**SCHOOL OF PUBLIC HEALTH**

**COLLEGE OF HEALTH SCIENCES**

**UNIVERSITY OF GHANA**

# RISK FACTORS FOR MOTHER-TO-CHILD TRANSMISSION OF HIV INFECTION IN GHANA: EVIDENCE FROM THE 2021-2022 HIV POSITIVE BABIES AUDIT

**BY**

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## DECLARATION

I, Junia Ebo Tawiah, hereby declare that apart from references to other people's works that have been duly acknowledged, this dissertation undertaken under the supervision of Dr. Harriet Affran Bonful, School of Public Health, University of Ghana, is a result of my independent work and has not been submitted for the award of any degree in any institution.

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Junia Ebo Tawiah (Student)

Date: 7th April, 2023

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Dr. Harriet Affran Bonful (Supervisor)

Date: 7th April, 2023

## DEDICATION

I dedicate this dissertation to my lovely parents, Dr. Jonathan Ebo Tawiah and Mrs Mary Tawiah, for investing in my education and for their continual support.

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## ABSTRACT

**Background**: Globally, mother-to-child transmission (MTCT) remains the major route of HIV infection in pediatric populations. Sub-Saharan Africa accounts for about 90% of MTCT of HIV worldwide. Ghana has a high rate of MTCT of HIV despite global and national preventive measures that have been carried out over the years to reduce the rate.

**Objective:** This study aimed to examine the risk factors associated with MTCT of HIV in Ghana.

**Method:** A 1:1 unmatched case-control study was conducted using data from the 2021-2022 HIV Positive Babies Audit by the National AIDS/STI Control Programme. A total of 184 cases and 184 controls were included in the study. The data was coded, cleaned with Microsoft Excel 2016 and analysed using Stata IC (version 16.0). Only variables with missing values of 5% or less were used for the regression analyses. After univariable logistic regression analysis, all variables with p-values of $\leq 0.20$ were entered into multivariable logistic regression analysis. P value $< 0.05$ was considered statistically significant 95% confidence interval (CI).

**Results**: Not being on antiretroviral (ARV) prophylaxis (AOR=4.35,95% CI:2.41 – 7.83, $p < 0.001$) and having ARV prophylaxis for less than 12 weeks (AOR=75.70, 95% CI:17.18 – 333.62, $p< 0.001$) were independently associated with the risk of MTCT of HIV.

**Conclusion:** ARV prophylaxis for the HIV-exposed baby is key for reducing the burden of MTCT of HIV in Ghana. All HIV-exposed babies in Ghana should be put on ARV prophylaxis for 12 weeks.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AIDS | Acquired Immune Deficiency Syndrome |
| ANC | Ante Natal Clinic |
| AOR | Adjusted Odds Ratio |
| ART | Antiretroviral Therapy |
| ARV | Antiretroviral |
| COR | Crude Odds Ratio |
| DNA | Deoxyribonucleic Acid |
| EID | Early Infant Diagnosis |
| EMTCT | Elimination of Mother-To-Child Transmission |
| GAC | Ghana AIDS Commission |
| HAART | Highly Active Antiretroviral Therapy |
| HIV | Human Immunodeficiency Virus |
| JICA | Japanese International Cooperation Agency |
| MOH | Ministry of Health |
| MTCT | Mother-To-Child Transmission |
| NACP | National AIDS/STI Control Programme |
| OR | Odds Ratio |
| PCR | Polymerase Chain Reaction |
| PMTCT | Prevention of Mother-to-Child Transmission |
| RNA | Ribonucleic Acid |
| STI | Sexually Transmitted Infection |
| UNAIDS | Joint United Nations Programme on HIV/AIDS |
| UNICEF | United Nations International Children's Emergency Fund |
| WHO | World Health Organization |

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# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the study

Globally, Human Immunodeficiency Virus (HIV) remains an infection of public health concern. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), over 38.4 million people worldwide were living with HIV in 2021, with 54% being women (UNAIDS, 2022). The World Health Organization (WHO) reported that pregnant women and children (0-14 years) who had HIV in 2021 were about 1.3 million and 1.7 million (WHO, 2022). 650,000 people worldwide died from HIV/AIDS-related illnesses in 2021, the majority coming from sub-Saharan Africa (UNAIDS, 2022).

Even though HIV is largely transmitted through unprotected anal and vaginal sexual contact with an infected person, other modes of transmission include transfusion of contaminated blood, sharing of contaminated sharp equipment, and transmission from an HIV-positive mother to her baby during pregnancy, childbirth, or postnatally via breastfeeding (Beyene et al., 2018). The latter, referred to as mother-to-child transmission (MTCT) or vertical transmission, remains the foremost mode of HIV transmission among pediatric populations, accounting for about 95% of pediatric HIV cases (Hurst et al., 2015). In the absence of prevention measures, approximately 15% to 45% of babies delivered by mothers living with HIV get infected (WHO, 2020). It is estimated that about 20-25%, 35-50% and 25-45% of vertical transmission of HIV occur in utero, during delivery, and through breastfeeding, respectively (Luzuriaga & Mofenson, 2016).

According to the United Nations International Children's Emergency Fund (UNICEF), since 2010, new HIV infections among children under five worldwide have declined by 50% - from 320,000

in 2010 to 160,000 in 2021 (UNICEF, 2022). Among the 35 UNICEF HIV priority countries, there was a 54% decline in new infections in children (0-5 years) – from 230,000 in 2010 to 130,000 in 2021. This decline has been due to global interventions such as the introduction of the 'Global Plan towards the Elimination of New HIV Infections among Children and Keeping their Mothers Alive' in 2011, largely because of increased access to Prevention of Mother-to-Child Transmission (PMTCT)-related services and increased number of pregnant HIV-positive women being initiated on lifelong antiretroviral medications. Other programmes included the 'Super-Fast-Track Framework to end AIDS in Children, Adolescents and Young Women by 2020' jointly led by UNAIDS and the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). Since the start of PMTCT programmes, 2.9 million HIV infections and 1.5 million deaths have been averted among pregnant women and children (UNICEF, 2021).

Despite the progressive decline in MTCT of HIV globally due to PMTCT programmes, some regions, such as most Sub-Saharan African countries, have not achieved elimination of mother-to-child transmission (EMTCT) of HIV. Some risk factors associated with MTCT of HIV have been found in these countries. A retrospective case-control study conducted in Mozambique identified the time of antiretroviral therapy (ART) initiation and viral load during pregnancy and lactation as predictors of MTCT of HIV (Osorio et al., 2021). Decentralization of ART services was associated with low MTCT while poor access to infant ART prophylaxis was associated with high MTCT of HIV in Malawi according to Van Lettow and his colleagues (Van Lettow et al., 2018).

Ghana is yet to achieve EMTCT with a national MTCT of 20.8% recorded in 2020 according to the National AIDS/STI Control Programme (NACP) of the Ghana Health Service (GHS) (GHS/NACP, 2020). However, little research has been done to assess the risk factors associated

with MTCT of HIV in Ghana. This study therefore aims to examine the risk factors associated with MTCT of HIV in Ghana.

### 1.2 Problem Statement

MTCT of HIV remains a public health problem in Ghana to date. There were an estimated 3,683 new child HIV infections in Ghana in 2020 due to MTCT of HIV, giving a rate of 20.8%, according to the National AIDS/STI Control Programme (GHS/NACP, 2020).

Certain risk factors have been researched to be associated with MTCT of HIV. Mixed feeding, absence of infant ARV prophylaxis, home delivery, and absence of maternal ART have been found to increase MTCT (Kassa et al., 2018). Initiating ART in the third trimester and during labour or postpartum, compared to initiation of ART before pregnancy, increased the risk of MTCT. Similarly, the children of single mothers and the absence of postpartum neonatal ART prophylaxis were factors significantly associated with MTCT of HIV (Remera et al., 2021).

MTCT accounted for over 95% of the incidence of HIV in children (0-14 years) in Ghana in 2020 (NACP, 2020). Without appropriate treatment, over 50% of these HIV-infected children die before their 2$^{nd}$ birthday (WHO, 2021). About 2,962 children in Ghana died from HIV/AIDS in 2020 (GAC, 2021).

NACP and its international partners such as UNAIDS, UNICEF and PEPFAR have employed PMTCT interventions in Ghana to reduce MTCT of HIV including: prevention of HIV infection in women of childbearing age; prevention of unwanted pregnancies among HIV-infected women; prevention of HIV transmission from HIV-infected women to their infants; and provision of treatment, care and support to HIV-infected women, their infants and their families. Despite the PMTCT interventions, the MTCT rate in Ghana is still high and falls short of the 5% target required

for EMTCT for breastfeeding populations as set by WHO. Few studies have been conducted to know the risk factors accounting for the high MTCT rate of HIV in Ghana.

### 1.3 Justification of the study

This study presents the opportunity to identify and address the factors accounting for MTCT of HIV in Ghana. This is essential for eliminating MTCT of HIV in Ghana. For instance, the socio-demographic correlates of MTCT from the study will inform healthcare providers about which pregnant women are more likely to transmit the virus vertically. This will help streamline interventions for such populations.

Also, the data to be gathered is representative of the entire country and can be used to formulate or evaluate existing policies, practices and interventions aimed at controlling MTCT of HIV in the country. With growing interest in maternal and child health, it is expected that the data from the study will be used by organizations for advocacy and the provision of social services.

Lastly, the data from this study will form the basis for further research into MTCT of HIV.

### 1.4 Research Questions

1. What is the association between sociodemographic factors and MTCT of HIV in Ghana?
2. What is the association between clinical factors and MTCT of HIV in Ghana?
3. What is the association between antenatal factors and MTCT of HIV in Ghana?
4. What is the association between delivery-related factors and MTCT of HIV in Ghana?
5. What is the association between postnatal factors and MTCT of HIV in Ghana?

## 1.5 Objectives

### 1.5.1 General Objective

The overall aim of the study is to examine the risk factors associated with MTCT of HIV infection in Ghana

### 1.5.2 Specific Objectives

1. To assess the association between sociodemographic factors and MTCT of HIV in Ghana
2. To assess the association between clinical factors and MTCT of HIV in Ghana
3. To assess the association between antenatal factors and MTCT of HIV in Ghana
4. To assess the association between delivery-related factors and MTCT of HIV in Ghana
5. To assess the association between postnatal factors and MTCT of HIV in Ghana

### 1.6 Conceptual Framework

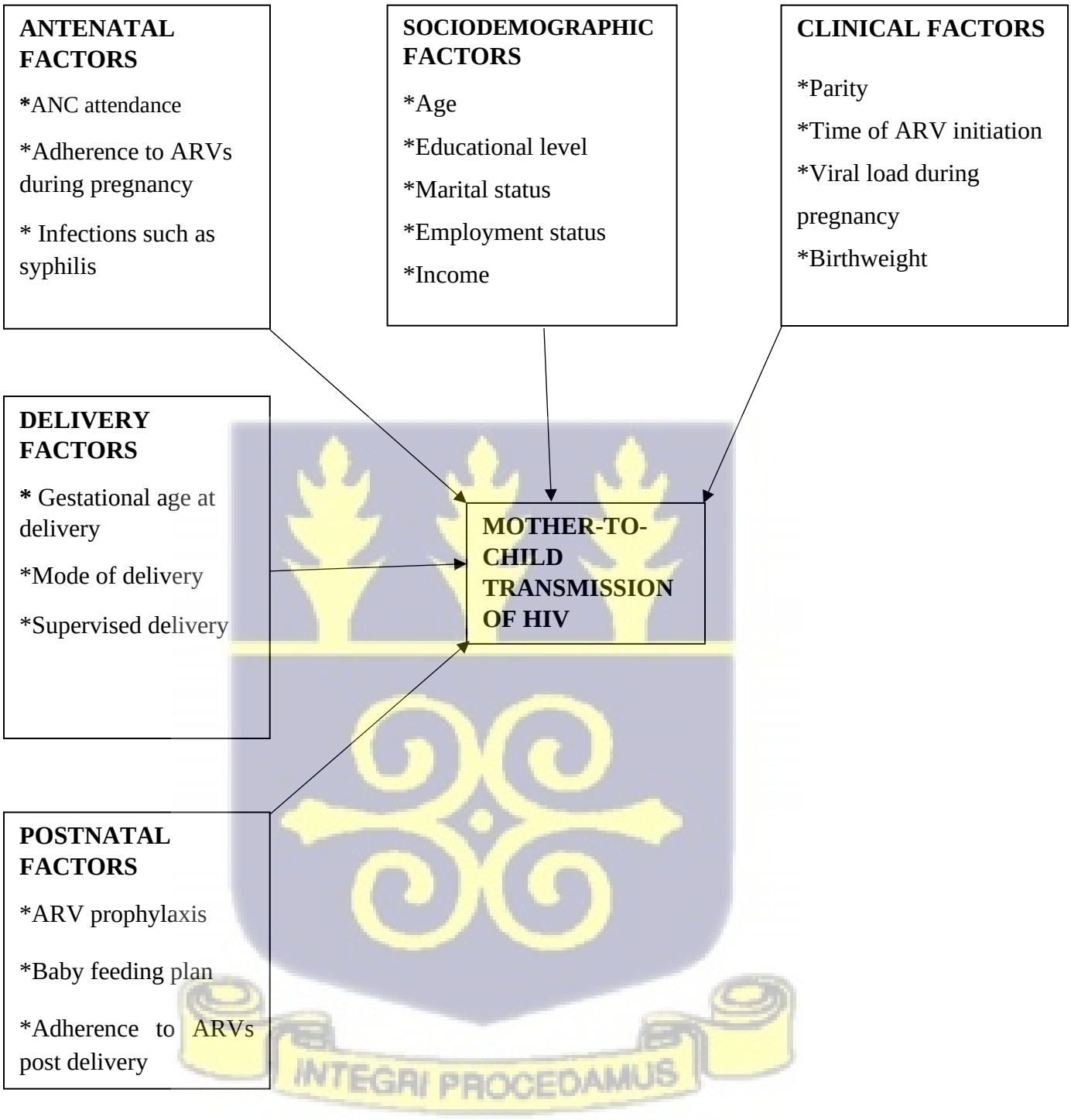


**Figure 1.6: Conceptual framework on the risk factors for MTCT of HIV**

**Source: Author's conceptualization**

### 1.7 Narrative on Conceptual Framework

MTCT of HIV is influenced by the mother's socio-demographic characteristics, clinical factors, antenatal, delivery-related and postnatal factors. For the socio-demographic characteristics, for example, HIV-positive mothers with higher education are more likely to adhere to their ARVs, possibly due to a better understanding of the benefits of the drugs in reducing HIV transmission to the baby. Again, married women are more likely to get support from their spouses in attending antenatal care and taking their ARVs compared to their unmarried counterparts. Also, women with employment are more likely to provide for themselves and afford transport fares to and from the hospital for ARVs compared to the unemployed who may not be able to afford transportation to the health centre sometimes. These missed appointments can result in ARV stock-outs which predispose them to MTCT of HIV.

Clinical factors such as high viral load and late initiation of ARVs are associated with a higher likelihood of MTCT of HIV. Poor adherence to ARVs during the antenatal period increases the likelihood of MTCT just as co-infection with other sexually transmitted infections such as syphilis. Delivery-related factors such as mode of delivery influence MTCT of HIV. For example, caesarian section as compared to spontaneous vaginal delivery reduces the risk of MTCT. Also, women who have supervised delivery have a reduced MTCT risk compared to unsupervised delivery. The exposed baby's weight is associated with MTCT with low-weight babies being at more risk. Post-natal factors such as ARV prophylaxis for the exposed baby reduce the likelihood of MTCT. Furthermore, the feeding plan for the exposed baby influences MTCT. Formula feeds only compared to mixed feeding and exclusive breastfeeding makes MTCT less likely since the baby does not take in the mother's breastmilk which could have HIV.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Overview of HIV Infection

Acquired Immune Deficiency Syndrome (AIDS) is caused by Human Immunodeficiency Virus (HIV). HIV belongs to the genus Lentiviruses, within the family of Retroviridae, and subfamily Orthoretroviridae (Styles et al., 2019). Based on genetic characteristics and differences in viral antigens, HIV is classified into two main types: HIV-1 and HIV-2. HIV-1 is more common and accounts for most AIDS cases. HIV-2 is less common and is concentrated in certain countries, especially in West Africa (Nguyen et al., 2016).

HIV/AIDS is a viral infection of global public health significance. About 38.4 million people were living with HIV worldwide in 2021, with over 15.5 million being women (UNAIDS, 2022). Globally, over 1.7 million children (0 – 14 years) were living with HIV in 2021 (UNAIDS, 2022). Mother-to-child transmission (MTCT) of HIV infection is the commonest mode of transmission of childhood HIV. Almost all HIV cases in children (0 - 14 years) are transmitted vertically (in utero, during labour and delivery, or through breastfeeding) (Afrane et al., 2021). In the absence of preventive interventions, about 30% of babies born to HIV-infected mothers become infected with HIV during pregnancy, childbirth or breastfeeding (WHO, 2021). The HIV MTCT rate without intervention is about 25.5%, however, this can be reduced to 0% to 2% through preventive interventions (Kariuki et al., 2017). About 95% of MTCT of HIV occurs in under-resourced regions, such as Sub-Saharan Africa (UNAIDS, 2021).

## 2.2 Mother-To-Child Transmission of HIV

Mother-To-Child Transmission of HIV (MTCT), also termed vertical transmission, is the transmission of HIV from the infected mother to her child (WHO, 2021). When the child is in contact with body fluids (including blood) from the HIV-infected mother, the child is susceptible to infection. According to WHO (2018), most HIV-positive children become infected through MTCT during pregnancy (before birth), delivery (during childbirth) or breastfeeding (after childbirth). The transmission can take place at three periods: in utero due to the transfusion of the fetus' blood in the placenta; during delivery when the baby crosses the birth canal and is in contact with the infected mother's blood and genital secretions; and during breastfeeding where cell-free and cell-associated viruses have been detected in breast milk (Hussen et al., 2022).

Placenta micro-transmission, which is the destruction of the blood barrier of the infant, is believed to facilitate MTCT (Nguyen et al., 2016). The precise cause of the transmission through the placenta is being researched. However, it seems to be associated with contractions during the initial stages of labour when the membranes rupture and ultimately, small quantities of maternal and foetal blood are exchanged. This exchange can lead to the transmission of HIV from the mother to the child (Milligan & Overbaugh, 2014). The majority of infections take place on the child's mucosal surface, such as the digestive system and the nasopharynx. During pregnancy, delivery and breastfeeding, the mucosal barrier is in close contact with the HIV-containing body fluids of the mother and has the time and opportunity for the transmission to happen (Milligan & Overbaugh, 2014).

In general, the risk of infection is 20% in the prepartum period and ranges from 45 – 50% in the postpartum period. The risk is 15 – 25% in developed countries and 25 – 45% in developing countries. This variance is chiefly due to the transmission of the infection through breastfeeding

by HIV-infected women in developing countries (WHO, 2021). In the prepartum period, malnutrition during pregnancy results in decreased immune response to the HIV. Reducing viral suppression means increasing viral load in the plasma and thus increasing the risk of vertical transmission (Nguyen et al., 2016).

MTCT of HIV can be prevented and reduced to the barest minimum when gravid women have access to PMTCT services during pregnancy, childbirth, and breastfeeding. With adequate funding, trained workforce and available resources, new pediatric infections can be prevented (Vrazo, Sullivan & Ryan-Phelps, 2018).

### 2.2.1 The Global Situation

HIV/ AIDS remains a public health problem in the world with over 38 million people infected with HIV/AIDS globally in 2021, including about 1.7 million children under 14 years of age (WHO, 2022). Most of these children became infected by their HIV-positive mothers during pregnancy, delivery, or breastfeeding (UNAIDS, 2022). Worldwide, 650,000 people died from HIV/AIDS-related conditions in 2021, with about 120,000 being children (UNAIDS, 2022). Although significant progress has been made in the prevention of new HIV infections (especially among children) and in reducing the number of annual HIV/AIDS-related deaths, HIV remains a significant global public health problem (Granich et al., 2015).

### 2.2.2 Sub- Saharan African Situation

Sub-Saharan Africa continues to be the worst affected region by HIV/AIDS despite having about 10% of the world's population (Kharsany & Karim, 2016). The United Nations Programme on HIV/AIDS, in 2008, reported that about two-thirds of all infected people worldwide were found in sub-Saharan Africa, with 1.9 million people being newly infected (91% being children) (UNAIDS, 2021). In 2020, it was estimated that about 37 million people were infected with HIV globally, 53% being women and more than two-thirds coming from sub-Saharan African countries. Of the 37 million people, over 1.7 million were children under 15, most of them from Sub-Saharan Africa (UNAIDS, 2021).

### 2.2.3 The Situation in Ghana

Ghana is a part of the sub-Saharan African region (which accounts for the majority of MTCT of HIV worldwide) (Dako-Gyeke et al., 2016). About 345,599 people were living with HIV in Ghana in 2021, giving a national prevalence of 1.67% (GAC, 2021). Women and children (under 14 years) formed 60% and 8% respectively of the number of HIV-infected Ghanaians in 2021. Over 9,859 persons died from HIV/AIDS-related deaths in the same year, with about 26% being children (GHS/NACP, 2021). There were 16,938 new HIV infections in Ghana in 2021, with 2,949 of these happening in children. MTCT accounted for about 95% of the new HIV infections in the pediatric population (UNAIDS, 2021). In 2021, the MTCT rate of HIV was 15.3% at the national level, with some regions in the country doing better and others worse compared to the national average (GHS/NACP, 2021).

The national HIV MTCT rate has been progressively reducing over the years owing to PMTCT interventions by the GAC, NACP and their internal partners such as WHO, UNAIDS, UNICEF,

and Japanese International Cooperation Agency (JICA) (GHS/NACP, 2021). In 2013, new HIV infections among children had declined by 76% in Ghana (UNAIDS, 2013). Despite the significant progress over the years, the HIV MTCT rate in recent years (estimated at 15.3% in 2021) still falls short of the target the Ministry of Health (MOH), GAC and NACP is working towards - elimination of MTCT of HIV (EMTCT) by 2030 (GHS/NACP, 2021). WHO has set an impact criterion of a rate of less than 5% in breastfeeding populations, for a country to be declared as having achieved EMTCT (WHO, 2021). Ghana just like many other sub-Saharan countries is yet to achieve this target.

### 2.3 Prevention and Elimination of Mother-To-Child Transmission

Prevention of Mother-To-Child Transmission (PMTCT) services is a top priority for HIV prevention in many countries worldwide. PMTCT aims to provide a comprehensive continuum of promotive, preventive, clinical and supportive services together with other public health interventions to preserve the health of the mother and prevent MTCT of HIV (GHS/NACP, 2019).

In recent years, PMTCT interventions have been strengthened towards the Elimination of mother-to-child transmission (EMTCT), which has been identified as a global public health priority in the context of the rights of a child to be born free of HIV (UNAIDS, 2021). The goal of EMTCT initiatives is to ensure services to reduce and maintain the MTCT of HIV at a very low level of little public health significance. EMTCT of HIV is key to the global effort of combating sexually transmitted infections and ending AIDS by the year 2030 (WHO, 2019). Validation of EMTCT of HIV by WHO requires that countries achieve country-level evidence of the EMTCT validation process indicator targets for two years and validation impact indicator targets for one year.

The minimum EMTCT impact targets as specified by the WHO are: less than 50 new pediatric infections per 100,000 live births; a transmission rate of less than 5% in breastfeeding populations or less than 2% in non-breastfeeding populations (WHO, 2021).

The four process indicators of EMTCT to be achieved are: population-level antenatal care coverage of more than or equal to 95%; coverage of HIV testing of pregnant women of more than or equal to 95%; ART coverage of HIV-positive pregnant women of more than or equal to 95% (WHO, 2021).

The components of the EMTCT strategy adopted are: primary prevention of HIV infection in women of childbearing age; prevention of unplanned pregnancies among HIV-infected women; prevention of HIV transmission from HIV-infected women to their infants; provision of treatment, care and support to HIV-infected women, their infants and their families (GAC, 2021).

While countries such as Thailand, Maldives, Belarus, Sri Lanka, Armenia, Moldova, and Cuba among other European and Asian countries have achieved MTCT of HIV, most sub-Saharan countries including Ghana are yet to meet the WHO set target for EMTCT of HIV, with the MTCT rate in Ghana being 15.3% in 2021 (WHO, 2022; GHS/NACP, 2021).

### 2.4 Risk Factors for MTCT

It is known that even without any preventive intervention, about 60% of pregnancies of HIV-infected mothers will not end in MTCT (WHO, 2021). Research has revealed that many factors affect the chances of MTCT of HIV, making it more or less likely (Hurst et al., 2015; Kassa et al., 2018). Some of these factors are discussed below:

### 2.4.1 Sociodemographic factors

Sociodemographic factors such as the employment status of the HIV-positive mother influence the chances of MTCT. According to a study done in Rwanda, children born to HIV-infected mothers working in the private sector had an increased likelihood of HIV infection than those born to mothers without employment (Nderelimana et al., 2021). The marital status of an HIV-infected woman and her partner's involvement in their healthcare affects the likelihood of MTCT. Concerning partner participation in PMTCT services utilization, women with low spousal participation in PMTCT were almost 6 times more likely to infect their infants with HIV as opposed to women with higher spousal participation (Hussen et al., 2022). MTCT is also influenced by the residence of the HIV-positive mother. HIV-infected mothers who were rural residents had higher odds of HIV transmission to their offspring in comparison with their counterparts who were urban residents (Hussen et al., 2022). HIV-exposed infants who were rural dwellers in comparison with those infants who were urban dwellers were significantly associated with HIV infection (De Lemos et al., 2013).

### 2.4.2 Clinical factors

**Parity**

The HIV-infected woman's parity was shown to be associated with MTCT with nulliparous women having a higher risk to transmit HIV to their infants. An explanation for this finding could be the observation of longer and more complicated labour in primiparous women compared to multiparous women (Teshale et.al, 2021).

**Time of ARV initiation**

The time of initiating ART for the HIV-infected mother influences MTCT (Technau et al., 2014; Sagay et al., 2015). Technau and his research team found early ART initiation during pregnancy reduced the likelihood of MTCT of HIV.

**Viral load during pregnancy**

Advanced clinical stages of HIV/AIDS results in low immunity, low CD4 count, high viral load and consequent increased risk of MTCT of HIV (Tadewos et al., 2017). Infants of mothers with HIV WHO clinical stage I and II had a higher tendency of getting HIV-infected, with odd ratios of 1.54 and 1.24 respectively (Nderelimana et al., 2021). A low CD4 count indicates an advanced stage of HIV/AIDS and is also a risk factor for MTCT (Delicio et al., 2011). Viral load is the current gold standard for monitoring response to ARVs as CD4 counts are no longer used (Afrane et al., 2021). Viral suppression in pregnancy reduces the risk of MTCT, hence the importance of viral load being checked (Osorio et al., 2021).

**Birthweight**

Low birth weight was associated with higher likelihood of MTCT in studies in Asia and Europe (Xiao et al., 2015; Marcu et al.,2022).

**2.4.3 Antenatal factors**

**Antenatal attendance**

HIV-positive mothers with no ANC attendance were 4.6 times more likely to infect their infants with the virus than mothers who attended ANC (Yitayew et al., 2019). HIV-infected mothers with one ANC visit were about 2 times more likely to infect their children. (Nderelimana et al., 2021).

**Adherence to Antiretrovirals**

Maternal ART was associated with reduced odds of HIV MTCT (De Lemos et al., 2013). The odds of MTCT were 5.7-fold more likely in HIV-positive women without ARV therapy than in those on ARV therapy before childbirth (Yitayew et al., 2019). Also, the likelihood of HIV transmission was more than 8 times higher in HIV-positive mothers with poor adherence to ART than their counterparts with good adherence to ART (Hussen et al., 2022). Infants of mothers with poor adherence to ART had 1.5-fold increased odds of becoming HIV-infected at birth compared with infants of mothers with good adherence (Nderelimana et al., 2021).

**Sexually Transmitted Infections such as syphilis**

It is proven that both ulcerative and non-ulcerative STIs increase HIV transmission (Ellington et al., 2011). Inflammation of the maternal genital tract mucosal lining, as happens in genital ulcer disease, has been shown to increase MTCT independently (John et al., 2011). Syphilis and herpes are both associated with genital lesions which increase local inflammation and genital shedding of HIV (Lehman et al., 2017). A study in the Ukraine among 521 HIV-infected pregnant women found that syphilis was associated with a five-fold increase in MTCT of HIV (Thorne et al., 2018).

**2.4.4 Delivery-Related factors**

**Gestational age at delivery**

The gestational age at delivery was independently associated with MTCT with those born preterm (before 37 completed weeks) at higher risk (Marcu et al., 2022).

**Supervision of delivery**

Mothers who delivered at home were 4.2 times more likely to infect their infants with HIV as opposed to those who gave birth in a health centre (Yitayew et al., 2019). A pooled meta-analysis done in Ethiopia in 2018 revealed increased odds of HIV positivity among the infants of HIV-

infected mothers who had home delivery compared to infants of mothers who delivered at health centres under skilled supervision (Kassa, 2018). In 2022, another study in Ethiopia showed similar findings - women who delivered at home were 6 times more likely to infect children in contrast with those who gave birth in a hospital (Hussen et al., 2022).

**Mode of delivery**

The different modes of delivery have been shown in literature to have different risks of MTCT. Assisted vaginal delivery was found to have a 6.87 folds higher risk of MTCT of HIV in contrast with those delivered by spontaneous vaginal delivery in a study in Ethiopia (Alachew et al., 2019). A systemic review and metanalysis of HIV-infected pregnant women found elective caesarean section to be protective against MTCT of HIV (Kennedy et al., 2017).

### 2.4.5 Postnatal factors

**Antiretroviral prophylaxis**

Postnatal factors such as antiretroviral (ARV) prophylaxis for the infant influence MTCT in the postpartum period. Giving ARV prophylaxis to the infant had an independent association with reduced odds of HIV infection (De Lemos et al., 2013). The odds of getting HIV were 5.3-fold higher in children without Nevirapine (NVP) prophylaxis in comparison with those who had NPV (Yitayew et al., 2019). A meta-analysis disclosed that infants without ARV prophylaxis were more probable to become HIV-positive compared with those on prophylaxis (Kassa, 2018). Good adherence to NVP prophylaxis was found to lower the likelihood of MTCT of HIV (Ngwende et al., 2013). Again, infants put on ARV prophylaxis after six weeks post-delivery were about 5-fold more likely to become HIV infected than those put on prophylaxis at an earlier time (Hussen et al., 2022).

**Baby feeding plan**

The feeding option for the exposed infant is very vital since about half of MTCT of HIV occurs during breastfeeding (WHO, 2022). In comparison to infants who were not breastfed, breastfeeding was shown to be marginally associated with increased odds of MTCT in a retrospective cohort study of 561 HIV-exposed infants in North-Eastern Brazil (De Lemos et al., 2013). In Ethiopia, mixed feeding increased the risk of MTCT compared to exclusive breastfeeding in a research that involved 3688 HIV-exposed infants (Kassa et al., 2018). Exclusive breastfeeding for less than 6 months was found to be protective against MTCT (Ngwende et al., 2013). Similarly, children on mixed feeding were ten times more likely to be HIV-positive compared to those on exclusive breastfeeding (De Lemos et al., 2013).

# CHAPTER THREE

# METHODS

## 3.1 Study Design

The study adopted a 1:1 unmatched case-control design using secondary data from the 2021/2022 HIV Positive Babies Audit by the NACP.

## 3.2 Study Area

This study involved analysis of secondary data obtained from the 2021-2022 HIV Positive Babies Audit by the National AIDS/STIs Control Programme (NACP). The audit was conducted in 5 regions of Ghana, namely Upper East, Bono East, Bono, Central, and Volta regions. These were the regions with the available data for the study.

The Upper East Region is the second smallest region in Ghana with a population of 1,011,545 as of 2021 according to the Ghana Statistical Services (GSS) (GSS, 2021). It has 15 districts, 543 PMTCT centres, 552 HIV testing centres, 28 ART centres and 352 Early Infant Diagnosis (EID) services centres (GHS/NACP, 2021). Its capital city is Bolgatanga.

The Bono Region has a population of 1,046,545. It has 12 districts, 171 PMTCT centres, 182 HIV testing centres, 44 ART centres and 117 EID centres. Its capital city is Sunyani.

The Bono East Region has a population of 1,016,515. It has 11 districts, 176 PMTCT centres, 195 HIV testing centres, 14 ART centres and 73 EID centres. Its capital city is Techiman.

The Central Region has a population of 2,201,863. It has 17 districts, 639 PMTCT centres, 625 HIV testing centres, 112 ART centres and 190 EID centres. Its capital city is Cape Coast.

The Volta Region has a population of 2,016,545. It has 25 districts, 393 PMTCT centres, 412 HIV testing centres, 44 ART centres and 130 EID centres. Its capital city is Ho.


**Figure 3.2: Map of Ghana showing its 16 regions**

***Source: The Permanent Mission of Ghana to the UN, 2022***

### 3.3 Study Population

The study population consisted of all HIV-exposed children (0-5 years) and their HIV-infected mothers from the selected regions.

An HIV-exposed child was defined as a child born to an HIV-positive mother (WHO, 2018)

#### 3.3.1 Inclusion Criteria

All HIV-exposed children (0-5 years) who were diagnosed as positive by either DNA PCR or antibody test between January 2021 and June 2022 were included in the study. HIV-exposed children 18 months to 5 years with negative antibody test at least 3 months after complete cessation of breastfeeding between January 2021 and June 2022 were also included.

#### 3.3.2 Exclusion Criteria

HIV-exposed children whose antenatal/delivery records were not available were excluded from the study.

#### 3.3.3 Case Definition

A case was defined as an HIV-exposed child with a positive DNA PCR test from birth to at least 3 months after complete cessation of breastfeeding if less than 18 months or a positive antibody test at 18 months or older if breastfeeding was completely ceased at least 3 months earlier.

#### 3.3.4 Control Definition

A control was defined as an HIV-exposed child with a negative antibody test at 18 months or older, at least 3 months after complete cessation of breastfeeding.

### 3.4 Sample Size

All the cases that met the eligibility criteria were included in the study. A total of 184 cases were recruited – 33 (Bono), 35 (Bono East), 25 (Central), 48 (Upper East) and 43 (Volta). For each case that was recruited from the regions, one control was recruited - resulting in 368 subjects (184 cases and 184 controls).

### 3.5 Sampling

A census approach was used to select all the cases (184). Corresponding controls were selected by simple random sampling (184 out of 237).

### 3.6 Data Extraction and Processing

Secondary data were extracted from the 2021/2022 HIV Positive Babies Audit by the NACP (conducted between January 2021 and June 2022) for the study. The extraction period lasted a week – from 15th to 22nd February, 2023. The raw data consisted of: the date and place (Region/Municipality/Health facility) of the audit; the socio-demographic characteristics, antenatal, delivery and postnatal details of the HIV-infected mother; the date of HIV testing and result of the exposed infant; the current health status of the infant and mother; the mother's sexual partner's HIV status; number of children tested for HIV and their results. The data contained 56 variables of 184 HIV-positive and 237 HIV-negative infants and their respective HIV-infected mothers, arranged in columns in a Microsoft Excel worksheet. Some of the entries were categorical (ordinal/nominal) and others numerical (continuous/discrete) based on the type of variable.

The raw data were reconstructed through variable selection, data cleaning and transformation to obtain the final dataset for the study. Variables of interest that addressed the study objectives were extracted using the abstraction sheet in Appendix I (adopted from the NACP HIV Audit tool in Appendix II). Variables such as the mother's sexual partner's HIV status, contraceptive usage

before pregnancy, gestational age at ART initiation, peripartum complications, duration of labour, dosage of ARV prophylaxis given, mother and child's current health status were not extracted on account of paucity of information from the audit.

The abstracted data were coded and cleaned using Microsoft Excel 2016. All the variables of interest were recoded into categorical data. Where an inferential statistical report on the mean was needed the original numerical data was maintained in addition to the generated categorical format. A detailed description of how the variables were coded is shown in Table 3.7.

### 3.7 Variables

The variables in this study were categorized into dependent and independent variables.

#### 3.7.1 Dependent Variable

The dependent variable of this study was the mother-to-child transmission (MTCT) of HIV infection as evidenced by the HIV positivity of an exposed child (Table 3.7).

#### 3.7.2 Independent Variables

The independent variables were classified as socio-demographic characteristics, antenatal factors, clinical factors, delivery factors and post-natal factors (Table 3.7)

**Table 3.7: Definition of variables and scale of measurement**

| Variables | Operational Definition | Type of Variable | Measurement |
|---|---|---|---|
| **Dependent Variable** | | | |
| Mother-to-child transmission of HIV | HIV positivity of an exposed child | Ordinal Categorical | 1= HIV-positive (case)<br>2= HIV-negative (control) |
| **Independent Variable** | | | |
| ***Maternal Socio-Demographics*** | | | |
| Age | Mother's age at index pregnancy | Ordinal Categorical | 1=Less than 24 years<br>2=25-34 years<br>3=35years and above |
| Educational Level | Mother's highest educational level | Ordinal Categorical | 1= None<br>2= Basic<br>3=Senior High and above |
| Marital Status | Mother's marital status | Nominal Categorical | 1= Single<br>2= Married<br>3= Other (Co-habiting, Separated, Widowed, Divorced) |
| Employment | Mother's employment status | Nominal Categorical | 1= Employed<br>2= Unemployed |
| Income level | Mother's monthly income | Ordinal categorical | 1= Less than Ghc500<br>2= Ghc500 to Ghc1000<br>3= More than Ghc1000 |
| ***Clinical factors*** | | | |
| Parity | Number of deliveries the mother has had in her lifetime | Ordinal categorical | 1= 0<br>2= 1-2<br>3= 3 or more |
| Viral load during pregnancy | Mother's viral load during pregnancy | Ordinal categorical | 1=Suppressed (≤1000 copies/ml)<br>2=Unsuppressed (> 1000 copies/ml) |
| Time of ARV initiation | Time mother started taking ARVs | Nominal categorical | 1=Preconception<br>2=During pregnancy<br>3=Post delivery |
| Birth weight | Baby's weight at birth (in kg) | Ordinal categorical | 1=Less than 2.5<br>2=2.5 and above |
| ***Antenatal factors*** | | | |
| Antenatal attendance | Whether mother attended ANC or not | Nominal categorical | 1=Yes<br>2=No |
| Adherence to ARV during pregnancy | Mother's adherence to ARVs | Ordinal categorical | 1= Good (no missed dose in a month)<br>2= Poor (missed dose in a |

| | | | |
|---|---|---|---|
| | | | month) |
| Syphilis Status | Whether mother tested positive for syphilis or not during pregnancy. | Nominal categorical | 1=Negative<br>2=Positive |
| ***Delivery factors*** | | | |
| Gestational age at delivery | The gestational age at which mother delivered baby (in weeks) | Ordinal categorical | 1=Preterm (< 37)<br>2=Term (37 – 42)<br>3=Post-term (> 42) |
| Mode of delivery | Mother's mode of delivery | Nominal categorical | 1=Spontaneous vaginal delivery<br>2=Assisted vaginal delivery<br>3=Caesarian section |
| Supervised delivery | Supervision of delivery by trained health staff or not | Nominal categorical | 1=Yes<br>2=No |
| ***Postnatal factors*** | | | |
| ARV prophylaxis | What type ARV prophylaxis was given to the baby | Nominal categorical | 1=None<br>2=Zidovudine + Nevirapine<br>3=Zidovudine/Nevirapine only |
| Adherence to baby's ARV prophylaxis | How well the baby was given the ARV prophylaxis | Ordinal categorical | 1= Good (no missed dose in a month)<br>2= Poor (missed dose in a month) |
| Duration of ARV prophylaxis | How long baby was on ARV prophylaxis (in weeks) | Ordinal categorical | 1= 0<br>2= >0 but less than 12<br>3= 12 |
| Baby feeding plan | Mode used in feeding the baby | Nominal categorical | 1= Exclusive breastfeeding<br>2= Mixed feeding<br>3= Formula feeding |
| Adherence to ARV post delivery | Mother's adherence to ARVs | Ordinal categorical | 1= Good (no missed dose in a month)<br>2= Poor (missed dose in a month) |

### 3.8 Data Analysis

The coded and cleaned data were exported into Stata version 16 for data analysis. Descriptive statistics including mean (standard deviation) were used for the numeric variables. Frequency and percentages were presented for categorical variables.

The outcome variable was dichotomized as "Cases (HIV-positive child)" and "Controls (HIV-negative child)". Association between the risk factors (exposure) and MTCT of HIV (outcome) was determined using Pearson's chi-square ($\chi 2$) or Fisher's exact tests where appropriate. A p-value $\leq 0.05$ was considered statistically significant at 95% confidence interval. Univariable logistic regression analysis was performed on the variables. Variables with p-values of $\leq 0.20$ were entered into multivariable logistic regression analysis. Only variables with missing values of 5% or less were used for all the regression analyses. P value $< 0.05$ was considered statistically significant at 95% confidence interval.

The variables that were excluded from the logistic regression analysis on account of having missing values of more than 5% included monthly income, educational level, birthweight, time of ARV initiation, syphilis status, viral load during pregnancy, antenatal clinic attendance, adherence to ARVs during pregnancy, gestational age at delivery, adherence to ARV prophylaxis for baby, baby feeding option and adherence to ARVs post-delivery.

### 3.9 Ethical Consideration

Ethical issues involved in the study were as follows:

#### 3.9.1 Ethical Clearance

Ethical clearance for the study was obtained from the Ghana Health Service Ethics Review Committee (GHS-ERC-025/01/23) (Appendix III).

### 3.9.2 Permission from the Study Site

Permission was sought from the National AIDS/STIs Control Programme (NACP) for the data extraction.

### 3.9.3 Confidentiality and anonymity

Codes were used to anonymize the dataset. All information obtained has been kept private and confidential by restricting access only to the researcher.

### 3.9.4 Data Storage and Protection

The data has been secured under electronic data management systems protected by passwords.

### 3.9.5 Results Dissemination

The findings from the study will be made available to policy stakeholders such as the NACP as well as published in different publications. This would enhance efforts towards the elimination of mother-to-child transmission of HIV in Ghana.

### 3.9.6 Conflict of Interest

There is no conflict of interest.

### 3.9.7 Funding

The entire work was funded by the researcher.

# CHAPTER FOUR

# RESULTS

## 4.1 Sociodemographic characteristics of the HIV-infected mothers

This study involved 184 cases and 184 controls in a 1:1 ratio for the selected regions. The mean age of the HIV-infected mothers was 31.1 ± 6.3 years with the majority being within the ages of 25-34 years, 58.2% for cases and 54.9% for controls. Comparatively, there were more married women among the controls (71.2%) than in the cases (59.2%). Most of the mothers, in both cases (59.3%) and controls (67.2%) were employed, with the majority earning less than GHS 500.00 per month. More mothers in the control group (34.4%) had at least senior high education compared to those in the cases group (32.5%) (Table 4.1).

**Table 4.1: Sociodemographic characteristics of HIV-infected mothers**

| Variables | MTCT of HIV | |
|---|---|---|
| | **Cases** N=184(%) | **Controls** N=184(%) |
| **Region** | | |
| Bono | 33(17.9) | 33(17.9) |
| Bono East | 35(19.0) | 35(19.0) |
| Central | 25(13.6) | 25(13.6) |
| Upper East | 48(26.1) | 48(26.1) |
| Volta | 43(23.4) | 43(23.4) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Age group (years)** | | |
| Mean age ± SD | 31.1 ± 6.3 | |
| 24 and below | 32(17.4) | 26(14.1) |
| 25 – 34 | 107(58.1) | 101(54.9) |
| 35 and above | 45(24.5) | 57(31.0) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Marital status** | | |
| Married | 109(59.2) | 131(71.2) |
| Single | 31(16.9) | 24(13.0) |
| Other | 44(23.9) | 29(15.8) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Employment type** | | |
| Employed | 105(59.3) | 117(67.2) |
| Unemployed | 72(40.7) | 57(32.8) |
| **Sub-total** | 177(100.0) | 174(100.0) |
| **Monthly Income Level** | | |
| < GH₵ 500 | 68(63.6) | 66(52.8) |
| GH₵ 500-1000 | 34(31.8) | 46(36.8) |
| > GH₵ 1000 | 5(4.7) | 13(10.4) |
| **Sub-total** | 107(100.0) | 125(100.0) |
| **Educational Level** | | |
| No education | 42(36.8) | 36(28.1) |
| Basic | 35(30.7) | 48(37.5) |
| Senior High and above | 37(32.5) | 44(34.4) |
| **Sub-total** | 114(100.0) | 128(100.0) |

### 4.2 Clinical factors of the HIV-infected mothers

With regards to parity, among the cases, mothers with one and two children (56.5%) were more than those without children (7%). This was similar to the controls which were (49.5%) and (6.5%) respectively**.** Most of the HIV-infected mothers were started on ARVs before pregnancy for both cases (46.1%) and controls (57.5%). The controls were virally suppressed (95.2%) compared to the cases (38.89%) during pregnancy. The mean birthweight of children born to the mothers was 2.9 ± 4.9kg (Table 4.2).

**Table 4.2: Clinical factors of the HIV-infected mothers**

| **Variables** | **MTCT of HIV** | |
|---|---|---|
| | **Cases** N=184(%) | **Controls** N=184(%) |
| **Parity** | | |
| Mean ± SD | 2.3 ± 1.5 | |
| No child | 13(7.1) | 12(6.5) |
| 1-2 | 104(56.5) | 91(49.5) |
| 3 and above | 67(36.4) | 81(44.0) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Time of ARV Initiation** | | |
| Preconception | 71(46.1) | 104(57.5) |
| During pregnancy | 50(32.5) | 76(42.0) |
| Post delivery | 15(9.7) | 1(0.6) |
| Not on ARVs | 18(11.7) | 0(0.0) |
| **Sub-total** | 154(100.0) | 181(100.0) |
| **Viral load during pregnancy** | | |
| Suppressed | 7(38.9) | 59(95.2) |
| Unsuppressed | 11(61.1) | 3(4.8) |
| Sub-total | 18(100.0) | 62(100.0) |
| **Birthweight (kg)** | | |
| **Mean ± SD** | 2.9 ± 4.9 | |
| < 2.5 | 25(16.2) | 18(10.2) |
| 2.5 and above | 129(83.8) | 158(89.8) |
| **Sub-total** | 154(100.0) | 176(100.0) |

SD – Standard Deviation

### 4.3 Antenatal factors of the HIV-infected mothers

ANC attendance was higher in the controls (97.7%) in comparison to the cases (81.1%). Adherence to ARVs was good in the majority of controls (89.3%) but poor in the majority of the cases (80.4%). None of the mothers in the control group had syphilis while 3.1% of the cases were infected with syphilis (Table 4.3).

**Table 4.3: Antenatal factors of the HIV-infected mothers**

| Variables | MTCT of HIV | |
|---|---|---|
| | **Cases** N=184(%) | **Controls** N=184(%) |
| **ANC attendance** | | |
| Yes | 133(81.1) | 167(97.7) |
| No | 31(18.9) | 4(2.3) |
| **Sub-total** | 164(100.0) | 171(100.0) |
| **Adherence to ARVs during pregnancy** | | |
| Good | 22(19.6) | 159(89.3) |
| Poor | 90(80.4) | 19(10.7) |
| **Sub-total** | 112(100.0) | 178(100.0) |
| **Syphilis Status** | | |
| Negative | 151(96.8) | 110(100.0) |
| Positive | 5(3.2) | 0.(0.0) |
| **Sub-total** | 110(100.0) | 156(100.0) |

### 4.4 Delivery-related factors of the HIV-infected mothers

Most of the pregnancies were carried to term in both the cases (79.2%) and controls (80.4%). Majority of the mothers delivered by SVD in both cases (83.7%) and controls (77.2%) with the majority of the deliveries being supervised (89.1%) and (97.3%) in the cases and controls respectively (Table 4.4).

**Table 4.4: Delivery-related factors of the HIV-infected mothers**

| Variables | MTCT of HIV | |
|---|---|---|
| | **Cases** N=184(%) | **Controls** N=184(%) |
| **Gestational age at delivery (weeks)** | | |
| Mean ± SD | 38.3 ± 2.9 | |
| Term | 114(79.2) | 119(80.4) |
| Preterm | 28(19.4) | 19(12.8) |
| Post-term | 2(1.4) | 10(6.8) |
| **Sub-total** | 144(100.0) | 148(100.0) |
| **Mode of delivery** | | |
| Spontaneous vaginal delivery | 154(83.7) | 142(77.2) |
| Assisted vaginal delivery | 11(6.0) | 10(5.4) |
| Caesarian section | 19(10.3) | 32(17.4) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Supervised delivery** | | |
| Yes | 156(89.1) | 179(97.3) |
| No | 19(10.9) | 5(2.7) |
| **Sub-total** | 175(100.0) | 184(100.0) |

SD – Standard Deviation

### 4.5 Postnatal factors of the HIV-infected mothers and their exposed babies

The majority of the babies were given a combination of Zidovudine and Nevirapine among the cases (53.8%) and controls (89.7%). The ARV prophylaxis for the babies was given for a mean duration of 8.2 ± 4.9 weeks across both the cases and controls. Exclusive breastfeeding was more in both cases (59.4%) and controls (84.4%). Post-delivery adherence to ARVs by the mothers was poor among majority of the cases (65.9%) but good in the majority of the controls (92.9%) (Table 4.5).

**Table 4.5: Postnatal factors of the HIV-infected mothers and their exposed babies**

| Variables | MTCT of HIV | |
|---|---|---|
| | **Cases** N=184(%) | **Controls** N=184(%) |
| **Type of ARV prophylaxis for baby** | | |
| Zidovudine + Nevirapine | 99 (53.8) | 165 (89.7) |
| Nevirapine/Zidovudine only | 22 (12.0) | 16 (8.7) |
| Not on ARV prophylaxis | 63 (34.2) | 3 (1.6) |
| **Sub-total** | 184(100.0) | 184(100.0) |
| **Duration of ARV prophylaxis** | | |
| Mean ± SD | 8.2 ± 4.9 | |
| 12 weeks | 58(32.4) | 145(79.7) |
| >0 but <12 weeks | 58(32.4) | 34(18.7) |
| 0 | 63(35.2) | 3(1.7) |
| **Sub-total** | 179(100.0) | 182(100.0) |
| **Adherence to Child's ARV prophylaxis** | | |
| Good | 55(52.4) | 167(93.3) |
| Poor | 50(47.6) | 12(6.7) |
| **Sub-total** | 105(100.0) | 179(100.0) |
| **Baby Feeding Plan** | | |
| Exclusive Breastfeeding | 98(59.4) | 152(84.4) |
| Formula feeding | 2(1.2) | 3(1.7) |
| Mixed Feeding | 65(39.4) | 25(13.9) |
| **Sub-total** | 165(100.0) | 180(100.0) |
| **Adherence to ARVs post delivery** | | |
| Good | 43(34.1) | 169(92.9) |
| Poor | 83(65.9) | 13(7.1) |
| **Sub-total** | 126(100.0) | 182(100.0) |

**4.6 Bivariate analysis of association between the independent variables and MTCT of HIV**

Chi-square test analysis was conducted on all the independent variables to show association with MTCT of HIV using a p-value of 0.05. Marital status was the only sociodemographic factor that had an association with MTCT of HIV (Table 4.6a). Time of ARV initiation and viral load during pregnancy were the clinical factors that were significantly associated with MTCT of HIV (Table 4.6b). ANC attendance and adherence to ARVs during pregnancy were the antenatal factors that had association with MTCT of HIV (Table 4.6b). All the delivery-related and postnatal factors showed statistically significant association with MTCT of HIV except mode of delivery (Table 4.6b and Table 4.6c).

**Table 4.6a: Chi-square test of association between the sociodemographic factors and MTCT of HIV**

| Variables | MTCT of HIV | | $x^2$ | P-value |
|---|---|---|---|---|
| | Cases N=184(%) | Controls N=184(%) | | |
| **Region** | | | 0.0000 | 1.000 |
| Bono | 33(17.9) | 33(17.9) | | |
| Bono East | 35(19.0) | 35(19.0) | | |
| Central | 25(13.6) | 25(13.6) | | |
| Upper East | 48(26.1) | 48(26.1) | | |
| Volta | 43(23.4) | 43(23.4) | | |
| **Age group (years)** | | | 2.2055 | 0.332 |
| 24 and below | 32(17.4) | 26(14.1) | | |
| 25 – 34 | 107(58.1) | 101(54.9) | | |
| 35 and above | 45(24.5) | 57(31.0) | | |
| **Marital status** | | | 5.9898 | **0.049** |
| Married | 109(59.2) | 131(71.2) | | |
| Single | 31(16.9) | 24(13.0) | | |
| Other | 44(23.9) | 29(15.8) | | |
| **Employment type** | | | 2.3674 | 0.124 |
| Employed | 105(59.3) | 117(67.2) | | |
| Unemployed | 72(40.7) | 57(32.8) | | |
| **Monthly Income** | | | 4.0130 | 0.134 |
| < GH₵ 500 | 68(63.6) | 66(52.8) | | |
| GH₵ 500-1000 | 34(31.8) | 46(36.8) | | |
| > GH₵ 1000 | 5(4.7) | 13(10.4) | | |
| **Educational Level** | | | 2.3004 | 0.317 |
| No education | 42(36.8) | 36(28.1) | | |
| Basic | 35(30.7) | 48(37.5) | | |
| Senior High and above | 37(32.5) | 44(34.4) | | |

**Table 4.6b: Chi-square test of association between clinical and antenatal factors and MTCT of HIV**

| Variables | MTCT of HIV | | $x^2$ | P-value |
|---|---|---|---|---|
| | Cases N=184(%) | Controls N=184(%) | | |
| **Parity** | | | 2.2310 | 0.328 |
| No child | 13(7.1) | 12(6.5) | | |
| 1-2 | 104(56.5) | 91(49.5) | | |
| 3 and above | 67(36.4) | 81(44.0) | | |
| **Time of ARV Initiation** | | | 39.9211 | **<0.001[a]** |
| Preconception | 71(46.1) | 104(57.5) | | |
| During pregnancy | 50(32.5) | 76(42.0) | | |
| Post delivery | 15(9.7) | 1(0.6) | | |
| Not on ARVs | 18(11.7) | 0(0.0) | | |
| **Viral load during pregnancy** | | | 30.5966 | **<0.001[a]** |
| Suppressed | 7(38.9) | 59(95.2) | | |
| Unsuppressed | 11(61.1) | 3(4.8) | | |
| **Birthweight (kg)** | | | 2.6148 | 0.106 |
| 2.5 and above | 25(16.2) | 18(10.2) | | |
| <2.5 | 129(83.8) | 158(89.8) | | |
| **ANC attendance** | | | 24.5464 | **< 0.001[a]** |
| Yes | 133(81.1) | 167(97.7) | | |
| No | 31(18.9) | 4(2.3) | | |
| **Adherence to ARVs during pregnancy** | | | 142.2933 | **< 0.001** |
| Good | 22(19.6) | 159(89.3) | | |
| Poor | 90(80.4) | 19(10.7) | | |
| **Syphilis Status** | | | 3.5932 | 0.079[a] |
| Negative | 151(96.8) | 110(100.0) | | |
| Positive | 5(3.2) | 0.(0.0) | | |

[a]Fisher's exact test;

**Table 4.6c: Chi-square test of association between delivery-related and postnatal factors and MTCT of HIV**

| Variables | MTCT of HIV | | $x^2$ | P-value |
|---|---|---|---|---|
| | Cases | Controls | | |
| | N=184(%) | N=184(%) | | |
| **Gestational age at delivery** | | | 7.1106 | **0.024[a]** |
| Term | 114(79.2) | 119(80.4) | | |
| Preterm | 28(19.4) | 19(12.8) | | |
| Post-term | 2(1.4) | 10(6.8) | | |
| **Mode of delivery** | | | 3.8478 | 0.146 |
| Spontaneous vaginal delivery | 154(83.7) | 142(77.2) | | |
| Assisted vaginal delivery | 11(6.0) | 10(5.4) | | |
| Caesarian section | 19(10.3) | 32(17.4) | | |
| **Supervised delivery** | | | 9.5261 | **0.002** |
| Yes | 156(89.1) | 179(97.3) | | |
| No | 19(10.9) | 5(2.7) | | |
| **Type of ARV prophylaxis for baby** | | | 71.0028 | **< 0.001[a]** |
| Zidovudine + Nevirapine | 99 (53.80) | 165 (89.67) | | |
| Nevirapine/ Zidovudine only | 22 (11.96) | 16 (8.70) | | |
| Not on ARV prophylaxis | 63 (34.24) | 3 (1.63) | | |
| **Duration of ARV prophylaxis** | | | 98.0739 | **< 0.001[a]** |
| 12 weeks | 58(32.4) | 145(79.7) | | |
| > 0 but < 12 weeks | 58(32.4) | 34(18.7) | | |
| 0 | 63(35.2) | 3(1.7) | | |
| **Adherence to Child's ARV prophylaxis** | | | 64.9208 | **< 0.001** |
| Good | 55(52.4) | 167(93.3) | | |
| Poor | 50(47.6) | 12(6.7) | | |
| **Baby feeding plan** | | | 29.044 | **< 0.001** |
| Exclusive Breastfeeding | 98(59.4) | 152(84.4) | | |
| Formula feeding | 2(1.2) | 3(1.7) | | |
| Mixed Feeding | 65(39.4) | 25(13.9) | | |
| **Adherence to ARVs post delivery** | | | 119.7038 | **< 0.001** |
| Good | 43(34.1) | 169(92.9) | | |
| Poor | 83(65.9) | 13(7.1) | | |

[a]Fisher's exact test;

### 4.7 Crude and Adjusted Analysis of Factors Associated with MTCT of HIV

Univariable logistic regression analysis was performed on the independent variables with less than 5% of missing values as shown in Table 4.7a and Table 4.7b. Independent variables with p-values $\leq 0.20$ from the univariable logistic regression analysis were entered into a multivariable logistic regression analysis. Overall, six variables were included in the multivariable logistic regression analysis – Marital status; Employment status; Supervision of delivery; Mode of delivery; Type of ARV prophylaxis for baby; and Duration of ARV prophylaxis. Table 4.7b summarizes the results of the multivariable logistic regression analysis. Out of the six, the type of ARV prophylaxis and duration of ARV prophylaxis showed independent association with MTCT of HIV. Babies who were not given any ARV prophylaxis had 75.70 times increased odds of MTCT compared to babies who were put on a combination of Zidovudine and Nevirapine prophylaxis. Also, babies who were given ARV prophylaxis for less than 12 weeks had a 4.35-fold increased likelihood of MTCT of HIV compared to those who were given the ARV prophylaxis for 12 weeks (Table 4.7b).

**Table 4.7a: Univariable logistic regression analysis of the independent variables**

| Variables | COR (95%CI) | P-value |
|---|---|---|
| **Region** | | |
| Bono | Ref | |
| Bono East | 1.00(0.512 – 1.96) | 1.000 |
| Central | 1.00(0.48 – 2.09) | 1.000 |
| Upper East | 1.00(0.53 – 1.87) | 1.000 |
| Volta | 1.00(0.53 – 1.90) | 1.000 |
| **Age group (years)** | | |
| 25 – 34 | Ref | |
| 24 and below | 1.16(0.65 – 2.08) | 0.615 |
| 35 and above | 0.75(0.46 – 1.20) | 0.226 |
| **Parity** | | |
| No child | Ref | |
| 1-2 | 1.05(0.46 – 2.43) | 0.900 |
| 3 and above | 0.76(0.33 – 1.78) | 0.533 |

COR- crude odds ratio, 95% CI - 95% confidence interval

**Table 4.7b: Univariable and multivariable logistic regression analysis of factors associated with MTCT of HIV**

| Variables | COR (95%CI) | P-value | AOR (95%CI) | P-value |
|---|---|---|---|---|
| **Marital status** | | | | |
| Married | Ref | | Ref | |
| Single | 1.55(0.86 - 2.80) | 0.144 | 1.25(0.59 – 2.66) | 0.557 |
| Other | 1.82(1.07 - 3.11) | 0.027 | 1.70(0.88 – 3.26) | 0.113 |
| **Employment status** | | | | |
| Employed | Ref | | Ref | |
| Unemployed | 1.41(0.91 – 2.18) | 0.124 | 1.37(0.80 – 2.35) | 0.245 |
| **Supervised delivery** | | | | |
| Yes | Ref | | Ref | |
| No | 4.36 (1.59-11.95) | 0.004 | 1.11(0.27 – 4.57) | 0.890 |
| **Mode of delivery** | | | | |
| Spontaneous vaginal delivery | Ref | | Ref | |
| Assisted vaginal delivery | 1.01(0.42 – 2.46) | 0.975 | 2.18(0.77 – 6.17) | 0.142 |
| Caesarian section | 0.55(0.30 – 1.01) | 0.054 | 0.54(0.25 - 1.17) | 0.118 |
| **Type of ARV prophylaxis for baby** | | | | |
| Zidovudine + Nevirapine | Ref | | Ref | |
| Nevirapine/Zidovudine only | 2.29(1.15 – 4.57) | 0.019 | 1.18(0.52 – 2.68) | 0.692 |
| Not on ARV prophylaxis | 35 (10.70-114.44) | < 0.001 | 75.70(17.18–333.62) | **< 0.001** |
| **Duration of ARV prophylaxis** | | | | |
| 12 weeks | Ref | | Ref | |
| >0 to <12 weeks | 4.26(2.53 – 7.18) | < 0.001 | 4.35(2.41 – 7.83) | **< 0.001** |
| 0 | 52.50(15.85 – 173.88) | < 0.001 | Null | |

COR- crude odds ratio, AOR- adjusted odds ratio, 95% CI - 95% confidence interval

# CHAPTER FIVE

# DISCUSSION

## 5.1 Sociodemographic factors and MTCT of HIV

Married mothers formed the majority of the cases and controls, which was not unusual in Ghana where cultural and religious beliefs encourage sex and child-bearing after marriage (Sarfo et al, 2021). The marital status of a HIV-infected mother in the present study had no association with MTCT of HIV similar to studies by Adogu et al. (2012) and Nkenfou et al. (2023). The institution of marriage in most cultures encourages fidelity of the married couple (Bertocchiet al., 2019). Being faithful to one sexual partner compared to having multiple partners is known to reduce an individual's chances of contracting STIs including HIV (Bertocchiet al., 2019). However, in the modern age, studies have shown that some married partners engage in extramarital sexual affairs making their exposure to STIs similar to their unmarried counterparts who are not necessarily bound to stay with one sexual partner (Coma et al.,2013). This near-equal exposure of both married and unmarried women to STIs in this context may explain the non-association of marital status with MTCT of HIV.

The employed formed majority in this study in contrast to research in Northern Cameroon where the majority were unemployed (Nkenfou et al., 2023). In the present study, employment status had no independent association with MTCT in line with some earlier studies (Sagay et al., 2015; Hussen et al., 2022). Being employed comes with the opportunity to earn some money which an HIV-infected mother can use for adequate feeding, transportation to the hospital for ANC care and medication refills with all these promoting good health and reducing the chances of MTCT of HIV (Kellett et al, 2016). However, those who are employed receive different financial returns depending on the kind of employment (self/private/government) and the financial state of the

employee which may not promise the aforementioned benefits. Also, some unemployed mothers have supportive partners and families who help them to provide for their basic needs including health needs. The above-mentioned reasons could be an explanation for the non-association of employment status with MTCT of HIV owing to the variable financial circumstances of both the employed and non-employed HIV-infected mother. A Rwandan study however showed an association between MTCT of HIV and employment status, where children born to mothers who worked in the private sector were at more risk of being infected with HIV compared with those born to mothers without employment (Nderelimana et al., 2021).

In summary, the sociodemographic factors (marital status and employment status) examined in the present study showed no association with MTCT of HIV in Ghana.

**5.2 Delivery factors and MTCT of HIV**

The different modes of delivery have been shown in literature to have different risks of MTCT. Assisted vaginal delivery was found to have a 6.87 folds higher risk of MTCT of HIV in contrast with those delivered by spontaneous vaginal delivery in a study in Ethiopia (Alachew et al., 2019). A systemic review and metanalysis of HIV-infected pregnant women found elective caesarean section to be protective against MTCT of HIV (Kennedy et al., 2017). In the present study, the majority of the mothers were delivered by SVD in both cases and controls. No association was found between the mode of delivery and MTCT of HIV in contrast to findings from the previously mentioned studies. The inconsistency between these studies may be due to the difference in the quality of management of the delivery process in these different settings.

Management of labour and delivery is crucial as 10-15% of MTCT happens at this stage (WHO, 2019). Delivery at hospitals or accredited maternity homes where supervision by trained health staff and provision of an emergency caesarian section or appropriate referral to higher health

facilities is ensured is highly recommended. Over 89% of the cases and controls had supervised delivery in this study. In contrast to research where unsupervised delivery was found to be a risk factor for MTCT for HIV, supervision of delivery was not independently associated with MTCT in the present study (Yitayew et al.,2021; Kassa et al., 2018). An explanation for this observation could be due to the possibility of some of the mothers who undertake home delivery bringing their infants to health centres afterward to be given immunization and medical attention (though this was not elicited in the study). These exposed infants could then be identified in the health centres and put on ARV prophylaxis as happens to HIV-exposed infants born under supervised delivery. The ARV prophylaxis is protective against MTCT of HIV (UNAIDS, 2021).

In summary, delivery-related factors (mode and supervision of delivery) were both not independently associated with MTCT of HIV in Ghana.

### 5.3 Postnatal factors and MTCT of HIV

ARV prophylaxis for the exposed baby after delivery is a protective factor against MTCT (De Lemos et al., 2013). The ARVs restrict the entry and replication of the HIV in the body of the exposed baby (Bhardwaj et al., 2014). In this study, babies who were not given any ARV prophylaxis had 75.70-fold increased odds of MTCT compared to babies who were put on a combination of Zidovudine and Nevirapine prophylaxis (AOR=75.70, 95% CI:17.18 – 333.62, p< 0.001). This result is in line with findings in Dessie Town, Ethiopia, where failure to initiate ARV prophylaxis for the infant increased the likelihood of MTCT of HIV (Aishat et al., 2015; Yitayew et al., 2022). The absence of the protection offered by ARVs against the entry and multiplication of HIV in the bodies of babies without the prophylaxis supports the observed increased risk (Bhardwaj et al., 2014).

The current protocol for ARV prophylaxis in Ghana is 12 weeks of a combination of Zidovudine and Nevirapine for HIV-exposed infants (GHS/NACP, 2021). The ARV prophylaxes were given for a mean duration of 8.2 ± 4.9 weeks in this study. The duration of ARV prophylaxis was independently associated with MTCT of HIV. Babies who were given ARV prophylaxis for less than 12 weeks had 4.35 times increased odds of MTCT of HIV in comparison with those who were given the ARV prophylaxis for 12 weeks (AOR=4.35, 95% CI: 2.41 – 7.83, $p < 0.001$). The longer period of protection offered by ARVs in the latter against the risk of MTCT of HIV could explain this finding (Bhardwaj et al., 2014).

To summarize, both postnatal factors (the type of ARV prophylaxis and duration of ARV prophylaxis) that were examined had independent association with MTCT in Ghana as discussed above.

### 5.4 Strengths and Limitations

#### 5.4.1 Strengths of the study

The study findings support the current policy by the GAC and NACP that all infants born to HIV-positive mothers in Ghana be put on a combination of Zidovudine and Nevirapine within 48 hours post-delivery for a period of 12 weeks. The continued implementation of this policy/guidelines would help the country in its efforts towards the elimination of MTCT of HIV by 2030.

### 5.4.2 Limitations of Study

There were a lot of missing values in some of the variables of the audit data. Variables with more than 5% missingness were not included in the logistic regression analyses as indicated in the methods chapter. The independent associations of these variables with MTCT of HIV were therefore not studied. Notably, antenatal and clinical factors though known risk factors of MTCT of HIV in literature, were not examined for their independent association with MTCT of HIV in the present study on account of the aforementioned limitation.

Also, there were not enough cases and controls for recruitment to increase the power of the study.

# CHAPTER SIX

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary

This research aimed to examine the risk factors associated with MTCT of HIV in Ghana as evidenced by the 2021-2022 HIV Positive Babies Audit by the NACP.

A total of 184 cases and 184 controls were studied in a 1:1 unmatched case control study design using audit data by the NACP.

Univariable logistic regression analysis was performed on the independent variables with less than 5% of missing values from which variables with p-values $\leq 0.20$ were entered into a multivariable logistic regression analysis. P-value $< 0.05$ was considered statistically significant at 95% confidence interval.

Major findings on the objectives of the study were as follows:

- The sociodemographic factors examined (marital status and employment status) showed no association with MTCT of HIV in Ghana.
- The delivery-related factors examined (mode and supervision of delivery) were not independently associated with MTCT of HIV in Ghana.
- The postnatal factors examined (the type of ARV prophylaxis and duration of ARV prophylaxis) had independent association with MTCT in Ghana.
- The independent association of antenatal and clinical factors with MTCT of HIV was not examined because of the study limitations stated in the previous chapter.

## 6.2 Conclusion

Not being on ARV prophylaxis was found to increase the odds of MTCT of HIV compared to being on a combination of Zidovudine and Nevirapine prophylaxis. Also, having ARV prophylaxis for less than 12 weeks was shown to increase the odds of MTCT of HIV compared to having ARV prophylaxis for 12 weeks.

## 6.3 Recommendations

The following are recommended based on findings from the study:

### Governance/Leadership

- The NACP should continue its policy of auditing HIV-positive babies. The audit team must get the responses and records for the various variables to reduce the percentage of missing values to the barest minimum to allow for the contributions of all the variables to MTCT of HIV in Ghana to be studied.
- The Ministry of Health and the Ghana Health Service should ensure that all HIV-exposed babies are put on ARV prophylaxis (combination of Zidovudine and Nevirapine) for 12 weeks as stated in the current policy/guidelines by the NACP and GAC. This should be adhered to at all the PMTCT centres, postnatal and child welfare clinics.

### Health Workforce

- The health workers and PMTCT staff especially the obstetricians, midwives and nurses should ensure that all the HIV-exposed babies are put on ARV prophylaxis after delivery. They should also support and supervise the HIV-infected mothers and caretakers of the exposed babies to give the ARV prophylaxis for the prescribed 12 weeks.

### 6.4 Future Research

Future research can focus on studying the audit data of all the regions of Ghana when available to examine the changing trends of the risk factors influencing MTCT of HIV in Ghana at both the national and regional levels. This would inform policy stakeholders of the relevant changes and adjustments to make to meet prevailing needs.

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## APPENDIX I: DATA ABSTRACTION FORM

| **Study Title** | Risk Factors For Mother-To-Child Transmission Of HIV Infection In Ghana: Evidence From The 2021-2022 HIV Positive Babies Audit | | |
|---|---|---|---|
| **Study Type** | Case Control Study | | |
| **Institution** | National AIDS/STI Control Programme | | |
| **Period of Extraction** | 15th February – 22nd February, 2023 | | |
| **Source of Data** | 2022-2022 HIV Positive Babies Audit | | |
| **Personnel** | Primary Investigator | | |
| | | | |
| **Variable** | Entry 1 | Entry 2 | Entry … |
| Child's Identification Number | | | |
| Child's HIV Result | | | |
| Region | | | |
| Age of Mother | | | |
| Educational Level | | | |
| Marital Status | | | |
| Employment Status | | | |
| Monthly income | | | |
| Parity | | | |
| Time of ARV initiation | | | |
| Viral load during pregnancy | | | |
| ANC attendance | | | |
| Syphilis Status | | | |
| Mother's ARV adherence during pregnancy | | | |
| Gestational age at delivery | | | |
| Supervision of delivery | | | |
| Mode of delivery | | | |
| Child's birthweight | | | |
| Type of ARV prophylaxis given to child | | | |
| Duration of ARV prophylaxis | | | |
| Adherence to ARV prophylaxis | | | |
| Mother's ARV adherence post delivery | | | |
| Baby feeding option | | | |

## APPENDIX II: NACP HIV AUDIT TOOL

CHILD'S CODE

☐ _____

1. CHILD'S HIV RESULT

☐ HIV positive

☐ HIV negative

2. REGION:

☐ Central

☐ Volta

☐ Upper East

☐ Bono East

☐ Bono

***SOCIO-DEMOGRAPHICS OF MOTHER***

3. Age (at last birthday):

_____

4. Highest Educational Level

☐ None

☐ Primary

☐ Junior High

☐ Senior High

☐ Tertiary

☐ Vocational

5. Marital Status:

☐ Single

☐ Married

☐ Cohabiting

☐ Widowed

☐ Separated

☐ Divorced

6. Type of employment

☐ Government employee

☐ Private employee

☐ Self-employed

☐ Unemployed

7. Monthly Income

☐ Less than Ghc 500

☐ Ghc 500 to Ghc1000

☐ More than Ghc 1000

***CLINICAL FACTORS***

8. Parity (Number of births)

☐ _____

9. Child's birthweight

☐ _____

10. Time of ARV initiation

☐ Preconception

☐ During pregnancy

☐ After delivery

11. Mother's viral load during pregnancy

☐ Unsuppressed

☐ Suppressed

☐ No viral load done

12. Mother's viral load after delivery

☐ Unsuppressed

☐ Suppressed

☐ No viral load done

***ANTENATAL FACTORS***

13. Mother's antenatal ARV adherence

☐ Good (no missed dose in a month)

☐ Fair (only one missed dose in a month)

☐ Poor (more than one dose missed in a month)

☐ Not assessed

14. Other risks during pregnancy

☐ Alcohol/ substance abuse

☐ Malnutrition

☐ Domestic violence

☐ Premature rupture of membranes

☐ Antepartum hemorrhage

☐ Syphilis

☐ Other sexually transmitted infections

***DELIVERY RELATED FACTORS***

15. Gestational age at delivery (weeks)

☐ _____

16. Was delivery supervised?

☐ Yes

☐ No

☐ Unknown

17. Mode of delivery

☐ Spontaneous vaginal delivery

☐ Assisted vaginal delivery

☐ Caesarian section

18. Peripartum complications

☐ None

☐ Intrapartum hemorrhage

☐ Other _____

***POSTNATAL FACTORS***

19. ARV prophylaxis given

☐ None

☐ Zidovudine only

☐ Nevirapine only

☐ Zidovudine + Nevirapine

☐ Other _____

20. Duration of ARV prophylaxis (weeks)

☐ _____

21. Mother's adherence to child's prophylaxis

☐ Good (no missed dose in a month)

☐ Fair (only one missed dose in a month)

☐ Poor (more than one dose missed in a month)

☐ Not assessed

22. Mother's postnatal ARV adherence

☐ Good (no missed dose in a month)

☐ Fair (only one missed dose in a month)

☐ Poor (more than one dose missed in a month)

☐ Not assessed

23. Mother's feeding plan (first 6 months)

☐ Exclusive breastfeeding

☐ Mixed feeding

☐ Formula feeding

## APPENDIX III: ETHICAL APPROVAL LETTER

**GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE**

*In case of reply the number and date of this Letter should be quoted.*

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Digital Address: GA-050-3303
Mob: +233-50-3539896
Tel: +233-302-681109
Email: ethics.research@ghs.gov.gh
13th February, 2023

*My Ref. GHS/RDD/ERC/Admin/App/23/109*
*Your Ref. No.*

Junia Ebo Tawiah
P. O. Box KB 77
Korle Bu – Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

| | |
|---|---|
| GHS-ERC Number | **GHS-ERC: 025/01/23** |
| Study Title | Risk Factors for Mother-To-Child Transmission of HIV Infection in Ghana: Evidence from the 2022 HIV Positive Babies Audit. |
| Approval Date | 13th February, 2023 |
| Expiry Date | 12th February, 2024 |
| GHS-ERC Decision | **Approved** |

**This approval requires the following from the Principal Investigator**

- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if the study cannot be implemented or is discontinued and the reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

**You are kindly advised to adhere to the national guidelines or protocols for the prevention of COVID-19**

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
Dr. Naa-Korkor Aflotey
(Ag. Head, Ethics & Research Management Department)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra