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Determinants of HIV infection among children born from mothers on prevention of mother to child transmission programme of HIV in southern Ethiopia: a case–control study

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ABSTRACT

Objective This study was aimed to identify determinants of HIV infection among children born from mothers on the prevention of mother to child transmission (PMTCT) programme in Southern Ethiopia. It was designed to explore the main contributors to the considerable transmission rate of HIV from mother to child.

Setting and design A multicentre facility-based unmatched case–control study was conducted using 27 health facilities providing PMTCT service in Southern Ethiopia.

Participants Out of 307 (62 cases and 245 controls) expected to participate in this study, a total of 290 mother–child pairs of 58 cases and 232 controls have completed the interview. Cases were children born to mothers on PMTCT programme and with DNA PCR or antibody HIV positive test result at ≤24 months of age. Controls were children born to mothers on PMTCT programme and with DNA PCR or antibody HIV negative test result at ≤24 months of age.

Result Data were collected from the mother and record and analysed using SPSS V.20. Logistic regression analysis was done for statistical association and the significance of association was declared at a p value of <0.05. Rural residence (adjusted OR (AOR): 4.15, 95% CI: (1.57 to 10.97)), knowing serostatus during current pregnancy (AOR: 5.11, 95% CI: (1.33 to 19.69)), home delivery (AOR: 6.00, 95% CI: (2.310 to 15.593)), poor partner involvement (AOR: 5.95, 95% CI: 1.91 to 18.53)), poor adherence, late enrolment of the child for ARV prophylaxis (AOR: 4.89, 95% CI: 1.34 to 17.88)), mixed breastfeeding practice (AOR: 10.36, 95% CI: (3.10 to 34.60)) and failure to be on cotrimoxazole therapy (AOR: 7.56, 95% CI: 2.07 to 27.61)) were factors significantly associated with MTCT.

Conclusion The finding implies that more needs to be done on rural residents, strengthening screening for HIV before pregnancy, encouraging male involvement, early enrolment of child for ARV prophylaxis, avoiding mixed breast feeding and putting newborn on cotrimoxazole therapy.

Strengths and limitations of this study

- This study has used both primary and secondary data to identify a wide range of potential determinants.
- Besides, the study did not identify whether the infection occur during pregnancy, during delivery or postpartum period.
- In addition, even though it was strived to control bias using primary and secondary data, it is not immune to recall bias as it is a case–control study.
- There was also incompleteness of recorded data that would have been strengthening the result of this study.

BACKGROUND

According to WHO, mother-to-child transmission (MTCT) of HIV occurs when an HIV-positive woman transmits the virus to her baby during pregnancy, childbirth or breast feeding. It is the most common route that children become infected with HIV and accounts for more than 90% of paediatric AIDS cases.[1 2]

To stop the global epidemic of HIV/AIDS, various measures have been among which prevention of MTCT (PMTCT) was one of those valuable measures.[3] PMTCT (also known as prevention of vertical transmission) is the intervention to prevent transmission of HIV from an HIV-positive mother to her child during pregnancy, delivery or breast feeding (WHO).[4] WHO recommends four prolonged approaches to comprehensive PMTCT strategy including; primary prevention of HIV infection among women of childbearing age, prevention of unintended pregnancy among women living with HIV, prevention of HIV transmission from women living with HIV to their child through treatment and care, support to women infected with HIV, providing appropriate treatment care and support to mother living with HIV and their children and families.[5 6]

In the absence of PMTCT services, 15%–45% of pregnant women will pass the virus to their children during pregnancy, delivery or breast feeding.[7 8] About one-fourth of exposed children acquire the virus during childbirth; while one-fifth acquire it during pregnancy and breast feeding depending on the presence/absence of other maternal and child-related risk factors.[9–11] Successful PMTCT programme which involves women and their children to receive a series of interventions including uptake of antenatal services and HIV testing during pregnancy, providing antiretroviral therapy (ART) to pregnant women living with the virus, using safe childbirth practices, proper infant feeding, early infant diagnosis and prophylaxis and other postnatal healthcare services can reduce risk of MTCT down to 5% in resource limited.[5]

The Joint United Nations Programme on HIV/AIDS leads and inspires the world to achieve its shared vision of zero new HIV infections, zero discrimination and zero AIDS-related deaths by 2030 as part of the Sustainable Development Goals.[12–14] However, about 159 000 children are still newly infected with HIV every year in sub-Saharan Africa including Ethiopia. More than half of new paediatric HIV infections occur during the breastfeeding period and most are infected through vertical transmission.[14 15]

According to UNAID estimate in 2016 Ethiopia rank fourth next to Indonesia (26.6%), Angola (21.0%), and Ghana (17.7%) with MTCT rate of 15.9%.[16 17] Over the past years, various efforts have been made to decrease MTCT of HIV among children born from HIV-positive mothers including early treatment of child and PMTCT.[17]

There are different recommended strategies in practice for the prevention of vertical transmission of HIV including making women get tested as soon as possible, preventing of unintended pregnancy, PMTCT, and early treatment of child born to HIV positive women, are the available strategies for prevention of vertical transmission of HIV. For instance, PMTCT programme is among valuable strategies being implemented, and different PMTCT guidelines were updated and recommended. Among those guidelines were the current WHO-recommended Option B+since 2012 which recommends initiating all HIV-infected pregnant women on lifelong triple-drug ART regardless of CD4 +cell count or WHO clinical stage.[17–20] In doing so around 1.4 million HIV infections among children were prevented between 2010 and 2018.[21]

Although different strategies have been implemented to reduce MTCT, studies showed that there is still a palpable transmission rate of HIV from mothers on PMTCT to their children. Some studies conducted in Africa showed the transmission rate of HIV infection among children born from mothers on PMTCT is still significantly high.[21–24]

OBJECTIVE

This study was planned to identify determinants of MTCT among children born from mothers on PMTCT programme to enhance the understanding of the reason for such a considerable transmission rate in the study area.

METHODS AND MATERIALS

Study design and setting

A multicentred facility-based unmatched case–control study was conducted in Southern Nations Nationalities and People Region of Ethiopia from 1 March 2019 to 20 July 2019. The region has an area of 118.000 km^2 (constituting a 10% share of the country) with a total population of 18 955 709 (shares 20% of the country's population). It has 1 central city administration, 14 zones and 4 special woredas. According to data obtained from the regional health bureau, there were 61 Hospitals, consisting of 53 governmental (2 referral, 11 general, 40 primary), 4 Non-governemental Organizations and 4 private hospitals. In the region, there are 715 Health centres (24 Non-governemental Organizations) 3866 functional health posts and 700 private clinics.

Population and eligibility criteria

The cases were children born to HIV-positive mothers on PMTCT programme during the study period at selected health facilities and have had DNA PCR or antibody HIV-positive test result at ≤24 months of age. The controls were selected among children born to HIV-positive mothers on PMTCT programme during the study period at selected health facilities and have had DNA PCR or antibody HIV negative test result at ≤24 months of age. To recruit the participants of the study, registry of HIV positive mothers having delivered child within the last 24 months was checked and the children-mother pair were classified based on DNA PCR or antibody HIV-positive test result in to cases and controls. Newly tested children were also included in to cases and controls based on the test results. The testing was done as routine practice by the institutions. Transfer out, lost to follow-up, children whose mothers/caretakers were critically ill and unable to give response were excluded.

Sample size and sampling technique

The sample size was calculated using Epi Info V.7 StatCalc function for sample size calculation for an unmatched case–control study. The assumptions used were 95% CI, power of 80% and considering the following possible determinants of HIV status of children born from HIV positive mothers from a previous comparable study conducted in Addis Ababa[25] (table 1).

Therefore, the largest sample size, the one which is calculated for home delivery (277) was used for this study including 56 cases and 221 controls. By adding a 10% non-response rate the final sample size was 307, of which 62 were cases and 245were controls.

Sampling procedure/technique

Among 14 zones and 4 special woredas, in the region, 8 zones were randomly selected using simple random

Table 1 Showing calculated sample size for the study

Variable (significant predictor)	CI	Power	Proportion of control exposed	OR	Sample size			Reference
					Case	Control	Total	
Mixed feeding	95%	80%	5.7	12.5	13	52	65 mother–child pairs	[25]
Born at home	95%	80%	3.4	5.3	56	221	277 mother–child pairs	
Poor ART adherence	95%	80%	22.7	3.1	38	152	190 mother–child pairs	

ART, antiretroviral therapy.

sampling. In each zone, all facilities which reported at least one HIV-positive child born from mothers on PMTCT programme, and whose age is less than or equal to 24 months were included. Then in each facility, all consenting cases, and their corresponding controls coming consecutively were included until the required number of cases were fulfilled. Accordingly, four controls for each case of children with their mother pair were included in the study as they came for their appointment.

Data collection tool and procedure

The questionnaire was adapted from previously published pieces of literature.[25–28] To strengthen the tools, relevant information from the medical record of the mother and the child, integrated PMTCT registration, and exposed infants' care follow-up registration books were collected using checklists. The questionnaire was prepared in the English version and translated to Amharic then retranslated back to English by a third person to keep the integrity of the translation.

Data were collected by trained diploma nurses having previous experience in similar data collection and three supervisors have controlled the overall data collection process. Concerning the data collection procedure, each mother who came to the facility for her appointment was approached and the purpose of the study was explained. Every volunteer mother was asked for verbal consent and then an exit interview was made by the data collector and medical records of the mother and the child were then explored for additional information. Some of the collected data via interview were cross-checked against recorded values.

We used the Strengthening the Reporting of Observational Studies in Epidemiology case–control checklist when writing our report.[29]

Patient and public involvement

The participants were orally informed about the objective of the study and there was a clear description of the study aim on the consent form. No patients were involved in the design of the study, the recruitment to and conduct of the study. The result of the study was not disseminated to the individual participants.

Measurements

HIV test results

HIV test result identified with DNA/PCR before 24 months of age, or by rapid antibody test after 18 months of age and 6 weeks of cessation of breast feeding.[30]

Nutritional status of the mother

Measured using mid upper arm circumference: If >22 cm=well nourished, ≤22 cm=malnourished.[30]

Knowledge about P/MTCT of HIV

was measured using six items out and respondents who correctly answered three or more questions were categorised as having good knowledge and those who answered below three questions were considered as having poor knowledge.

Partner involvement level

The level of partner involvement in PMTCT programme was measured using eight items. A total score of four out of eight questions was considered as a 'high' partner involvement and a score less than four was considered as 'low' partner involvement.[28]

Participated in mother to a mother support group

Mother member of a formally organised group formed by HIV-positive mothers who pass through PMTCT services and participated in at least one regular meeting.[25]

ART adherence

According to ART protocol, it is measured based on the number of missed doses within 60 days. Three or fewer doses, four to eight doses, nine or more doses rated as good, fair and poor, respectively.[30]

Cotrimoxazole adherence

According to ART protocol is measured based on the number of missed doses per month. Less than three doses, three to nine doses, more than nine doses rated as good, fair and poor, respectively.[30]

ARV prophylaxis

Short-term use of ARV drugs in children to reduce MTCT.

Data processing and analysis

After coding, the data were entered into EPI Info V.7.2.3.0. Then data were checked for completeness and consistency by looking at their distribution and exported to SPSS V.20.0 for further analysis. Then

descriptive, bivariate and multivariate logistic regression analysis were performed. Bivariate analysis was done to determine the crude association between the independent variables and the dependent variable. All variables having a p≤0.25 in the bivariate analysis were considered to be a candidate for multivariate analysis. Any correlation between variables was checked and no correlation was found between variables included in the analysis. To assess the goodness-of-fit of the final model, Hosmer and Lemeshow goodness-of-fit test was applied. The OR with their corresponding CI was used to assess the strength of association.

RESULT

Socioeconomic and demographic characteristics of mothers

A total of 290 mothers on PMTCT with their children were involved in this study with a response rate of 94.5% (93.4% for cases and 94.7% for controls). Concerning maternal characteristics, the mean age of mothers was 30.1 years with an SD of 4.8 years. More than half of mothers of the cases 32 (55.2%) and controls 135 (58.2%) were between 25 and 34 years. The majority of the controls 176 (75.9%) were urban residents while 37 (63.8%) of cases live in a rural area. Concerning occupational status, 18 (31.0%) of mothers of the HIV-positive children and 81 (34.9%) of mothers of HIV-negative children were housewives. Among them, 49 (84.5%) of mothers of cases and 207 (89.2%) of controls were married. Educationally majority of mothers of the cases 32 (55.2%) did not attend formal education (table 2).

Table 2 Socioeconomic and demographic characteristics mothers for determinants of HIV infection among children born from mothers on PMTCT programme in Southern Nations Nationalities and Peoples Region July 2019

Variables	Case (n=58) No (%)	Control (n=232) No (%)
Age		
15–24 years	10 (17.2)	33 (14.2)
25–34 years	32 (55.2)	135 (58.2)
35–44 years	16 (27.6)	64 (27.6)
Residence		
Urban	21 (36.2)	176 (75.9)
Rural	37 (63.8)	56 (24.1)
Occupation		
Housewife	18 (31.0)	81 (34.9)
Employee	10 (17.2)	43 (18.5)
Merchant	11 (19.0)	46 (19.8)
Daily labourer	8 (13.8)	29 (12.5)
Farmer	11 (19.0)	33 (14.3)
Marital status		
Single	2 (3.4)	6 (2.6)
Married	49 (84.5)	207 (89.2)
Widowed	4 (6.9)	12 (5.2)
Divorced	3 (5.2)	7 (3.0)
Maternal education status		
No formal education	32 (55.2)	78 (33.6)
Primary education	15 (25.9)	97 (41.8)
Secondary and above	11 (19.0)	57 (24.6)
Partner educational status		
No formal education	22 (37.9)	81 (34.9)
Primary education	19 (32.8)	68 (29.3)
Secondary and above	17 (29.3)	83 (35.8)
Income		
≤500	15 (25.9)	73 (31.5)
501–1000	27 (46.6)	105 (45.3)
≥1000	16 (27.6)	54 (23.3)

PMTCT, prevention of mother to child transmission.

Maternal obstetrics and nutritional characteristics

The majority of mothers of the cases (35 (60.3%)) and controls (148 (63.8%)) have less than or equal to 4 children. Concerning the pregnancy status, 41 (70.7%) of mothers of cases and 148 (63.8%) of mothers of control did not plan to be pregnant for the index child. Thirty-nine (67.2%) of the cases and 180 (77.6%) of controls attended ANC follow-up more than four times. Among mothers of the cases, 14 (24.1%) were diagnosed with HIV during current pregnancy while 210 (90.5%) of mothers of the controls knew their HIV status before current pregnancy and 7 (12.1%) of mothers of cases were positive for syphilis serology. More than half of mothers of the controls 160 (69.0%) and 13 (22.4%) of cases gave birth at a health facility. 50 (86.2%) of mothers of the cases and 186 (80.2%) of controls had a spontaneous vaginal delivery (table 3).

Regarding maternal nutritional status during pregnancy and lactation, there was no complete record of data. From the obtained data, the majority of the mother of cases 32 (71.1%) and controls 152 (73.4) were well-nourished during pregnancy. Similarly, 30 (65.2%) of cases' mothers and 142 (69.3%) controls' mothers were well nourished during breast feeding (figure 1).

Maternal clinical immunological and related factors

Accordingly, the majority of mothers of the cases were in WHO clinical stage I during the pregnancy 51 (87.9%) and breastfeeding period 46 (79.3%). Most of the mothers of cases and controls have good ART adherence, 46 (79.3%) and 213 (91.8%), respectively (table 4).

Most of the mothers of the cases and controls were a member of the mother-to-mother support group which is 36 (62.1%) and 179 (77.2%), respectively. Likewise, there was high partner involvement among both mothers of controls 199 (85.8%) while it is only 32 (55.2%) among the cases. The majority of mothers of the controls have

Table 3 Maternal obstetric and nutritional factors for determinants of HIV infection among children born from mothers on PMTCT programme in Southern Nations Nationalities and Peoples Region July 2019

Variables	Cases (n=58) No (%)	Controls (n=232) No (%)
No of delivery		
1–4	35 (60.3)	148 (63.8)
≥5	23 (39.7)	84 (36.2)
Pregnancy status		
Planned	17 (29.3)	84 (36.2)
Not planned	41 (70.7)	148 (63.8)
No of ANC visit		
≥4	39 (67.2)	180 (77.6)
<4	19 (32.8)	52 (22.4)
Weight at delivery		
>=55 kg	31 (53.4)	131 (56.5)
<55 kg	27 (46.6)	101 (43.5)
The time when serostatus was known		
During the current pregnancy	14 (24.1)	22 (9.5)
Before the current pregnancy	44 (75.9)	210 (90.5)
Place of delivery		
Health facility	13 (22.4)	160 (69.0)
Home	45 (77.6)	72 (31.0)
Mode of delivery		
SVD	50 (86.2)	186 (80.2)
Emergency CS	1 (1.7)	135 (9.6)
Elective CS	1 (1.7)	22 (9.5)
Instrumental delivery	3 (5.2)	4 (1.7)
Episiotomy	3 (5.2)	7 (3.0)

ANC, antenatal care; CS, caesarean section; n, sample size; PMTCT, prevention of mother to child transmission; SVD, spontaneous vaginal delivery.

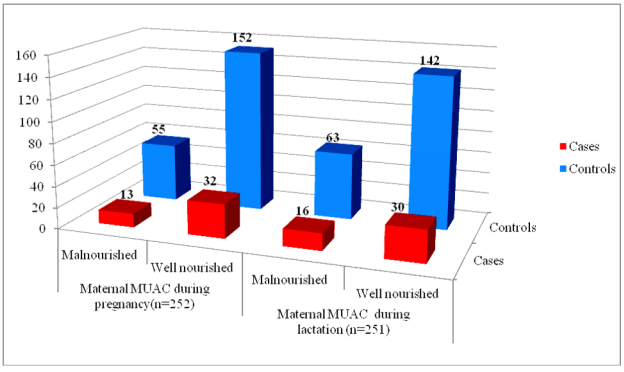

Figure 1 Nutritional status of mothers during pregnancy and breast feeding among mothers on PMTCT in southern Ethiopia. MUAC, mid upper arm circumference; PMTCT, prevention of mother to child transmission.

Table 4 Maternal clinical and other factors for determinants of HIV infection among children born from mothers on PMTCT programme in Southern Nations Nationalities and Peoples Region July 2019

Variables	Cases (n=58) No (%)	Controls (n=232) No (%)
WHO clinical stage during pregnancy		
Stage I	51 (87.9)	212 (91.4)
Stage II	7 (12.1)	20 (8.6)
WHO clinical stage during breast feeding		
Stage I	46 (79.3)	213 (91.8)
Stage II	12 (20.7)	19 (8.2)
Maternal breast condition		
Normal	51 (87.9)	214 (92.2)
Cracked/mastitis	7 (12.1)	18 (7.8)
Syphilis test result during ANC		
Negative	43 (74.1)	189 (81.5)
Positive	7 (12.1)	17 (7.3)
Unknown	8 (13.8)	26 (11.2)
Cotrimoxazole therapy		
Yes	53 (91.4)	208 (89.7)
No	5 (8.6)	24 (10.3)
Cortimoxazole adherence		
Good	43 (81.1)	158 (76.0)
Poor	10 (18.9)	50 (18.9)
ART adherence		
Good	37 (63.8)	216 (93.1)
Poor	21 (36.2)	16 (6.9)
MTMSG involvement		
Yes	36 (62.1)	179 (77.2)
No	22 (37.9)	53 (22.8)
Partner involvement		
High	32 (55.2)	199 (85.8)
Low	26 (44.8)	33 (14.2)
Knowledge about PMTCT		
Good	30 (51.7)	182 (78.4)
Poor	28 (48.3)	50 (21.6)

ANC, antenatal care; ART, antiretroviral therapy; MTMSG, mother-to-mother support group; n, sample size; PMTCT, prevention of mother to child transmission.

good knowledge of PMTCT, 182 (78.4%) and about half 30 (51.7%) of mothers of cases had good PMTCT knowledge (table 4).

Regarding CD4 and viral load, there is a significant incomplete record from the chart of mothers, and based on the available data, 85.7% (24/28) of the cases and 92.1% (93/101) of the controls have a CD4 count greater than 350 during pregnancy and 17 out of 39 (43.6%) of the cases, 65 out of 109 (59.6%) of controls have low and undetected viral load, respectively (figure 2).

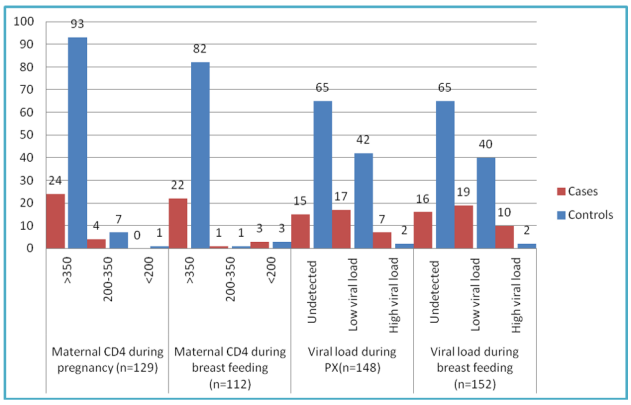

Figure 2 Maternal CD4 and viral load during pregnancy and breast feeding among mothers on PMTCT in southern Ethiopia. PMTCT, prevention of mother to child transmission.

Child-related factors

The majority of controls were boys 131 (56.5%) and almost half of cases 30 (51.7%) were girls. Fifty-seven (98.3%) of cases and 224 (96.6%) of controls born from full-term pregnancy with a birth weight of >2.5 kg among 41 (70.7%) of cases and among 179 (77.2%) of controls. More than half of the cases 31 (53.4%) were enrolled for ARV prophylaxis lately while 202 (87.1%) of controls enrolled for ARV prophylaxis before 6 weeks. Regarding adherence to cotrimoxazole therapy, 36 (85.7%) of cases and 201 (95.3%) of controls had good cotrimoxazole adherence. On the other hand, 21 (36.2%), 7 (12.1%), and 30 (51.7%) of cases had exclusive breast feeding, exclusive replacement feeding and mixed feeding, respectively (table 5).

Determinants of HIV infection among children born from mothers on PMTCT

To identify determinants of HIV infection among children born from mothers on PMTCT using multivariable logistic regression, variables having a p<0.25 on bivariate analysis were included in the model. Among the variables included in the final model, HIV-positive mothers living in rural areas were four times more likely to pass the infection to their children when compared with those who are urban residents (adjusted OR, AOR: 4.15, 95% CI: (1.57 to 10.97)). Mothers who knew their HIV serostatus during current pregnancy were five times more likely to transmit the virus to their children (AOR: 5.11, 95% CI: 1.33 to 19.69). Likewise, those who gave birth at home were also six times more likely to transmit HIV to their children than those delivered at a health facility (AOR: 6.00, 95% CI: 2.31 to 15.59).

Concerning partner involvement in maternal PMTCT services utilisation, mothers having low partner involvement in maternal PMTCT were about six times more likely to transmit the virus to their children when compared with those with higher partner involvement (AOR: 5.95, 95% CI: 1.91 to 18.53). In addition, mothers with poor ART adherence were more than eight times more likely to infect their children than those with good ART adherence (AOR: 8.53, 95% CI 2.55 to 28.48).

Regarding child-related factors, children who were enrolled for ARV prophylaxis after 6 weeks of birth were about five times more likely to acquire HIV than those enrolled earlier (AOR: 4.892, 95% CI: 1.34 to 17.88)). Similarly, children who were mixed-fed were ten times more likely to acquire the virus from their mother when compared with those who were exclusively breastfed (AOR: 10.36, 95% CI: 3.10 to 34.60). In addition, children

Table 5 Child-related factor for determinants of HIV infection among children born from mothers on PMTCT programme in Southern Nations, NAtionalities and Peoples Region July 2019

	Cases (n=58)	Controls (n=232)
Variables	**No (%)**	**No (%)**
Child sex		
Male	28 (48.3)	131 (56.5)
Female	30 (51.7)	101 (43.5)
Gestational age		
Term	57 (98.3)	224 (96.6)
Preterm	1 (1.7)	8 (3.4)
Weight at delivery		
>2.5 kg	41 (70.7)	179 (77.2)
<2.5 kg	17 (29.3)	53 (22.8)
Age at enrolment to Antiretroviral prophylaxis		
≤6 weeks	37 (63.8)	213 (91.8)
>6 weeks	21 (36.2)	19 (8.2)
Nevirapine prophylaxis		
Yes	55 (94.8)	230 (99.1)
No	3 (5.2)	2 (0.9)
Cotrimoxazole therapy		
Yes	42 (72.4)	211 (90.9)
No	16 (27.6)	21 (9.1)
Cotrimoxazole adherence	(n=42)	(n=211)
Good	36 (85.7)	201 (95.3)
Poor	6 (14.3)	10 (4.7)
Child feeding practice		
Exclusive breast feeding	21 (36.2)	171 (73.7)
Exclusive replacement feeding	7 (12.1)	32 (13.8)
Mixed feeding	30 (51.7)	29 (12.5)
Duration of breast feeding		
Not breast fed	7 (12.1)	32 (13.8)
For 6 months only	27 (46.6)	121 (52.2)
6–12 months	16 (27.6)	69 (29.7)
12–18 months	8 (13.8)	10 (4.3)
Vaccination status		
Complete	36 (62.1)	163 (70.3)
Incomplete	22 (37.9)	69 (29.7)

n, sample size; PMTCT, prevention of mother to child transmission.

who were not on cotrimoxazole therapy had more than seven times the risk of acquiring HIV from their mother than those who were on the cotrimoxazole therapy (AOR: 7.56, (95% CI: 2.07 to 27.61) (table 6).

DISCUSSION

According to evidence, using success full PMTCT strategy can reduce the risk of transmission down to 5% in breastfed and 2% in non breastfed children, through effective implementation of PMTCT.[4 5]

Although PMTCT greatly reduces the transmission of the virus from infected mother to her child, various factors are shown to be associated with MTCT among mothers on PMTCT.[18–26 31–35] In this study, the multivariable logistic analysis revealed that mothers who live in rural areas were four times more likely to infect their children compared with urban residents. This finding is in line with the finding of studies done in Dire-Dawa city, Eastern Ethiopia[24] and other studies in Northwestern Ethiopia.[34] Similar findings were also identified from a study in Southwestern Ethiopia.[35] This might be attributed to low PMTCT service utilisation in rural areas because of awareness problems and distance from the health facilities.

Knowledge of the HIV serostatus of the mother during the current pregnancy was another determinant of MTCT in this study. In this regard, mothers who knew their serostatus during the current pregnancy were five times more likely to pass the virus to their child compared with those mothers who knew their serostatus before the current pregnancy. This finding was also in agreement with a study conducted in the Oromia region.[26] This is because preconception serostatus knowledge gives the mother chance to stay longer on ART resulting in viral suppression and more awareness about PMTCT during pregnancy delivery and during breast feeding as she engages in different ART services. Also, a recent infection can result in a high viral load, which in turn, might increase the risk of transmission.

Mothers who gave birth at home were six times more likely to transmit the infection to their children than their counterparts. This finding was also comparable to evidence of studies conducted elsewhere[24 25 35 36] and it is attributed to the fact that mothers who gave birth at home have less chance of getting safe delivery practice than those who gave birth at health facility and children born at home may not get ARV prophylaxis and other preventive services immediately after birth which increase risk of acquiring the infection.

Another important factor that contributed to MTCT in this study was low partner involvement in PMTCT service utilisation where mothers with low partner involvement were nearly six times more likely to pass HIV than those with higher partner involvement. This finding is in agreement with the result of a study conducted in Addis Ababa.[25] This could also be attributed to the fact that more partner involvement in maternal PMTCT increases maternal uptake of PMTCT and the use of other interventions for HIV that in turn increase maternal treatment outcome and child prevention.[28]

Additionally, this study has shown that mothers who poorly adhered to ART were greater than eight times more likely to transmit the virus compared with those having good ART adherence. Poor ART adherence can cause treatment failure resulting in drug resistance which possibly increases viral load and maternal HIV disease progression leading to increased risk of MTCT.[37] The result is similar but higher in the magnitude of risk than a case–control study conducted in Addis Ababa.[25]

According to the current study, the time of child enrolment in ARV prophylaxis was another determinant of MTCT. Those children who lately enrolled in ARV prophylaxis were about five times at higher risk than children enrolled in ARV prophylaxis at an early stage. This finding complies with a study conducted in Dire Daw city.[24] The possible explanation for this risk difference might be being without ARV prophylaxis leaves the child unprotected with exposure on any occasion during interaction with his mother including breast feeding.

Another child-related determinant factor identified in this study was child cotrimoxazole therapy; where those who did not take cotrimoxazole therapy were seven times more likely to acquire HIV from their mother than those who were on the therapy. This result is in line with the finding of the study conducted in the Oromia region of Ethiopia.[23] This risk difference can be explained by the fact that those who are not on cotrimoxazole therapy can be easily exposed to bacterial infection which in turn increases the risk of transmission.

Finally, a child-related determinant associated with MTCT is mixed breastfeeding practice. This study revealed children who had been mixed-fed were 10 times more likely to be infected when compared with those who are exclusively breastfed. This finding is in line with the studies conducted in Nigeria,[38] Uganda[39] and Southwestern Ethiopia.[36] The possible reason for this risk difference might be mixed feeding which involves feeding both breast milk and additional foods including formula food can increase the likelihood of damaging the epithelial lining of the child which in turn may result in infection that increases the risk of infection.

This study tried to assess determinants of vertical transmission of HIV among women attending PMTCT at different ART centres in the study area. The study also tried to cover a large geographical area by including facilities in southern Ethiopia. However, certain methodological limitations should be taken into consideration while using these findings. One of such limitations was the cases were selected conveniently based on their consecutive arrival at the PMTCT centres for appointments. In addition, there may also be a certain recall bias for information that was asked retrospectively due to the length of time since the birth of the child.

Table 6 Determinants of HIV infection among children born from mothers on PMTICT programme in Southern Nations, Nationalities and Peoples Region July 2019

Variables	Cases no (%)	Controls no (%)	COR (95% CI)	AOR (95% CI)	P value
Residence					
Urban	21 (36.2)	176 (75.9)	**1**	**1**	
Rural	37 (63.8)	56 (24.1)	5.537 (3.00 to 10.23)	**4.15 (1.57 to 10.97)***	**0.004**
Maternal education level					
No formal education	32 (55.2)	78 (33.6)	2.13 (0.99 to 4.57)	1.04 (0.29 to 3.76)	0.953
Primary education	15 (25.9)	97 (41.8)	0.80 (0.35 to 1.86)	0.45 (0.10 to 1.96)	0.288
Secondary and above	11 (19.0)	57 (24.6)	1	1	
Pregnancy plan					
Yes	17 (29.3)	84 (36.2)	1	1	
No	41 (70.7)	148 (63.8)	1.37 (0.73 to 2.56)	1.09 (0.40 to 2.99)	0.863
No ANC visit					
≥4	39 (67.2)	180 (77.6)	1		
<4	19 (32.8)	52 (22.4)	1.69 (0.99 to 3.16)	1.31 (0.43 to 3.96)	0.637
Time of serostatus knowledge					
During current px	14 (24.1)	22 (9.5)	3.04 (1.44 to 6.40)	**5.11 (1.33 to 19.69)***	**0.018**
Prior to current px	44 (75.9)	210 (90.5)	1	1	
Syphilis serology during px					
Negative	43 (74.1)	189 (81.5)	1	1	
Positive	7 (12.1)	17 (7.3)	1.81 (0.70 to 4.63)	3.80 (0.73 to 19.84)	0.113
Unknown	8 (13.8)	26 (11.2)	1.35 (0.57 to 3.19)	1.40 (0.34 to 5.68)	0.640
Place of delivery					
Health facility	13 (22.4)	160 (69.0)	1		
Home	45 (77.6)	72 (31.0)	7.69 (3.91 to 15.14)	**6.00 (2.31 to 15.59)†**	**0.000**
Member of a mother-to-mother group					
Yes	36 (62.1)	179 (77.2)	1		
No	22 (37.9)	53 (22.8)	2.06 (1.12 to 3.88)	1.17 (0.40 to 3.42)	0.775
Partner involvement					
High	32 (55.2)	199 (85.8)	1	1	
Low	26 (44.8)	33 (14.2)	4.90 (2.60 to 9.25)	**5.95 (1.91 to 18.53)***	**0.002**
PMTCT knowledge					
High	30 (51.7)	182 (78.4)	1	1	
Low	28 (48.3)	50 (21.6)	3.40 (1.86 to 6.21)	1.38 (0.46 to 4.09)	0.565
WHO clinical staging during breast feeding					
Stage I	46 (79.3)	213 (91.8)	1		
Stage II	12 (20.7)	19 (8.2)	2.92 (1.33 to 6.44)	1.24 (0.26 to 5.92)	0.789
ART adherence					
Good	37 (63.8)	216 (93.1)	1	1	
Poor	21 (36.2)	16 (6.9)	7.66 (3.66 to 16.03)	**8.53 (2.55 to 28.48)†**	**0.000**
Age at enrolment for ARV prophylaxis					
<6 weeks	37 (63.8)	213 (91.8)	1	1	
>6 weeks	21 (36.2)	19 (8.2)	6.36 (3.12 to 12.97)	**4.89 (1.34 to 17.88)***	**0.016**
Cotrimoxazole therapy					
Yes	42 (72.4)	211 (90.9)	1	1	

Continued

Table 6 Continued

Variables	Cases no (%)	Controls no (%)	COR (95% CI)	AOR (95% CI)	P value
No	16 (27.6)	21 (9.1)	3.83 (1.85 to 7.92)	**7.56 (2.07 to 27.61)***	**0.002**
Child feeding practice					
Exclusive breast feeding	21 (36.2)	171 (73.7)	1	1	
Exclusive replacement feeding	7 (12.1)	32 (13.8)	1.78 (0.70 to 4.54)	1.86 (0.47 to 7.28)	0.374
Mixed feeding	30 (51.7)	29 (12.5)	8.42 (4.26 to 16.67)	**10.36 (3.10 to 34.60)†**	**0.000**

*Statistically significant at p<0.05.
†Statistically significant at p<0.001.
ANC, antenatal care; AOR, adjusted OR; ART, antiretroviral therapy; COR, crude OR; PMTCT, prevention of mother to child transmission.

CONCLUSION

In conclusion, the study indicated that there was a higher risk of MTCT among children born from mothers who were rural residents, who gave birth at home, have low partner involvement in PMTCT, those who know their HIV serostatus during the current pregnancy, mothers having poor ART adherence. In addition, children with late enrolment to ARV prophylaxis, who did not take cotrimoxazole therapy and mixed-fed children were at higher risk of acquiring HIV from their mothers who were on PMTCT. Concerned bodies need to work more on rural residents, strong follow-up mechanisms for HIV-positive pregnant women on PMTCT, and strong advisory and training services for HIV-positive mothers on PMTCT on exclusively breastfeeding practice for their newborn child in the first 6 months of its life.

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