(COMPLETED RESEARCH)

DETERMINANTS OF INFANTS HUMAN IMMUNODEFICIENCY VIRUS POSITIVITY RATES IN GREATER LETABA MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA.

By

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DEDICATIONS

To my mother and late father who inspired me to learn in the earliest years. Your love and your kind words continue to inspire me.

To my brothers and sisters, Alex, Qaleki, Baby (Yvonne), Caswell, Comfort, Rhulani (Canny), and Linky (Deya) for their love, encouragement, moral support, care, and concern.

My sisters-in-law Vinky and Dudu (malume Ndu) for your prayers.

My dear sons Tsakelani and Sagwadi (Xigwili) for the patience offered during my absence.

DECLARATION

I declare that **DETERMINANTS OF INFANTS HUMAN IMMUNODEFICIENCY VIRUS POSITIVITY RATES IN GREATER LETABA MUNICIPALITY** is my work in design and in execution and that all the material contained herein has been duly acknowledged by means of complete references. The mini dissertation hereby submitted to the University of Limpopo for the degree of Master of Public Health has not previously been submitted by me for a degree at this University or any other institution.

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12 September 2021
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Date

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ABSTRACT

Introduction:

HIV/AIDS remains a disease of public health importance and mother-to-child transmission (MTCT) is one of the major problems. Sub-Saharan Africa is the most severely affected region, accounting for more than 90 percent of paediatric HIV infections. Most of these infections occurred during pregnancy, delivery or breastfeeding making the prevention of mother-to-child transmission (PMTCT) a public health priority. Over the last few years, efforts have been made in Sub-Saharan countries to improve PMTCT and the success of prevention of mother-to-child transmission of HIV (PMTCT) is dependent upon high retention of mother-infant pairs within the PMTCT cascade. Assessing the risk factors for MTCT will help to decrease child morbidity and mortality and strengthen PMTCT programs as there is dearth of evidence regarding factors determining MTCT HIV infection to infants born to HIV positive mothers. The purpose of this study was to investigate the determinants for the human Immunodeficiency Virus positivity rates in the Greater Letaba Municipality. The study objectives were to describe the demographic characteristics of mothers and babies who tested polymerase chain reaction test (PCR)-positive in the Greater Letaba Municipality during the two-year period from 2015 to 2016, in order to determine maternal and neonatal factors associated with high positive PCR; and to determine health system-related factors associated with a high positive PCR result.

Methodology

The current study followed a quantitative approach in which convenient and purposive sampling was used, focusing on records of infants born from HIV-positive women in all clinics at Greater Letaba Municipality were reviewed. All records of infants who were tested for HIV and the PCR results were positive from birth up to 12 months of age were retrospectively reviewed and for the health care workers, all nurses working as managers of a clinic were interviewed. The Statistical Package for the Social Sciences (SPSS) version 23 computer software and Stata 15 was used. for comparison of categorical variables was done using a Chi-Squared test, whereas continuous variables were compared using a t-test and P-value of <0.05 was considered significant. To determine maternal and neonatal factors associated with high positive PCR, Factor analysis was used with rotated factor loadings done using the Varimax method.

Results: A total of 107 records were retrieved and audited. Fisher's exact test was used to determine the relationship between selected variables, where $p<0.05$ was set as level of significance. The findings reveal that the number of infants exposed to HIV during pregnancy has steadily increased. The current study further indicates that health system factors such as unskilled or untrained NIM-ART nurses in the facilities is a contributory factor to infant's positivity rate in Greater Letaba hospital. Equal proportions of both male and female babies were found to be PCR positive at 6 weeks. The study further revealed that the highest proportion of the mothers who gave birth to PCR positive babies for the reporting period were married mothers, in the age group 25-29 years (46.1%). The second largest proportion of mothers who gave birth to PCR positive babies were single mothers in the age group 25-29 years (38.4%).

The results show that high PCR positivity can be attributed to about 5 main Factors namely: maternal antenatal history (22% contribution to total variance), maternal HIV care history (18% contribution to total variance), measures of adherence to treatment (17% contribution to total variance), maternal exposure to HIV (14% contribution to total variance) and lastly the ART regimen (12% contribution to total variance).

Conclusion: The study findings revealed that there is still vertical transmission of HIV to infants and the prevalence of HIV among infants born from seropositive mothers despite the availability of the latest Prevention of Mother to Child Transmission (PMTCT) Guidelines in all health care facilities. Even though transmission is reduced to the meaningful number ($<5\%$), there are still appropriate measures that should be taken to reduce the transmission of HIV from mothers to infants. The delayed diagnosis, adherence to ART by mothers, infant ARV prophylaxis at birth and feeding practices contributed the vertical transmission of HIV to infants. Strengthening of the PMTCT of HIV programme, increasing antenatal HIV screening and linking it to care and treatment of HIV positive mothers to obtain zero infant HIV prevalence in the region. Infant prophylaxis and maternal PMTCT interventions should be provided to all exposed infants and mothers based on the guidelines by the health institutions. Nurse-initiated management of antiretroviral treatment (NIM-ART) training of professional nurses is being offered by the Department of Health in South Africa, but it does not yield positive results as far as the PMTCT is concerned. This may be due to shortage of staff, especially trained professional nurses (PN), as well as the workload.

Key concepts:

Infant and Human immune deficiency virus

Contents

DEFINITIONS OF CONCEPTS

Infant: An **infant** is a child younger than one year of age (NDoH, 2014). In the context of this study, an infant will refer to the child from birth to 12 months of age.

Human immunodeficiency virus (**HIV):** is the virus that can lead to acquired immunodeficiency syndrome (AIDS). HIV can damage a person's body by destroying specific blood cells, called CD4 and T cells, which are crucial to help the body fight disease (WHO, 2014).

LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
ANC	Ante Natal Clinic
ART	Antiretroviral Therapy
AZT	Azidothymidine
DBS	Dried Blood Spot
CDC	Centres for Disease Control and Prevention
DNA	Deoxyribonucleic Acid
EID	Early Infant Diagnosis
ELISA	Enzyme-Linked Immunosorbent Assay
FDC	Fixed Dose Combination Drugs
HAART	Highly Effective Anti- Retroviral Treatment
HCT	HIV Counselling and Testing
HIV	Human Immunodeficiency Virus
NDoH	National Department of Health
NIM-ART	Nurse Initiated and Management of Anti-Retroviral Treatment
NVP	Nevirapine
PCR	Polymerase Chain Reaction
PI	Protease Inhibitor
PMTCT	Prevention of Mother to Child Transmission
PN	Professional Nurse
UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNICEF	United Nation Children's Funds
WHO	World Health Organization

CHAPTER 1

1.1. INTRODUCTION AND BACKGROUND

The human immunodeficiency virus (HIV) is a retrovirus belonging to the family of lentiviruses. Retroviruses can use their RNA and host DNA to make viral DNA and are known for their long incubation periods (Sahoo, Rao & Sudhakar, 2015; Kirchner, 2019). HIV is spread mainly through blood or body fluids (Peters, Marston & De Cock, 2014; Yoshimura, 2017). Subjects can become infected with HIV by sexual contact, needle sharing, blood transfusions, or maternal transmissions as a blood-borne virus or via breast-milk (Nambiar & Short, 2019). The incubation period of HIV-1 from infection to the development of acquired immunodeficiency syndrome (AIDS) ranges from 8 to 11 years (Monaco, Gootenberg, Zhao, Handley, Ghebremichael et al., 2016; Yoshimura, 2017). In the past 3 decades, HIV has caused a great burden to global wealth and health. According to the WHO global health survey, 36.7 million people were infected with HIV, causing 1.1 million deaths in 2015. Since 1981, more than 78 million people have been infected with human immunodeficiency virus (HIV) resulting in 35 million deaths. (Yoshimura, 2017).

Untreated HIV replication causes progressive CD4$^+$ T cell loss and a wide range of immunological abnormalities, leading to an increased risk of infectious and oncological complications (Deeks, Overbaugh, Phillips & Buchbinder, 2015). This later leads to the development of acquired immunodeficiency syndrome (AIDS) which is defined by the presence of less than 200 CD4 T cells/µL circulating in the blood or the development of an AIDS-defining opportunistic infection (OIs) or cancer (Monaco et al., 2016). The (OIs) are the most common complication of HIV infection and they cause significant morbidity and mortality in people with HIV infection (Shahapur & Bidri, 2014; Ali, Ahmad, Aziz & Zaman, 2019). HIV causes severe damage to immune system and eventually destroys it by using the DNA of CD4+cells to replicate itself. In that process the virus eventually destroys CD4+ cells (Sahoo et al., 2015)

HIV pandemic has been among the major global public health threats and since its beginning, an estimated 78 million people around the world have become infected and 35 million have died of AIDS-related illnesses leading to major losses of life expectancy (Deeks, Overbaugh, Phillips & Buchbinder, 2015; Monaco et al., 2015; Nash, Yotebieng & Sohn, 2018). Despite immense progress in understanding the virus and its pathogenesis,

the development of a preventive vaccine or efficacious treatment to permanently cure HIV-1-infected individuals has not occurred (Veenhuis, Clements & Gama, 2019). This results in approximately more than 2 million people worldwide been infected with HIV annually, and almost 80% of new infections occur in 22 countries while an average of a million people dying every year of AIDS-related causes (Altaf, 2018; Veenhuis, Clements & Gama, 2019).

Highly effective treatment for HIV, available in resource-rich settings since 1995, took more than 10 years to reach those areas of the world hardest hit by HIV, such as sub-Saharan Africa (SSA), home to 25.7 million people or 70% of those living with HIV today (Nash et al., 2018). Early treatments for HIV were limited and most patients died. However, over three decades of study have provided a wealth of information about the natural history of HIV, allowing the development of effective antiretroviral therapy (ART). ART has radically improved the prognosis for patients living with HIV, meaning a normal or near-normal life expectancy, particularly when the diagnosis is made before HIV-related complications occur (Melhuish & Lewthwaite, 2018). Successful management of paediatric and adult HIV disease includes lifelong administration of ART (Dubrocq & Rakhmanina, 2018).

The global ART coverage remained low at 49% despite significant global investment in the AIDS response that has increased from 5 to 19 billion during the first 15 years of the current century (Dubrocq & Rakhmanina, 2018). Although the global scale-up of antiretroviral drug access, health system strengthening, and community initiatives has proven successful in improving HIV treatment through increased access to medication, counselling, support groups, and behavioural interventions, unplanned treatment interruptions continue to occur among populations living with HIV (Wouters, Van Damme, van Rensburg, Masquillier & Meulemans, 2012). The successful scale-up of antiretroviral therapy (ART) in sub-Saharan Africa (SSA) will require policy makers to address the gender gap in HIV testing and treatment access (Sharma, Barnabas & Celum, 2017). This will also assist in the strengthening of the WHO prevention of mother-to-child transmission (PMTCT) guidelines. When these guidelines are followed, it is possible to reduce HIV transmission from the mother to the child from 15–40 % to 5 % or less in the breastfeeding population, the case in most resource-limited settings, to less than 2 % in a non- breastfeeding population (Grede, de Pee & Bloem, 2014).

In 2016, approximately 790,000 women were newly infected with HIV-1, contributing to the estimated 17.8 million women living with HIV-1 worldwide (Saleska, Turner, Maierhofer, Clark & Kwiek, 2018). Most HIV infections among children are the result of mother-to-child HIV transmission (MTCT) during pregnancy, delivery, or breastfeeding. The rate of MTCT can be greatly reduced by testing women for HIV infection during pregnancy, treating HIV-positive women with antiretroviral drugs (ARVs) during pregnancy, delivery, and breastfeeding, and giving ARVs to their newborn babies (Drake, A.L., Wagner, A., Richardson, B. and John-Stewart, G., 2014). The global epidemic of HIV has affected the lives of millions of children and optimal adherence to antiretroviral (ARV) drugs is essential to protect children from acquiring HIV therefore eliminating new paediatric infections of HIV (Okawa, Chirwa, Ishikawa, Kapyata, Msiska, Syakantu, Miyano, Komada, Jimba & Yasuoka, 2015). In the absence of intervention, the rates of HIV transmission during pregnancy, labor or breastfeeding vary from 15-45%. Therefore, suitable antenatal care attendance during pregnancy with the use of ARV can contribute to the reduction of vertical HIV transmission rates to levels below 2% and reduce of the viral load (VL) (Barral, Oliveira, Lobato, Mendoza-Sassi, Martínez & Gonçalves, 2014).

HIV prevalence is high among South African women of reproductive age (Haffejee, Ports & Mosavel, 2016). South Africa's constitution protects reproductive rights for people living with HIV (PLWH), and recent guidelines from the Southern African HIV Clinicians Society and South Africa's Department of Health offer strategies for those who choose to conceive (Matthews, Milford, Kaida, Ehrlich, Ng, Greener, Mosery, Harrison, Psaros, Safren & Bajunirwe, 2014). Transmission of HIV from mothers to children is a concern in South Africa (Haffejee et al., 2016). However, remarkable success preventing and treating paediatric HIV infection has been documented in this country. In 2014, MTCT rates were estimated at 4.0% and more than 150,000 children initiated on ART (Abrams, Woldesenbet, Silva, Coovadia, Paed, Black, Technau & Kuhn, 2017). The South African government is currently promoting integrated care—a re-engineering of the primary health care system (Tomlinson, O'Connor, Le Roux, Stewart, Mbewu, Harwood & Rotheram-Borus, 2014). To support this policy shift, it is critical that we understand the determinants or possible risk factors associated with HIV positivity rates among infants and therefore the decision to conduct this study in the Greater Letaba Municipality of Mopani District in Limpopo Province, South Africa was taken.

1.2. PROBLEM STATEMENT

A study conducted by Wang, Wolock, Carter, Nguyen, Kyu, et al., (2015) indicated that there is still a challenge in eliminating mother-to-child transmission (MTCT), with over 16,000 new paediatric infections detected in 2015. However, Maritz, Hsiao, Presier & Myer (2016) indicated that only 49% of infants presented for follow-up early infant diagnosis (EID) testing after a negative PCR result at birth are far below the national estimates of EID coverage in South Africa. Despite substantial progress in the delivery of HIV prevention programs, some communities continue to experience high rates of HIV infection in South Africa (Kharsany, Frohlich, Yende-Zuma, Mahlase, Samsunder, Dellar, Zuma-Mkhonza, Karim & Karim, 2015). Mopani District in Limpopo Province is not an exception to increase in HIV among pregnant women and the researcher has observed that, despite the PMTCT programs offered in health facilities, HIV-positive women on anti-retroviral therapy (ART) in the Greater Letaba still give birth to HIV-positive babies. This observation, therefore, led to a need to establish why there is such a high prevalence of HIV among infants in Greater Letaba, while a PMTCT programme is implemented in government health facilities in the region. It has come to the attention of the researcher that the majority of HIV-positive women continuously seek medical assistance as a result of the transmission of HIV to their children.

1.3. LITERATURE REVIEW

A review of literature is necessary to understand how other researchers have investigated the problem and concluded their studies. When researchers embark on a study, it is very important to determine what work has been done in that field of study (Brink, van der Walt & van Rensburg, 2006). Relevant literature on HIV, globally, in Africa and in South Africa, was reviewed. A further review of the literature relating to infants with HIV and relating to the polymerase chain reaction test, mode of transmissions, HIV testing in infants, interventions to reduce PCR positivity were done. The literature review will be discussed in-depth in Chapter 2.

1.4. PURPOSE OF THE STUDY

There is lack of information on the determinants and prevalence of PCR positive results in children in the Greater Letaba Municipality. The study, therefore, seeks to explore the maternal, neonatal and health system factors associated with high PCR positive results in children in the Greater Letaba Municipality.

1.4.1. Aim of the study

The aim of the study was to assess the determinants of HIV positivity rates among infants in the Greater Letaba Municipality between 2015 and 2016 in the Limpopo Province of South Africa.

1.4.2. Objectives of the study

The objectives of the study were as follows:

- To describe the demographic characteristics of mothers and babies who tested PCR positive in the Greater Letaba Municipality between 2015 to 2016.
- To determine maternal and neonatal factors associated with high positive PCR results.
- To discuss health system related factors associated with high positive PCR results.

1.5. RESEARCH QUESTION

The research question in the current was "what are the determinants of HIV positivity rates among infants in the Greater Letaba Municipality between 2015 and 2016 in the Limpopo Province of South Africa?"

1.6. RESEARCH METHODOLOGY

Brink, van der Walt & van Rensburg (2013) define methodology as a way of obtaining, organizing, and analysing data. A quantitative and descriptive research design was used in this study. The detailed methodology, which included research design, study site, population, sampling, data collection, reliability, validity, data analysis and ethical considerations, together with validity, reliability, and bias, will be elaborated on in Chapter 3.

1.7. ETHICAL CONSIDERATIONS

The aspects of ethical considerations, such as ethical clearance, confidentiality, confidentiality, anonymity, informed consent, protection form harm and protection of privacy, will be dealt with in Chapter 3.

1.8.   SIGNIFICANCE OF THE PROPOSED STUDY

With the rise in the number of HIV-positive babies, the study could assist the Department of Health by revealing the health systems factors which have resulted in this increase in the infant HIV-positive rate. This study could also assist the Department to better understand the current situation regarding the transmission of HIV from mothers to their unborn babies and children in the Greater Letaba Sub-District in the Mopani District of the Limpopo Province, so that the Department can plan to take care of the resources for managing and strengthening the PMTCT programme. Managing and strengthening the PMTCT programme could occur through the development of improvement plans; a review policy, guidelines, and protocols for management of pregnant women and infants born from HIV-positive mothers; the training of personnel on PMTCT; and by ensuring the availability of PCR test kits within a conducive infrastructure.

The findings of this study might also help the authorities at the healthcare institution to make informed decisions about solving the problem. Furthermore, the proposed study may help teenagers, all women of childbearing age and all who take care of children to decide on the precautionary measures to be taken to prevent the HIV infection of unborn babies and infants. The study may support future research on related topics, as the recommendations of the study may be used by other researchers to identify research gaps and assist in building the literature in this discipline.

CHAPTER 2

2.1.   INTRODUCTION

HIV is a retrovirus (Sahoo et al., 2015; Kirchner, 2019) which is transmitted mainly through blood or body fluids (Yoshimura, 2017). It can hide in, and hijack, the cells of the immune system and force them to make new copies of the virus then eventually destroys the infected cells and weakens the ability of a person with HIV to fight off infections and disease (Williams, Hurst, Stöhr, Robinson, Brown, Fisher, Kinloch, Cooper, Schechter, Tambussi & Fidler, 2014). HIV damages a person's body by destroying specific blood cells, called CD4 and T cells, which are crucial to helping the body fight disease. When the immune system has been adequately being damaged by HIV, other opportunistic infections start to take over then eventually leading to AIDS (WHO, 2014). Most people who are diagnosed early and treated, now live longer having healthier lives and they do not develop AIDS or opportunistic infections are no longer life-threatening to them (Williams, Hurst, Stöhr, Robinson, Brown, Fisher, Kinloch, Cooper, Schechter, Tambussi & Fidler, 2014).

Early testing for HIV and entry into care are crucial to optimise treatment outcomes of HIV-infected patients and to prevent spread of HIV (De Coul, Van Sighem, Brinkman, Van Benthem, Van Der Ende, Geerlings & Reiss, 2016). Efforts to rapidly scale up access to HIV care and treatment have been successful at initiating large numbers of individuals on ART (Lahuerta, Wu, Hoffman, Elul, Kulkarni, Remien et al., 2014). The global increase in number of PLWH and timely administration of ART has resulted in more women with HIV getting pregnant. Apart from general health concerns, pregnancy in these women carries a risk of perinatal transmission (Bagga & Arora, 2020).

Sub-Saharan Africa is the most severely affected region, accounting for more than 90 percent of paediatric HIV infections. Most of these infections occurred during pregnancy, delivery or breastfeeding making the PMTCT a public health priority. Over the last few years, efforts have been made in Sub-Saharan countries to improve PMTCT (Sidze, Faye, Tetang, Penda, Guemkam, Ateba et al, 2015). Therefore, testing for HIV in the neonatal period has been routinely recommended for all HIV-exposed infants in the developed world for over two decades. In 2015, birth testing for certain asymptomatic HIV-exposed infants was included in the South African National Consolidated Guidelines for the first time (Sherman, 2015). The main public health goal of prevention of HIV infection is to interrupt transmission and to improve treatment outcomes for individual HIV-infected patients (De

Coul et al., 2016). Lastly, HIV infection contributes significantly to causes of death in sub-Saharan African countries (Adetokunboh & Oluwasanu, 2016) and infection with HIV is one of the major causes of paediatric mortality and morbidity in countries with middle and low financial resources, where a large proportion of HIV infection happens (Bokharaei-Salim, Kalantari, Gholamypour, Najafi, Keyvani, Esghaei, Monavari, Khanaliha, Bastani, Fakhim & Garshasbi, 2018).

2.2. Mode of HIV transmission to infants

The possibility of transmission of the HIV from mother to child was identified very early after the onset of the epidemic, as early as 1983. The infection of the child is characterized by a high risk of early and severe evolution with encephalopathy and death in the first 2 years of life (Blanche, 2020). Globally, more than 90% of all HIV-positive children get infected during pregnancy or delivery (Bornhede, Soeria-Atmadja, Westling, Pettersson & Navér, 2018). About 600,000 children are infected with the HIV virus each year through MTCT and the majority of these cases are in Africa (Ikeako, Ezegwui, Nwafor, Nwogu-Ikojo & Okeke, 2015). MTCT of HIV is the spread of HIV from an HIV-infected woman to her child during pregnancy, childbirth (also called labour and delivery), or breastfeeding (through breast milk) (Fonjungo, et al., 2013; Adetokunboh & Oluwasanu, 2016; Bokharaei-Salim et al., 2018). This mode of HIV transmission remains one of the most important challenges all over the world (Adetokunboh & Oluwasanu, 2016) and it is the leading cause of HIV infection in children (Domingues, Saraceni & Leal, 2018).

2.2.1. HIV transmission during pregnancy

The mechanism of HIV transmission to the child during pregnancy is still hypothetical, based on indirect arguments, and probably not unequivocal (Blanche, 2020). There is an increased risk of HIV acquisition during pregnancy and the postpartum period, relative to the non-pregnant period. This is mainly due to the physiological changes that accompany pregnancy, including immune and hormonal alterations and shifts in the vaginal microbiome, offer mechanistic hypotheses to support increased HIV risk (Thomson, Hughes, Baeten, John-Stewart, Celum, Cohen et al., 2018). Approximately 5 to 10% of infants are affected by HIV during pregnancy and a mother infected with HIV during pregnancy has a higher chance of then transmitting the virus to her baby (Afran, Garcia Knight, Nduati, Urban, Heyderman & Rowland-Jones, 2014).

The risk of MTCT may be higher for HIV-infected women who become infected during pregnancy than for those who are seropositive before pregnancy. This is mainly because the levels of circulating HIV virus are known to be higher in the first few weeks of infection and typically remain high for the first 3–4 months after infection (Dinh, Delaney, Goga, Jackson, Lombard, Woldesenbet, Mogashoa, Pillay & Shaffer, 2015). Therefore, maternal HIV RNA load is the foremost risk factor for MTCT of HIV (Bailey, Zash, Rasi & Thorne, 2018).

Transmission *in utero* has also been reported in some reports widespread HIV-1 infection has been detected in aborted foetuses (Afran et al., 2014). This is mainly because HIV viral loads are often very high near the time of HIV infection, and because high HIV viral load is one of the factors most strongly associated with MTCT of HIV. Acquisition of HIV infection by women shortly before the onset of pregnancy or during pregnancy is likely to be associated with an increased risk of *in utero* HIV transmission (Taha, James, Hoover, Sun, Laeyendecker, Mullis, Kumwenda, Lingappa, Auvert, Morrison & Mofensen, 2011).

In utero HIV transmission might happen if the placenta is damaged and blood from the mother transfers into the blood circulation of the foetus (Afran et al., 2014). Chorioamnionitis has been linked to damage to the placenta and an increased HIV transmission risk (Ocheke, 2017). Maternal VL at delivery is a strong predictor of in utero and intrapartum MTCT (Davey, Ajibola, Maswabi, Sakoi, Bennett, Hughes, Isaacson, Diseko, Zash, Batlang & Moyo, 2020). This might be because HIV-infected cells travel across the placenta, or it might happen because HIV slowly gets through the different layers of the placenta until the virus gets to the blood that reaches the foetus (Heerema-McKenney, 2018).

2.2.2. HIV transmission during childbirth

Women who present at the time of labour, who are confirmed HIV-positive but has either not received antenatal antiretroviral therapy or has a viral load greater than 400 copies/μL, are at high risk of infecting their children with HIV (Eriksen, Albert, Blaxhult, Carlander, Flamholc et al., 2017). Premature rupture of membranes more than four hours before delivery or a prolonged or difficult labour which is poorly managed, having an episiotomy and aggressive suctioning of the infant's mouth and throat also play a role in MTCT of HIV (Mahwasane, 2018). A cervical or vaginal infection, for example bacterial vaginosis, in the

absence of antiretroviral treatment, increases the risk of vertical transmission of HIV during childbirth (Slyker, Patterson, Ambler, Richardson, Maleche-Obimbo, Bosire et al., 2014). During childbirth, a baby may be infected by its HIV mother's cervical secretions or blood (Lohman-Payne, Gabriel, Park, Wamalwa, Maleche-Obimbo, Farquhar et al., 2018).

2.2.3. HIV transmission during breastfeeding

Breastfeeding is the other common route of MTCT, and breast milk viral load has been reported to correlate inversely with maternal CD4 T cell count, implying that maternal disease status will affect the extent of infant HIV exposure through breast milk. (Afran et al., 2014). Approximately 10 to 20% of HIV-positive infants are infected during breastfeeding (Ikeako et al., 2015). During breastfeeding the baby can be infected with HIV found in the mother's breast milk or blood (Waitt, Olagunju, Nakalema, Kyohaire, Owen, Lamorde & Khoo, 2018.). Mixed feeding increases the risk of MTCT of HIV. Breastfeeding woman who are not on ART and whose viral load is above 1000 copies/UL, are at high risk of transmitting HIV to their children (NDoH, 2013; Du Plessis, 2018). Maternal factors known to increase the risk of HIV transmission through breastfeeding include recent infection, advanced stage of the HIV disease, a low CD4 count, a high viral load, mastitis, and abscesses (Waitt, Low, Van de Perre, Lyons, Loutfy & Aebi-Popp, 2018). The risk of transmission also increases with prolonged breastfeeding WHO, 2016)

2.3. HIV diagnosis and testing in children

Early diagnosis of HIV infection among infants and young children is critical as prompt initiation of ART markedly reduces morbidity and mortality. This also provides an opportunity to measure the effectiveness of PMTCT programs by documenting transmission rates (Mazanderani & Sherman, 2019). This requires diagnosis by virological testing, which is complex, expensive, and inaccessible in many settings (Penazzato, Revill, Prendergast, Collins, Walker, Elyanu, Sculpher & Gibb, 2014). However, making an early definitive diagnosis of HIV is becoming increasingly difficult despite improvements in the accuracy and availability of infant diagnostic testing (Spooner, Govender, Reddy, Ramjee, Mbadi, Singh & Coutsoudis, 2019). Importantly, the challenges associated with early infant diagnosis (EID) relate directly to improvements in prevention of mother-to-child transmission (PMTCT) of HIV (Luo, Boeras, Broyles, Fong, Hsiao, Kiyaga et al., 2019.).

Early initiation of ART for HIV-infected infants reduces mortality but to diagnose HIV infection in infants and children up to the age of 12 months, virologic tests have been recommended by the WHO (Fonjungo, 2013; Mazanderani & Sherman, 2019). Early diagnosis of infants infected with HIV, followed by prompt ART treatment, may reduce morbidity and mortality, failing which, almost 50% of the children infected during pregnancy or delivery die within one year. About 50% of children infected during breastfeeding die within 9 years of infection (WHO, 2012; Fonjungo, 2012). False-positive results for up to 18 months or longer occur as a result of the inadequacy of an infant's antibody testing to diagnose HIV infection (WHO, 2018). It is, therefore, important to provide accurate diagnostic services for identification of infants infected with HIV. An infant is only diagnosed with HIV after two positive PCR tests are received (Kalk, Kroon, Boulle, Osler, Euvrard, Stinson, Timmerman & Davies, 2018; Spooner et al., 2019). The PCR test has been widely used for the diagnosis of HIV among exposed infants due to its high sensitivity and specificity DNA. The PCR test is performed using a small blood spot (dried blood spot) sample (Vubil, Nhachigule, Loquiha, Meggi, Mabunda, Bollinger, Sacks, Jani & Vojnov, 2020).

Approximately 90% of women in South Africa deliver in healthcare facilities and therefore, a birth PCR should achieve higher early infant diagnosis (EID) coverage than the 6-week test (Haffejee et al., 2016). Performing PCR testing at birth would identify approximately 75% of perinatally HIV-infected infants and this will be early enough for ART to impact on early mortality (Gill, Hoffman, Mokone, Tukei, Nchephe, Phalatse, Tiam, Guay & Mofenson, 2017). Therefore, more accurate monitoring of transmission for MTCT should be ensured to identify those infected infants who are lost by 6 weeks. Routine HIV-1 polymerase chain reaction (PCR) testing at birth for all HIV-exposed neonates was introduced into the South African Consolidated Guidelines in June 2015 in order to enhance access to care and thereby reduce HIV-related morbidity and mortality (Technau, Mazanderani, Kuhn, Hans, Strehlau & Abrams et al., 2017). The HIV PCR sensitivity at birth for detecting perinatal HIV infections (in utero and intrapartum HIV infection) can never approach 100% because the PCR test detects in utero infections only and cannot detect intrapartum infections (Technau et al., 2017).

2.4.   Prevention of mother to child transmission of HIV

Preventing transmission of HIV from mother to child after birth is one of the greatest challenges in HIV prevention (Ikeako et al., 2015). The widespread implementation of PMTCT programmes has been one of the great public health success stories of the 21st century (Afran et al., 2014). PMTCT services also play an important role in primary prevention for pregnant women who screen negative, particularly for those identified as being at high risk for HIV acquisition (Mutabazi, Zarowsky & Trottier, 2017). The combination of tailored ART to mother and infant, together with improved obstetric management and the avoidance of breastfeeding, has virtually eliminated infant HIV-1 infection in much of the developed world (Afran et al., 2014). In the absence of preventive measures, MTCT of HIV can reach 25–40%, but the use of prophylactic measures, mainly combined antiretroviral drugs, can reduce MTCT to rates below 0.5% (Bornhede et al., 2018; Domingues et al., 2018). Hence, effective, and safe ART is vital to decrease the rate of vertically transmitted children ((Bornhede et al., 2018).

As of 2017, all countries in sub-Saharan Africa (SSA) have adopted the Option B+ guidelines into their PMTCT programs, drastically expanding access to ART. Since 2011, the number of Women Living with HIV (WLHIV) covered by ART in SSA has risen from 3.7 million (29.2% of eligible women) to 8.7 million (61.7% of eligible women) in 2016 (Cichowitz, Watt & Mmbaga, 2018). Pre-exposure prophylaxis (PrEP) is one strategy of several that can be considered to support safer conception in serodiscordant couples, alongside a range of behavioural and biomedical interventions including fully suppressive treatment of partner(s) HIV infection; current evidence, albeit limited, supports the safety of PrEP in the periconception period and during pregnancy (Bailey et al., 2018)

The risk of MTCT could depend on the timing of HIV infection, the concentration of HIV in her blood and the amount of blood to which the fetus is exposed (Dinh, Delaney, Goga, Jackson, Lombard, Woldesenbet, Mogashoa, Pillay & Shaffer, 2015). Current guidelines in South Africa (SA) recommend testing pregnant women for human immunodeficiency virus (HIV) antibodies at the first antenatal care visit, retesting at 32 weeks' gestation and again at labor, with the goal of this testing being the early identification of both existing undiagnosed HIV infection as well as incident infections occurring during pregnancy (Dinh et al., 2015).

Without intervention, 15–20% of non-breastfed newborns are infected; however, only one-third of the infected children has detectable virus at birth, demonstrating that viral replication started *in utero*, as opposed to infected children, whose virus becomes detectable only after a few weeks of life (Blanche, 2020). The use of ART during and after pregnancy is necessary for the PMTCT of HIV. In the absence of intervention programs to prevent MTCT, the likelihood of HIV transmission in the uterus and during childbirth is from 15-30 percent, and in the case of breastfeeding increases to 20-45 percent. It should be noted that the strategies for PMTCT can decrease the risk of vertical transmission of HIV to less than 1 percent in developed countries, but there has been less success with this approach in developing nations, despite the positive activities that have been undertaken (Bokharaei-Salim et al., 2018)

2.5. Management of New-borns Exposed to Maternal HIV Infection

Prophylaxis reduces HIV DNA concentrations at birth, complicating the early identification of infected infants for the initiation of early treatment (Mitchell, Dross, Beck, Micek, Frenkel.2004). There are case studies highlighting the challenges of "false negative" and "indeterminate" HIV PCR results in the early infant diagnosis within the context of current PMTCT prophylaxis, which led authors to call for revised diagnostic guidelines (Mazenderani, Du Plessis, Thomas, Venter, & Avenan. 2014). In the event that a child is HIV-positive, ART would be immediately prescribed, along with a Bactrim (cotrimoxazole) prophylaxis to prevent the development of pneumonia (NDoH, 2015; Du Plessis, 2018). Retrovir syrup should be administered to the newborn upon delivery, within 6 to 12 hours of birth, continuing 12 hourly for the next six weeks. Dosage adjustments should be continually, as the infant grows (NDoH, 2014; Sosnik & Augustine, 2016). In the event that a mother had not received ART during the course of her pregnancy, viramune oral suspension may be prescribed (NDoH, 2014; Cha, Elsamadisi, Su, Phipps & Birnbaum, 2016; Lau, Brophy, Samson, Kakkar, Campbell, Yudin et al., 2017). According to WHO (2012), babies born to women with HIV receive HIV medicines for 4 to 6 weeks after birth and should not be breastfed (Nagot, Kankasa, Tumwine, Meda, Hofmeyr, Vallo et al., 2016). Treatment interventions, such as the use of ART, for infected pregnant mothers, as well as safe infant feeding, have helped reduce the risk of MTCT from 40% to 30% (Nachega, Uthman, Mofenson, Anderson, Kanters, Renaud et al., 2017).

2.5.1. ART prophylaxis in HIV-exposed infants

To make breastfeeding safer, all HIV-exposed children should receive prophylactic Nevirapine (NVP) from birth, for 6 weeks (Tiwari, Bharadva, Yadav, Malik, Gangal, Banapurmath et al., 2016). If there is no breastfeeding, the infant must take NVP until six weeks of age (Tiwari et al., 2016; Larsen, Magasana, Dinh, Ngandu, Lombard, Cheyip et al., 2019). In several cases, daily NVP will be required beyond 6 weeks. Infant post-exposure prophylaxis should be prescribed for 6-12 weeks after delivery, dependent on when maternal ART was initiated, or not (Bamford, Turkova, Lyall, Foster, Klein, Bastiaans et al., 2018; WHO, 2018). Some infants will receive dual prophylaxis, using NVP plus Azidothymidine

(AZT). After infant prophylaxis has been completed, the mother will continue to breastfeed. Reduced MTCT will be reliant on maternal adherence to lifelong ART throughout the breastfeeding period. It is recommended that HIV-positive women breastfeed their infants until 12 months of age (WHO, 2018). Eligibility criteria for ART prophylaxis is indicated in Table 2.1 below:

Table: 2.1 when to start: Eligibility criteria for ART prophylaxis in HIV-exposed infants.

Criteria	Comment
Mothers on lifelong ART NVP	NVP and AZT immediately at birth and then daily for 6 weeks and only if the mother has been on ART for more than 4 weeks prior to delivery.
Mother did not get any ART before or during delivery and tests HIV-positive >72 hours post-delivery or Mother is newly diagnosed HIV-positive within 72 hours of delivery or mother started ART less than 4 weeks prior to delivery	NVP as soon as possible and daily for 12 weeks (if infant is breastfed) 12 weeks extended NVP is only necessary if the infant is being breastfed. Check feeding practice at the 6-week EPI visit to ensure infant receives correct duration of prophylaxis
Mother received no ART before delivery	An infant should receive birth PCR An additional HIV PCR test is required 4 weeks after NVP is discontinued. This extended period of infant prophylaxis is required to allow time for maternal viral suppression. It takes up to 12 weeks for the viral load to become undetectable on ART
Breastfeeding mother diagnosed with HIV	Start mother on a FDC immediately
Infant tests HIV PCR negative	stop AZT and continue NVP for 12 weeks
If mother has received 12 weeks of ART, then infant NVP can be stopped If infant tests HIV PCR+,	initiate ART immediately Do HIV PCR and return for results in 7 days Additional HIV PCR 4 weeks after stopping NVP Infant HIV testing 6 weeks post-cessation of breastfeeding (either HIV PCR or ELISA, depending on age)

World Health Organization, 2018

Table 2.2 below presents the ARV drug dosing for children from birth - 28 days of age which is adapted from: Updated recommendations on first-line and second-line antiretroviral regimens and post-exposure prophylaxis and recommendations for early infant diagnosis of HIV: interim guidelines. Supplement to the 2016 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: World Health Organization; 2018.

Table: 2.2 Infant ART dosing chart

Baby birth weight ≥ 2.5 kg (≥ 35 weeks gestational age at birth)	Lamivudine (3TC) 4mg/kg/dose twice daily (BD) Zidovudine (AZT) 6 mg/kg/dose twice daily (BD) Nevirapine (NVP) 2 mg/kg/dose Twice daily (BD)

World Health Organization, 2018

Dosing is based on the birth weight of the child, and it is not necessary to change the dose before 28 days of age (for example if the infant's weight decreases in the first week or two of life). Caregivers who will be administering ARV medication to the child must be supplied with a syringe (2 mL or 5 mL) for each of the 3 ARVs and shown how to prepare and administer the correct dose. If required, bottles and syringes should be colour coded with stickers and a sticker of the relevant colour used to mark the correct dose on the syringe.

2.6. Determinants of infant HIV positivity rates

Assessing the risk factors for MTCT will help to decrease child morbidity and mortality and strengthen PMTCT programs as there is dearth of evidence regarding factors determining MTCT HIV infection to infants born to HIV positive mothers (Wudineh & Damtew, 2016). There are maternal factors and health system-related factors which contribute to MTCT.

2.6.1. Maternal factors related to increase in infant HIV positivity rate

Maternal HIV viral load (VL) is the main determinant of MTCT risk, with transmission being directly proportional to maternal viraemia. In turn, reduction in maternal VL is the goal of triple-drug ART delivered as part of PMTCT services (Myer, Phillips, McIntyre, Hsiao, Petro, Zerbe, Ramjith, Bekker & Abrams, 2017). Being co-infected, for example, having tuberculosis (TB) with HIV/AIDS can increase the chance of HIV transmission by elevating

viral load or causing immune activation (Sidze et al., 2015). Having TB and HIV also increases the risk of in utero transmission of TB (Jones, Hesseling, Tena-Coki, Scriba, Chegou, Kidd, Wilkinson & Kampmann, 2015). Advanced HIV disease or a previous AIDS defining illness and older age of the mother increases the likelihood of MTCT (Pinnetti, Tintoni, Ammassari, Tamburrini, Bernardi, Liuzzi et al., 2015.).

Frequent and unprotected sex, especially with multiple partners, and smoking during pregnancy increase the likelihood of transmission of HIV from mother to baby (Karim, Baxter & Birx, 2017). Nutritional deficiencies may exacerbate the risks of perinatal infection (Shah, Verma, Oleske, Scolpino & Bogden, 2019). Furthermore, Mirkuzie et al. (2010), explain that having a high viral load and low CD4 count make in utero transmission more likely. In utero transmission might also be linked to when women start HIV drugs during pregnancy. It is more likely to happen if women start treatment later in pregnancy and the viral load stays higher for longer (Chagomerana, Miller, Tang, Hoffman, Mthiko, Phulusa, John, Jumbe & Hosseinipour, 2018). In a study conducted in Dire Dawa City, Eastern Ethiopia, it was reported that mother's place of residence, infant's place of delivery, infant ARV prophylaxis at birth, feeding practice, infant age at enrolment, maternal enrolment into care, and PMTCT mother-child pairs were all associated with mother-to-child HIV transmission (Wudineh & Damtew, 2016).

In a study conducted in South Africa, it was found that children with any PMTCT exposure (maternal and/or infant antiretrovirals) had better outcomes than those with no PMTCT. This included reduced mortality as well as lower viral loads and higher CD4% at enrolment (Abrams et al., 2017). In another study the changes in circumstances such as taking care of a new baby and returning to work, or negative treatment from clinic staff have been reported as factors related to ART discontinuation in the postpartum period. Fear of side effects and non-disclosure of HIV status were also associated with low uptake of IPT among PLWH (Kim, Dowdy, Martinson, Golub, Bridges & Hanrahan, 2018).

2..6.2. Health system factors contributing to infant HIV positivity rates.
Investment to scale-up early infant diagnosis (EID) of HIV has increased substantially in the last decade (Penazzato et al., 2014; Peter, Zeh, Katz, Elbireer, Alemayehu, Vojnov et al., 2017). This investment includes physical infrastructure, equipment, human resources, and specimen transportation systems as well as specialized mechanisms to deliver

laboratory results to clinics (Essajee, Bhairavabhotla, Penazzato, Kiragu, Jani, Carmona, Rewar et al., 2017). There are approximately more than 200 000 infants acquired HIV infection worldwide and most of these children live in sub-Saharan Africa, where in the absence of diagnosis and early treatment, 50% of HIV-infected children die by age 2 years (Penazzato et al., 2014).

Integration of PMTCT and maternal and newborn child health (MNCH) services has been one of the areas where there has been a shift from a siloed to a more integrated approach (Grede, de Pee & Bloem, 2014). However, addressing supply side issues around the availability and quality of care at the health centre level alone cannot guarantee better results without a more explicit focus on access issues. Access to PMTCT care and treatment services is affected by a number of barriers which influence decisions of women to seek care (Colombini, Stöckl, Watts, Zimmerman, Agamasu & Mayhew, 2014); Grede et al., 2014).

Adherence among pregnant and breastfeeding women remains a challenge across sub-Saharan Africa (Hampanda, 2016). The other element of PMTCT programmes showing poor uptake and adherence is follow up of exposed infants (Colombini et al., 2014; Hampanda, 2016). Poor adherence to PMTCT medication, in addition to low levels of access, uptake and retention in PMTCT care for pregnant and lactating women, contribute to persistently high levels of MTCT with low levels of adherence to PMTCT regimens (Grede et al., 2014; Omonaiye, Kusljic, Nicholson & Manias, 2018.). Many women drop out of PMTCT care, with only 15–30 % of women being retained (Grede et al., 2014; Price, Kayange, Zaba, Chimbwandira, Jahn, Chirwa et al., 2014). Different forms of violence affected PMTCT adherence differentially and physical violence had a less pronounced effect on non-adherence than emotional and sexual violence (Hampanda, 2016). Adherence is one part of overall access to care which encompasses testing, initiation, uptake, adherence to medication and retention in care (Ezennia, Geter & Smith, 2019)

2.7. Interventions to reduce PCR positivity

Transmission of HIV infection is low when HIV is detected as early as possible during pregnancy, or even before a woman gets pregnant (Schnack, Rempis, Decker, Braun, Rubaihayo, Busingye, Tumwesigye, Harms & Theuring, 2016). Primary interventions involve adherence to antiretroviral treatment for the mother coupled with retention in care

as these PMTCT. The baby also should be put on a short course of antiretroviral drugs (Aliyu, Blevins, Audet, Kalish, Gebi, Onwujekwe et al., 2016). VL monitoring to ensure viral suppression in pregnant and breastfeeding women carries unique potential benefits for maternal, child, and family health. With viral suppression, ART reduces morbidity and mortality in HIV-infected individuals [7] and decreases the risk of secondary transmission (Myer, Essajee, Broyles, Watts, Lesosky, El-Sadr & Abrams, 2017). To fully benefit from the prevention of MTCT of HIV, HIV-positive pregnant and/or breastfeeding women and their infants must successfully navigate a number of steps. These steps, also referred to us the PMTCT cascade, include maternal HIV testing; and for HIV-positive mothers, assessment of treatment eligibility, initiation of maternal ARV drugs, initiation of infant ARV, infant HIV testing and ART initiation for HIV-infected infants (Ambia & Mandala, 2016). The timing of ART is key in the prevention of MTCT (Dinh, Mushavi, Shiraishi, Tippett Barr, Balachandra, Shambira et al., 2018.)

2.8. Conclusion

The HIV infection among infants, and the determinants of the increase in HIV infections among infants, has been discussed in this chapter, including the management of new-borns exposed to maternal HIV infection. The next chapter will deal with the methods followed in conducting the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

The literature review was discussed in the previous chapter. This chapter deals with the methods and materials used in the study. Descriptions of the study design followed, including research setting and the study population, will ensue. Sampling procedure and size will be clarified, including the inclusion and exclusion criteria. Data collection tools used to collect data and the measures taken to ensure validity and reliability of the tools will be explained. Potential sources of bias and the measures taken to minimise bias will be outlined. Furthermore, data analysis methods and statistical tests, as well as ethical considerations, will be dealt with in this chapter

3.2. Research Method

Brink, van der Walt and van Rensburg (2013) define methodology as a way of obtaining, organizing, and analysing data. The study is a quantitative, descriptive cross-sectional analysis of secondary data, as well as data collected from interviews with nurse managers. Cross-sectional research is a research approach in which the researcher investigates the state of affairs within a population at a certain point in time in order to provide a snapshot of the outcome and the characteristics associated with that population at that point in time (Eugene & Christine, 2017).

The purpose of selecting this approach as to allow the researcher to describe the population and associations between different variables. In this case the purpose of the study was to investigate the determinants of infant HIV positivity rates in the Greater Letaba Municipality, as well as the health system factors contributing to infant HIV positivity rates. Thus, data from a single point in time was analysed. No follow-up was done with respect to the findings. This design was chosen as it is relatively cheap and quick to conduct cross-sectional research, which is well suited to describing variables and their distribution, making the approach ideal for prevalence studies (Eugene & Christine, 2017).

3.2.1. *Research design*

Quantitative research design is the use of a fixed design that organises, in advance, the research question, as well as a detailed method of data collection and analysis (Creswell, 2008). A quantitative research approach was selected for the purpose of the research as the study involved data collection by means of a structured questionnaire. This study was cross-sectional in nature and a cross-sectional survey was used to describe attitudes or other characteristics of a particular population. However, the survey will not address the cause of the phenomenon being studied (Creswell, 2008). The study followed a quantitative, retrospective cross-sectional study design in order to investigate factors associated with HIV transmission among infants born to HIV-positive mothers. A retrospective study is an epidemiological study in which a group of people are identified who have experienced a particular event (Burns & Groove, 1998). Information was retrospectively obtained from the records of all infants recorded in the health facility's data base between 2015 and 2016.

3.2.2. *Study area*

The study was conducted in Greater Letaba Municipality (GLM) in the Mopani District of the Limpopo Province. This municipality is situated in the North-Eastern quadrant of the Limpopo Province within the Mopani District Municipality Area. Greater Letaba is bordered by Greater Tzaneen to the south, Greater Giyani to the east, Molemole to the west, and Makhado to the North as shown in Figure 1 below.

Figure 1 Maps of South Africa and the Limpopo Province showing the Greater Letaba Municipality located in the Mopani District.

The Greater Letaba Municipality is municipality has 21 clinics, 1 hospital and 1 Community Health Centre. Approximately 42% of communities reside within 20 km of a hospital, 4% of communities reside within 10 km of a Health Centre and 91% of communities live within

5 km of a clinic within the GLM. The population of GLM is approximately 218 030, the unemployed rate is 30% and approximately 8407 of households have no income; they depend on social grant and free basic services from the municipality (StatsSA, 2018 update).

3.2.3. Study population

Population is a large collection of individuals who are the main focus of a research study, or a well-defined collection of individuals known to have similar characteristics (Burns & Grove, 2005). This is supported by Creswell (2013) who defined a study population as the general group from which the targeted few are drawn. The target population for the current study included all HIV-exposed infants in the Greater Letaba Municipality, whose DNA PCR was positive, between 2015 and 2016. The infants were up to 12 months old. The second study population in this study was drawn from the nurse managers in all the clinics in the Greater Letaba Municipality, who completed the health system related factors questionnaire in Section D of the PCR audit tool.

3.2.4. Sampling

Sampling is the process where a sample is selected from an accessible population (de Vos, 1998). The sampling method used in this study was convenient and purposive sampling, as the focus was on infants born from HIV-positive women. All nurse managers from all the clinics were included in the interview to determine the health system related factors associated with high infant PCR positivity.

3.2.5. Sampling method

The total number of all PCR positive and negative infants born from HIV positive mothers recorded between 2015 and 2016 and all the professional nurses rendering PMTCT services from healthcare facilities in the area were included to participate in the study. The sampling for infant records was based on all HIV-positive women who gave birth. Therefore, all the infants born from HIV-positive women were included in the study, irrespective of their HIV status, as only a few infants were born to HIV-positive mothers in this study area between 2015 and 2016. All nurse managers from each of the clinics in the area were interviewed about the health system related factors associated with high PCR positivity.

3.3. Data management

3.3.1. Data collection tool

A structured data collection tool, adapted from the DoH (Department of Health, South Africa, 2014), was used to collect the data. The questionnaire consisted of closed-ended questions only and was divided into four sections, as follows: Section A: The PCR data collection tool, Section B: Maternal details, Section C: Baby details and Section D: Health system factors.

3.3.2. Pilot study

A pilot study is a small version, or trial run, of the main study done in preparation for the major study (Polit & Beck, 2012). In this study, to test for face validity of the data collection tool, a pilot study was conducted at the Primary Gateway Clinic in the Greater Tzaneen Municipality and the results from the pilot were used to rectify the questionnaire. Ten records were used, which assisted the researcher to test whether the content band structure was relevant and relevant amendments were made accordingly.

3.3.3. Data collection

Data collection and fieldwork was conducted by the researcher using the standardised data collection tool adapted from the NDoH (2014). The tool was used to extract records of all registered HIV-exposed infants from birth to 12 months and PCR-tested infant charts documented from 2015 to .2016. The data was retrieved from the maternal and babies' records or registers at District office and a checklist was formulated to check important elements such as maternal and neonatal factors associated with high positive PCR and health system related factors associated with high positive PCR from each maternal and babies' information.

Inclusion and exclusion criteria

3.3.1.1. Inclusion criteria

All records of infants who were tested for HIV and the PCR results were positive from birth up to 12 months of age were included. For the health care workers, all nurses working as managers of a clinic were included in the study.

3.3.1.2. Exclusion criteria

All records of infants born to HIV-positive mothers who had incomplete information were excluded and all infants with missing PCR test results, and those whose tests has not been repeated, were excluded from the study. For health care workers, all clinic managers who refused to participate in the study were excluded.

3.4. Data Analysis

According to Serakan and Bougie (2013), the process of data analysis takes many different forms depending on the nature of the research question and design, and the nature of the data itself. DePoy and Gitlin (2011) describe the purpose of data analysis as to categorise, order, manipulate and organise raw data so that the information derived from such data can be described in meaningful terms. In this study, data was analysed using the Statistical Package for the Social Sciences (SPSS) version 23 computer software and Stata 15. The entered data was doubled checked and duplicated to ensure correctness and accuracy. Categorical variables were presented as percentages and frequencies, while continuous variables were presented as mean, median and standard deviation. Furthermore, comparison of categorical variables was done using a Chi-Squared test, whereas continuous variables were compared using a t-test and P-value of <0.05 was considered significant.

To determine maternal and neonatal factors associated with high positive PCR, Factor analysis was used with rotated factor loadings done using the Varimax method. Factor analysis is a data summarization technique used to group variables according to some underlying dimensions (factors) that can explain high PCR positivity. To successfully carry out factor analysis, some statistical assumptions must be satisfied to justify the use of factor analysis.

Statistical Assumptions:

1. Bartlett test of sphericity—tests the presence of correlations among the questions/variables under the null hypothesis: If the correlation Matrix is an Identity matrix it means there is no correlation.

2. Measure of Sampling Adequacy—measures the appropriateness of Factor analysis, overall index > 0.5 is a go-ahead to use factor Analysis.

Results for the assumptions tests

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.628
Bartlett's Test of Sphericity	Approx. Chi-Square	293.476
	Df	105
	Sig.	.000

Both tests indicate that there is significant correlation between the variables and support the relevance of Factor analysis. Odds ratios were used to determine the likelihood of initiating treatment when the turn-around times for PCR were different. Simple Linear regression was used determine if the Gap in linkage to HIV care among pregnant women was dependent on the workload per initiation and management of antiretroviral therapy (NIMART) trained Nurse.

3.5. Reliability & Validity

3.5.1. Reliability

Reliability is the degree of stability exhibited when a measurement is repeated under identical conditions (Leady & Omrod, 2010). Reliability is the extent to which the same finding will be obtained if the research was repeated at another time by another researcher. If the same finding can be obtained again, the instrument is consistent or reliable. Reliability of the data collection tool was done through the pilot study which was done to test whether the tool will collect data that is relevant and intended to be collected hence the modification of the tool after piloting was done to test for validity.

3.5.2. Validity

Validity is defined by Leady & Omrod (2010) as a way of determining how well a survey measures what it is set out to measure. Validity is understood best by posing this question: 'Are we measuring what we think we are measuring?' This is very difficult to assess. In the study to test validity, the questionnaire that was used to collect data was used previously in another PCR positivity study and its applicability and feasibility have been validated in the pilot study. The same checklist used for piloting was unchanged, as it was

found that it measured what it was supposed to measure. Validity will further be ensued by providing precise and detailed information on data analysis.

3.6.   Bias

Bias is defined as any propensity which prevents fair consideration of a request. In research, bias occurs when a systematic error is introduced into sampling or testing by selecting or encouraging one outcome or answer over others (Pannucci & Wilkins, 2010). The types of biases which could possibly arise from the study are researcher bias, measurement bias and respondent bias. Researcher bias includes characteristics and/or behaviours of the researcher which may influence the data, including omission of questions, and inconsistent instructions. Researcher bias was minimized in this study by giving the nurses clear instructions on how to administer the questionnaire. Measurement bias is introduced by using incorrect equipment, including poor questionnaire design. To minimise measurement bias, the researcher piloted the questionnaires. Respondent bias is error introduced by the participants when completing the questionnaires. In this study, the researcher used English for the questionnaires, along with clear instructions on how to complete the questionnaire and sufficient space was provided for participants to express answers. In order to minimize respondent bias.

3.7.   ETHICAL CONSIDERATIONS

3.7.1.   *Permission to conduct the study*

Prior to conducting the study, the research proposal was submitted to School of Health Care Sciences Senior Degree Committee (SDC) and Faculty Higher Degree Committee (FHDC) for review. Ethical approval was obtained from the University of Limpopo's Turfloop Research Ethics Committee (TREC). The purpose of the study was elaborated on in an information leaflet presented to the participating clinics. The ethical clearance letter obtained from the above-mentioned committee was used to seek permission from the Provincial Department of Health Research Committee, the Regional Department of Health and from the operational managers of Greater Letaba Municipality clinics (see example of permission letters in Appendix D).

3.7.2. Voluntary participation

The professional nurses were informed of their right to withdraw their participation in the study at any stage.

3.7.3. Confidentiality and anonymity

Confidentiality refers to the fact that information provided by participants in answering the research questions will not be shared with anyone and that the information will remain protected from any third party (de Fos, Strydom, Fouché & Delport. 2011). The names of the participants were not used, the questionnaires were linked by identifier numbers and the participants' information was not divulged. Safe keeping of records was enhanced by keeping the completed questionnaires in a locked cupboard, in a safe place, where only authorised personnel had access to the documents. The documents will be kept for a period of 5 years after data analysis and reporting.

3.7.4. Privacy

Professional nurses (the respondents) completed the questionnaire in a private room in order to maintain privacy, and unauthorized personnel were not allowed to enter the room during completion of questionnaires. The research report is presented in such a way that nobody will be aware of responses to the questions of a particular participant (Leady & Omrod, 2005).

3.7.5. Informed consent

All individuals have a right to decide for themselves whether or not to participate in the study, and to continue or stop participating at any time, without any negative or adverse consequences. Participants were asked to give permission for their participation. Those who agreed to participate were given a consent form to sign, after the researcher informed them of the aims and objectives of the study, and the data collection procedure to be followed in the study (see example of a consent form is attached in Appendix B).

3.7.6. Protection from harm

No harm was inflicted on the patients' dignity. Confidentiality and privacy were strictly adhered to. No physical or psychological harm was inflicted on anyone.

3.7.7. Beneficence

The results of this study were useful in making nurses aware of the importance of implementing PMTCT programmes in health facilities. They study was also useful in preventing transmission of HIV infection from the HIV-positive mothers through the application of PMTCT programmes.

CHAPTER FOUR: THE RESULTS

4.1. Introduction

In the previous chapter the research methodology used in this study was discussed. In this chapter, the results of the study are presented and interpreted. The chapter is divided into three subsections, namely: 1. Mother and baby demographic, the description of maternal and clinical background. 2. Analysis results of maternal and neonatal factors associated with high PCR positivity. 3. Analysis results of health system related factors associated with high PCR positivity.

4.2. Mothers' demographics and background

During the period of the study, a total of 107 records were retrieved and reviewed, of which 42% (n=45) of the mother-child pairs fulfilled the inclusion criteria.

Figure 4.1: The age distribution of mothers

	20 - 24	25 - 29	30 - 34	≥ 35
Age in years	20	42,2	28,9	8,9
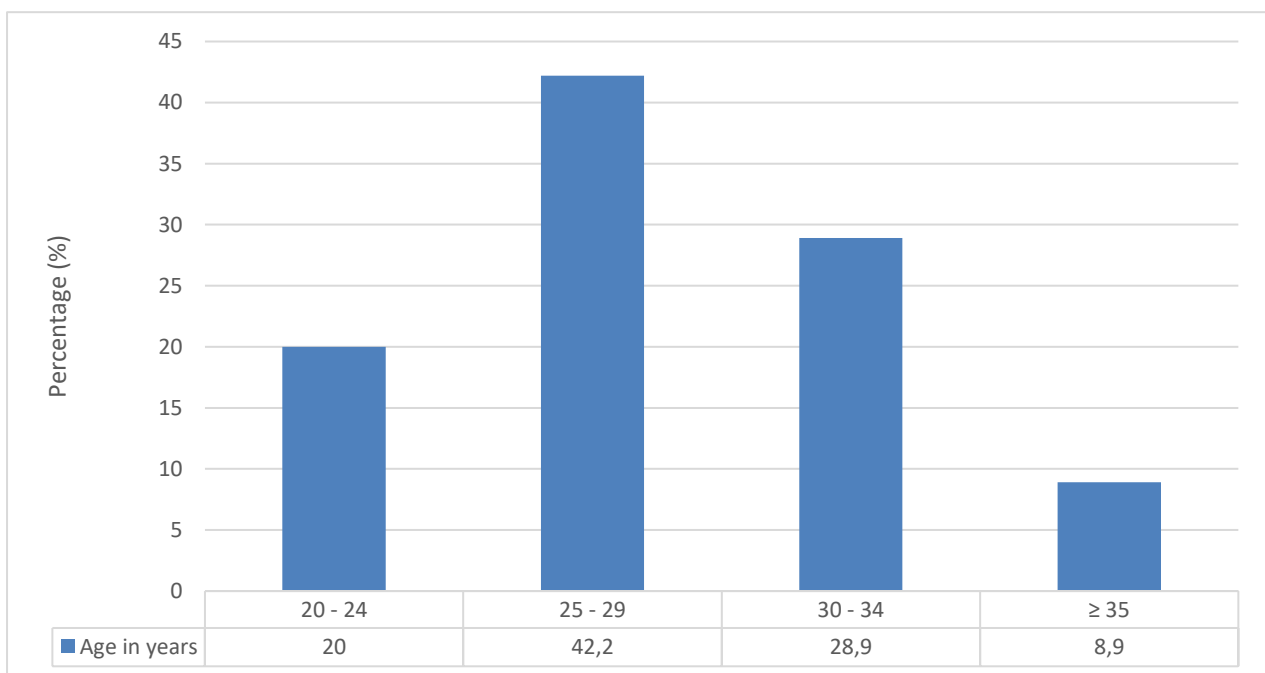
Figure 4.1 above presents the age distribution of mothers in the current study.

The majority of the mothers were in the age group 25–29 years (42.2%), followed by the age groups 30 – 34 years, 20 –24 years and, lastly, age group 30 years and above, at

28.9%, 20% and 8.9% respectively. Cumulatively, 17.1% of mothers were in the age group between 25 – 34 years.

Table 4.1 below illustrates the mother's demographic information (age and marital status), maternal history (gravida and parity) and clinical history (HIV care and antenatal care).

Table 4.1: Mothers' Information

		Age (years)				P-value
		20-24	25-29	30-34	35+	for trend
Marital status	n (%)	n (%)	n (%)	n (%)	n (%)	
Single	30 (67.0)	7 (23.0)	12 (40.0)	8 (27.0)	3 (10.0)	0.829
Married	15 (33.0)	2 (13.0)	7 (47.0)	5 (33.0)	1 (7.0)	
Mother's gravida						
1	15 (33.0)	5 (33.0)	7 (47.0)	2 (13.0)	1 (7.0)	
2	17 (38.0)	3 (18.0)	9 (53.0)	5 (29.0)	-	
3	8 (18.0)	1 (13.0)	3 (37.0)	3 (37.0)	1 (13.0)	0.076
4	5 (11.0)	-	-	3 (60.0)	2 (50.0)	
Mother's parity						
0	23 (51.1)	7 (30.4)	9 (39.1)	4 (17.3)	3 (13.4)	
1	10 (25.6)	-	5 (50.0)	4 (40.0)	1 (10.0)	
2	4 (11.1)	1 (20.0)	2 (40.0)	1 (2)	-	0.302
3	2 (4.4)	-	-	2 (100)	-	
HIV status at 1st booking						
Positive new	20 (47.7)	5 (12)	8 (19.0)	4 (10.0)	3 (7.0)	
Known HIV on ART	20 (47.6)	3 (15.0)	9 (45.0)	7 (35.0)	1(5.0)	0.759
Known HIV not on ART	2 (4.7)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	

Overall, a greater proportion (67%) were unmarried. Considering age groups, the majority of mothers who were not married were in the age group 25–29 years, followed by those in the 30–34 years, age group and the 20–24 years' age group, at 40%, 27% and 23% respectively. Thirty-three percent of the mothers were gravida one, while 51% were para 0. At first booking 47.7% of women were found to be HIV-positive and were also on treatment. The majority of the mothers who were known to be HIV-positive and who were on ART. Forty-five percent of HIV-positive mothers on ART were in the age group 25-29 year, followed by age group 30-34 (35%), while 15% of mothers who were HIV-positive

and on ART were from the age group 20-24 years. Only a few mothers in the 35 years and above category were recorded at first booking (7%). With regard to gravida, the majority were mothers between 30-34 years of age (60%, where n=3), followed by 50% (n=2) in the 35 years and above category. Parity increased with an increase in age of the mother, particularly between the ages of 30 and 34 years.

Table 4.2: Mother HIV treatment by diagnosis period

| | N | Mothers on ART | | |
		Yes	No	Not documented
Before pregnancy	27 (60)	26 (65)	1 (100)	-
During first booking	8 (17.7)	8 (20)	-	-
Re-test during current pregnancy	4 (8.8)	4 (10)	-	-
During post-natal period	2 (4.4)	2 (5)	-	-
Unspecified	4 (8.8)	-	-	4 (100)

The majority (60%) of the mothers were diagnosed as HIV-positive before pregnancy, followed by 17.7% of mothers who diagnosed HIV-positive during their first booking. Maternal HIV treatment by diagnosis period is presented in Table 2. Overall, 89% (n=40) of the mothers were initiated on ART, of which 65% (n=26) were on ART before the current pregnancy.

4.3. Baby's demographics

The proportion of the babies were 53% females as compared to 47% males as illustrated in figure 4.2 below.
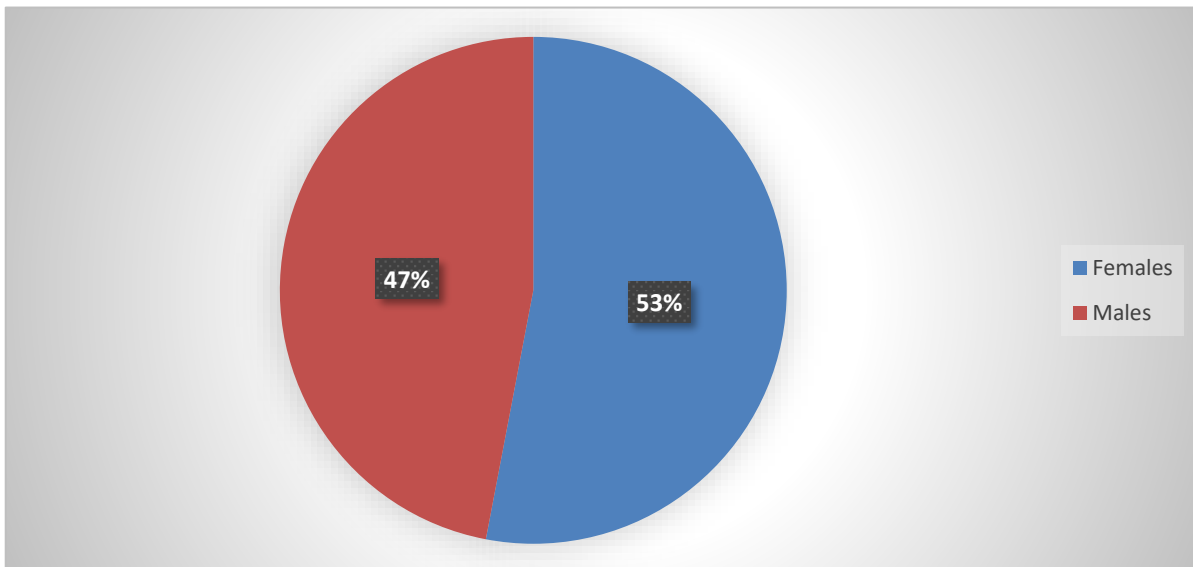
Figure 4.2: The gender distribution of babies

Table 4.3 presents the demographic information of the babies by gender. It was found that only 2.4% of infants were preterm and a greater proportion (97.6%) was born at gestational age 37 – 47 weeks. Eighty-six-point-six percent of the babies were HIV-positive, and 59% were PCR positive at birth followed by those who were born at. The majority of PCR positive babies at birth were females (54%). Male babies found to be PCR positive around 10 weeks after birth (100%) with equal proportions of both male and female babies who were found to be PCR positive at 6 weeks.

Table 4.3: Babies' demographics by selected clinical data

	N	Female n (%)	Male n (%)
Gestational age at birth			
<37 weeks	1 (2.4)	-	1 (100)
37 – 42 weeks	41 (97.6)	22 (53.7)	19 (46.3)
HIV status			
Positive	39 (86.6)	21 (53.8)	18 (46.0)
Negative	6 (13.3)	3 (50.0)	3 (50.0)
PCR incidence period			
At birth	26 (59.0)	14 (54.0)	12 (46.0)
6 weeks	4 (9.0)	2 (50.0)	2 (50.0)
Around 10 weeks after birth	3(6.8)	-	3 (100)
between 10 weeks and 12 months	5(11.3)	5 (100)	-

The highest proportion of the mothers who gave birth to PCR positive babies during the reporting period were single mothers (66.6%). Considering age groups, 46.1% of married mothers in the age group 25–29 years gave birth to HIV-positive babies, followed by age groups 30 – 34 years, 20 – 24 years, and 35 years and above, at 30.7%, 15.3% and 7.6%, respectively. A similar trend was seen among single mothers who gave birth to HIV-positive babies. Twenty-six percent of the HIV-positive babies were born at 38 weeks, followed by those at 37 weeks, 40 weeks, 39, at 21%, 22%, 21%, 18%, respectively, while the number of babies born at 5 weeks and 26 weeks were 5% and 3% respectively, as presented in figure 4.3 below.
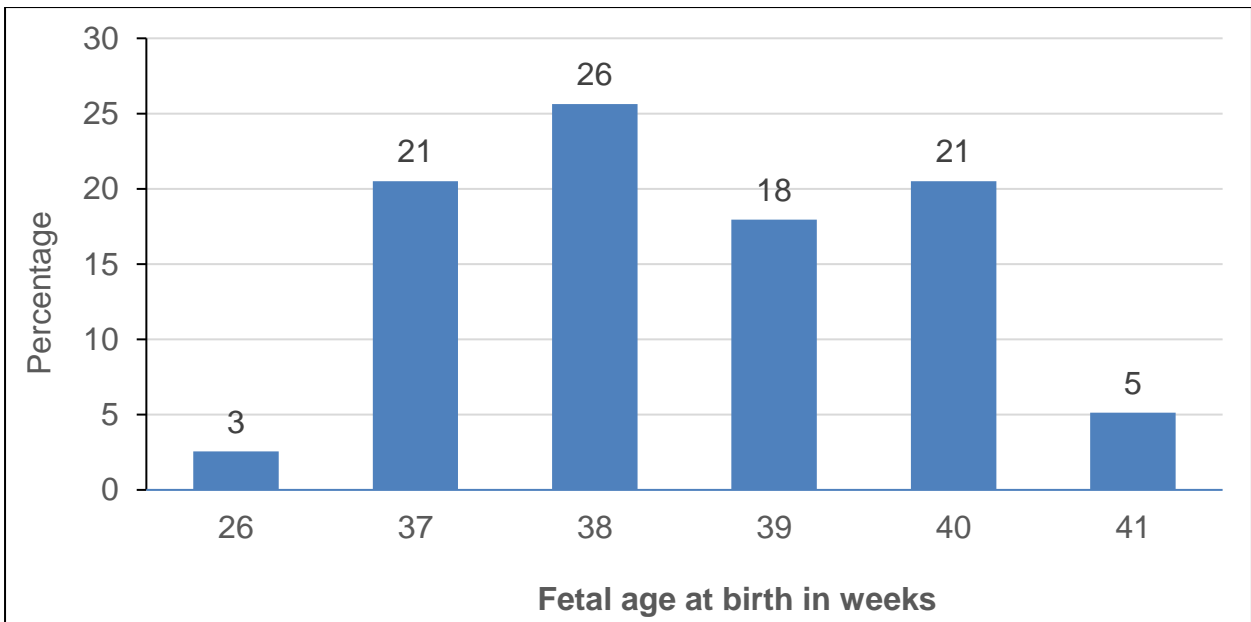
Figure 4.3: Distribution of gestational age at birth

Figure 4.4 below presents treatment status of the babies during the period of the study. The majority (87%, where n=34) of the babies were initiated on ART, while only one (3%) were not initiated on ART and in the case of 10 of the babies, their treatment status was not documented, as presented in Figure 4.4 below.
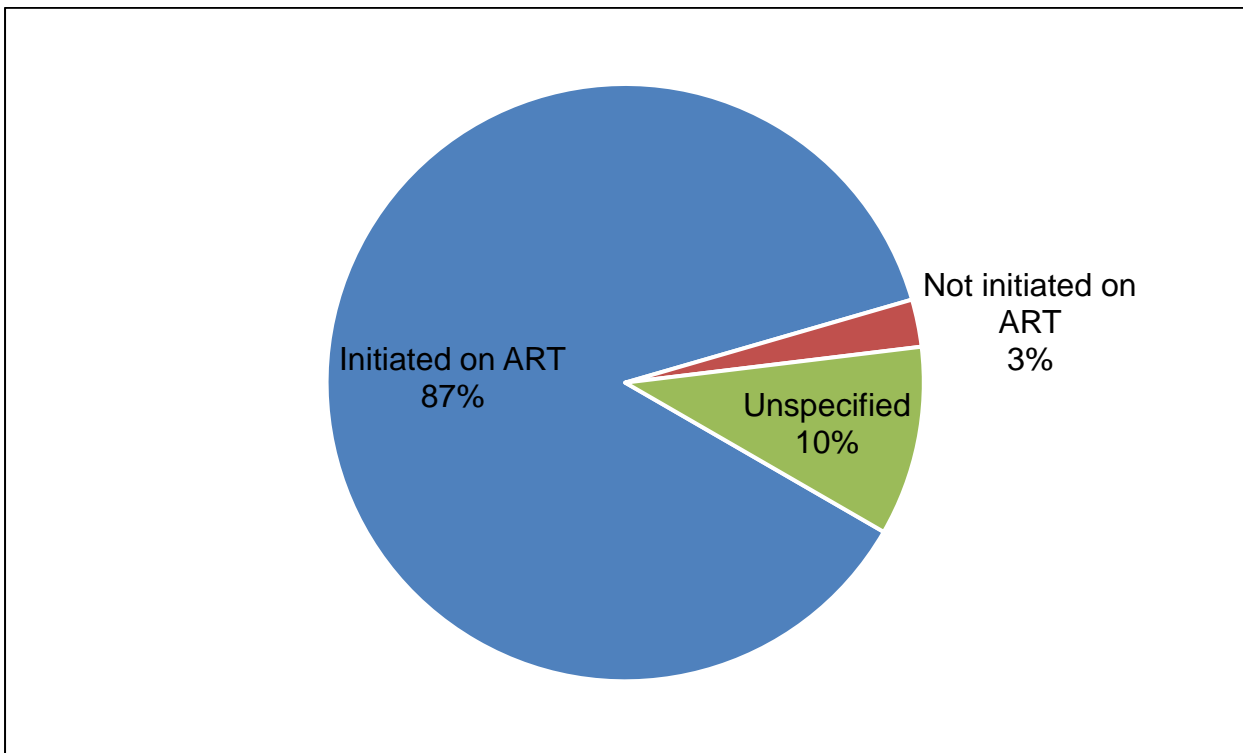
Figure 4.4: Infants status on the initiation on ART

4.4. Maternal and neonatal factors associated with high PCR positivity

To determine maternal and neonatal factors associated with high positive PCR, the following variables were analysed using factor analysis. Factor Analysis will be used to derive underlying causes of high PCR positivity and investigate which maternal and neonatal variables best explain these derived causes which can be termed factors.

A total of 16 variables listed below are analysed using factor analysis and an initial output called the "total variance explained" is generated.

1. Mothers Age
2. Mothers Gravida
3. Mothers Parity
4. Baby's fatal Age at Birth
5. Mothers gestational age at 1st booking
6. Last VL Count before Delivery
7. 1st VL Count after Delivery
8. Duration of HIV positive status
9. Duration on ART
10. Mothers HIV Status at 1st Booking
11. Mothers Marital Status
12. Treatment Regimen
13. Total prescriptions dispensed
14. HIV Diagnosis Modality
15. Infant Feeding Option
16. Period of PCR diagnosis (Baby)

Table 4.4: Total variance Explained using Principal Component Analysis.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.563	30.422	30.422	3.327	22.181	22.181
2	2.512	16.749	47.170	2.698	17.987	40.168
3	2.422	16.149	63.319	2.572	17.145	57.313
4	1.517	10.111	73.431	2.045	13.632	70.945
5	1.384	9.227	82.658	1.757	11.713	82.658
6	.954	6.362	89.020			
7	.851	5.675	94.695			
8	.335	2.232	96.927			

From the output in Table 4.4 above, a total of Five Factors highlighted above have emerged from the resulting Extraction and the 1st factor contributes 22, 2% and cumulative variance of all 5 factors contributes 82, 6% of the total variance. This means that the 5 factors explain 82% of the difference (variance) in responses/findings amongst the experimental units. A final output table called the rotated component matrix is used to interpret the result

Table 4.5: Rotated Matrix using Varimax with Kaiser Normalization.

	Component				
	1	2	3	4	5
Mothers Gravida	.927	-.080	-.148	-.115	.052
Mothers Age	.900	-.114	.096	-.038	-.029
Mothers Parity	.827	.106	-.300	-.039	.153
Mothers gestational age at 1st booking	-.588	.035	.021	.323	.356
Mothers Marital Status	-.051	.887	.259	-.043	-.119
HIV Diagnosis Modality	-.106	.867	.009	.052	-.159
Duration on ART	.013	.785	-.349	.279	.378
Infant Feeding Option	.097	-.044	.971	-.084	.059
1st VL Count after Delivery	-.474	.205	.755	.165	.032
Total prescriptions dispensed	.328	.030	-.623	.052	.612
Last VL Count before Delivery	-.477	.418	.567	.370	.311
Duration of HIV positive status	-.100	.219	.063	.854	-.083
Baby's foetal Age at Birth	-.099	-.006	.003	.741	-.097
Mothers HIV Status at 1st Booking	.149	.477	.117	-.594	-.433
Treatment Regimen	-.047	-.127	.144	-.195	

<u>Interpretation of results</u>

In Table 4.5 above it has been revealed that variables are considered significantly correlated to a factor if the correlation coefficient (r) in the rotated component matrix is greater than 0.5. Five factors were derived using factor Analysis.

- **Factor 1**: Was made up of the following variables (in that order of significance): Mothers gravida r=0.927, Mothers Age r=0.9, Mothers Parity r=0.827 and Mothers Gestational Age at 1st booking r=-0.588. Factor 1 has a common underlying theme that has to do with maternal antenatal history.

- **Factor 2**: Was made up of the following variables (in that order of significance): Mothers Marital Status r=0.887, HIV Diagnosis Modality r=0.867 and Duration on ART r=0.785. Factor 2 has a common underlying theme that has to do with HIV care. How marital status and HIV care are related still needs further investigation.

- **Factor 3**: Was made up of the following variables (in that order of significance): Feeding Option r=0.971,1st VL Count after Delivery r=0.755, Total prescriptions dispensed r=0.623, Last VL Count before Delivery r=0.567. Factor 3 has a common underlying theme that has to do with measures of adherence to treatment. Adherence may influence infant feeding options which is the 4th variable highly correlated to this factor.

- **Factor 4**: Was made up of the following variables (in that order of significance): Duration of HIV positive status r=0.854, Baby's foetal Age at Birth r=0.741, Mothers HIV Status at 1st Booking r=0.594. Factor 4 has a common underlying theme that has to do with exposure to HIV infection of the mother. Premature delivery and exposure to HIV may be further investigated as these variables have significant correlations to the same factor.

- **Factor 5**: Was made up one variable, Treatment Regimen, r=0,861
  This implies that the Regimen that a mother is on can be a contributing factor on its own to high PCR positivity.

Conclusion

The results show that high PCR positivity can be attributed to about 5 main Factors namely: maternal antenatal history (22% contribution to total variance), maternal HIV care history (18% contribution to total variance), measures of adherence to treatment (17% contribution to total variance), maternal exposure to HIV (14% contribution to total variance) and lastly the ART regimen (12% contribution to total variance).

4.5. Health system factors associated with PCR positivity

In describing health system factors associated with PCR positivity, Prevention of Mother to Child transmission (PMTCT) guidelines of 2019 will be used as a guide to discuss the extend of implementation of chosen critical factors in mitigating high PCR positivity in Greater Letaba Municipality. Table 4.7 elaborates on the health system factors and how they ultimately affect implementation of guidelines and results in higher chances of PCR positive cases.

4.5.1. Use of PMTCT latest guidelines.

The PMTCT guidelines is the guiding document that should be used by clinicians and health professionals to mitigate the risk of vertical transmission and thereby reducing the PCR positivity. Its availability and training is the responsibility of the administrative leads of the health system at large and its utilization is the responsibility of clinicians. Data was collected on the availability of the guidelines at 14 health facilities in Greater Letaba.

Table 4.6 Availability of PMTCT guidelines

		n (%)
Latest PMTCT guideline	Available upon request	10 (75)
	Not available upon request	4 (25)

Table 4.6 above shows that out of the 14 facilities audited on availability of the latest PMTCT guidelines to manage pregnant women, 10 (72%) of facilities availed the guidelines.

Table 4.7 Health system factors and guideline interventions that affect PCR positivity

Guideline	Health system factor that can affect intervention	Inter-relationships with PCR positivity
• Treatment for HIV as a prophylactic intervention • Newly diagnosed pregnant women started on ART • Already on ART pregnant women to continue treatment	ARV drug stock-outs	
• Training of Clinicians on implementing guidelines and use of algorithms and decision tools (part 4 of the guidelines) • Algorithms on Viral load monitoring o Dolutegravir and risk of Neural tube defects o ART initiation algorithm o Key adherence messages	NIM-ART Training coverage Availability of PMTCT guidelines Number of mentorship visits by district or development partners to NIM-ART-Trained Nurses	
• All HIV-exposed Infants should receive a birth HIV-PCR to identify HIV transmission that occurred in-utero. o Exposed infants should be provided with high-risk prophylaxis until the result of the delivery-VL can be checked at the 3-6-day postnatal visit. When the delivery-VL result is known, the infant can be re-classified as high/ low-risk and prophylaxis adjusted accordingly.	PCR test kits stock-outs PCR tests turn-around time	

4.5.2. Viral load monitoring

A comparison was done on the monitoring of Viral loads which should be done at least 3 times before delivery according to the guidelines.

Table 4.8 Viral Load monitoring of pregnant women HIV positive (2015 and 2016)

Facility	VL1 n (%)	VL2 n (%)	VL3 n (%)	VL4 n (%)	VL5 n (%)	Grand Total
Bellevue Clinic	45 (51.1)	28 (31.8)	12 (13.6)	3 (3.4)	0 (0)	88
Bolobedu Clinic	23 (67.6)	7 (20.6)	3 (8.8)	1 (2.9)	0 (0)	34
Charlie Rangaan Clinic	17 (41.5)	15 (36.6)	7 (17.1)	2 (4.9)	0 (0)	41
Duiwelskloof CHC	43 (58.9)	21 (28.8)	6 (8.2)	2 (2.7)	1 (1.4)	73
Duiwelskloof. Clinic	16 (69.6)	7 (30.4)	0 (0)	0 (0)	0 (0)	23
Kgapane Clinic	54 (65.9)	24 (29.3)	3 (3.7)	1 (1.2)	0 (0)	82
Lebaka Clinic	37 (46.8)	23 (29.1)	13 (16.5)	6 (7.6)	0 (0)	79
Mamaila Clinic	25 (65.8)	13 (34.2)	0 (0)	0 (0)	0 (0)	38
Mamanyoha Clinic	7 (43.8)	7 (43.8)	2 (12.5)	0 (0)	0 (0)	16
Maphalle Clinic	32 (65.3)	16 (32.7)	1 (2)	0 (0)	0 (0)	49
Matswi Clinic	51 (51)	28 (28)	13 (13)	7 (7)	1 (1)	100
Meedingen Clinic	48 (55.8)	25 (29.1)	11 (12.8)	2 (2.3)	0 (0)	86
Middelwater Clinic	35 (64.8)	16 (29.6)	3 (5.6)	0 (0)	0 (0)	54
Modjadji 5 Clinic	28 (65.1)	11 (25.6)	4 (9.3)	0 (0)	0 (0)	43
Pheeha Clinic	26 (46.4)	18 (32.1)	11 (19.6)	1 (1.8)	0 (0)	56
Raphahlelo Clinic	24(82.8%)	5 (17.2)	0 (0)	0 (0)	(0%)	29
Rotterdam Clinic	19 (67.9)	7 (25)	2 (7.1)	0 (0%)	(0%)	28
Seapole Clinic	40 (53.3)	23 (30.7)	11 (14.7)	1 (1.3)	0 (0)	75
Sekgopo Clinic	33 (60)	18 (32.7)	3 (5.5)	1 (1.8)	0 (0)	55
Senobela Clinic	37 (56.1)	21 (31.8)	8 (12.1)	0 (0)	0 (0)	66
Shotong Clinic	21 (67.7)	9 (29)	1 (3.2)	0 (0)	0 (0)	31
ZZ2 Non-Medical Site	6 (100)	0 (0)	0 (0)	0 (0)	0 (0)	6
Grand Total	**667 (57.9)**	**342 (29.7)**	**114 (9.9)**	**27 (2.3)**	**2 (0.2)**	**1152**

The results show that only 58% of viral loads were done and 30% had second last viral loads and at last only 9,9% had 3rd last viral loads done in line with guidelines to have at least 3 viral loads before delivery.

4.5.4. **Turn-round time for PCR and delay in initiating positive infants on ART.**

The guidelines indicate that exposed infants should be provided with high-risk prophylaxis until the result of the delivery-VL can be checked at the 3-6-day postnatal visit. When the delivery-VL result is known, the infant can be re-classified as high/ low-risk and prophylaxis adjusted accordingly. The researcher suspected that turn-around time of more than 5 days has a significant impact on mothers defaulting from visiting the clinic after the 3rd day since they are encouraged to visit the clinic 3 days postnatally as part of routine mother and child wellness clinic. If the PCR result comes later than this visit, the mothers may delay bringing their infants back for initiation and some may take the advantage of not returning at all back to the clinic.

In a randomly chosen period of the study, (Oct 2015-June 2016), 194 valid tests were analysed. The graph below shows the initiation patterns. Overall, so far. 50% initiated were initiated by the time of data collection.
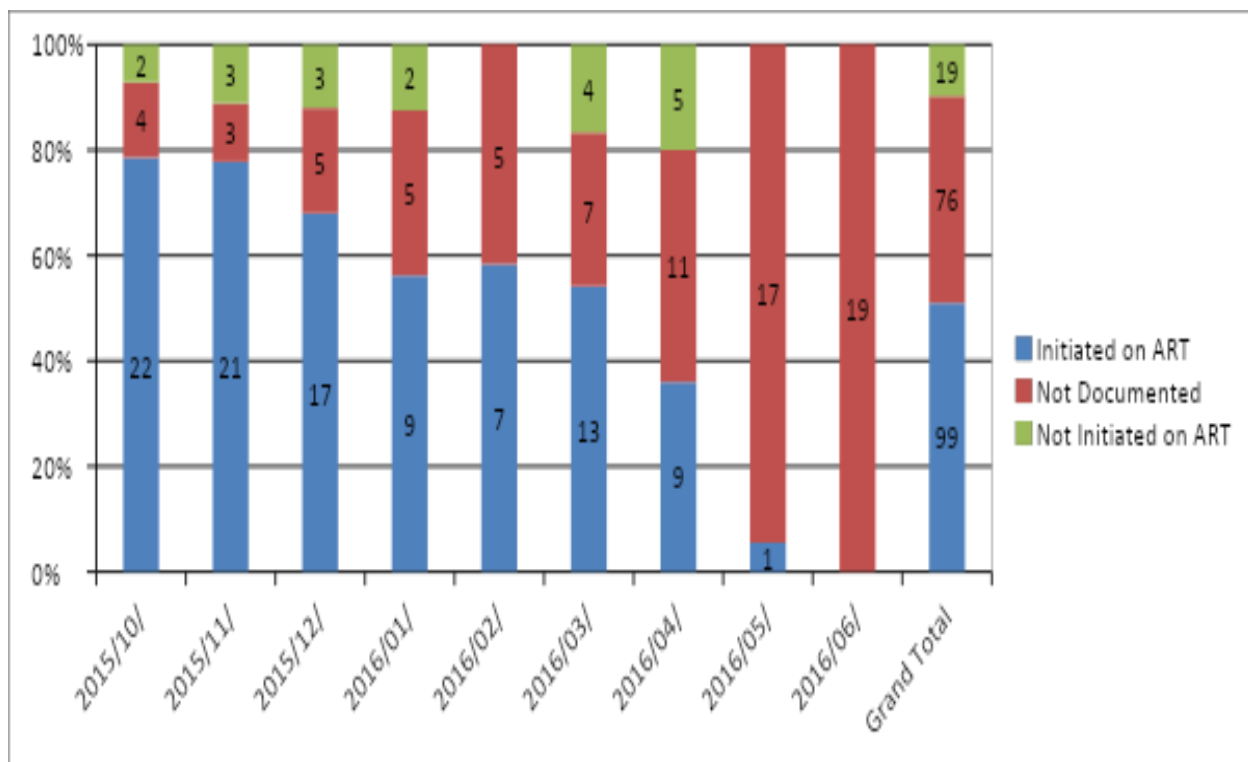

Figure 4.8 Outcomes of the verified PCR positive babies

Twenty-eight (28) cases were audited with information on PCR turn-around time. In approximately 78.5% of the cases, the babies turn-around time for PCR tests was 7 days, in 21.5 % of the cases; turn-around time was 5 days.

Table 4.9: Turn-around-time for PCR tests results

		n (%)
Turn-around time for PCR tests	7 days	22 (78.5%)
	5 days	6 (21.5%)

Table 4.10 Contingency table used to calculate Odds ratios

	Infant Started on ART	Infant not started on ART	Total
5 Days	2	4	6
7 Days	17	5	22
Total	19	9	28

The proportion were calculated to determine the likelihood of initiating treatment when the turn-around times for PCR were different. The proportion was 10/68=0,147 and the interpretation is that PCRs that have a turn-around times of 5 days have less chances of being initiated on treatment than PCRs that have a turn-around time of 7 days. This could be because a mother would find it hard to come back to the clinic just 2 days after the 3rd day postnatal check-up but would prefer coming a week later.

4.5.5. NIMART trained Nurses vs initiation of positive pregnant women on ART

Every professional nurse should be NIM-ART trained in health facility that provides ART services to patients. Figure 4.5 below indicates the total number of professional nurses versus the NIM-ART trained professional nurses in the Greater Letaba Sub-District. The majority of the nurses (76.5%, where n=52) were NIM-ART trained, while only 24.5% (n=16) of the professional nurses in the sub-district were not trained in NIM-ART.

Table 4.5 below is about the availability of NIM-ART trained nurses per health facility. A total of fourteen health facilities were reviewed with respect to the availability of

professional nurses who were NIM-ART trained. There were 68 professional nurses in these health facilities. In the case of seven of the health facilities, all their professional nurses were trained on NIM-ART. In four health facilities, between 67% to 80% of their professional nurses were trained on NIM-ART. In one clinic, 57% of the professional nurses were trained on NIM-ART. Two health facilities were functioning with only less than 50% of the professional nurses trained on NIM-ART, and the number of NIM-ART trained nurses at these facilities were 33% and 43% of the total number of nurses at these facilities.

Table 4.11: Distribution of professional nurses NIM-ART trained

Facility	Total number of Professional Nurses	Number of NIM-ART trained nurses		Facility	Total number of Professional Nurses	Number of NIM-ART trained nurses
Clinic B	4	4 (100)		Clinic K	5	4 (80)
Health Centre	10	10 (100)		Clinic E	4	3 (75)
Clinic C	2	2 (100)		Clinic F	6	4 (67)
Clinic H	3	3 (100)		Clinic G	3	2 (67)
Clinic I	4	4 (100)		Clinic D	7	4 (57)
Clinic J	2	2 (100)		Clinic A	6	2 (33)
Clinic L	5	5 (100)		Clinic M	7	3 (43)
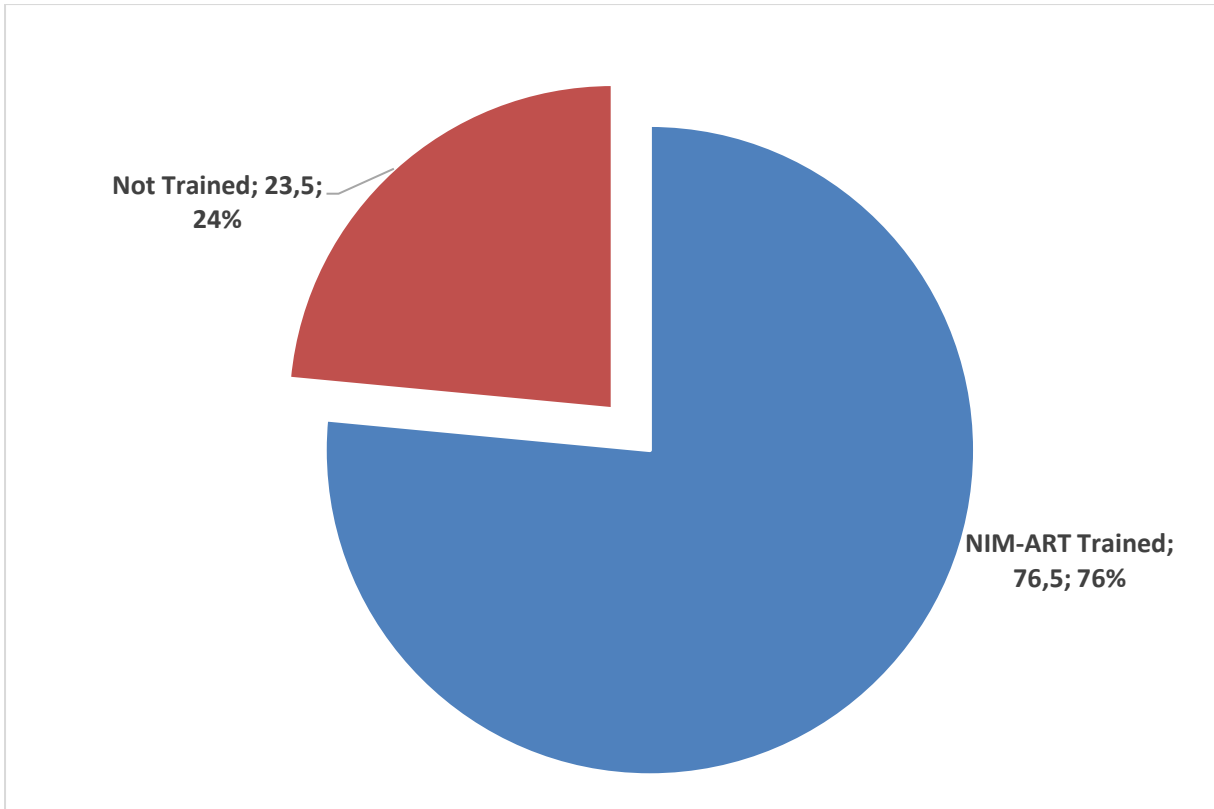
Figure 4.9: The availability of NIM-ART trained nurses in Greater Letaba Municipality

The researcher investigated the workload per NIMART-trained Nurse and its impact on initiation of pregnant positive women on ART as non-initiation means a higher risk of vertical transmission (see table 4.11 below). The average number of patients remaining on treatment per NIMART-trained nurse was calculated for each facility in Greater Letaba municipality against percentage of pregnant women booking for ANC who are positive but not on ART. The percentage of pregnant women booking for ANC who are positive but not on ART is a proxy to show the gap in linkage to ART care of women already tested HIV positive which may be due to huge workloads by NIMART-trained professionals.

Table 4.12 calculates the relative workloads calculated as a proportion of total number of clients on treatment to the number of Nimart-trained nurses in that health facility. From the experience of the researcher as a roving nurse mentor, this has a direct effect on the quality of care and adherence to guidelines since a huge workload usually results in oversight and non-adherence to guidelines.

Table 4.12: Workload per NIMART-trained Nurse and its impact on initiation of pregnant positive women on ART

Facility	` Antenatal known HIV positive but NOT on ART at 1st visit	` Antenatal already on ART at 1st visit	` Linkage gap	` Total remaining on ART(TROA) end of Dec2016	` NIM-ART trained Nurses	NIM-ART Workload
lp Bellevue Clinic	16	40	28,6%	778	2	389,0
lp Bolobedu Clinic	9	18	33,3%	407	4	101,8
lp Charlie Rangaan Clinic	24	17	58,5%	471	4	117,8
lp Duiwelskloof CHC	35	33	51,5%	905	10	90,5
lp Duiwelskloof Clinic	14	9	60,9%	453	4	113,3
lp Kgapane Clinic	56	35	61,5%	1282	2	641,0
lp Lebaka Clinic	16	24	40,0%	647	4	161,8
lp Mamaila Clinic	28	26	51,9%	777	3	259,0
lp Mamanyoha Clinic	2	13	13,3%	191	3	63,7
lp Maphalle Clinic	24	43	35,8%	915	3	305,0
lp Matswi Clinic	28	43	39,4%	895	4	223,8
lp Meedingen Clinic	33	52	38,8%	1074	2	537,0
lp Middelwater Clinic	22	24	47,8%	524	5	104,8
lp Modjadji 5 Clinic	8	7	53,3%	510	3	170,0
lp Pheeha Clinic	15	25	37,5%	385	4	96,3
lp Raphahlelo Clinic	18	16	52,9%	549	2	274,5
lp Rotterdam Clinic	17	18	48,6%	378	3	126,0
lp Seapole Clinic	17	23	42,5%	748	4	187,0
lp Sekgopo Clinic	15	34	30,6%	1069	5	213,8
lp Senobela Clinic	18	35	34,0%	1015	3	338,3
lp Shotong Clinic	24	62	27,9%	949	5	189,8

Table 4.13: Other Health System factors

Health system factors		n (%)
Babies PCR test kit in health facility	Available	12 (85.7)
	Not available	2 (14.3)
ARV drug stock-out	Yes	14 (100)
	No	0 (0)

Results also showed that 14% of the babies PCR test kit were not available at the time of record review, the babies missed as a result of PCR kit stock out might have been managed earlier should their PCRs done timely. No facilities experienced ARV drug stock-outs.

In total.

4.6. Conclusion

In this chapter, the results of the study were presented and interpreted. In the next chapter, the findings will be discussed and compared to literature

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

The previous chapter presented and interpreted the results of the research study. In this chapter, the results of the study are discussed, conclusions reached, recommendations made, and the limitations of the study are provided. In 2015, the National Department of Health introduced the PMTCT Guidelines to manage pregnant women in order to prevent the transmission of HIV from mother to child before pregnancy, during pregnancy, after delivery and during the breastfeeding period. This study aimed to determine the determinants of human immunodeficiency virus positivity rates in the Greater Letaba Municipality, Limpopo Province, South Africa.

5.2. SUMMARY OF RESEARCH

The study investigated the determinants for the human Immunodeficiency Virus positivity rates in the Greater Letaba Municipality. It also investigated maternal, neonatal and health system factors and their association with PCR positivity. The study data was triangulated from two main sources: 1. clinical information of all HIV-exposed infants up to 12 months whose DNA PCR was positive between 2015 and 2016 and 2: Information obtained from nurse managers who completed the health system related factors questions from a designed PCR audit tool in all the clinics in the Greater Letaba Municipality where it was applicable.

The proposed sampling for infant records was based on all HIV-positive women who gave birth and the babies' PCR tests were positive. An initial sample of 107 records were available and only 45 met the criteria for the final sample. All nurse managers from each of the clinics in the area were interviewed about the health system related factors associated with high PCR positivity.

A pilot study was conducted at the Primary Gateway Clinic in the Greater Tzaneen Municipality and the results from the pilot were used to rectify the questionnaire. Ten records were used, which assisted the researcher to test whether the content band structure was relevant and relevant amendments were made accordingly.

Data was analysed using the Statistical Package for the Social Sciences (SPSS) version 23 computer software and Stata 15. Descriptives were presented as percentages and

frequencies using graphs and tables. Factor analysis was used to determine maternal and neonatal factors associated with high positive PCR. An analysis of variance statistical method was used to establish the relationship between availability of guidelines and compliance with monitoring of viral loads. Odds ratios were used to determine the likelihood of initiating treatment when the turn-around times for PCR were different. Simple Linear regression was used determine if the Gap in linkage to HIV care among pregnant women was dependent on the workload per NIMART trained Nurse.

5.3. DISCUSSION AND INTERPRETATION OF FINDINGS

The results from this study show that forty-five (45) records of mothers paired with their infants from the fourteen primary health care facilities were in the age group 25 –34 years (71.7%). A study conducted in Northwest Ethiopia also reported approximately 67.2% of mothers were in the age group 25 – 34 years (Moges, Kassa, and Boneya, 2017) but mostly single and their gravidas 1 and 2 were almost in equal proportions (46.3% gravida 2) to this current study (gravida 2 ,38%). The study further indicated that 51% mothers were pregnant for the first time were para 0.

The results also show that, of the mothers who were married, with known HIV and on ART, 45% were in the age group 25-29, followed by mothers in the age group 30-34 (35%) while 15% were in the age group 20-24 years. Only a few mothers were of 35 years of age and above (7%) at first booking. Of these, 5% were known to be HIV-positive and on ART.While Bankole, Biddlecom, Dzekedzeke, Akinyemi, Awolude, Adewole. (2014) found that HIV-positive mothers on the antiretroviral drug presented with the low viral load, indicating a reduced probability of transmitting the virus to the child during pregnancy, childbirth, and breastfeeding. Mothers on chronic HIV care would likely be armed better knowledge of PMTCT and the need to adhere to the recommended prevention mechanism (UNAIDS,2011).

The results of this study revealed that a greater proportion (97.6%) of the babies were born at gestational age between 37 and 42 weeks which concurs with a study by Moges et al., 2017 which reported 95.8% of infants were delivered at term (gestational age 37 weeks to 42 weeks). The number of infants exposed to HIV during pregnancy has steadily increased (Moraleda, de Deus, Serna-Bolea, Renom, Quintó, Macete,

Menéndez & Naniche, 2014) and the findings of this study also revealed that approximately 86.6% of infants were exposed to HIV and then as a result got infected.

The majority of PCR positive babies at birth were females (54%). Only male babies were found to be PCR positive at around 10 weeks after birth (100%). Equal proportions of both male and female babies were found to be PCR positive at 6 weeks. The current study also revealed that the highest proportion of the mothers who gave birth to PCR positive babies for the reporting period were married mothers and had showed statistically significant with HIV positivity which concurs with a study conducted in Tigray, Northern Ethiopia (Desta, Saravanan, Hilekiros, Kahsay, Mohamed et al., 2019). in the age group 25-29 years (46.1%). The second largest proportion of mothers who gave birth to PCR positive babies were single mothers in the age group 25-29 years (38.4%). Only a few mothers in the 35 years and above age group were found to be married (7%).

5.3.2. Maternal and neonatal factors associated with high positivity

Results from Factor analysis showed that five factors are significantly associated with positivity of PCR tests. The most influential factor was linked to maternal antenatal history where the highest determinant was the mother's gravida, r=0.927. This contrasts with a study by Dunning et al., (2017) and the clinical differences in the two groups of infants at high-risk of HIV transmission were found against maternal age, gestation and infant birth weight and were not found against infant sex, infant feeding mode or gravidity. The findings are similar to the study findings by Dunning et al., (2017) conducted in in Cape Town, South Africa as the clinical differences in the two groups could be found for maternal age, gestation, and infant birthweight, which were all part of the criteria used to identify infants at high-risk of HIV transmission.

The next influential factor was linked to HIV care history where the highest determinant was HIV diagnosis modality, r=0,867. The modalities investigated were 1. Diagnosis anytime in the postnatal period 2. Diagnosis during 1st booking 3. Known Positive and diagnosed before current pregnancy and 4. Diagnosis during re-test of current pregnancy including at delivery. This implies that the stage of HIV diagnosis is very influential to the risk of vertical transmission. In the findings of a study conducted by Berhan, Abebe, Gedefaw, Tesfa, Assefa and Tafere (2014), it was reported that mothers who became pregnant after they knew their HIV serostatus were 0.22 times less likely

to have HIV-positive child, compared to those mothers who only knew their HIV status during antenatal care or post-partum, after onset of pregnancy, which concurs with the current study fndings. A similar study by UNAIDS/WHO 2012 in Dire Dawa City, Eastern Ethiopia reported a higher risk of infection due to delayed HIV diagnosis of the mother (Ebuy, Bekele & Redae., 2020). Studies conducted in Ukraine and at the University of Gondar Hospital in Ethiopia also showed similar findings (Bailey, Townsend, Semenenko, Malyuta, Cortina-Borja & Thorne., 2013). Furthermore, Bailey et al, said that the possibility of a higher rate of MTCT in HIV-positive in mothers who are newly diagnosed, compared to those mothers with known HIV-positive status could be due to the fact that: mothers who know their HIV-positive status showed good clinical adherence to their treatment, so they could benefit from taking the antiretroviral drugs. This was also in line with factor 4 whose theme was linked to duration of exposure to HIV infection of the mother where the highest determinant was Duration of HIV positive status r=0.854.

The 3rd influential factor was linked to measures of adherence to ARV treatment where the highest determinant was Feeding Option r=0.971. Adherence may influence infant feeding options. The next highest determinant was 1st VL Count after Delivery r=0.755. In the multivariate logistic regression analysis, being rural resident (AOR: 3.29; 95% CI: 1.40, 7.22), delivery at home (AOR: 3.35; 95% CI: 1.58, 8.38), infant not receiving ARV prophylaxis at birth (AOR: 5.83; 95% CI: 2.84, 11.94), mixed feeding practice (AOR: 42.21; 95% CI: 8.31, 214.38), and mother-child pairs not on PMTCT were found to be the most important significant determinants of mother-to-child HIV transmission (Wudineh & Damtew, 2016.)

In a study conducted in Dire Dawa City, Eastern Ethiopia, it was reported that mother's place of residence, infant's place of delivery, infant ARV prophylaxis at birth, feeding practice, infant age at enrolment, maternal enrolment into care, and PMTCT mother-child pairs were all associated with mother-to-child HIV transmission (Wudineh &Damtew, 2016). The last influential factor was made up one variable, Treatment Regimen, r=0,861. This implies that the regimen that a mother is on can be a contributing factor on its own to high PCR positivity.

5.3.3. Health system factors associated with high positivity

Three (3) health system factors were and their impact on key results related to prevention of mother to child transmission were investigated. An analysis of variance to establish the relationship between availability of guidelines and compliance with monitoring of viral loads showed no statistically significant association, p= 0.178 >0,05. This implies that viral load monitoring will not be improved even with the availability of clear guidelines on how to monitor the viral loads. This is supported by Ford et al., (2015) as they say viral load and CD4 cell counts at baseline continue to be important for initial clinical management decisions, but once ART is initiated and patients have achieved virological suppression and stabilised on treatment, the additional value of CD4 testing in the presence of routine viral load monitoring is questionable. In approximately 78.5% of the cases, the babies turn-around time for PCR tests was 7 days which concurs with findings from a study conducted in rural Zambia (Sutcliffe, Van Dijk, Hamangaba, Mayani & Moss., 2014.) but the findings are in contrary to the study findings in Nairobi, Kenya as the average turn-around time was 25 days (Wagner, Slyker, Langat, Inwani, Adhiambo et al. 2015).

The Odds ratio calculation, OR =0.413, showed that PCRs that have a turn-around times of 5 days have less chances of being initiated on treatment than PCRs that have a turn-around time of 7 days. This is in contrary to a study by Spooner et al., (2019) which revealed that there was a median same-day turn-around time and 100% ART initiation of HIV-infected infants with reduced ART initiation time. In a multi-centre study conducted in Mozambique it was found that the median age at test sample collection was 34 days with 68.8% under 2 months of age and the initiation of ART was delayed as the results came back very late (Jani et al., 2018). The contributory factors to the delay in initiation of ART in our study could be attributed to the fact that a mother would find it hard to come back to the clinic just 2 days after the 3rd day postnatal check-up but would prefer coming a week later.

Task shifting has enabled South Africa (SA) to rapidly expand its HIV treatment programme. This has been achieved by training and mentoring primary-care nurses in nurse NIMART (Jones & Cameron, 2017). The workload per NIMART-trained Nurse and its impact on initiation of pregnant positive women on ART as non-initiation means a higher risk of vertical transmission. The average number of patients remaining on

treatment per NIMART-trained nurse was calculated for each facility in Greater Letaba municipality against percentage of pregnant women booking for ANC who are positive but not on ART.

During the period of the study, there were 68 professional nurses employed at the clinics in the area of interest, of which 76% were NIM-ART trained. At half of the health facilities, all PN were NIM-ART trained. This shows that professional nurses are well trained and are knowledgeable in management of the pregnant women, from first booking until delivery, as well as during the post-natal period. The results show that the latest PMTCT Guidelines were used to treat 87% of the mothers, while in only 4% of cases the babies PCR test kits were out of stock. There were no facilities that experienced ARV drug stock-outs. In almost 71% of cases the babies turn-around time for PCR tests was 7 days and in 29% of cases the turn-around time was 5 days. Patient and health system factors are critical in determining the success of PMTCT programmes and the attainment of Elimination of Mother to Child Transmission goals. Ante-natal services remain largely segregated and there is still a failure to prioritise pregnant women for the initiation of ART (Stinson, Boulle, Kotzee, Abrams & Myer, 2010). A study by HAPCO, (2011) & FMOH, (2011), in Eastern Ethiopia, reported that low coverage of PMTCT services has been a consistent problem as nearly 82% of women accessed ANC services at least once during their most recent pregnancy; and PMTCT services were available only in 54% of all facilities. Furthermore, while 98% of pregnant women who attended ANC clinics providing PMTCT services were counselled, a quarter were not tested for HIV. Even among those who were HIV-positive, 60% were not provided with ARV prophylaxis for PMTCT.

A study done in Addis Ababa, Ethiopia, however, indicated that 50% of the already limited qualified midwives were retiring from active services, which necessitated the training of the young midwives. In resource-limited countries, with a high prevalence of MTCT of HIV infection, where PMTCT is not widespread and EID is still a challenge, assessing the risk factors for MTCT will help to decrease child morbidity and mortality and strengthen PMTCT programs (Mirkuzie et al., 2014). The current study shows that babies delivered during the study period were managed by some of the trained professional nurses. However, every professional nurse should be NIM-ART trained, meaning that the Department should conduct training for the remaining 25% of nurses

in order to prioritise the high-volume facilities as far as HIV is concerned, and to staff coverage by skilled personnel at all times.

5.4. LIMITATIONS OF THE STUDY

The data to investigate the determinants of infant's HIV positivity rates were only collected using a structured questionnaire, with a small sample size. A larger sample size would allow for more conclusive findings. Moreover, the study would be more informative if it also involved a qualitative data collection method, so that mothers could share more insights into their experience regarding the services they receive in health care facilities. Not all potential maternal factors for the vertical transmission of HIV were explored by the study. The study was only conducted in one sub-district; therefore, the results cannot be generalized to the whole population of the Mopani District. This study was not conclusive as to whether socio demographic data has any influence on infant HIV positivity rates, or whether results would be the same should the study be performed in another sub-district or performed in the Limpopo Province as a whole.

5.5. RECOMMENDATIONS

For South Africa to reduce MTCT to <5% and, thereby, attaining global and national goals to virtually eliminate HIV infection among children, successful implementation of the world's largest PMTCT programme is required. Health authorities should focus on incorporating EID training into PMTCT counselling sessions held during the antenatal period. PMTCT counsellors and NIM-ART trained nurses should be trained sufficiently in EID. This will prepare nurses toward accessing the EID after delivery. Improved record keeping at health institutions is needed to track factors affecting MTCT of HIV. For example, documenting a baby's treatment status, gestational age at delivery, enrolment into a PMTCT care programme and duration of ART can improve in understanding the influential factors affecting MTCT of HIV. Refresher courses should be offered to NIM-ART trained nurses regarding the updated PMTCT Guidelines, s with the intention of keeping these nurses updated on the latest trends concerning EID, MTCT and PMTCT.

5.6. CONCLUSION

The study findings revealed that there is still vertical transmission of HIV to infants and the prevalence of HIV among infants born from seropositive mothers despite the availability of the latest Prevention of Mother to Child Transmission (PMTCT) Guidelines in all health care facilities. Even though transmission is reduced to the meaningful number (< 5%), there are still appropriate measures that should be taken to reduce the transmission of HIV from mothers to infants. The delayed diagnosis, adherence to ART by mothers, infant ARV prophylaxis at birth and feeding practices contributed the vertical transmission of HIV to infants. Strengthening of the PMTCT of HIV programme, increasing antenatal HIV screening and linking it to care and treatment of HIV positive mothers to obtain zero infant HIV prevalence in the region. Infant prophylaxis and maternal PMTCT interventions should be provided to all exposed infants and mothers based on the guidelines by the health institutions.

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APPENDICES

APPENDIX A: INFORMATION LETTER

Determinants OF Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, Limpopo Province, South Africa.

INTRODUCTION

I invite you to volunteer for a research study. This information sheet is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. You should not agree to take part unless you are completely happy about the study.

PURPOSE OF THIS STUDY

The research will bring to light the extent of PCR positive infants in Greater Letaba between 2015 and 2016. The study will also reveal the health systems factors which result in the increase in HIV positive in infants and it will also assist the government, department of health to strengthen PMTCT programmes, to develop improvement plans and also to review guidelines, policies, and protocols for management of pregnant women and infants born from HIV positive mothers.

WHAT DOES THE STUDY INVOLVE?

The research has 2 parts; the first part; you are expected to complete the consent form that will be given to you by the researcher in approximately 30 minutes and also expected to complete the self-administered questionnaire.

ETHICAL APPROVAL

This research study Protocol has been submitted to the Senior Degree Committee (SDC), Faculty Higher Degree committee (FHDC) for review and the University of Limpopo Research Ethics Committee (TREC) for ethical approval. the Turfloop Research Ethics Committee (TREC) and the Provincial Department of Health, Regional

Department of Health and operational managers of Greater Letaba Municipality clinics (Greater Letaba Sub- District).

YOUR RIGHTS AS A PARTICIPANT

Your participation is entirely voluntary, and you can refuse to participate or withdraw at any time without giving any reasoning. Your right to anonymity, privacy and confidentiality will be ensured all the time. As health care providers, whether you participate in the project or not, no participant will be punished or victimized for refusing to participate in the study.

Contact persons: Ms Mkhari LBT (Researcher)

Cell phone number: 0826807009

Email address: mkharilbt@gmail.com

University of Limpopo: CONSENT FORM

Statement concerning participation in a research project**.**

Name of the research project

Determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, Limpopo Province, South Africa.

I have heard the aims and objectives of the proposed study and was provided the opportunity to ask questions and given adequate time to rethink the issue. The aims and objectives of the study are clear to me. I have not been pressurized to participate in anyway. I understand that participation in this research project is completely voluntary and that I may withdraw from it at any time and without stating reasons. This will have no influence on my work and the position I hold. I know that this study has been approved by the Research, Ethics and Publications Committee of the University of Limpopo and the Department of Health Greater Letaba Sub-district). I am fully aware that the results of this study will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed.

I hereby give consent to participate in this research project.

…………………………………   …………………………….

Name of the participant   Signature of the participant

……………………………   ………........ ……………………………………

Place   Date   Witness

Statement by the researcher

I provided verbal information regarding this study, and I agree to answer any future questions concerning the study as best as I am. I also give assurance that adherence to the approved protocol will be prioritized.

Name of the researcher   Signature   Date   Place

APPENDIX C: **Application letter to conduct a research study– Department of Health**

UNIVERSITY OF LIMPOPO
DEPARTMENT OF PUBLIC HEALTH

Private Bag X1106

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To: The Research Committee Department of Health

Mopani District

PERMISSION TO CONDUCT A RESEARCH STUDY

I hereby request permission to conduct a research study in your facility at Greater Letaba. I am a Master of Public Health (MPH) student at the University of Limpopo. As part of the requirements for the degree; I am expected to carry out a research project. The title of the proposed study is **Determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, Limpopo Province, South Africa.**

The purpose of the study is to determine the determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, 2015 – 2016, Limpopo Province, South Africa.

The research will be carried out by 2017, the researcher will conduct a quantitative, cross-sectional study among a representative sample nurses at the clinic using a self-administrative questionnaire to assess none compliance to standard treatment guidelines and Shortage of screening or PCR test kits at facility level

All ethical considerations will be upheld during the conduction of the pilot and research study. The complete research protocol is attached for your information.

Your consideration of the request will be highly appreciated

Yours Faithfully

Researcher

Ms. Mkhari LBT   …………………….   Date: /   /20…

Supervisor

Dr. Maimela E   ……………………   Date: /   /20….

Finding Solutions for Africa

UNIVERSITY OF LIMPOPO
DEPARTMENT OF PUBLIC HEALTH

Private Bag X1106

Sovenga

0727

Cell:0826807009

mkharilbt@gmail.com

To: The PHC Manager

Greater Tzaneen Sub- District

PERMISSION TO CONDUCT A PILOT STUDY

I hereby request permission to conduct a pilot study at Gateway clinic. I am a Master of Public Health (MPH) student at the University of Limpopo. As part of the requirements for the degree; I am expected to carry out a research project. Attached see copy of letter of approval from the department of health, Mopani District Office.

The title of the proposed study is **Determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, 2015 – 2016, Limpopo Province, South Africa.**

The purpose of the study is to determine the determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, 2015 – 2016, Limpopo Province, South Africa.

The research will be carried out by 2018, the researcher will conduct a quantitative, cross-sectional study among a representative sample nurses at the clinic using a self-administrative questionnaire to assess none compliance to standard treatment guidelines and Shortage of screening or PCR test kits at facility level.

All ethical considerations will be upheld during the conduction of the research study. The complete research protocol is attached for your information.

Your consideration of the request will be highly appreciated

Yours Faithfully

Researcher
Ms. Mkhari LBT   ……………………   Date: 26 / 02 /2018

Finding Solutions for Africa

UNIVERSITY OF LIMPOPO
DEPARTMENT OF PUBLIC HEALTH

Private Bag X1106
Sovenga
0727
Cell: 0826807009
mkharilbt@gmail.com

To: The   PHC Manager
Greater Letaba Sub- District
PERMISSION TO CONDUCT A RESEARCH STUDY

I hereby request permission to conduct a research study at Greater Letaba facilities. I am a Master of Public Health (MPH) student at the University of Limpopo. As part of the requirements for the degree; I am expected to carry out a research project. Attached see copy of letter of approval from the department of health Mopani District Office.

The title of the proposed study is **Determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, 2015 – 2016, Limpopo Province, South Africa.**

The purpose of the study is to determine the determinants of infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba municipality, 2015 – 2016, Limpopo Province, South Africa.

The research will be carried out by 2018, the researcher will conduct a quantitative, cross-sectional study among a representative sample nurses at the clinic using a self-

administrative questionnaire to assess none compliance to standard treatment guidelines and Shortage of screening or PCR test kits at facility level.

All ethical considerations will be upheld during the conduction of the research study. The complete research protocol is attached for your information.

Your consideration of the request will be highly appreciated

Yours Faithfully

Researcher

Ms. Mkhari LBT   …………………….   Date: 26 / 02 /2018

Finding Solutions for Africa

APPENDIX F: ETHICAL APPROVAL TO CONDUCT THE STUDY

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 2212, Fax: (015) 268 2306, Email:noko.monene@ul.ac.za

**TURFLOOP RESEARCH ETHICS
COMMITTEE CLEARANCE CERTIFICATE**

MEETING: 31 August 2017

PROJECT NUMBER: TREC/259/2017: PG

PROJECT:

Title: Determinants of infants Human Immunodeficiency Virus positivity
                       rates in Greater Letaba Municipality, Limpopo Province, South Africa
Researcher: LBT Mkhari
Supervisor: Dr E Maimela
Co-Supervisor: Prof L Skaal
School: Health Care Sciences
Degree: Masters in Public Health

PROF TAB MASHEGO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics
Council, Registration Number: **REC-0310111-031**

Note:
i)   Should any departure be contemplated from the research procedure as approved, the
       researcher(s) must re-submit the protocol to the committee.
ii)   The budget for the research will be considered separately from the protocol.
       PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

APPENDIX G: PERMISSION FROM DEPARTMENT OF HEALTH TO CONDUCT THE STUDY

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH

Enquiries: Stols M.L (015 293 6169)   Ref:4/2/2

Mkhari LBT (LP_201710 19)
Private Bag X1106
Sovenga
0727

Greetings,

RE: Determinants of Infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba Municipality, Limpopo Province South Africa.

The above matter refers.

1. Permission to conduct the above mentioned study is hereby granted.

2. Kindly be informed that:-

   - Research must be loaded on the NHRD site (http://nhrd.hst.org.za) by the researcher.
   - Further arrangement should be made with the targeted institutions, after consultation with the District Executive Manager.
   - In the course of your study there should be no action that disrupts the services.
   - After completion of the study, it is mandatory that the findings should be submitted to the Department to serve as a resource.
   - The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
   - The above approval is valid for a 3 year period.
   - If the proposal has been amended, a new approval should be sought from the Department of Health.
   - Kindly note, that the Department can withdraw the approval at any time.

Your cooperation will be highly appreciated.

_____   11/12/2017
Head of Department   Date

18 College Street, Polokwane, 0700, Private Bag x9302, POLOLKWANE, 0700
Tel: (015) 293 6000, Fax: (015) 293 6211/20 Website: http//www.limpopo.gov.za

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APPENDIX H: DATA COLLECTION TOOL

Unique Participant ID:		District :			
Sub_District:		Facility Name:			
		Facility Type:			

SECTION A: Demographics

Mothers Age:	
Mothers' Marital Status	
Mothers' Highest Level of Education	
Mothers gestational Age at Booking:	
Mothers HIV Status at 1st Booking	
Mothers' gravida	
Mothers'para	
Babys gender	
Babys' Gestational Age at Birth	
Baby PCR positive Incidence Period	

SECTION B: Marternals' Clinical and Care Information

1st Booking Date			
1st HIV diagnosis Date			
HIV diagnosis modality			
Initiated on ART?		ART Start Date	
Delivery Date			

SECTION C: Childs' Information

Infant Feeding Option	
Approximate Weaning date(s)	
Infant Prophylactic treatment Issued ?	
Last PCR test negative Date, If Applicable	
PCR test positive date, If Applicable	
Infant Started on ART?	
Infant ART start Date	
Infant Treatment Regimen	
Current Infant Treatment Outcome	
ARV Drugs Out of stock during period _____	
Number of Nimart trained Nurses in Facility	
Number of Mentorship visits by District of Partners on PMTCT	
Number of 1st Bookings over the past 12 months	
Number of Pregnant women positive at 1st Booking	
Number of PCR tests positive at Birth	
Number of PCR tests positive at 10 weeks	

SECTION D: Health System Information & Stats(To be carried out at Facilities across the sub-district)

1.		
	Any PCR test kits Out of Stock during period?	
4.		
	Turn-around time for PCR tests(in Days)	
5.		
	Level of compliance with confirmation of positive PCR tests	See dictionary for qualification of levels
6.		
	Latest PMTCT Guidelines available?	
7.		
	Are Health-Care Providers available in the facility?	
8.		
	PMTCT guideline used in the management of the mother?	
9.		
10.		
11.		
12.		
13.		
14.		
15.		

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Postnet Suite 226 • Private Bag X9307 • Polokwane • 0700
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Date: 17 September 2019

To Whom it May Concern

I hereby confirm that I have proof-read the document entitled: "Determinants of Infants Human Immunodeficiency Virus Positivity Rates in Greater Letaba Municipality, Limpopo Province, South Africa" authored by Mkhari LBT, and have suggested a number of changes which the author may, or may not, accept, at her discretion.

Each of us has our own unique voice as far as both spoken and written language is concerned. In my role as proof-reader I try not to let my own "written voice" overshadow the voice of the author, while at the same time attempting to ensure a readable document.

Please refer any queries to me.

Andrew Scholtz