolment practice. Interventions aimed at encouraging earlier ANC visits could be crucial in facilitating timely ART initiation, potentially leading to further reductions in MTCT rates.

The substantial transmission risk observed for women initiating ART late, during labor or postpartum, underscores the need for enhanced PMTCT interventions targeting these high-risk groups. The PMTCT program should prioritize this population for antenatal care, labor and delivery, and breastfeeding support. Our findings indicated that three-fourths of infections occurred before 6–8 weeks of age, emphasizing the importance of prevention during pregnancy, labor, and the immediate postpartum period. Interventions may include considering universal elective cesarean section delivery for all pregnant women regardless of viral load status, and initiating presumptive triple HIV therapy rather than dual prophylaxis until the infant's HIV status can be determined [38].

We found significantly lower risks of perinatal and end-of-care MTCT with the DTG-based regimen compared to the EFV-based regimen. This real-world effectiveness findings confirmed the rapid virological suppression achieved with DTG, as documented in previous clinical trials [18, 19]. This regimen is especially helpful in decreasing MTCT for women enrolled in late pregnancy care, such as in Ethiopian settings. Our findings of no difference in the breastfeeding MTCT rate between the two regimens should be interpreted cautiously. First, very few infants are infected during breastfeeding transmission, and it is difficult to reach a conclusion. It might be also be related to the diagnosis of HIV-infection. We couldn't detect time to HIV-infection difference due to the end of care test program. However, these findings might also suggest the long-term negligible impact of DTG-based regimen on the MTCT rate. This is likely due to the long-term similar virological suppression efficacy of both regimens, as evidenced by clinical trials [20, 39]. This was also observed in the Botswana population, almost all of whom were on ART before conception. There was no difference in the MTCT rate between the two regimens in a large cohort study [21].

Despite the low risk of MTCT after DTG optimization, the nonsignificant trend change should be interpreted cautiously. Although the DTG-based regimen decreased the transmission risk by three-fourths, other contributing factors to vertical transmission should be addressed, such as late ART initiation. It is important to note that the DTG optimization program can be considered the critical step towards the global elimination target. However, it also signals the importance of addressing other MTCT contributing factors. Unexpectedly, the 2022 birth cohort MTCT rate was higher than that in 2021 and 2021. A similar finding was also reported in the UNAIDS estimate [6]. This could be the effect of the COVID-19 pandemic on pregnant women's access to HIV testing and

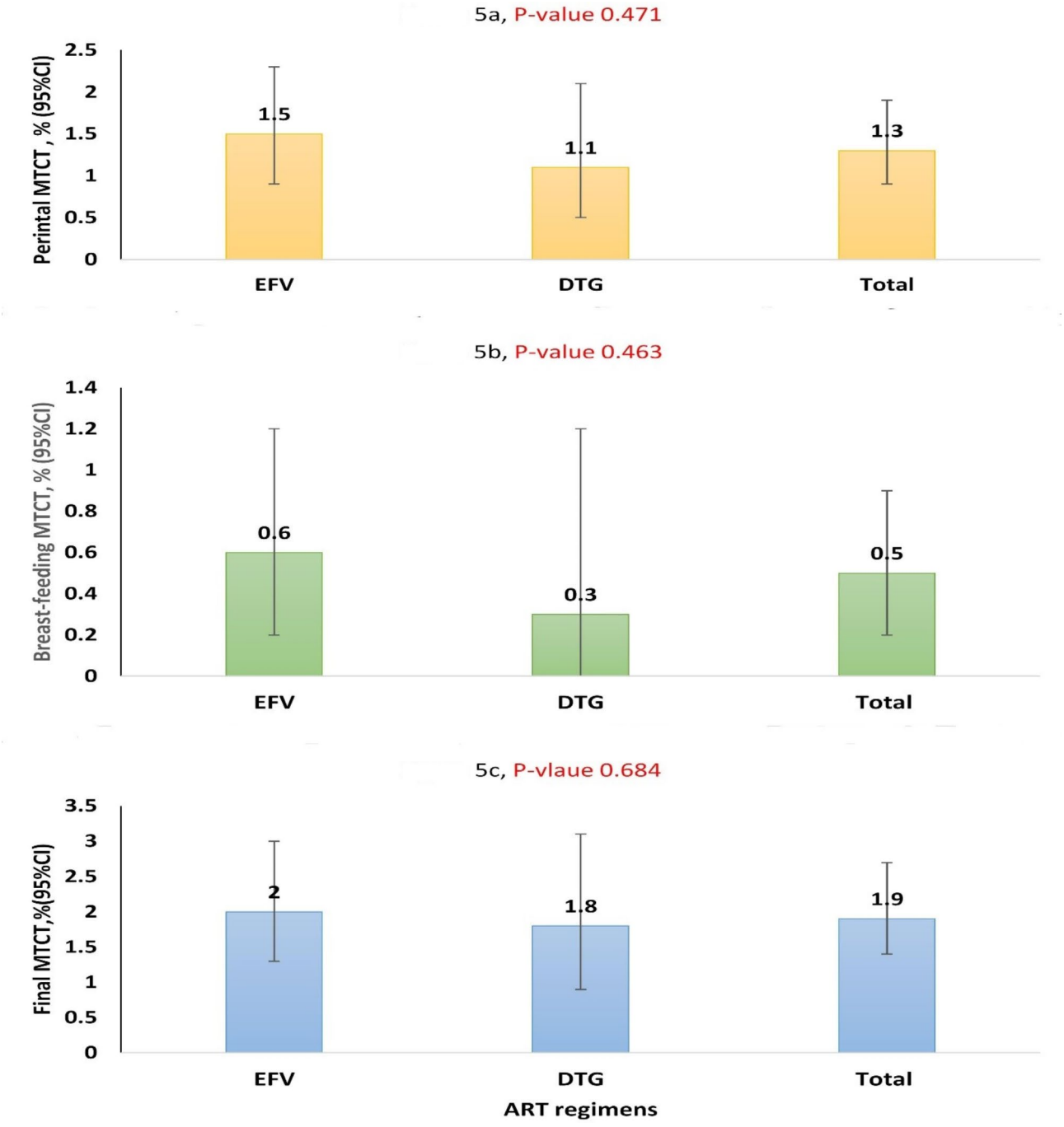

Fig. 5 The risks of MTCT of HIV with 95% Confidence Intervals among ART regimens. Figure 5a–c shows the risks of MTCT of HIV among HIV-Infected pregnant or breastfeeding mothers using Dolutegravir (DTG) or Efavirenz (EFV) based ART regimens during routine PMTCT care (2017–2022) in selected hospitals in Ethiopia; 5a) Perinatal MTCT(*N* = 2053), 5b) Breastfeeding MTCT (*N* = 1822) and 5c) end of care MTCT (*N* = 1853)

treatment, as evidenced in other studies [40]. However, a detailed analysis is required to conclude.

The government also needs to address regional performance variations. Only one-third of the hospitals, mainly in Addis Ababa, had less than 5% of the WHO-recommended MTCT rate at the end of care. This might be attributed to the difference in the health-seeking behaviour of the population in Addis, where early initiation of antenatal and ART treatment is likely. This could also be a limiting factor for future country-level elimination validation, as the WHO recommends achieving this goal in the entire population.

The strengths of this study include the following: (1) the relatively large population of HIV-exposed infants

Table 4 Multivariate logistic regression analysis of MTCT outcomes by ART regimen, adjusted for age, study site, hospital level, place of delivery, and WHO staging

Baseline difference Variables	Category	Perinatal MTCT			Final MTCT			Breastfeeding MTCT		
		AOR	95% CI for AOR		AOR	95%CI for AOR		AOR	95% CI for AOR	
ART regimen	TDF + 3TC + EFV	Ref(1)			Ref(1)			Ref(1)		
	TDF + 3TC + DTG	**0.23**	**0.09**	**0.82**	**0.23**	**0.06**	**0.85**	0.18	0.02	1.96
Age	15–24	Ref (1)			Ref(1)			Ref(1)		
	25–29	0.83	0.28	2.41	0.88	0.24	3.26	0.79	0.13	4.86
	30–34	0.87	0.26	2.85	1.16	0.29	4.66	0.36	0.03	4.33
	>=35	1.18	0.31	4.45	1.58	0.33	7.59	0.62	0.05	7.38
Study site	Addis Ababa	Ref(1)			Ref(1)			Ref(1)		
	Oromia	5.77	1.22	27.41		0.00	.	1.63	0.21	12.59
	SNNPR	6.38	0.99	41.23	0.00	0.00	.	0.59	0.03	10.73
	Sidama	11.94	2.23	63.90	0.00	0.00	.	2.69	0.20	37.03
Level of hospital	Primary	Ref(1)			Ref(1)			Ref(1)		
	General	0.71	0.19	2.70	0.67	0.13	3.41	1.19	0.11	13.33
	Tertiary	0.75	0.26	2.19	1.24	0.34	4.50	0.63	0.08	5.31
Place of delivery	Study site hospital	Ref(1)			Ref(1)			Ref(1)		
	Other healthcare facility	2.899	1.015	8.283	3.385	1.039	11.030	2.004	0.23	17.61
	Home delivery	6.83	0.75	2.28	10.02	0.99	101.78	0.00	0.00	.
WHO staging	1	Ref(1)			Ref(1)			Ref(1)		
	2	4.82	0.93	25.03	2.45	0.24	25.27	7.26	0.68	78.07
	3	0.00	0.00	.	0.00	0.00	.	0.00	0.00	.
	4	0.00	0.00	.	0.00	0.00	.	0.00	0.00	.

Table 4 presents the results of the multivariate logistic regression analysis for MTCT outcomes by ART regimen, adjusted for age, study site, hospital level, place of delivery, and WHO staging. COR represents the crude odds ratio, while AOR denotes the adjusted odds ratio. Significant values, indicated in bold, have a P-value of less than 0.05.

within a demographically heterogeneous, multicenter population in real routine PMTCT practice outside the clinical trials; (2) the limited selection bias of infants who participated in the study, as nearly all infants who met the inclusion criteria were included; (3) despite the expected nature of the retrospective cohort for missing data, we were able to analyse nearly 95% of the participants enrolled in PMTCT care.

Our study has several limitations. First, it was conducted exclusively in public hospitals, excluding patients from lower-level healthcare facilities such as health centers and private clinics. This exclusion may introduce variability, as patients in these settings could have different characteristics that affect outcomes. Consequently, the generalizability of our findings to all facility levels should be interpreted with caution. However, we did include primary hospitals that serve as referral sites for health centers, suggesting that patients from health centers may be similar to those from primary hospitals. Furthermore, we did not observe any differences in MTCT rates based on hospital level, which may indicate that our findings might also applicable to lower healthcare levels.

Another limitation is the lack of viral load data or CD4 count in our analysis, as the viral load analysis periods varied among study participants. Additionally, we did not assess the potential impact of single-dose NVP postnatal prophylaxis compared to the recent dual prophylaxis regimen involving NVP and AZT. Further studies are recommended to assess the real world impact of the dual prophylaxis.

Lastly, due to the observational nature of the study, establishing definitive causal associations is challenging. For instance, it is difficult to determine whether the recent low MTCT rates are solely attributable to the optimization of DTG-based regimens, as other service-related factors may also contribute to these positive outcomes.

Conclusion

In the studied cohort population, we observed less than 3% MTCT rate at the end of PMTCT care. The findings might suggest the achievement of MTCT elimination at the hospital level. Although the DTG-based regimen demonstrated a lower risk of transmission, other contributing factors, such as late ART initiation, should be urgently addressed. Future research should focus on prospective designs, interventions targeting late ART initiation, and understanding regional disparities to further advance efforts to eliminate MTCT by 2030.

Abbreviations

3TC Lamivudine
ART Antiretroviral treatment

AZT	Zidovudine
CD4	Cluster of differentiation 4
CI	Confidence Interval
DTG	Dolutegravir
EFV	Efavirenz
HIV	Human immuno deficiency virus
LNMP	Last Normal Menstrual Period
MOH	Ministry of Health
MTCT	Mother-to-child transmission
NVP	Nevirapine
PMTCT	Prevention of mother-to-Child transmission
SPSS	Statistical Package for the Social Sciences
TDF	Tenofovir disoproxil fumarate
UNAIDS	Joint United Nations program on HIV/AIDS
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions
A conceptualized the overall study design, participated in data collection and quality monitoring, analyzed the first analysis, and wrote the first draft of the manuscript with the overall supervision of EA, BT, EM, Y and SV. ST, BK, D, and SH participated in the data collection. EA, BT, EM, Y, and SV reviewed the draft manuscript. All the authors have read and provided feedback and approved the final draft.

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Data availability
All data relevant to the study are included in this manuscript.

Declarations

Competing interests
The authors declare no competing interests.

Ethics approval and consent to participate
Ethical approval was obtained from the ethical review boards of the Hawassa University College of Medicine and Health Sciences institutional review board (IRB), with reference number (IRB/076/2022, dated December 10/2022). The members of the ethics committee include Dr. Embiale Mengiste, Dr. Muhammed Ayalew and Dr. Freshet Assefa. Informed consent was waived based on the use of anonymized data from routine healthcare records.

Data sharing
All data relevant to the study are included in this manuscript.

Ethics approval and consent to participate
Ethical approval was obtained from the ethical review boards of the Hawassa University College of Medicine and Health Sciences institutional review board (IRB). The members of the ethics committee include Dr. Embiale Mengiste, Dr. Freshet Asefa, Dr. Muhammed Ayalew. Informed consent was waived based on the use of anonymized data from routine healthcare records.

Consent for publication
not applicable **Patient and public involvement**: Patients or the public were not involved in the design, or conduct, or reporting. However, we will involve the public or stakeholders during dissemination of the result.

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