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Incidence of mother-child transmission of HIV-1 in the departments of Mono and Couffo in Benin: The associated factors in 2019

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Despite the worldwide success of the introduction of human immunodeficiency virus (HIV) testing and treatment with antiretroviral drugs, HIV remains a real public health problem. Vertical mother-to-child transmission is a form responsible for many cases of new infections. The objective of the study is to carry out an inventory of mother-to-child transmission of HIV-1 in the departments of Mono and Couffo. A total of 374 drops of dry blood (DBS) were collected from infants born to HIV-positive mothers during the year 2019. Information on the type of treatment, the type of infant diet was also collected. These different samples were used for RNA extraction. The early diagnosis of these infants as well as the determination of the viral load were carried out by reverse transcriptase-Polymerase Chain Reaction (RT-PCR) using the Roche automated system. The results showed that 93.41% of the newborns included in this study tested negative for early detection by RT-PCR. Significant associations were observed between early diagnosis of newborns and maternal feeding pattern, PMTCT protocol, and maternal viral load with regression logistics and Chi-square testing. Monoprophylaxis was predominant in the protocol for the prevention of neonatal mother-to-child transmission (PMTCT) (96.28%). The national program for the prevention of vertical transmission of HIV from mother to child deserves to be continued and strengthened with the objective of zero newborns infected at birth in the departments of Mono and Couffo.

Key words: HIV1, HIV-positive mothers, newborns, associated factors.

INTRODUCTION

HIV has been present since 1981 and despite the worldwide success of introducing diagnostic tests and treating HIV with antiretroviral drugs, it remains a real challenge for humanity, especially as no preventive treatment has been further developed (UNAIDS, 2016).In sub-Saharan Africa, about 60% of HIV infections in young adults occur in women (UNAIDS, 2020). This gender disparity is particularly pronounced among adolescents and young adults, where the incidence of HIV in women is up to eight times higher than in men (Kharsany and Karim, 2016). This poses a real challenge in which women play a very indispensable role in procreation by

carrying a pregnancy. Transmission of HIV from HIV-positive mothers to newborns can occur during pregnancy or through breastfeeding (Frange and Blanche, 2014; Potty et al., 2019) but transmission can also occur during labor and delivery. In fact, more than 36 million people were living with the virus in 2015, including more than 2 million newly infected (UNAIDS, 2016). These figures include 1.8 million infants infected with HIV, the majority of whom acquired the virus through mother-to-child transmission of HIV (UNAIDS, 2016). In Benin, the prevalence of HIV/AIDS has stabilized at 1.2% since 2006 with a female predominance (1.4% among women and 1.0% among men) (Ministry of Health Benin, 2019). In order to fight against this form of transmission, Benin has set up a national program for the prevention of mother-to-child transmission (PMTCT) since 2004. Every pregnant woman is systematically offered, during prenatal consultations, an HIV test after a free counseling session and informed consent according to the recommendations of UNAIDS and WHO (Kêdoté et al., 2011). This program also includes the early diagnosis of HIV in newborns of HIV-positive mothers from the first month of life.

Benin has twelve (12) departments and among them, those in which the largest number of cases of HIV infection are recorded are Mono (2.1%) and Couffo (2.2%) for less than 1% (0.4%) in the departments of Alibori, Atacora, Borgou, Plateau and Zou (Ministry of Health Benin, 2018). These two departments are known to have the lowest PMTCT coverage rate of 81% for a national coverage of 98.46% (Ministry of Health Benin, 2019). Therefore, this study focused on the quality of PMTCT in these departments in order to identify billers associated with mother-to-child transmission of HIV1 in these departments. This study was then conducted with the aim of determining the incidence of vertical mother-to-child HIV transmission in the departments of Mono and Couffo in order to contribute to the reduction of mother-to-child HIV transmission in these departments.

METHODOLOGY

Study design

This was a cross-sectional retrospective analytical study, led on 347 HIV positive women's and their children in the departments of Mono and Couffo in Benin in 2019.

Setting

HIV-positive mothers and newborns enrolled in the study came from health centers in the departments of Mono and Couffo. The study was carried out throughout 2019 (January 1st to December 31th).

The samples collected in the various health centers of the two departments were sent to the Mono and Couffo Integrated Support Center for People Living with HIV (CIPEC Mono-Couffo) located in the town of Lokossa for the various analyses.

Participants

As the sampling was exhaustive, all HIV-positive women who gave birth in 2019 in a health center in the departments of Mono and Couffo were taken into account in the study.

Variables

The dependent variable in this study is mother-to-child transmission of HIV 1. The other variables in this study to be considered as factors that may influence the occurrence of the event which is mother-to-child transmission of HIV 1 are: the sex of the child (male or female) and method of breastfeeding the child until the date of collection. There is at this level 4 breastfeeding mode as its replacement feeding, protected maternal breastfeeding when the mother is on ARVs, unprotected maternal breastfeeding for mothers who breastfeed without ARV treatment and mixed breastfeeding when both types of breastfeeding are used (protected maternal breastfeeding + replacement feeding). As other variables, we have the duration of breastfeeding, the PMTCT protocol used for the mother and the PMTCT protocol used for the newborn.

Data sources/measurement

The information to fill in the variables of interest was recorded in the medical records of mothers and newborns. This is in fact demographic data such as the sex of the child, the method of breastfeeding, the PMTCT protocol of the mother and that of the child and the date of weaning.

Bias

The possible bias of this study lies in the fact that the present study only took into account women who visited a health center in the two departments. Given that this is a rural area of the country where women still perform traditional births at home without knowing the women's HIV status, this may be a bias in determining the incidence of mother-to-child transmission of HIV in these two departments. The possible role of prenatal and parturition could also constitute a bias in the study.

Study size

As the sampling is exhaustive, the size of the study corresponds to the number of patients during the study period. A total of 349 newborns from 349 mothers were enrolled in the study.

Statistical methods

The data entry was carried out with the Excel 2019 table and the

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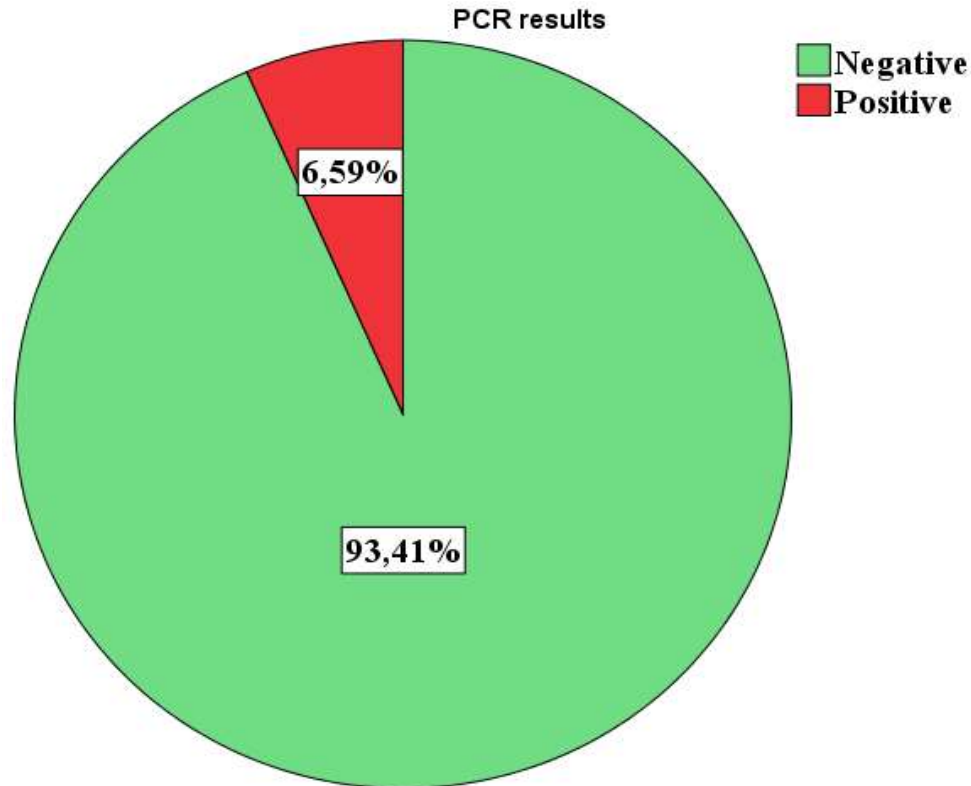
PCR results

Figure 1. PCR results for newborns.

statistical analysis with the Stata SE 11 software. The statistical analysis initially consisted of a univariate analysis, the variables with a p <0.05 were selected as having a potential association with the HIV-positive status of the child.

For multivariate analysis, variables significantly associated in univariate analysis, as well as those with a p-value less than or equal to 0.20 (forced variables) were included in the multivariate analysis model. Following step-by-step analysis and verification of interactions, variables with a p <0.05 were independently considered to be associated with the question of the child's HIV status. The results were presented as an odds ratio (OR) with their 95% confidence interval. The interpretation threshold α = 0.05 was used.

The Chi square test was carried out in addition because if the logistic regression shows the statistical link between the factors and the independent variables, the Chi square shows the degree of this bond.

Sampling

The biological materials in the present study consist of (Dry Blood Spot DBS) samples obtained from the heel or atrial fingertip of infants born to HIV-positive mothers and EDTA blood samples from mothers that were used for viral load testing. The last viral load of mothers before childbirth was used in this study.

RNA Extraction

RNA extraction was performed according to the manufacturer's recommendations for the kit Abbott *m*sample preparation system

(Abbott, Chicago, United State).

Early HIV-1 diagnosis among infants

The early diagnosis of HIV-1 in newborns was carried out by RT-PCR according to the recommendations of the COBAS Ampliprep/COBAS Taqman CAP/CTM system version 2.0 qualitative of the Roche range (Roche Diagnostics Ltd., Rotkruez, Switzerland). This target system targeting both the HIV-1 gag p24 gene and the LTR region. The statistical program HI2QLD48 was used on the analyzer (Gueye et al., 2016; Shin et al., 2019).

Detection of viral charge in HIV-positive pregnant women

The same procedure was used for the detection of the viral load of women within this time with the quantitative kit. The HI2CAP48 program was used (Avettand-Fénoël et al., 2019; Wojewoda et al., 2013).

RESULTS

This study was conducted in order to produce an inventory of mother-to-child transmission of HIV-1 in the departments of Mono and Couffo. Analysis of the distribution of infants included in this study according to the sex shows a male predominance in a low average (Figure 1). The age distribution of these infants shows a high representation of infants in the 0 to 6 months age

Table 1. Socio-demographic characteristic of the study population

Parameter		Effective	Frequency (%)
Gender	Male	178	51
	Female	171	49
	0 - 6	300	86
	6 - 12	38	10.80
Age (months)	12 - 18	9	2.60
	18 - 24	1	0.30
	> 24	1	0.30
	Alternative foods	7	2.01
	Unprotected breastfeeding	136	38.97
Feeding mode	Protected breastfeeding	201	57.59
	Mixed breastfeeding	5	1.43
	0 - 6	1	0.30
Weaning duration	6 - 12	2	0.60
(months)	12 - 18	1	0.30
	Not yet weaning	245	98.80
	None	61	17.48
	Monoprophylaxis	9	2.58
PMTCT protocol for	Triprophylaxis	25	7.16
mothers	Tritherapy during pregnancy	130	37.25
	Tritherapy before pregnancy	124	35.53
	None	12	3.44
PMTCT protocol for	Monoprophylaxis	325	96.28
infants	Triprophylaxis	12	3.44

group with a percentage of 86% (Table 1). There was also repair according to the feeding mode and the weaning period. The majority of these infants were fed through protected breastfeeding (57.59%) and 98.85% of these infants were not yet weaned by more than 1 year of age and ½ (Table 1). Investigation of the PMTCT protocol showed that the two most predominant were triple therapy before pregnancy and triple therapy during pregnancy, with percentages of 37.25 and 35.53% respectively (Table 1).

With regard to the PMTCT protocol for newborns, monoprophylaxis is predominant with a percentage of 96.28% (Table 1). This study was also conducted to explore the link between viral load in mothers and transmission of the virus to newborns. Thus, the PCR performed for early diagnosis yielded a positivity rate of 6.59%.

The regression took place in two stages. All the independent variables are inserted and only those significant at only 20% are kept. It was noticed that no variable can predict whether the child will be infected or not (Table 2). During the second step, the independent

variables were taken separately at the 5% threshold. The results show that the risk of HIV infection is 1.14 times higher in girls than in boys. Unfortunately, this is not significant. There is therefore a probable association between the sex of the child and HIV infection during pregnancy, but this link is not significant. Compared to simple breastfeeding, protected breastfeeding is a protective factor against the onset of infection in the child during pregnancy (OR < 1) with a significant association.

Mixed breastfeeding mothers are 5.71 times more likely to have their infants infected with HIV, but this association is insignificant.

Prophylaxis during pregnancy would better protect the child against possible HIV infection (OR < 1). Mothers who do not take prophylaxis are 6 times more likely to give birth to an infected child than those who receive prophylaxis (before or during pregnancy). This link is not significant in the present study.

Pregnancies in which the infant's PMTCT protocol isnot followed have a 9-fold risk of leading to HIV-positive births. This link is also not significant.

Research on the link between mother's last viral load

Table 2. Univariate analysis for logistics regression.

Parameter	Odds ratio (OR)	IC95%	P-value
Gender			
Male	-	-	
Female	1.256	[0.49; 3.24]	0.66
Feeding mode			
Unprotected Breastfeeding	-	-	-
Protected Breastfeeding	0.33	[0.10; 1.08]	0.08
Alternative Foods	2.86	[0.40; 20.55]	0.30
PMTCT protocol for mothers			
Triprophylaxis	-	-	-
Tritherapy during pregnancy	0.76	[0.08; 7.33]	0.81
Tritherapy before pregnancy	1.12	[0.11; 11.03]	0.92
None	4.39	[0.52; 37.08]	0.17
PMTCT protocol for infants			
Monoprophylaxis	-	-	-
Triprophylaxis	6.78	[1.14; 40.16]	0.04
Mother's viral load			
<1000	-	-	-
>1000	10,73	[2.9; 39.0]	0.02
Undetectable	1,42	[0.35; 5.83]	0.619

and children's PCR positivity shows a significant link between mothers' viral load and mother-to-child transmission of HIV (Table 3).

The Chi-square results confirm those of the logistic regression and also reveal the same factors (Table 4).

DISCUSSION

The HIV pandemic continues to cause a heavy burden in large populations such as those in the Mono Couffo departments in Benin. Reducing the transmission of the virus continues to be at the heart of many actions at the national and international level. In Benin, the PMTCT Program, which aims to reduce vertical mother-to-child transmission, has been in place since 2004, but there are still cases of children born from seropositive mothers with HIV. This study therefore sought to identify the factors that influence this transmission in the departments of Mono and Couffo where the highest rates of HIV infection in Benin are recorded. Early detection of newborns by RT-PCR gave a positivity rate of 6.59%. This rate, although low, poses the problem of the full implementation of the national program for the prevention of mother-to-child HIV transmission. It is far higher than the rate reported in developed countries such as the United Kingdom (less than 2% from 200-2006) (Townsend et al.,

2008). The same is true for many other developed countries (Frange et al., 2014). African countries such as the Ivory Coast 3.28% (Lasme-Guillao et al., 2011), Cameroon 4.6% (Tsingaing et al., 2011), Mali 1.98% (Traore et al., 2011), Malawi 4.1% (Kim et al., 2013), South Africa 3.3% (Mnyani et al., 2014), Zambia 3.3% (Chibwesha et al., 2011) and Ethiopia 2.3% (Kassaw et al., 2020). Schumann at al. (2020) have presented very low rates of MTCT. Some countries have even reported having completely eliminated mother-to-child transmission of the virus (WHO, 2016, 2018).

Indeed, many studies have reported the existence of several factors that can lead to the absence of opportunities for the prevention of vertical transmission of HIV such as the lack of knowledge of the population on the prevention of mother-to-child HIV transmission, the antenatal service system and the HIV testing capacity of institutions, the monitoring method all correlated with underdevelopment (Peltzer et al., 2011).

The vast majority (86%) of the newborns included in this study were between 0 and 6 months old. This rate, close to national statistics, which gives 79.9% of screening in the first half of 2015, shows commendable efforts by the government to reduce the incidence of mother-to-child HIV transmission by providing CIPECs with equipment for this diagnosis and to review the plan to eliminate mother-to-child HIV transmission (CNLS, 2016).

Table 3. Multivariate analysis for logistics regression.

Parameter	Odds ratio (OR)	IC95%	P-value
Gender			
Male	-	-	-
Female	1.14	[0.49; 2.67]	0.75
Feeding mode			
Unprotected Breastfeeding	-	-	-
Protected Breastfeeding	0.26	[0.09; 0.70]	0.008
Alternative Foods	5.71	[0.88; 37.1]	0.06
PMTCT protocol for mothers			
Triprophylaxis	-	-	-
Tritherapy during pregnancy	0.8	[0.08; 7.47]	0.85
Tritherapy before pregnancy	1.2	[0.13; 10.08]	0.89
None	6	[0.73; 48.89]	0.09
PMTCT protocol for infants			
Monoprophylaxis	-	-	-
Triprophylaxis	3	[0.61; 14.58]	0.17
Mother's viral load			
<1000	-	-	-
>1000	10.73	[2.9; 39.0]	0.02
Undetectable	1.42	[0.35; 5.83]	0.619

This report also highlighted the gaps in the diagnosis which is justified by cases of children screened between 6 and 24 months. According to some authors, the socio-economic level of mothers, the low level of education and the non-involvement of the co-progenitor can constitute real obstacles (Mnyani et al., 2014; Morfaw et al., 2013; Tshikwej Ngwej et al., 2015).

The study of factors related to mother-to-child transmission of HIV shows a statistical association of mother-to-child transmission of HIV-1 with factors such as mother's PMTCT protocol, method of breastfeeding newborns, and the last viral load of mothers in the departments of Mono-Couffo in 2019.

The studies by Kassaw et al. (2020) and Mandelbrot et al. (2015) have already shown the effectiveness of WHO option B, which recommends the administration of antiretroviral treatment to all HIV-positive pregnant and breastfeeding women, regardless of CD4 cell count or clinical stage. However, in some regions of the world, such as the rural areas considered in this study, the effectiveness of the prenatal consultations recommended by the WHO is still a problem. Women lacking in means are unable to make antenatal consultations with no knowledge of serological status. Numerous studies have also highlighted the role of breastfeeding in the mother-to-child HIV 1 transmission (Moseholm and Weis, 2020; Operto, 2020) and that of the role of neonatal and child prophylaxis (Hurst et al., 2015). Regarding the method of

breastfeeding, social factors such as knowledge of the serological status by the husband or the in-laws play an enormous role in the choice of the method of breastfeeding despite medical advice, especially in rural areas (Bonvalet, 2011). It is also necessary to take into account the rural environment which, according to the WHO, influences compliance with PMTCT recommendations (Frange and Blanche, 2014). The studies by Saizonou et al. (2014) showed, for example, a good score for compliance with PMTCT in Cotonou, the economic capital of Benin (WHO, 2012).

It is therefore important to further strengthen current strategies in order to increase adherence of HIV-positive women to PMTCT guidelines. The study by Tudor et al. describes, for example, that integrated PMTCT services could effectively reduce mother-to-child HIV transmission (Car et al., 2012). Ibeziako et al. (2012) have shown that holistic but cost-effective prevention interventions helps reduce the rate of mother-to-child HIV transmission, even in economically developing countries (Ibeziako et al., 2012). These measures will achieve a reduction or even eradication of mother-to-child HIV transmission (Darak et al., 2012).

Conclusion

In pregnant women, routine screening is crucial to prevent any vertical transmission of HIV. In this study

Table 4. Distribution of newborn PCR results by gender.

Parameter	PCR result		Total (%)	Khi^2 test (%)
	Negative (%)	Positive (%)		
Female	159 (48.8)	12 (52.2)	171 (49)	
Male	167 (51.2)	11 (47.8)	178 (51)	0.460
Total	326 (100)	23 (100)	349 (100)	
Substitute foods	7 (2.1)	0 (0)	7 (2)	
Unprotected Breastfeeding	121 (37.1)	15 (65.2)	136 (39)	
Protected breastfeeding	195 (59.8)	6 (26.2)	201 (57.6)	0.0004
Mixed feeding	3 (0.9)	2 (8.7)	5 (1.4)	
Total	326 (100)	23 (100)	349 (100)	
1 year	2 (0.6)	0 (0)	2 (0.6)	
10 months	1 (0.3)	0 (0)	1 (0.3)	
1year ½	1 (0.3)	0 (0)	1 (0.3)	0.963
Not yet	322 (98.8)	23 (100)	345 (98.9)	
Total	326 (100)	23 (100)	349 (100)	
None	49 (15)	12 (52.2)	61 (1.5)	
Monoprophylaxis	9 (2.8)	0 (0)	9 (2.6)	
Triprophylaxis	24 (7.4)	1 (4.3)	25 (7.2)	
Tritherapy during pregnancy	120 (36.8)	4 (17.4)	124 (35.5)	0.0003
Tritherapy before pregnancy	124 (38)	6 (26.1)	130 (37.2)	
Total	326 (100)	23 (100)	349 (100)	
None	10 (3.1)	2 (8.7)	12 (3.4)	
Monoprophylaxis	315 (96.6)	21 (91.3)	336 (96.3)	
Triprophylaxis	1 (0.3)	0 (0)	1 (0.3)	0.348
Total	326 (100)	23 (100)	349 (100)	
< 1000	111 (34)	7 (30)	118 (34)	
> 1000	51 (16)	13 (57)	64 (18)	
Undetectable	164 (50)	3 (13)	167 (48)	0.002
Total	326 (100)	23 (100)	349 (100)	

covering two of Benin's twelve departments, it emerged that this protocol is truly effective for this prevention. However, studies still need to be conducted in the other departments of Benin in order to get a true picture of the situation. The existent preventing program has been in place since 2004; we should therefore think about monitoring this program while following the Deming wheel (Plan-Do-Check-Act) for a continuous improvement of its effectiveness.

ABBREVIATIONS

HIV, Human immunodeficiency virus; **DBS,** dry blood spots; **EDTA,** ethylene diamine tetra acetic; **RT-PCR,** reverse transcriptase-polymerase chain reaction; **PMTCT,** prevention of mother-to-child transmission; **CIPEC (in French),** Support Center for People Living with HIV; **OR,** odds ratio; **WHO,** word health organization.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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