Feeding Abilities of HIV-Exposed Uninfected Neonates in KwaZulu-Natal, South Africa: A Descriptive Exploratory Study

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DECLARATION

I, Mrs Tessa Pettifer (née Eybers), declare as follows:

1. That the work described in this thesis has not previously been submitted to the University of KwaZulu-Natal or any other tertiary institution for purposes of obtaining an academic qualification, whether by me or any other party.
2. That this research project was conducted by me and that the accompanying report is my own work. Any assistance I received is detailed in the acknowledgements.

Signed _____ Date _____

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"That your faith might not rest in the wisdom of men but in the power of God"

1 Corinthians 2:5

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ART:	antiretroviral therapy
ARV:	antiretroviral
BBA:	born before admission
GA:	gestational age
HEI:	HIV-exposed infected
HEU:	HIV-exposed uninfected
PCR:	polymerase chain reaction test
PMTCT:	prevention of mother-to-child transmission of HIV
SB:	swallow-breathe
SLT:	speech-language therapist
SSB:	suck-swallow-breathe

KEY DEFINITIONS

ARV-exposed neonate: A neonate born to an HIV-positive mother who was on ART (for any length of time) during her pregnancy (Noguera et al., 2004).

Dysphagia, or swallowing disorders, can be defined as difficulties in the various phases of swallowing, that is the oral phase (including oral preparation and transit of bolus), pharyngeal phase, and oesophageal phase (Arvedson, 2008; Calis et al., 2008), which may result in malnutrition, growth failure and delayed development (Schwarz, 2003).

Feeding difficulties encompass a broad range of feeding problems and may involve deficits with sucking, swallowing and breathing or with the coordination between these components. Feeding difficulties may also include food refusal, gastro-oesophageal reflux, and growth failure (Andrew & Sullivan, 2010; Arvedson, 2008; Van der Meer, Holden, & Van der Weel, 2005).

HIV-exposed neonate: A neonate born to an HIV-positive mother or a neonate who is breastfed by an HIV-positive mother is considered to be HIV-exposed (World Health Organisation, 2006b).

HIV-exposed uninfected neonate: An HIV-exposed neonate whose HIV blood test results (e.g. HIV PCR test) show the absence of HIV infection.

ABSTRACT

Background: HIV-exposed uninfected (HEU) children born to HIV-positive mothers have poorer developmental and health outcomes than their HIV-unexposed peers. Feeding ability is a critical component when considering the health of HEU neonates. The aim of the study was to describe the feeding abilities of HEU neonates born to HIV-positive mothers accessing health care at a public sector hospital in KwaZulu-Natal.

Methods: A descriptive exploratory study was conducted with 10 HIV-positive mothers and their neonates. A screening tool was utilised to evaluate the HEU neonates' feeding abilities. Information regarding mothers' health during pregnancy was gathered retrospectively from hospital medical records. All data were entered into SPSS and analysed using descriptive statistics.

Results: All 10 HIV-exposed neonates were confirmed to be HIV uninfected by HIV PCR tests. Four out of the 10 neonates failed the screening tool and presented with feeding difficulties such as prolonged feeding time (n = 1), reduced feeding time (n = 2), swallow-breathe discoordination (n = 2), weak sucking (n = 1), insufficient oral intake (n = 1), inappropriate state of arousal for feeding (n = 1), inspiratory stridor (n = 1), signs of distress (n = 1), and regurgitation (n = 1). Mothers' CD4 counts ranged from 205 to 820 cells/mm^3(µl). Five neonates were exposed to ARVs in-utero from 24 weeks gestational age. Three of these neonates failed the screening tool. Seven of the 10 mothers experienced health concerns during pregnancy, including pregnancy related anaemia (n = 3), preterm labour without delivery (n = 2), vaginal warts (n = 2), vaginal ulcers (n = 1), asthma (n = 1), and epilepsy (n = 1).

Conclusions and recommendations: The findings of the study show that HEU neonates are at risk for feeding difficulties. Health care professionals should regard this population as at-risk. In order to facilitate early identification and intervention and to prevent adverse health sequelae, appropriate screening and follow up measures should be implemented.

Keywords: HIV/AIDS, Feeding, Neonates, HIV-exposed uninfected

CHAPTER 1: INTRODUCTION

Feeding is critical for growth and survival (Black et al., 2013; Walker et al., 2007). Children require a vast number of feeding skills as they progress through the various stages of feeding that accompany developmental periods. Successful feeding is measured by the ability to meet nutrition and hydration requirements and display adequate weight gain (Delaney & Arvedson, 2008). From birth, neonates need to effectively and safely suck, swallow and breathe in a coordinated fashion. If this ability is impaired, the neonate's nutrition may become compromised which could lead to ill health and poor development (Black et al., 2013; Walker et al., 2007).

Feeding is a broad term that encompasses aspects such as the mealtime environment, the skills necessary for feeding, appetite, and caregiver-child interaction (Winstock, 2005; Wolf & Glass, 1992). Feeding difficulties therefore include a range of problems such as difficulties with coordinating sucking, swallowing and breathing, or problems with either of these components (Delaney & Arvedson, 2008). Feeding difficulties may also involve food refusal, gastro-oesophageal reflux and failure to grow well (Andrew & Sullivan, 2010; Arvedson, 2008; Van der Meer et al., 2005). In contrast 'dysphagia' is a term used to describe problems with the various phases of swallowing, which include the oral phase, pharyngeal phase and oesophageal phase (Arvedson, 2008; Calis et al., 2008). In this study, swallowing difficulties (or dysphagia) is viewed as part of the broader concept of feeding difficulties.

1.1 Factors that Affect Feeding in Neonates

Certain neonatal and maternal factors may directly or indirectly affect feeding abilities at birth. Neonatal factors include gestational age, birthweight, and complications involving the birth process (Boskabadi, Maamouri, & Mafinejad, 2011; Hourani, Ziade, & Rajab, 2011; Parikh et al., 2014; Rommel, De Meyer, Feenstra, & Veereman-Wauters, 2003).

Maternal factors such as advanced maternal age (>35 years) and maternal health could influence neonatal outcomes (e.g., low birth weight or preterm birth) (Koyanagi et al., 2011; Ludford, Scheil, Tucker, & Grivell, 2012; Republic of South Africa: Department of Health, 2015b) which may in turn affect neonatal feeding abilities. In HIV-positive mothers, there is an association between low maternal CD4 count and frequent infant illness (Koyanagi et al., 2011). Depending on the type of illness (e.g., respiratory difficulties), feeding abilities may be affected as a consequence (Van der Meer et al., 2005). A CD4 count between 700-1500 cells/mm^3(µl) is considered within normal range for healthy HIV-positive adults (Lloyd, 1996). A low CD4 count (500 cells/mm^3(µl) or less) is recognised to indicate compromised health (Lloyd, 1996).

1.2 Feeding in the Context of HIV exposure and ARV exposure

South Africa has the biggest epidemic of HIV/AIDS in the world (World Health Organisation, 2014). In 2015, it was estimated that 6.19 million people in South Africa were living with HIV, which was an increase from the estimated 4.09 million in 2002 (Statistics South Africa, 2015). UNAIDS estimates an even higher figure of 7 million people in South Africa who were living with HIV in 2015 (UNAIDS, 2016). The estimated prevalence of HIV among pregnant women in South Africa in 2013 was 25%, 90% of whom were on antiretroviral therapy (ART) to prevent mother-to-child transmission (World Health Organisation, 2014).

ART is medication given to HIV-positive persons and consists of a single type or combination of more than one type of ARVs. The World Health Organisation recommends that all HIV-positive adults are given ART regardless of clinical stage or CD4 count, however persons with CD4 count equal to or less than 350 cells/mm^3(µl) should be treated with priority in terms of ART initiation (World Health Organisation, 2016a). In South Africa, HIV-positive pregnant women are provided with an ART called fixed-dose combination (FDC) (Republic of South Africa: Department of Health, 2015b). FDC is a single dose tablet consisting of 300 mg tenofovir disoproxil fumarate (tenofovir) (TDF), 200 mg emtricitabine (FTC) and 600 mg efavirenz (EFV) (Davies, 2013). HIV-positive pregnant women qualify for lifelong ART regardless of CD4 count and are given FDC from their first antenatal clinic visit (Republic of South Africa: Department of Health, 2015b).

Due to the success of implementing ART during pregnancy, the rate of mother-to-child transmission in South Africa has decreased significantly (from 26% in 2009 to 17% in 2013) (World Health Organisation, 2014). This has resulted in a large number of neonates being born HIV-exposed. A neonate is considered HIV-exposed when he or she is born to an HIV-positive mother or the neonate is breastfed by an HIV-positive mother (World Health Organisation, 2006b).

HIV-exposed uninfected (HEU) children have delays in development and higher morbidity and mortality rates than HIV-unexposed children (Brahmbhatt et al., 2006; Koyanagi et al., 2011; Van Rie, Mupuala, & Dow, 2008). Despite the critical role of feeding in adequate nutrition, heath and development, literature has not investigated the feeding abilities of HEU neonates, infants or children. Rather the focus has been on feeding methods (i.e. breastfeeding verses infant formula feeding for infants fed by HIV-positive mothers) as opposed to the feeding abilities of HEU neonates and infants (Coovadia & Coutsoudis, 2007; Kuhn & Kroon, 2015; World Health Organisation & UNICEF, 2016).

1.3 Feeding in the Context of Child Health and Survival

Feeding plays a vital role in adequate nutrition, health and survival (Rogers & Arvedson, 2005). If a neonate is unable to feed effectively they may become stunted which will affect their brain development (Black et al., 2013). In addition, children who are malnourished are more at risk for infections (Fraker, King, Laakko, & Vollmer, 2000). Poor nutrition and delayed child development are prevalent in contexts affected by HIV/AIDS and in resource constrained countries such as those in Sub-Saharan Africa (Black et al., 2013; Sunguya et al., 2011).

Child mortality rate is a key indicator when investigating the health and welfare of children. In sub-Saharan Africa, one in 12 children dies before the age of five (UNICEF, World Health Organisation, Group World Bank, & United Nations, 2015). This ratio far exceeds the child mortality rate in high-income countries (one in 147) (UNICEF et al., 2015) and the majority of these children died from causes that could have been prevented (United Nations, 2015b). There is an urgent need to address the staggering number of preventable child deaths in countries such as sub-Saharan Africa and Southern Asia.

A third of all children under-five who died in 2015 were in sub-Saharan Africa. In 2015 this region's under-five mortality rate was 83 per 1000 births, compared to the World under-five mortality rate which was 43 per 1000 births (UNICEF et al., 2015). Neonates born in resource-scarce settings with high disease burdens are particularly vulnerable (McDonald et al., 2013; UNICEF et al., 2015) as a significant portion (44% in 2013) of under-five deaths occur during the first 28 days (neonatal period) (World Health Organisation, 2015).

1.4 The Global Emphasis on Child Mortality and HIV

In September 2015, the United Nations highlighted the importance of child survival and health by adopting the post-2015 development agenda called Transforming Our World: the 2030 Agenda for Sustainable Development (United Nations, 2015a). This agenda calls world leaders to aim towards reaching the Sustainable Development Goals (SDGs). The SDGs embody a renewed commitment to the survival of children. One of the aims is to end all preventable deaths of neonates (World Health Organisation, 2015), and children under the age of five by 2030 (UNICEF et al., 2015). In accordance with this goal, all countries are to at least (a) reduce neonatal mortality to 12 in 1000 live births, and (b) reduce under-five mortality rate to 25 per 1000 live births in each country. The SDGs also aim to (c) put an end to all forms of malnutrition and meet the nutritional requirements of children (United Nations, 2015a).

Putting an end to the HIV epidemic is also high on the SDGs' agenda (United Nations, 2015b). Progress has been made in the fight against HIV/AIDS as HIV infections have decreased globally, from 2.2 million in 2000 to 2.1 million in 2015 (UNAIDS, 2016). The decrease in the number of those newly infected along with the increased availability of ART have contributed to a major decline in HIV mortality levels – from 2.4 million people in 2005 to an estimated 1.5 million in 2013 (World Health Organisation, 2015). Despite this decrease, it was estimated that in 2015, 36.7 million people were living with HIV (UNAIDS, 2016).

The global strategy on child health encourages countries' academic institutions to conduct research in the area of child health and to disseminate findings in order to guide policies and practice (United Nations, 2015b). Therefore in order to determine what may be contributing to the high mortality rate of HEU children, it is necessary to investigate these children's feeding abilities.

1.5 Conclusion and Rationale

In countries with high HIV rates and good ART coverage, a large number of HEU children are being born (Filteau, 2009; World Health Organisation, 2014). The substantial role of feeding in malnutrition, disease and mortality cannot be ignored. Feeding difficulties will have adverse consequences for a child's nutritional status which places them at greater risk for illness, disease, and poor health outcomes (Fraker et al., 2000; Rogers & Arvedson, 2005).

Despite research on morbidity, mortality and developmental issues (Brahmbhatt et al., 2006; Reikie et al., 2014; Van Rie et al., 2008), there is a global (UNICEF et al., 2015; World Health Organisation, 2014) as well as local (Republic of South Africa: Department of Health, 2015b) lack of awareness of the vulnerability of HEU neonates, infants and children. If HEU neonates are at risk for feeding difficulties it is important for health professionals, such as speech-language therapists (SLTs), to be informed of this risk. This knowledge will allow for early identification and intervention of feeding difficulties, which will also prevent secondary health problems such as poor weight gain, illness and infections. This study addresses a gap in the knowledge of the feeding abilities of HEU neonates.

1.6 Problem Statement

An increasing number of HEU neonates are being born within the public health care sector in South Africa. These neonates are more at risk for infections and have a greater chance of dying in comparison to HIV-unexposed neonates (Brahmbhatt et al., 2006; de Moraes-Pinto et al., 1996; Koyanagi et al., 2011) but it is not known whether these neonates are at risk for feeding difficulties. In order to effectively assess and manage this population, health professionals require more knowledge about these neonates than what is currently available.

1.7 Research Question

What are the feeding abilities of HIV-exposed neonates born at a public sector hospital in KwaZulu-Natal?

1.8 Aim and Objectives

The aim of the study was to describe the feeding abilities of HEU neonates born at a public sector hospital in KwaZulu-Natal. The following objectives were formulated in order to achieve this aim:

1. To develop an informal neonatal feeding screening tool by reviewing literature and consulting with an expert reference group in order to screen the feeding of HEU neonates born at a public sector hospital.
2. To profile the feeding abilities of HEU neonates in terms of their sucking, swallowing and breathing by using the developed neonatal feeding screening tool in order to describe the feeding abilities of this population.

3. To describe the HIV-positive mothers' health during pregnancy by gathering medical and biographical information as recorded in their hospital files to determine the presence of any maternal health risks which could impact on the HEU neonates' feeding abilities.

CHAPTER 2: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Overview

This chapter presents a conceptual framework that may be used to understand HEU neonates from a feeding rehabilitation perspective. The chapter reviews normal feeding development, and the factors affecting neonatal feeding are discussed. The developmental and health outcomes of children as a consequence of HIV- and antiretroviral (ARV) exposure are also described. Thereafter the chapter outlines feeding difficulties in the paediatric HIV-exposed infected (HEI) population. The chapter concludes by exploring the ways in which the developmental and health problems faced by HEU children could be affecting their feeding abilities.

2.2 Introduction of Conceptual Framework

It is estimated that almost a third of all children in certain parts of Southern Africa are born HIV-exposed uninfected (Shapiro & Lockman, 2010). Several studies have shown that these children do not have the same developmental and health outcomes as their HIV-unexposed peers (Brahmbhatt et al., 2006; Drotar et al., 1997; Kourtis et al., 2013; Van Rie et al., 2008). In order to understand this population in terms of their feeding abilities, a conceptual framework (Figure 2.1) was developed and is presented in this chapter. The researcher used literature to support and explain her standpoint.

In-utero exposure to drugs is known to result in abnormal gestational development (Arvedson & Brodsky, 2002; Ortigosa et al., 2012). The foetal brain is particularly vulnerable during the gestational period as the blood-brain barrier is not fully established and therefore toxins can easily enter the brain. Even small neurological injuries will hold adverse consequences for brain development later in life (Arvedson & Brodsky, 2002). Figure 2.1 depicts a conceptual framework that can be used to understand how HIV- and ARV exposure could affect feeding development in neonates. These influencing factors are explored in light of their possible effects on cognitive, sensory and motor development, and the resultant feeding outcomes.

HIV exposure and ARV exposure are interrelated as an ARV-exposed child will by default also be HIV-exposed. The length of ARV exposure depends on when the mother started ART (Republic of South Africa: Department of Health, 2015b). The duration of HIV exposure depends on when the mother contracted HIV (before pregnancy or at some stage during pregnancy).

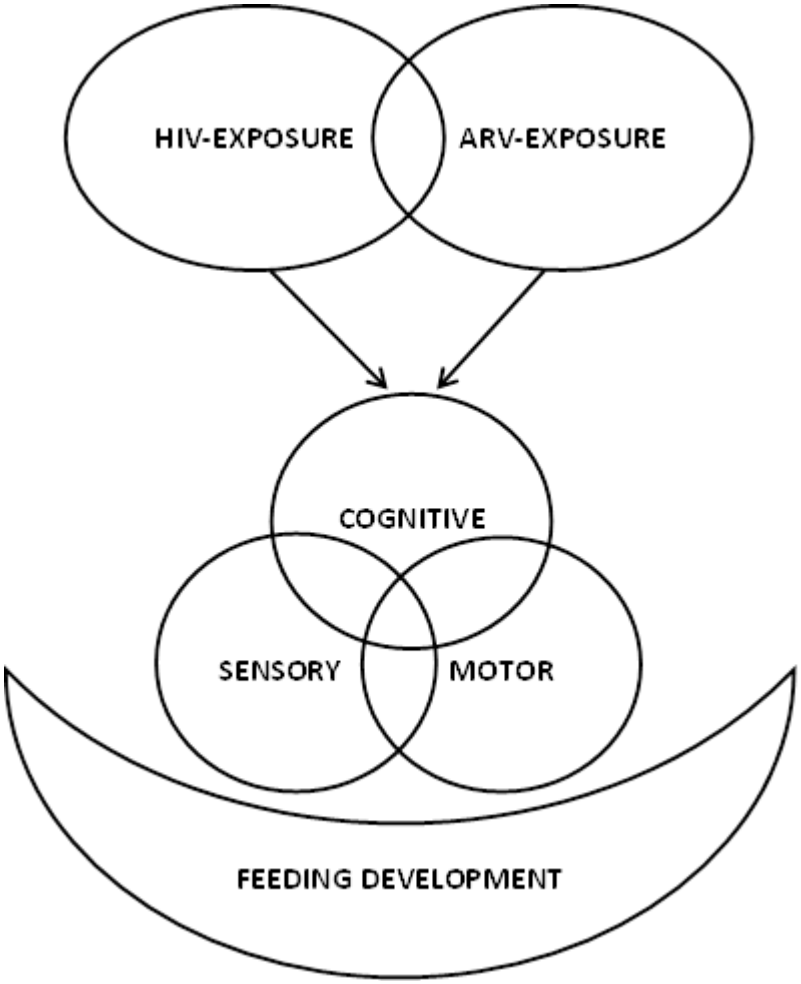

Figure 2.1. Conceptual framework of the effects of HIV- and ARV exposure on feeding development.

For the purposes of this study, HIV exposure is defined as a neonate who is born to an HIV-positive woman and has thereby been exposed to the HIV virus in-utero and/or during delivery (by coming into contact with the mother's blood and mucous membranes) (Republic of South Africa: Department of Health, 2015b). Neonatal ARV exposure is defined as exposure to maternal ARVs while in-utero (Blanche et al., 1999; Republic of South Africa: Department of Health, 2015b).

2.3 In-Utero and Post-Natal Feeding Development

When considering the effects of HIV- and ARV exposure on feeding, it is important to understand normal feeding development. Feeding development begins in-utero, with structures and functions developing during the embryonic and foetal periods, continuing until early childhood (Delaney & Arvedson, 2008). Ultrasound studies have shed light on when various functions necessary for feeding to develop in-utero (Miller, Sonies, & Macedonia, 2003). In these studies, consistent swallowing was observed by 22-24 weeks GA accompanied by suckling movements. Consistent tongue midline depression (similar to when full term infants cup a nipple using their tongue) as well as consistent tongue protrusion and retraction (similar to suckling in full term infants) were noted by

28 weeks GA. Lingual movements were found to be more mature post 28 weeks GA (Miller et al., 2003).

A well-functioning respiratory system is an important component for feeding success. At 24 weeks GA, the lungs are still developing and by 26-29 weeks respiration has matured sufficiently for a neonate to breathe air (Delaney & Arvedson, 2008). After birth, sucking, swallowing and breathing need to be coordinated in order to feed successfully (Delaney & Arvedson, 2008). A mature suck-swallow-breathe (SSB) ratio, seen as 1:1:1, can be achieved by 37 weeks GA (Lau, 1996). Sucking skills are generally agreed to be mature by 34 weeks GA (Delaney & Arvedson, 2008; Lau, 1996). A newborn infant demonstrates a suckling pattern which involves backward-forward movement of the tongue, up and down jaw movement and loose approximation of the lips (Arvedson & Brodsky, 2002). Most infants born close to term are able to feed orally although mild discoordination may be present. Research has suggested that it may take a two or three days for the SSB coordination to stabilise and for an adequate suck to be produced (Da Costa et al., 2010; Delaney & Arvedson, 2008).

A neonate's neurocognitive status, motor system and sensory system are interlinked in the process of feeding and swallowing. Normal swallowing relies on sensory input from receptors such as mechanoreceptors, proprioceptive receptors, olfactory receptors, and receptors for taste and temperature (Arvedson & Brodsky, 2002). This information influences the motor movements involved in sucking and swallowing (for example, proprioceptive receptors provide information on the size of the bolus which affects how the bolus is managed in the oral cavity by the tongue). The neurocognitive status of a neonate could affect the integrity of signals between the sensory system and the motor system, thereby influencing the motor patterns required for feeding (Arvedson & Brodsky, 2002; Wolf & Glass, 1992).

2.4 Factors Affecting Feeding in Neonates

Several factors may influence a neonate's ability to feed effectively. These include birthweight, gestational age, maternal age and maternal health. Neonates born with a low birth weight are more likely to display feeding difficulties than neonates born with a healthy birth weight (Rommel et al., 2003). In addition, premature birth (less than 37 weeks gestational age) has been associated with the presence of feeding difficulties (Dodrill, 2011). The American College of Obstetricians and Gynaecologists (2013) advised that 'term pregnancy' should be replaced with the more specific categories of 'early term' (37 weeks to 38 weeks and 6 days), 'full term' (39 weeks to 40 weeks and 6 days), 'late term' (41 weeks to 41 weeks and 6 days) and 'post term' (42 weeks and over). These terms were introduced to discourage the practice of non-medical deliveries before 39 weeks and to improve neonatal outcomes. Studies have shown that early term birth is associated with increased respiratory distress, feeding difficulties, and neonatal intensive care unit (NICU) admission (Hourani et al., 2011; Parikh et al., 2014). Therefore, neonates born before 39 weeks may be at risk for poorer outcomes including feeding difficulties.

Maternal health may influence neonatal and feeding outcomes. In the case of HIV, a CD4 count of 500 cells/mm^3(µl) or less indicates compromised health (Lloyd, 1996), and low maternal CD4 count has been linked to frequent illness in HEU infants (Koyanagi et al., 2011). Advanced maternal age (older than 35 years) is associated with poorer neonatal outcomes, such as prolonged hospital stay (>28 days), low Apgar score (<7 at 5 minutes), and low birth weight (Cleary-Goldman et al., 2005; Laopaiboon et al., 2014; Ludford et al., 2012), and is therefore a risk factor for feeding difficulties.

2.5 HIV Exposure

2.5.1 HIV exposure in-utero

Virus exposure in-utero may result in a proinflammatory intrauterine environment (Adams Waldorf & McAdams, 2013; Romero, Gotsch, Pineles, & Kusanovic, 2007) which is inflammation inside a mother's uterus. Foetal exposure to inflammation has emerged as a major contributing factor to prenatal complications (e.g., preterm labour), poor foetal growth and development, and adverse neonatal outcomes such as foetal lung and brain injury (Adams Waldorf & McAdams, 2013; Elovitz et al., 2011). Foetal lung injury and neurological damage will impact feeding as neonates require well-functioning nervous and respiratory systems for successful feeding to take place (Delaney & Arvedson, 2008).

In the case of HIV, the placenta and foetal membranes may be invaded by the HIV virus as it travels through the maternal blood circulation (Spinillo, Iacobone, Calvino, Alberi, & Gardella, 2014) resulting in the release of proinflammatory cytokines in the foetal membranes (Spinillo et al., 2014). Cytokines are signalling molecules that play a role in regulating inflammation (McAdams & Juul, 2012). In HEU neonates, a proinflammatory environment in-utero is indicated by evidence of increased T cell apoptosis (programmed cell death) (Alberts et al., 2002) in umbilical cord white blood cells (Economides et al., 1998).

Cytokines can also compromise the development and functioning of the foetal central nervous system (Spinillo et al., 2014). Data from animal studies support this: a link between intrauterine inflammation and neurodevelopmental deficits has been demonstrated in a rabbit model where newborn rabbits demonstrated significantly increased tone as well as difficulty coordinating sucking and swallowing when compared to a control group (Saadani-Makki et al., 2010).

Previously it was understood that if an inflammatory cascade does not cause preterm birth, it is also insufficient to pose any harm or long term consequences to the neonate (Elovitz et al., 2011). However, this is argued to be incorrect in a mouse model where a correlation was demonstrated between mild intrauterine inflammation (insufficient to result in labour or cause a maternal immune response) and prenatal brain injury (Elovitz et al., 2011). This finding has implications for human mothers who experience preterm labour without preterm birth as their neonates "may be at significant risk for adverse neurological outcomes" (Elovitz et al., 2011, p. 10). In a study by Williams et al., (2010), high maternal viral load was associated with lower neurocognitive development in HEU

children. This finding provides further evidence for the inflammatory cascade and cytokine mediated neurological injury (Williams, et al., 2010).

A common type of foetal membrane inflammation is called chorioamnionitis which is inflammation in the chorioamniotic membranes of the foetus (Adams Waldorf & McAdams, 2013; Elovitz et al., 2011). Chorioamnionitis, associated with HIV exposure in-utero (Ackerman & Kwiek, 2013; Galinsky, Polglase, Hooper, Black, & Moss, 2013; Schwartz et al., 2000), may result in an increase in cytokine levels which could trigger preterm labour and result in preterm birth which is known to hold risk for neonatal outcomes (McAdams & Juul, 2012).

2.5.2 HIV exposure and immune irregularities

HIV exposure in-utero even without transmission appears to result in certain immune irregularities. For example, HEU infants have been found to have reduced levels of specific maternal antibodies which provide resistance to infections such as measles and tetanus (Cumberland et al., 2007; de Moraes-Pinto et al., 1996, 1998). Immunoglobulin G (IgG) is a type of antibody, involved in protecting the body from infections (Zinkernagel, 2001). In the last trimester, maternal IgG is transferred via the placenta to the foetal blood circulation which protects the infant from infections for the first few months of life (Zinkernagel, 2001). High maternal viral load, which is a measurement of the number of free virus particles in the blood (Bekker, 2010), has been correlated with decreased IgG transfer (Farquhar et al., 2005). The suggested reasons for fewer maternal IgG in the neonate are diminished functioning of maternal B cells, and placenta abnormalities resulting in decreased IgG transfer (Afran et al., 2014). Collectively these differences in immune development could have implications for susceptibility to infections, and morbidity and mortality rates (Afran et al., 2014; Reikie et al., 2014). Infectious diseases such diarrhoea and pneumonia are some of the most common illnesses under-five children die from (UNICEF et al., 2015). In HEU infants, pneumonia is the most prevalent serious illness seen during the first 3 months of life (Kourtis et al., 2013). Pneumonia compromises the respiratory system which has adverse implications for feeding (Rommel et al., 2003; Wolf & Glass, 1992).

2.5.3 HIV exposure and morbidity and mortality rates

HEU children have higher morbidity and mortality rates when compared to HIV-unexposed children. Morbidity refers to the frequency which a certain population experiences disease or adverse health (World Health Organisation, 2003). Mortality refers to the frequency of death in a specific population in a given time period (World Health Organisation, 2003).

HEU infants are more frequently admitted to hospitals (specifically during the neonatal period) due to infections than HIV-unexposed infants in the first year of life (Koyanagi et al., 2011; Slogrove, Cotton, & Esser, 2009; Slogrove et al., 2012), indicating that this population has a higher incidence of severe infections (requiring hospitalisation) than HIV-unexposed children. The main causes of morbidity in HEU infants have been found to be gastrointestinal and respiratory infections (Slogrove et al., 2012; Venkatesh et al., 2011).

In terms of mortality, a study conducted in rural Uganda, before ART was widely available, estimated the two year mortality rates of HEI, HEU and HIV-unexposed newborn infants (Brahmbhatt et al., 2006). The mortality rate of HEU infants was found to be higher (165.5 per 1000 children) than HIV-unexposed infants (128 per 1000). Higher mortality rates in HEU infants are associated with early cessation of breastfeeding in studies conducted in Zambia and Malawi (Fawzy et al., 2011; Kourtis et al., 2013). A Zambian study reported that HEU infants who stopped breastfeeding at five months old had a mortality rate of more than double (17.4% versus 9.7%) of those who did not stop breastfeeding before 18 months (Kuhn et al., 2010). In contrast, a study conducted in an urban area in South Africa, where mothers had access to infant formula and safe drinking water, did not find feeding method to be associated with mortality in HEU infants (Venkatesh et al., 2011). Other factors that have been associated with child mortality include maternal death and maternal CD4 count (Newell et al., 2004).

In summary, in-utero HIV exposure (without infection) may result in neurodevelopmental deficits, and an increased chance of infection. These consequences may impair an HEU neonate's ability to feed effectively.

2.6 ARV Exposure

2.6.1 Effects of ARV exposure on gestational and postnatal development

Most types of ARVs are able to cross the placenta during pregnancy (Else, Taylor, Back, & Khoo, 2011). In terms of the ART typically prescribed to HIV-infected pregnant women in South Africa, TDF readily crosses the placenta, limited data is available on FTC, and EFV has been shown to cross the placenta in animal studies (reviewed in Else et al., 2011). HEU children are exposed to ARVs from in-utero until the end of breastfeeding which could be up to one year of age or longer (World Health Organisation & UNICEF, 2016). In order to monitor the health of this population, it is important to understand the consequences of the medications that these children are exposed to at such critical developmental periods in their lives (Afran et al., 2014; Heidari et al., 2011).

Preterm birth, low birth weight and small for gestational age are all risk factors for poor feeding at birth (Dodrill, 2011; Rommel et al., 2003). In-utero exposure to ART has not been found to increase the risk of preterm birth, small for gestational age or low birth weight (Kourtis, Schmid, Jamieson, & Lau, 2007; Siberry et al., 2012). However, protease inhibitors may be associated with preterm birth if used in early pregnancy (Watts et al., 2013). In a large American cohort, in-utero TDF exposure was not found to have adverse effects on birth weight or infant growth up to six months (Ransom et al., 2013). Another study done with mothers from Uganda and Zimbabwe found that there is no association between in-utero exposure to TDF and growth up to two years (Gibb et al., 2012). Despite these findings, there is still uncertainty regarding the safety of TDF during pregnancy (Jibril & Egunsola, 2013).

There are conflicting findings regarding evidence for neural tube defects in neonates exposed to EFV. Neural tube defects are central nervous system abnormalities or defects of the spine which

occur during gestational development and include spina bifida and certain brain malformations (Padmanabhan, 2006). Children born with brain abnormalities could have developmental delays and resultant feeding difficulties (Arvedson & Brodsky, 2002). Several case reports have shown evidence of neural tube defects in neonates exposed to EFV (Chersich et al., 2006). In contrast, two studies based in sub-Saharan Africa (in urban Botswana and in a regional hospital in South Africa) found no significant increase in congenital birth defects among pregnant women using EFV-based ART in first trimester (Bera et al., 2010; Bussmann et al., 2007).

Neonatal growth and development necessitates normal functioning metabolism in all regards (Kirmse et al., 2013). Optimal mitochondrial functioning is a key aspect to cellular metabolism (producing energy for a cell) (Hoffmann, Zschocke, & Nyhan, 2009). ARV exposure in HEU infants has been found to result in biological changes which are largely attributed to mitochondrial toxicity and dysfunction (Afran et al., 2014). These biological changes include altered cardiac growth and functioning (Lipshultz et al., 2013). HEU infants exposed to ARVs have also been found to have a higher chance of dysfunctional fatty acid oxidation than HEU infants not exposed to ARVs (Kirmse et al., 2013). Fatty acid metabolism occurs in the mitochondria, and dysfunction results in skeletal muscle weakness (Hoffmann et al., 2009). In France, HEU children exposed to AZT were found to have mitochondrial dysfunction and in rare cases neurological complications (Blanche et al., 1999). Mitochondrial dysfunction was also found in similar studies (Barret et al., 2003; Blanche, Tardieu, Benhammou, Warszawski, & Rustin, 2006). In addition, there is evidence for nucleoside analogues such as FTC causing lactic acidosis and hyperlactataemia in neonates which may also result in skeletal muscle weakness (Blanche et al., 2006; Noguera et al., 2004; Republic of South Africa: Department of Health, 2015b). Weakness in the muscles involved with sucking and swallowing could result in feeding inefficiency and compromise swallowing safety (Arvedson & Brodsky, 2002; Wolf & Glass, 1992).

Jao and Abrams (2014) expressed concern regarding the effect of in-utero ARV exposure on children's health later in life as foetal metabolic programming may be affected by the in-utero environment and give rise to future chronic illnesses. They recommended that even small changes in HEU infant metabolism should be monitored due to the possible far reaching effects (Jao & Abrams, 2014).

2.7 Development of HIV- and ARV-Exposed Children

Most studies on HIV exposure and development focus on children who are HEI instead of HEU (Baillieu & Potterton, 2008; Drotar et al., 1997; Le Doare, Bland, & Newell, 2012). For example, a South African cross sectional study investigated the development of 40 HEI children aged 18-30 months. The HEI children were found to have a 7.63 month delay in cognitive development and a 9.65 month delay in motor development (Baillieu & Potterton, 2008). A global language delay was found in 82.5% of the sample and 85% of the HEI children demonstrated a gross motor delay. A study done in Kampala, Uganda found HEI children's motor development, muscle tone, coordination and

reflexes to be the developmental areas most affected by HIV infection (Drotar et al., 1997). A review of the neurodevelopment of HEI children living in sub-Saharan Africa also found motor development to be the most severely affected aspect of development (Abubakar, Van Baar, Van De Vijver, Holding, & Newton, 2008).

Much of the literature regarding the development of HIV- and ARV-exposed children are from high income countries or those with greater access to resources (Chase et al., 2000; Malee et al., 2011; Williams et al., 2010). Low- and middle-income countries such as those in Sub-Saharan Africa have a high rate of malnutrition and opportunistic infections which make the findings from more developed countries (such as those in Europe and America) not comparable to developing countries (Van Rie et al., 2008). Those studies that do investigate HEU children's development, lack a matched control group of HIV-unexposed children (Chase et al., 2000; Kandawasvika et al., 2011; Knight, Mellins, Levenson, Arpadi, & Kairam, 2000). In socioeconomically disadvantaged contexts such as Sub-Saharan Africa, it is especially important to have a matched control group when interpreting findings as the normative data from standardised assessments will not be applicable in these settings (Le Doare, Bland, & Newell, 2012).

Regardless of the challenges and limited data, a few studies that included a matched control group of HIV-unexposed children found differences in development between HEU and HIV-unexposed children. These studies are summarised in Table 2.1. The areas in which HEU children showed a delay (in comparison to HIV-unexposed children) include motor skills, expressive language skills, cognitive performance, verbal IQ and memory.

Table 2.1

Key findings of studies investigating HEU children's development

Reference	**Country**	**Study population**	**Ages**	**Assessment tool(s)**	**Key findings**
Boivin et al., 1995	Zaire	11 HEI children 26 HEU children 15 HIV-unexposed children (control group)	>2 years of age	Kaufman Assessment Battery for Children	Poorer cognitive performance
Drotar et al., 1997	Uganda	79 HEI children 241 HEU children 116 HIV-unexposed children (control group)	Assessed from 6 to 24 months of age at: 6, 9, 12, 18, and 24 months	The Bayley Scales of Infant Development	Delay in motor skills. More than double (11%) the number of HEU infants had motor difficulties by 12 months compared to the number of HIV-unexposed infants (5%)

Kerr et al., 2014	Thailand and Cambodia	160 HEU children 167 HUU children	1 to 12 years	Beery Visual Motor Integration (VMI) test, Color Trials, Perdue Pegboard, and Child Behavior Checklist (CBCL). Only Thai children also completed: Wechsler Intelligence Scale (IQ) and Stanford-Binet II memory tests	Small but statistically significant lower scores in verbal IQ and memory
Van Rie et al., 2008	Democratic Republic of Congo	35 HEI children 35 HEU children 90 HIV-unexposed children (control group)	18 to 72 months	As appropriate for age: Bayley Scales of Infant Development II, Peabody Developmental Motor Scales, Snijders-Oomen Nonverbal Intelligence Test, Rossetti Infant-Toddler Language Scale	Significant delay in motor and expressive language skills

2.8 Effect of HIV- and ARV Exposure on Feeding

After an extensive review of the literature, no published or unpublished studies were found on the feeding abilities of HEU children or neonates. In this population the focus in literature has been on the feeding methods rather than feeding abilities (Coovadia & Coutsoudis, 2007; Kuhn & Kroon, 2015; World Health Organisation & UNICEF, 2016). A limited number of studies describe the feeding difficulties of HEI children (Nel & Ellis, 2012; Pressman & Morrison, 1988), as most studies on HEI children's feeding report on the causes rather than the nature of the feeding difficulties. These causes include: (a) candidiasis in the oral cavity, pharynx and/or oesophagus resulting in odynophagia (Cooke, Goddard, & Brown, 2009; Loveland, Mitchell, van Wyk, & Beale, 2010), (b) oesophageal strictures (Cooke et al., 2009; Loveland et al., 2010; Sidler, Salzmann, Juzi, & Moore, 2006), (c) oesophageal ulceration (Cooke et al., 2009), and (d) gastro-oesophageal reflux (Henderson et al.,

1994). The key findings of two studies that described the nature of the feeding difficulties of HEI children are summarised below.

A South African study reported on the feeding and swallowing of 25 HEI children (age range: 2.8 months to 7.6 years; median: 8 months) (Nel & Ellis, 2012). The children were assessed using a clinical feeding assessment and videoflouroscopy. Eighty percent (n = 20) of the children presented with clinical signs for feeding and/or swallowing difficulties: 11 children demonstrated oral phase dysphagia, four had dysphagia in the pharyngeal phase, five showed dysphagia in both oral and pharyngeal phases.

A study conducted in the United States of America, a resource rich context, retrospectively reviewed the records of 55 HEI children (age range: 3 months to 5.11 years) who attended a paediatric hospital (Pressman & Morrison, 1988). The authors found that eleven of the children (20%) had mild to moderate feeding difficulties. The children presented with prolonged feeding times, certain food consistencies proved problematic, their nutritional intake was inadequate, and progressing to age appropriate consistencies was challenging. Fourteen (25%) children had severe feeding and swallowing difficulties in that they were unable to survive on oral feeds alone.

The prevalence of feeding difficulties differs greatly in these two studies (45% - 80%). The discrepancy could in part be explained by referral bias as the sample in the South African study only included children who were referred to the swallowing disorder clinic for suspected difficulties with swallowing. South Africa having a higher disease burden could further account for the large difference in HEI children with feeding difficulties. No studies on the feeding of HEI neonates were found.

2.8.1 Feeding of HEU children

HEU children are at risk for CNS damage from in-utero inflammation (Adams Waldorf & McAdams, 2013; Elovitz et al., 2011; Romero et al., 2007; Saadani-Makki et al., 2010). The possibility of CNS insult is supported by findings from developmental studies on HEU children where cognitive, motor and language delays were found (Boivin et al., 1995; Drotar et al., 1997; Kerr et al., 2014; Van Rie et al., 2008). Children with neurological deficits are known to frequently present with feeding difficulties (Arvedson, 2013; Barratt & Ogle, 2010), therefore HEU neonates may present with feeding difficulties at birth as a result of HIV mediated in-utero inflammation.

HEU children may also present with immune irregularities which could increase their chance for infections early in life (Afran et al., 2014; Clerici et al., 2000; Cumberland et al., 2007; Kakkar et al., 2014; Reikie et al., 2014). Data on morbidity rates support these findings (Koyanagi et al., 2011; Slogrove et al., 2012; Slogrove et al., 2009). Infections of the respiratory system would impact a neonate's ability to feed as respiration is a key component in neonatal feeding (Rommel et al., 2003; Wolf & Glass, 1992).

In summary, ARV-exposed HEU children have been shown to exhibit mitochondrial dysfunction, lactic acidosis and dysfunctional fatty acid metabolism which may result in skeletal

muscle weakness (Blanche et al., 2006; Blanche et al., 1999; Kirmse et al., 2013; Noguera et al., 2004; Republic of South Africa: Department of Health, 2015b). Muscle weakness could impede a neonate's ability to suck and swallow effectively (Arvedson & Brodsky, 2002; Hoffmann et al., 2009; Wolf & Glass, 1992).

2.9 Conclusion

This chapter presented a conceptual framework which can be used to understand how feeding in HEU neonates may be affected by HIV- and ARV exposure. The review of literature in this chapter revealed that HIV- and ARV-exposed neonates may experience skeletal muscle weakness, neurological damage from in-utero inflammation, altered cardiac functioning, a higher chance of respiratory illnesses, and also delays in development. As described above, these adverse consequences could result in feeding difficulties.

HEU neonates' feeding abilities have not previously been investigated. This population is at risk for poor health and developmental delays. Effective and safe feeding is essential for HEU children to achieve and maintain good health and development. Therefore in order to assist HEU neonates to survive and grow well, their feeding abilities require investigation.

CHAPTER 3: METHODOLOGY

3.1 Aim and Objectives

The aim of the study was to describe the feeding abilities of HEU neonates born at a public sector hospital in KwaZulu-Natal. The following objectives were formulated in order to achieve this aim:

1. To develop an informal neonatal feeding screening tool by reviewing literature and consulting with an expert reference group in order to screen the feeding of HEU neonates born at a public sector hospital.
2. To profile the feeding abilities of HEU neonates in terms of their sucking, swallowing and breathing by using the developed neonatal feeding screening tool in order to describe the feeding abilities of this population.
3. To describe the HIV-positive mothers' health during pregnancy by gathering medical and biographical information as recorded in their hospital files to determine the presence of any maternal health risks which could impact on the HEU neonates' feeding abilities.

Objective 1 involves the development of the data collection tool and informed the methodology of the study. The outcomes for Objective 1 are reported in this chapter. The results for Objectives 2 and 3 are described in Chapter 4.

3.2 Research Location

The study was conducted at a public sector hospital, in the eThekwini Health District, KwaZulu-Natal Province. KZN Province has the highest prevalence of HIV in the country, where, in 2010, 39.5% of pregnant women were HIV-positive (Republic of South Africa, 2012). The hospital provides regional and tertiary services to KwaZulu-Natal (KZN) and the Eastern Cape (KwaZulu-Natal Department of Health, 2001). There is a speech therapy department at the hospital which provides services to in-patients and out-patients. The majority of patients who access services at this hospital are Black African, isiZulu speaking and are from low socioeconomic backgrounds.

3.3 Research Design

The study used a non-experimental, descriptive exploratory research design. The main aim of non-experimental research is to describe certain phenomena as they occur without manipulating any variables (Brink, Van der Walt, & Van Rensburg, 2012). A descriptive design is a type of non-experimental design that entails collecting information about a particular phenomenon and describing the observations without establishing cause-effect relationships (Brink et al., 2012; Maxwell & Satake, 2006). The study is exploratory in nature in that it sought to obtain data in a field where limited information is available (Brink et al., 2012). The design does not allow for causality between variables to be established (Brink et al., 2012); however it enabled the researcher to describe the variables of interest (i.e., feeding abilities of neonates) using structured observations making it appropriate for the study aim.

3.4 Study Population and Sampling

The study population consisted of mother and neonate feeding pairs, of which the mothers were all HIV-positive and the neonates were HEU. The mothers of the neonates acted as study participants as they were the primary caregivers and subsequently the primary feeders of the neonates. However the neonates were the targeted study population and the units of analyses. The term 'units of analyses' refers to the individuals (or objects) from which the researcher desires to make deductions (Terre Blanche, Durrheim, & Painter, 2006). The focus of the study was the feeding of HEU neonates, therefore the HEU neonates were the primary source of information that the researcher sought to investigate

3.4.1 Sampling technique

The study used non-probability, purposive and convenience sampling. Non-probability sampling entails selecting participants by non-random methods. It is cost-effective and convenient when the researcher does not have access to the population of interest (Brink et al., 2012), i.e., KZN, in its entirety. Purposive sampling entails including participants based on whether they meet certain selection criteria (Maxwell & Satake, 2006). This is necessary when the researcher wants to describe the behaviour or abilities of participants who display certain characteristics (Maxwell & Satake, 2006), such as HIV exposure. Convenience sampling entails selecting participants based on their availability at the time of recruitment and data collection (Brink et al., 2012). A disadvantage of purposive, convenience sampling is that it limits generalisability of the results and it may introduce bias (Brink et al., 2012). Since this study did not seek to generalise the results, this type of sampling was appropriate. In addition, convenience sampling is useful when the time frame to complete the study does not allow for probability sampling to be used (Brink et al., 2012).

3.4.2 Sample size

The researcher approached 18 mother and neonate feeding pairs during the pre-determined one month data collection period. Of the 18 mothers, 14 consented to participate in the study. After controlling for confounding variables (detailed under '3.6 Data Collection Procedure'), the final sample contained 10 mother and neonate feeding pairs. This sample size is comparable to other descriptive exploratory studies which had samples ranging from 10 to 14 participants (Bahrami, 2011; Koepke & Bigelow, 1997; McCallin & Frankson, 2010; Morgan, Ward, & Murdoch, 2004; Van der Meer et al., 2005; Yam, Rossiter, & Cheung, 2001). The sample size is appropriate from a scientific perspective as important confounders were excluded to make the results more reliable (Maxwell & Satake, 2006). Certain factors influenced the obtained sample size:

- The interpreters were not available for the entire duration of the data collection period.
- The hospital experienced a substantial decrease in patient numbers during the data collection period.

- Mothers were discharged within 24 hours of giving birth, therefore recruiting mothers before discharge was not always possible

3.5 Participant Description

All 10 of the mother and neonate feeding pairs were Black African. All the mothers were HIV-positive. Eight mothers were isiZulu mother tongue speakers. One mother was an isiXhosa first language speaker and another mother was a chiShona first language speaker, with isiZulu being their second/other language. The mothers' ages ranged from 19 to 42 years, with the median age being 26 years.

Seventy percent of the neonates were male (n = 7) and the mean gestational age was 38.2 weeks with a range of 37 (early term) to 41 weeks (late term). Ninety percent of the neonates were under 48 hours old at the time of the feeding screening and half had a chronological age of 24 hours or less (range: 10 – 51 hours). Neonates' birth weights ranged from 2.61kg to 3.57 kg with an average of 3.05 kg. None of the neonates were critically ill or in the NICU. All 10 neonates were born via normal vaginal delivery and were oral feeders. Six neonates were breastfed and four were cup fed with infant formula. All neonates were confirmed to be HIV-uninfected by an HIV polymerase chain reaction (PCR) test. The HIV PCR test is a viral detection test (Republic of South Africa: Department of Health, 2015b). A retrospective review done in South Africa found the test to be highly sensitive (98.8%) and specific (99.4%) in identifying HIV infection at six weeks of age (Sherman et al., 2005).

3.6 Data Collection Procedure

Data were collected from two sources using data collection tools devised for this study: (a) a retrospective review of the mothers' and neonates' hospital records using the medical and biographical schedule (Appendix C) and (b) a screening of neonates' feeding abilities using the Screening for Swallowing And Feeding in Neonates (SSAF-N) (Appendix D). Each neonate's HIV PCR test result was also collected from the neonate's medical records. Figure 3.1 depicts the steps in the data collection process.

Step 1: Participant identification and recruitment. HIV-positive mothers and their neonates who were present in the maternity wards at the time of recruitment were considered for inclusion. The HIV/AIDS counsellors in the two maternity wards were informed of the purpose of the study and the selection criteria. On the days of data collection, the HIV/AIDS counsellors informed the researcher when there were patients in the ward who met the selection criteria. The researcher also perused the labour ward birth registry and the maternity wards' admission registers to identify possible participants as these registers contained information regarding the required criteria for inclusion, such as maternal HIV status and neonate gestational age. Mothers, who met the selection criteria described in Table 3.1 and Table 3.2, were approached and informed of the nature and purpose of the study. Each mother was invited to participate in the study before being asked to review and sign the voluntary informed consent form (Appendix A) which was available in English and isiZulu. The informed consent form was explained to each mother prior to asking her to sign it.

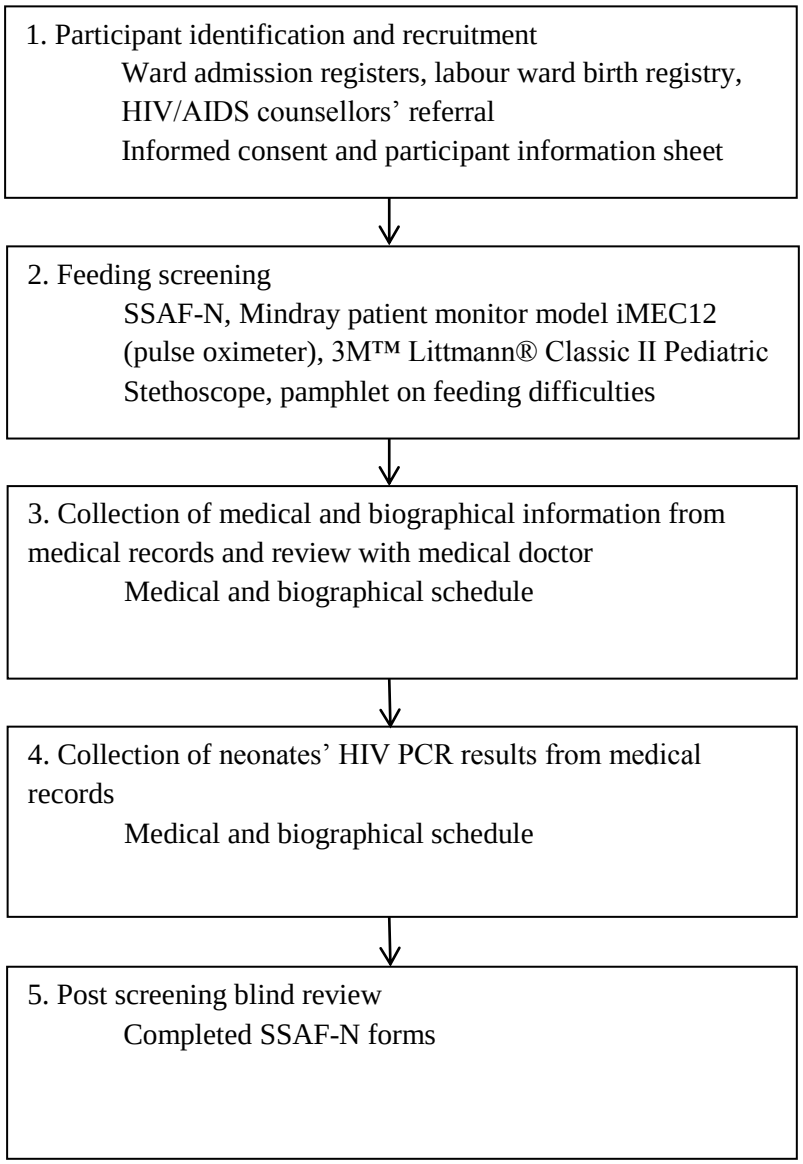

Figure 3.1. Steps in the data collection procedure and relevant tools used in each step

Step 2: Feeding observation. The feeding screening took place in the two maternity wards at the hospital. Each mother was asked when she last fed her child to determine when the neonate might be ready for his/her next feed. An appropriate time for the feeding screening to take place was arranged with the mother. The SSAF-N was used during the feeding screening to collect information regarding each neonate's state, motor control, feeding position, posture, oral tone, and latching ability. As part of the feeding screening, mothers were also requested to comment on the appropriateness of their child's feeding time and oral intake. Predetermined criteria were used to determine whether a neonate passed or failed the SSAF-N (detailed under '3.7.2 Components of data collection instrument').

Table 3.1

Inclusion criteria for mother and neonate feeding pairs

Inclusion criteria:	**Rationale**
Maternal HIV status: Mothers who contracted HIV before or during pregnancy	The focus of the study was on neonates who had been exposed to HIV in-utero and/or during delivery. Research has shown that exposure to HIV even in the absence of infection leads to poorer developmental outcomes (Drotar et al., 1997; Kourtis et al., 2013; Van Rie et al., 2008).
Birth mode: Neonates born by normal vaginal delivery	Neonates born by caesarean section (i.e., medicated birth) display differences in sucking and feeding behaviour when compared to neonates born without maternal anaesthesia or analgesia (such as vaginal delivery) (Baumgarder, Muehl, Fischer, & Pribbenow, 2003; Ransjö-Arvidson et al., 2001).

Table 3.2

Exclusion criteria for mother and neonate feeding pairs

Exclusion criteria:	**Rationale**
Gestation period: Neonates born prematurely (less than 37 weeks) (Nguyen & Wilcox, 2005)	Neonates who are born prematurely have a greater chance for adverse outcomes such as feeding difficulties than neonates who are born early term and full term (Arvedson & Brodsky, 2002; Engle & Kominiarek, 2008; United Nations Children's Fund & World Health Organisation, 2004).
Birth weight: Neonates who had a low birth weight (less than 2500g) (United Nations Children's Fund & World Health Organisation, 2004)	Neonates born with a low birth weight have a greater chance for feeding difficulties (Arvedson & Brodsky, 2002).
Neonatal health: Neonates who were in the NICU or otherwise critically ill	Neonates who are ill and require additional medical attention may not be able to feed as effectively as neonates who are deemed to be healthy (Arvedson & Brodsky, 2002).
Feeding method: Neonates who were non-oral feeders	The study required neonates who are oral feeders so that these skills could be observed and appraised for purposes of this study.

Once the feeding screening was completed, mothers were given a pamphlet on feeding difficulties (Appendix H). This pamphlet was developed by the researcher and it contains basic information on how to identify if a child has a feeding difficulty. The pamphlet was designed to assist

mothers to identify any feeding difficulties in their neonates so that intervention can take place early on. Any neonates who failed the feeding screening were referred to the SLTs working at the hospital for further assessment and management.

Step 3: Collection of medical and biographical information from medical records and review with medical doctor. Data were collected from the mothers' and neonates' hospital files using the medical and biographical schedule. Each mother and neonate's hospital file were available at their hospital bed. The researcher recorded information from the files as per the medical and biographical schedule. In the interest of efficiency, this was done while waiting for the neonate to be ready to feed and in between recruiting other participants.

After reviewing the medical files of the mothers and neonates and extracting the relevant medical information, a medical doctor employed at the hospital was asked to review the files and to highlight important medical information to the researcher. This was done to prevent the researcher from misinterpreting any information from the files.

Step 4: Collection of neonates' HIV PCR results from medical records. The neonates' HIV PCR test tracking numbers were obtained from their hospital files. An administration assistant working at the hospital used the tracking numbers to locate the HIV PCR test results from the laboratory database. During the time of data collection (August 2015), eight out of ten neonates' results were available. The remaining two neonates' HIV PCR results were obtained from their HIV PCR test done at six months of age. Even though it was not known whether these two neonates were HIV infected or not, they were included in the sample as they met the selection criteria of being HIV-exposed.

Step 5: Post screening blind review. After conducting the feeding observations, a post screening review of the completed SSAF-N forms was conducted by an SLT reviewer in order to assess the accuracy of the researcher's clinical interpretations. This was done blindly in that the reviewer was unaware which neonate passed or failed the SSAF-N. The researcher and reviewer demonstrated an 89% agreement. The post screening blind review is detailed under '3.9 Validity, Reliability and Bias'.

3.6.1 Interpreter

During recruitment and data collection, the researcher was accompanied by an interpreter as the researcher is not fluent in isiZulu. The purpose of the interpreter was to ensure that mothers who were not English first language speakers understood what the study entailed and were therefore able to provide informed consent. The interpreter's role also entailed being culturally sensitive to the interactions between the mother and the researcher. Two interpreters were used during the data collection period as the first interpreter was not available for the entire data collection period and therefore a second interpreter was used for the remaining period. Both interpreters were isiZulu first language speakers and English second language speakers. Both interpreters were from KZN and were

therefore familiar with the isiZulu culture. Prior to collecting the data, the researcher explained the following to each interpreter:

- The aim and purpose of the study including the confidential nature of data collection. Each interpreter signed a confidentiality agreement (Appendix B)
- The data collection process (pilot study, recruitment, informed consent form, feeding screening, and pamphlet on feeding difficulties)
- Their role as interpreter:
    - To interpret the meaning of what was said rather than word for word
    - To explain any cultural nuances that the researcher might miss or misinterpret.

By explaining the data collection procedure detail, the interpreter had a thorough understanding of the data collection procedure and could therefore identify if the mothers misunderstood any aspect of the informed consent form or feeding screening.

3.6.2 Pilot study

Prior to conducting the main study, a pilot study was conducted as per the steps in Figure 3.1 in order to identify and address any problems with the research procedure and to test the SSAF-N. The pilot study allowed the researcher to determine whether the study was feasible and it alerted the researcher to any difficulties that needed to be avoided or resolved prior to conducting the main study (Brink et al., 2012). Three mother and neonate pairs were recruited for the pilot study. See Appendix I for a copy of the informed consent form used for the pilot study participants. Of the three participants, only one feeding observation could be done as the other two participants were discharged before a feeding observation could be conducted. The only adjustment made to the data collection instrument was to omit the World Health Organisation (WHO) staging of HIV/AIDS as there was limited documentation of this in the hospital files. One change was made to the data collection procedure relating to the place where the neonates' feeding abilities were screened.

Prior to commencing the pilot study, the researcher planned to conduct the feeding screening in a separate room to ensure privacy. However, the only room available was outside the maternity ward and hospital protocol stipulated that mothers were not allowed to leave the ward with their neonates until they had been discharged. This challenge was resolved by assessing the neonates in the ward. No changes were made to the SSAF-N after the pilot study.

3.7 Data Collection Instrument

A research instrument was developed for the purposes of data collection. The research instrument comprised of two sections, (a) the medical and biographical schedule (Appendix C) and (b) the SSAF-N (Appendix D).

3.7.1 Development of data collection instrument

The medical and biographical schedule was compiled in order to capture the health and biographical information of the mothers and neonates. The schedule included maternal health

concerns during pregnancy, ART use before and during pregnancy, neonatal birth complications and HIV PCR results. Making use of a structured tool allowed for uniform and consistent data collection across participants.

During the time of designing the study, there was no validated neonatal feeding screening tool available in literature (Arvedson, 2008; Da Costa, Van den Engel-Hoek, & Bos, 2008) suited to the purposes of the study. Commercially developed tools such as Neonatal Oral Motor Assessment Scale (Palmer, Crawley, & Blanco, 1993), were not appropriate for the study population as they do not include aspects such as general motor control, state, position, posture, or signs of distress. These factors should be taken into account when determining an infant's feeding abilities (Arvedson, 2008). Other tools such as Systematic Assessment of the Infant at the Breast and Preterm Infant Breast-feeding Behaviour Scale are specific for breastfeeding (Association of Women's Health, Obstetric, 1990; Nyqvist, Rubertsson, Ewald, & Sjoden, 1996).

The mother-baby-friendly hospital initiative is supported in all public care settings in South Africa (Republic of South Africa: Department of Health, 2013). This initiative includes encouraging mothers to breastfeed rather than formula feed (regardless of HIV status), due to the benefits of breastfeeding. Should a mother decide to formula feed rather than breastfeed, she will be taught to feed using an open rimmed cup rather than a bottle. This is done to decrease the chance of infection in the neonate (Republic of South Africa: Department of Health, 2013). In light of this, it was necessary to use a tool that would suit the South African context where mothers may breastfeed or cup feed while in hospital. Since no such tool was available, it was decided to create a research instrument that could be adjusted for the modality of feeding and would therefore better suit the purposes of the study.

The researcher consulted literature on paediatric feeding and swallowing assessments (Arvedson & Brodsky, 2002; Cichero, 2006; Lau, Smith, & Schanler, 2003; Wolf & Glass, 1992) and used the information gained to compile the SSAF-N. It was not possible to validate the SSAF-N (and it has thus not been tested for sensitivity or specificity); instead an expert reference group was consulted for further development and refinement of the screening tool. An expert reference group can take on various forms but it broadly consists of a carefully selected group of people who are asked to provide expert opinions on a certain matter (Fretheim, Schünemann, & Oxman, 2006). The expert reference group also provided comments on the components of the medical and biographical schedule (presented in Table 3.3). When conducting a study, an expert reference group allows a higher degree of rigour to be established (Fretheim et al., 2006).

The first expert reference was one of the study supervisors. The other participants for the expert group were selected by means of snowball sampling. This type of sampling entails requesting the participant(s) who have been recruited to identify other potential participants who are deemed to have sufficient experience and knowledge to contribute to the study (Brink et al., 2012). This sampling method enabled for quick and efficient identification of participants. The inclusion criteria

for an expert reference group depend on the project's aims and the function that the experts are required to fulfil (World Health Organisation, 2006a). The expert reference group for the research study consisted of three SLTs who are considered to be experts in the field of feeding and swallowing disorders by their peers. The following selection criteria were applied:

Inclusion criteria:

- Recognised experts: They are considered to be experts in the field of feeding and swallowing disorders by their academic peers. Therefore they would need to be recommended by their peers which was achieved by snowball sampling (Brink et al., 2012).
- Clinical experience: They have at least 3-5 years of clinical experience in the field of paediatric feeding and swallowing disorders.
- Research experience: They have at least 3-5 years of experience in conducting research in the field of paediatric feeding and/or swallowing disorders.

Exclusion criteria:

- Availability: They are not able to provide written and/or verbal feedback within 7-10 working days of receiving the SSAF-N and the medical and biographical schedule for review.

The expert reviewers were informed of the nature and purpose of the study as well as the local context in which the study was taking place. They were also informed of the ethical considerations as outlined in the informed consent form for the expert reference group (Appendix E). The expert reviewers were asked to comment on the following aspects of the screening tool and medical and biographical schedule:

- Components
    - Level of detail needed to comply with the aim of it being a screening tool
    - Other components that should be included
    - Components that should be excluded
- The level of appropriateness for the study population and for its intended purpose
- The composition and clarity of the screening tool.

Aspects incorporated, adjusted or excluded after expert reviewers' feedback are detailed in Table 3.3. Some components were deemed inappropriate or unnecessary for the purpose of the screening tool. Reasons for this are provided in Table 3.3. Following the feedback from the expert reference group, all comments were reviewed with one study supervisor and the SSAF-N and medical and biographical schedule were refined and adjusted accordingly.

3.7.2 Components of data collection instrument

The components of the medical and biographical schedule are in the final version of the schedule in Appendix C. Table 3.4 describes the different components that are included in the SSAF-N. Each component's definition and justification from the literature is also provided. The main components of the SSAF-N include the neonates' suck, swallow and breathing in relation to feeding.

Table 3.3

Feedback from expert reference group

Area	Comment	Action
1. Components of SSAF-N	1.1 Include method of feeding observed	Incorporated
	1.2 Include feeding time	Incorporated
	1.3 Include oral intake (if other than breastfeeding)	Incorporated
	1.4 Include state of arousal	Incorporated
	1.5 Include physiologic stress cues as embedded factors	Incorporated
	1.6 Include feeding position, posture and oral tone	Incorporated
	1.7 Include general motor control	Incorporated
	1.8 Include information on mother's emotional state	Excluded. Reason: Too broad for the focus of the study
	1.9 Observe whether neonate's nasal passages are clear	Excluded. Reason: Not necessary for the purpose of the feeding screening
	1.10 Include heart rate and respiration rate	Excluded. Reason: Not necessary for the purpose of the feeding screening
	1.11 Observe for adequate saliva management	Excluded. Reason: Infants under three months old produce very small amounts of saliva (Winstock, 2005).
	1.12 Specify pass/fail criteria	Incorporated
	1.13 Specify normal vs abnormal sucking rate	Incorporated
	1.14 Specify SSB ratio norms	Incorporated
	1.15 Specify normative data for SpO_2	Incorporated
2. Components of schedule	2.1 Exclude antenatal clinic attendance dates	Adjusted accordingly
	2.2 Exclude number of children previously born to mother	Adjusted accordingly
	2.3 Include biographical and medical sections regarding neonate	Incorporated
3. Composition of tool	3.1 Separate the maternal biographical and medical information from the clinical screening components, i.e., make two forms	Adjusted accordingly
	3.2 Cluster cervical auscultation and breathing together on screening form	Adjusted accordingly
	3.3 Structure form with pass and fail columns for ease of use	Adjusted accordingly

The SSAF-N was designed to be used as a screening tool primarily involving a feeding observation. A structured feeding observation is a well-recognised component of a feeding screening and it involves observing a caregiver and neonate feeding session as it would occur naturally (Wolf & Glass, 1992). The aim of a feeding screening is to determine: (a) the chance of the patient having a feeding difficulty, (b) whether further evaluation is necessary, (c) whether the patient is a safe oral feeder (Swigert, Riquelme, & Steele, 2009), and (d) whether the patient can maintain sufficient nutrition and hydration required for growth (Arvedson, 2008). It is meant to be quick and minimally invasive. Based on this the researcher formulated the following criterion that would result in the neonate failing the SSAF-N:

- Displaying difficulties in two or more components in the SSAF-N (e.g., A, B, C or D) which would put them at risk for not meeting their hydration and nutritional requirements or would result in feeding being deemed unsafe.

All components were judged as appropriate or inappropriate. In the SSAF-N certain criteria or examples are provided when a feeding behaviour would be considered inappropriate (see Appendix D).

3.7.2.1 Feeding method. Certain components in the SSAF-N were interpreted differently based on the feeding modality. Information regarding feeding time and oral intake were obtained by asking the mothers. Feeding time was judged as appropriate when it was reported to be between 15 and 30 minutes (Arvedson, 2008); therefore feeding for longer than 30 minutes was considered to be prolonged and feeding for less than 15 minutes was considered to be reduced. The oral intake component of the SSAF-N was only applied to cup fed neonates as oral intake cannot be calculated for neonates who are breastfed. Cup fed and breastfed neonates were assessed differently for component of coordination. For breastfed neonates, their SSB coordination was considered. Cup fed neonates were assessed according to their swallow-breathe (SB) coordination. Latching was only considered for breastfed neonates as cup fed neonates do not latch onto a cup and do not create an oral seal with their lips, rather the cup rests on their lower lip. The neonate also ‘laps’ the milk up (Flint, New, & Davies, 2007), therefore sucking cannot be observed during cup feeding. Since sucking is a component of breastfeeding, the researcher determined breastfed neonates’ sucking strength by inserting a gloved finger into each neonate’s mouth and feeling the strength of the neonate’s suck.

Table 3.4

Components of the SSAF-N

Screening components	**Definition**	**Rationale**
Feeding duration (breast and cup feeding)	The time is takes for a neonate to complete a feed (Arvedson & Brodsky, 2002).	This is an important aspect to include in a feeding screening as prolonged feeding times could indicate the presence of feeding difficulties (Arvedson, 2008)
Oral intake (cup feeding only)	The amount of milk that a neonate consumes in one feed (Arvedson & Brodsky, 2002).	Adequate nutritional intake is essential for growth and development. Limited intake could be related to feeding and swallowing difficulties (Arvedson & Brodsky, 2002)
State of arousal (breast and cup feeding)	A neonate's alertness level at a specific time (Wolf & Glass, 1992)	A neonate's state needs to be considered during feeding screening so that incorrect conclusions are not made regarding their feeding ability (Rossetti, 2001). Optimal state of arousal for feeding include drowsy, quiet awake, or active awake (Delaney & Arvedson, 2008).
General motor control (breast and cup feeding)	Factors influencing general motor control include postural control, muscle tone and gross motor skills (Arvedson & Brodsky, 2002; Wolf & Glass, 1992).	Safe and effective feeding requires good general motor control (Andrew & Sullivan, 2010; Arvedson & Brodsky, 2002)
Suck (breastfeeding only)	In the neonate, this is referred to as 'suckling' which involves the tongue moving forward and backward to draw liquid out of the nipple or teat (Arvedson & Brodsky, 2002).	Sucking is a key aspect of breast or bottle feeding and should be assessed as part of a screening or comprehensive assessment (Arvedson, 2008)
Feeding position (breast and cup feeding)	The position in which a neonate is placed (for example, arm held) during feeding (Arvedson & Brodsky, 2002)	Position during feeding is an important consideration as it impacts the neonate's ability to feed successfully (Arvedson & Brodsky, 2002; Wolf & Glass, 1992)
Posture (breast and cup feeding)	A neonate's resting posture involves the position of their trunk and limbs when their body is at rest (Arvedson & Brodsky, 2002)	Observation of an infant's resting posture provides valuable information about muscle tone (Arvedson & Brodsky, 2002)
Oral tone (breast and cup feeding)	"The tension in a muscle in its resting state measured by the amount of resistance produced during passive range of motion" (Arvedson & Brodsky, 2002, p.618)	Infants with abnormal tone generally have difficulty sucking and feeding efficiently (Arvedson & Brodsky, 2002)
Latching: lip seal and strength of suck (breastfeeding only)	Latching involves the infant's ability to create an adequate seal on the nipple or teat (Cichero, 2006)	Adequate latching is important for successful feeding to occur (Arvedson & Brodsky, 2002)

Screening components	Definition	Rationale
Coordination of SSB or SB (breast and cup feeding)	An infant's ability to coordinate their sucking, swallowing and breathing in order to feed efficiently and safely (Lau et al., 2003)	Neonates with disorganised feeding have a high risk of developing long term feeding difficulties (Arvedson & Brodsky, 2002). Early sucking ability is associated with subsequent feeding skills and neurodevelopment in later years (Da Costa et al., 2010, 2008; Qureshi, Vice, Taciak, Bosma, & Gewolb, 2002).
Swallowing (breast and cup feeding)	Transfer of a bolus from the oral cavity to the stomach (Arvedson & Brodsky, 2002).	Difficulties with swallowing could result in aspiration of the bolus which may cause aspiration pneumonia (Arvedson & Brodsky, 2002)
Breathing Respiration at rest, during feeding and after swallowing. (breast and cup feeding)	This includes observations of respiration rate and quality during inhalation and exhalation (Arvedson & Brodsky, 2002)	Neonates who have respiratory difficulties have a higher chance for feeding difficulties (Van der Meer et al., 2005). A feeding screening should include components relating to respiration as changes during or after feeding may indicate the presence of feeding difficulties (Arvedson & Brodsky, 2002).
Stress cues (breast and cup feeding)	Physiological stress cues include changes in cardiac function, respiration and colour (Groher & Crary, 2010).	It is important to assess the impact of feeding on a neonate's physiological state (Groher & Crary, 2010).

3.7.2.2 Cervical auscultation and pulse oximetry. In order to measure respiration (at rest, during and after feeding) and arterial oxygen saturation, the feeding screening used pulse oximetry and cervical auscultation. Pulse oximetry is a measurement of oxygen levels in the arterial blood (Cichero, 2006). A Mindray patient monitor, model iMEC12 (Mindray Medical International Limited) was used to collect information on each neonate's arterial oxygen saturation levels before, during and after feeding. This provided information regarding the possibility of penetration during the feeding observation. Appendix F details the pulse oximetry protocol that was used in the study. The pulse oximetry protocol was adapted from Cichero (2006) and Sherman, Nisenboum, Jesberger, Morrow, and Jesberger (1999).

Cervical auscultation is a method to assess the swallowing sounds and related respiration sounds (Arvedson & Brodsky, 2002) and is considered to be a useful adjunct to a feeding screening (Cichero, 2006). Cervical auscultation was conducted using a 3M™ Littmann® Classic II Pediatric Stethoscope (3M™). This method assisted the researcher to listen for any indicators of compromised swallowing safety, and to assess each neonate's breathing prior to, during and post feeding. Appendix G describes the cervical auscultation protocol used in the study, which was adapted from Cichero (2006).

3.8 Data Analysis

In order to perform descriptive statistical calculations, the quantitative data obtained from the SSAF-N and medical and biographical schedule were entered into Statistical Package for the Social Sciences (IBM SPSS Statistics 23.0, IBM). Descriptive statistical calculations allowed for a more in-depth understanding of the patterns in the data. These descriptive statistical calculations included:

- The sum or percentage (calculated for the variables: mothers starting ART at a certain period, mothers with health concerns, neonates with birth complications, language, race, and feeding method)
- The range (calculated for the variables: maternal age, gestational age, CD4 count, and birth weight)
- The median (calculated for the variables: maternal age and CD4 count)
- The mean (calculated for the variables: gestational age, birth weight, and CD4 count)

Tables were used to depict the results. Certain groups of results were presented together in a table so that informal correlations could be made. For example, characteristics of the neonates (e.g. birth weight, gestational age, and birth complications) were depicted in relation to their feeding difficulties. By presenting the feeding difficulties of the neonates who failed the SSAF-N along with data such as gestational age and birth complications in a table format, informal inferences could be made regarding the possible influence of birth complications on feeding outcome. Similarly, a table was used to depict HIV-positive mothers' health in relation to the neonates' screening results. This allowed for comparisons to be made across mother-neonate pairs.

3.9 Validity, Reliability and Bias

The study employed measures to enhance validity and reliability, and to reduce any possible bias. As discussed under '3.7.1 Development of data collection instrument' an expert reference group was utilised to increase the validity of the research instrument (Maxwell & Satake, 2006).

Content validity is an assessment of the degree to which an instrument covers the components required in order to measure what it intends to measure (Brink et al., 2012). Face validity involves using expert intuitive judgement to determine whether an instrument measures what it was designed to measure (Brink et al., 2012). By presenting the SSAF-N to a group of experts in the field, and incorporating their feedback, content validity and face validity of the research instrument were established (Maxwell & Satake, 2006).

Several methods were employed to increase the reliability of the researcher's clinical judgements during the data collection. The feeding screenings were conducted by the researcher who is a qualified SLT. The researcher was trained in neonatal feeding screening procedures by the main supervisor who is experienced in paediatric feeding assessments. The training was conducted at the same site as the data collection and it consisted of reviewing the screening protocol and procedure. The training also included how to conduct cervical auscultation and measure and interpret pulse

oximetry. This increased the reliability of the researcher's judgements regarding feeding ability.

In order to further increase the reliability of the results, the researcher's interpretations of the feeding observations were appraised by means of a post-screening blind review of the completed SSAF-N forms with the screening result (pass or fail) omitted. Convenience sampling was used to select the blind reviewer. An SLT who worked at the hospital was requested to act as the blind reviewer. The blind reviewer had more than five years' experience of working with paediatric feeding and swallowing difficulties and held a Master's degree in Communication Pathology. Nine of the total (n = 10) number of the completed SSAF-N forms (see Appendix J for a copy of the informed consent form of the SLT) were reviewed by the blind reviewer. The blind reviewer made a clinical judgement regarding what the screening outcome should be for each case based on the feeding observations recorded on each form. The researcher and blind reviewer had an 89% agreement which was calculated in the following manner:

$$\frac{s}{f} \times 100 = percentage\ agreement\ (\%)$$

s = number of screening outcomes (pass or fail) that the reviewer agreed with
f = total number of forms reviewed by the reviewer

The equation with the values reads as follows:

$$\frac{8}{9} \times 100 = 88.9\% \sim 89\%$$

After discussing the one disagreement, the blind reviewer agreed with the researcher's judgement regarding the disputed case. Conventionally an agreement of more than 80% is acceptable (Meline, 2009).

As an additional reliability measure, a medical doctor was consulted during the hospital file reviews and asked to highlight any relevant medical information that the researcher may have interpreted incorrectly. The medical doctor also interpreted medical jargon for the researcher so that the information could be understood correctly.

According to Brink et al., (2012), participants will sometimes try to present themselves in a favourable way when they are aware of being observed. This kind of bias was reduced by informing participants that only their children's feeding abilities were being observed, and that in no way were their abilities as mothers being evaluated. By communicating this, bias resulting from researcher subjectivity (preference toward a certain outcome) is also reduced (Brink et al., 2012).

3.10 Ethical Considerations

The research procedure followed the guidelines of the World Medical Association (WMA) Declaration of Helsinki (World Medical Association, 2013). The WMA Declaration of Helsinki is a statement of ethical principles to be used when conducting research involving human participants.

Before commencing with the study, ethical clearance was obtained from the Biomedical Research Ethics Committee (BREC) of the University of KwaZulu-Natal (ethical clearance number: BE 223/15, Appendix K and Appendix L). Once BREC granted the researcher permission to conduct the study, a letter was sent to the Chief Executive Officer (CEO) of the hospital to request permission for the study to be conducted at the hospital (Appendix M). Thereafter permission to conduct the study in KZN was requested from the Provincial Department of Health (DOH) by means of the online proposal submission process. Once permission was obtained from all relevant gatekeepers (Appendix N), potential participants were identified and recruited.

3.10.1 Informed consent

The ethical principal of autonomy states that individuals have the right to self-determination which means that they should be given the opportunity to make their own decisions and not be coerced in any way (Brink et al., 2012). The principle of autonomy was upheld by informing the potential participants of the aims and purpose of the study, as well as the potential risks and benefits of the study (World Medical Association, 2013). This was explained verbally (in English and/or isiZulu) as well as given in writing (Appendix A). The potential participants were informed that participation was voluntary and that they were allowed to withdraw from the study at any time without facing any adverse consequences. The informed consent form was available in English and isiZulu and participants were given a copy of the informed consent form for their own records.

3.10.2 Risks and benefits

Participation in the research held minimal risk for the mothers and neonates. The feeding screening was conducted by a qualified SLT who is registered with the Health Professions Council of South Africa (HPCSA). The majority of the feeding screening involved observations during a routine feeding session which was non-invasive and relatively unobtrusive. The feeding screening entailed procedures that are well documented in the field of speech language therapy (Arvedson & Brodsky, 2002; Cichero, 2006) and are considered safe enough to perform as part of a feeding screening protocol.

All neonates who failed the SSAF-N were referred to the SLTs working at the hospital. This ensured that those neonates who presented with feeding difficulties were assessed further and managed accordingly.

3.10.3 Vulnerable groups and individuals

The WMA Declaration of Helsinki (2013) stated that research on a vulnerable group (such as infants) is only justified if it is not possible for the research to be conducted on a non-vulnerable group, and also if the research is for the purpose of the health needs of this population and that the

group will stand to benefit from the research outcomes. The current research study aimed to determine the health needs (specifically the feeding and swallowing) of an under-described population in the literature. The findings of this study will enable health care personnel to improve the health services for to this vulnerable population.

3.10.4 Privacy and confidentiality

The privacy of participants was maintained by utilising a quiet area in the wards to discuss the study with the mothers and to obtain informed consent. Identifying information of the participants was kept confidential during data collection, data analysis, in the research report, and will be kept confidential in any type of presentation or in any article submitted for publication. The names of the participants were coded and were referred to as such. The master copy of the participants' names and the corresponding codes, as well as all electronic data were kept in a secure password protected file to which only the researcher and supervisors had access. Paper data were kept in a locked cupboard which also only the researcher and supervisors had access to. The only time identifying information was disclosed was when an infant displayed feeding difficulties and a referral to an SLT was deemed necessary. Electronic and paper data relating to the research study (excluding those relating to identifying information of participants) will be kept for five years after the study has been completed (Republic of South Africa: Department of Health, 2015a). Thereafter electronic data will be permanently deleted and paper data will be shredded by the researcher and securely discarded.

3.10.5 Beneficence and non-maleficence

When a neonate failed the SSAF-N, they were referred to an SLT. After the feeding observation, every mother received an information pamphlet on feeding and what signs indicate the presence of feeding difficulties. In this way, mothers learned how to identify whether their child has feeding difficulties which will lead to early intervention taking place. This was a direct benefit of participating in the study. The pamphlet was also given to the speech language therapy department at the hospital to use for future patients seen at the hospital.

3.10.6 Justice

The ethical principle of justice was achieved by informing the participants that they could ask questions and have their questions fully answered. Once completed, the results of the study will be made available to the hospital.

3.11 Summary

This chapter described and explained the methodological considerations of the research study. Aspects pertaining to the study design, data collection instrument and procedure, data analysis as well as validity, reliability and bias were discussed. The chapter concluded with the key ethical principles that were considered during this study. The results are presented in Chapter 4.

CHAPTER 4: RESULTS

4.1 Introduction

The aim of the study was to describe the feeding abilities of HEU neonates born at a public sector hospital in KwaZulu-Natal. Three objectives were formulated in order to achieve this aim:

1. To develop an informal neonatal feeding screening tool by reviewing literature and consulting with an expert reference group in order to screen the feeding of HEU neonates born at a public sector hospital.
2. To profile the feeding abilities of HEU neonates in terms of their sucking, swallowing and breathing by using the developed neonatal feeding screening tool in order to describe the feeding abilities of this population.
3. To describe the HIV-positive mothers' health during pregnancy by gathering medical and biographical information as recorded in their hospital files to determine the presence of any maternal health risks which could impact on the HEU neonates' feeding abilities.

The results of Objective 1 are reported in Chapter 3. The results of Objectives 2 and 3 are presented in this chapter and are discussed in Chapter 5. The results and discussion have also been written in the form of an article manuscript which is presented at the end of this chapter.

4.2 Results of Objectives 2 and 3

4.2.1 Objective 2: Profile of HEU neonates' feeding abilities

Sixty percent of the neonates (two cup feeders and four breast feeders) displayed appropriate feeding abilities and passed the SSAF-N. Table 4.1 describes the feeding abilities of all the neonates (n = 10). The results are presented under the same components that are included in the SSAF-N. The areas in which the neonates showed no difficulties include general motor control, feeding position, posture, tone, lip seal and respiration during feeding. Four neonates (40%) failed the SSAF-N and collectively demonstrated difficulties in feeding time, oral intake, state of arousal, strength of suck, SB coordination, signs of distress, respiration before and after feeding, and prandial oxygen desaturation during feeding. Of the four neonates who failed the SSAF-N, three neonates (Neonates 2, 3 and 7) presented with difficulties relating to feeding duration: two neonates demonstrated reduced feeding times of less than 15 minutes and one neonate demonstrated a prolonged feeding time of more than 30 minutes. Two of the four neonates who failed the SSAF-N were breastfed and the remaining two were cup fed.

Table 4.2 details the neonates' characteristics, including their feeding method and observed feeding difficulties (where applicable). Information regarding each neonate's gender, gestational age, birthweight, chronological age, birth complications is also provided. The neonates who failed the SSAF-N are shaded in grey for ease of reference. As described under '3.7.2 Components of data collection instrument', in order to fail the SSAF-N the neonate had to demonstrate inappropriate feeding abilities in two or more components, resulting in the neonate being placed at risk for not meeting nutrition and hydration requirements or being at risk for unsafe feeding.

Table 4.1

Profile of feeding abilities of HEU neonates

Participant	A. Feeding duration and intake		B. State and motor control		C. Suck						D. Breathing and swallowing						Screening result
								Latching[2]			Respiration						
	Feeding time	Oral intake[1]	State of arousal	General motor control	Feeding position	Posture	Tone	Lip seal	Strength of suck	Coordination[3]	At rest	During feeding	After feeding	Swallowing	SpO_2 % difference	Signs of distress	
1	A	A	A	A	A	A	A	-	-	**Ic**	A	A	A	**I**	A	absent	**Fail**
2	**I**	**I**	**I**	A	A	A	A	-	-	**Ic**	A	A	A	**I**	A	present	**Fail**
3	**I**	-	A	A	A	A	A	A	**I**	Ab	**I**	A	**I**	A	A	absent	**Fail**
4	A	-	A	A	A	A	A	A	A	Ab	A	A	A	A	A	absent	Pass
5	A	-	A	A	A	A	A	A	A	Ab	A	A	A	A	A	absent	Pass
6	A	-	A	A	A	A	A	A	A	Ab	A	A	A	A	A	absent	Pass
7	**I**	-	A	A	A	A	A	A	A	Ab	A	A	A	A	**I**	absent	**Fail**
8	A	-	A	A	A	A	A	A	A	Ab	A	A	A	A	A	absent	Pass
9	A	A	A	A	A	A	A	-	-	Ac	A	A	A	A	A	absent	Pass
10	A	A	A	A	A	A	A	-	-	Ac	A	A	A	A	A	absent	Pass
Total[4]	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**0**	**1**	**2**	**1**	**1**	**4**

Note. 1 = only applicable to cup fed neonates; 2 = only applicable to breastfed neonates; 3 = breastfed neonates were assessed for SSB coordination, cup fed neonates were assessed for swallow-breathe coordination; 4 = Total number of neonates displaying inappropriate abilities for each component; A = appropriate; Ab = Appropriate for breastfeeding; Ac = appropriate for cup feeding; I = Inappropriate; Ic = Inappropriate for cup feeding.

Table 4.2

Characteristics of HEU neonates in relation to feeding difficulties

Participant No.	**Gender**	**GA (weeks)[1]**	**BW**	**CA (hours)**	**Birth complications / concerns**	**Feeding method[2]**	**Feeding difficulties observed during screening**
1	Female	39: Full term	2.72	20	Prolonged ROM, poor sucking at birth	Cup	SB discoordination and nasal regurgitation
2	Female	41: Late term	3.17	10	None	Cup	Lethargic and difficult to rouse for feeding, reduced feeding time and intake, SB discoordination, signs of distress and regurgitation
3	Male	38: Early term	2.73	38	BBA, mild respiratory distress	Breast	Prolonged feeding time (>30mins), poor sucking strength and inspiratory stridor
4	Male	37: Early term	2.61	40	None	Breast	None
5	Male	38: Early term	2.67	26	None	Breast	None
6	Male	38: Early term	3.43	23	None	Breast	None
7	Female	38: Early term	3.57	17	Signs of respiratory distress	Breast	Reduced feeding time (5 mins) and oxygen desaturation during feed
8	Male	37: Early term	3.19	18	None	Breast	None
9	Male	37: Early term	3.45	28	None	Cup	None
10	Male	39: Full term	3.00	51	BBA, poor sucking at birth, conjunctivitis	Cup	None

Note. CA: chronological age; BW: birth weight; GA: gestational age; prolonged ROM: prolonged rupture of membranes; BBA: born before admission (non-hospital delivery); 1 = early term: 37 – 38 weeks + 6 days; full term: 39 – 40 weeks + 6 days; late term: 41 – 41 weeks + 6 days; post term: 42 weeks and beyond (The American College of Obstetricians and Gynecologists, 2013); 2 = cup fed neonates were fed with infant formula.

The mother of Neonate 1 experienced prolonged rupture of membranes (ROM) before labour began. Prolonged ROM is the rupture of foetal membranes lasting more than 18 hours before the onset of labour (Al-Qa'Qa' & Al-Awaysheh, 2005). This neonate was born full term at 39 weeks gestational age and her mother chose to feed her infant formula (given via a cup as per the mother-baby-friendly hospital initiative). Neonate 1 was noted in the hospital file to have poor sucking at birth. During the feeding screening, 20 hours after birth, the neonate showed difficulty in SB coordination resulting in subsequent nasal regurgitation. The observed SB discoordination could

result in the infant formula entering the neonate's airway and result in aspiration, which caused concern for the neonate's feeding safety. Arguably, the neonate's observed discoordination and resultant nasal regurgitation may have been transitory and a normal feeding occurrence as some full term neonates demonstrate discoordination while feeding (Da Costa et al., 2010; Delaney & Arvedson, 2008). It could not be determined by the SSAF-N whether this neonate has any velopharyngeal insufficiency which would result in milk coming through the nose. However, taking the neonate's medical history into account (poor sucking at birth) the researcher decided that the neonate required a follow up assessment to establish feeding safety. The neonate consequently failed the SSAF-N.

Neonate 2 was born 41 weeks gestation (late term). The neonate was cup fed with infant formula as her mother had poor milk production. The mother reported reduced feeding time and oral intake. During the feeding screening (10 hours after birth) the neonate drank the formula very quickly. Her swallowing and breathing were discoordinated and her SpO_2 dropped (not sustained for one minute) and then subsequently recovered. Within 10 seconds of demonstrating the drop in SpO_2 and stopping feeding, the neonate appeared to be in distress (wide eyed look and three second breath hold) and regurgitated her feed. This neonate was very lethargic and not in the appropriate state for feeding. She did not demonstrate effective feeding during the feeding screening and therefore failed the SSAF-N.

Neonate 3 was born before admission (BBA) which means that he was born before his mother was admitted to the hospital. This is considered a risk factor for infection in neonates (Thaver & Zaidi, 2009). The neonate was born early term at 38 weeks gestational age. He demonstrated mild respiratory distress at birth (as documented in the hospital file). The neonate was breastfed and his mother reported a prolonged feeding time (longer than 30 minutes). During the feeding screening (conducted 38 hours after birth), the neonate demonstrated weak sucking on the researcher's gloved finger. He also presented with inspiratory stridor, which was observed by the researcher before and after feeding. Inspiratory stridor is a harsh respiratory sound (typically heard during inspiration) resulting from partial obstruction of the supra-glottic or glottic airway (Daniel & Cheng, 2011). Inspiratory stridor could be as a result of several underlying pathologies including laryngomalacia and it requires prompt investigation to determine the cause of the partial airway obstruction (Daniel & Cheng, 2011). The inspiratory stridor along with the reported prolonged feeding time resulted in the neonate failing the SSAF-N as these difficulties could result in feeding inefficiency and poor weight gain.

Neonate 7 was born at 38 weeks gestation (early term). At birth the neonate showed signs of respiratory distress which was recorded in the hospital file. The neonate was screened using the SSAF-N 17 hours after birth. The neonate's mother reported a reduced feeding time (about 5 minutes in total) during breastfeeding. During the feeding screening, the neonate's oxygen saturation decreased from 98% (before feeding) to 95% (after feeding) which was sustained for 1 minute before

recovery to baseline saturation. Considering the neonate's history of showing signs of respiratory distress as well as reduced time spent feeding, this neonate was deemed by the researcher as requiring a follow up assessment to determine whether the neonate is feeding safely and efficiently.

Of the neonates who passed the SSAF-N, only one neonate (Neonate 10) presented with any birth concerns. He was born full term at 39 weeks gestational age and demonstrated poor sucking at birth (as recorded in the hospital file). This neonate was cup fed with infant formula. He was assessed by the researcher at 51 hours chronological age. He demonstrated appropriate feeding abilities and therefore passed the SSAF-N.

4.2.2 Objective 3: HIV-positive mothers' health during pregnancy

Seven of the mothers had health concerns during pregnancy which had been noted in their hospital files by the medical staff. All health concerns were treated and managed during pregnancy. Three mothers (Mothers 2, 6 and 9) presented with pregnancy related anaemia. Two mothers went into labour prematurely but did not give birth until 38 weeks gestation. Two mothers had vaginal warts and one mother had vaginal ulcers. One mother presented with epilepsy which was a known medical condition prior to pregnancy. Table 4.3 outlines the HIV-positive mothers' health in relation to the neonatal screening result. In Table 4.3, the mothers whose neonates failed the SSAF-N are shaded in grey for ease of reference. The participant numbers of the mothers correlate to the participant numbers of the neonates.

The CD4 counts of the nine mothers whose CD4 counts were available ranged from 205 to 820 cells/mm^3(µl) (median: 500 cells/mm^3(µl)). The average CD4 count of the mothers whose neonates failed the SSAF-N was 398 cells/mm^3(µl). The average CD4 count of the mothers whose neonates passed the SSAF-N was 570 cells/mm^3(µl). Therefore the mothers whose neonates passed the SSAF-N had a higher mean CD4 count than the mothers whose neonates failed the SSAF-N.

Half of the mothers (n = 5) started ART during or after their sixth month of pregnancy. Three mothers (Mothers 4, 8 and 9) who had been on ART before becoming pregnant gave birth to neonates who presented with adequate feeding abilities during the SSAF-N screening; these neonates were exposed to ARVs during the entire gestation period. Three mothers whose neonates failed the SSAF-N only started ART during or after their sixth month of pregnancy, which means that these neonates were exposed to ARVs from 24 weeks gestation. All mothers were on the FDC type of ART.

Table 4.3

Maternal health in relation to neonatal screening result

Participant no.[1]	Age	CD4 count	ART initiation[2]	Health concerns during pregnancy	Neonatal screening result
1	22	372	7th month pregnancy	None	Fail
2	24	299	7th month pregnancy	Anaemia, vaginal warts	Fail
3	30	368	1st month pregnancy	Preterm labour at 36 weeks (birth at 38 weeks)	Fail
4	28	500	>12 months prior pregnancy	None	Pass
5	19	608	4th month pregnancy	Preterm labour 34 weeks (birth at 38 weeks)	Pass
6	26	205	6th month pregnancy	Anaemia (blood transfusion at 36 weeks gestation), vaginal ulcers	Pass
7	32	553	6th month pregnancy	None	Fail
8	42	-	5 months prior pregnancy	Asthmatic (controlled with medication)	Pass
9	26	820	>12 months prior pregnancy	Slight anaemia	Pass
10	25	719	8th month pregnancy	Epilepsy, vaginal warts	Pass

Note. 1 = The mothers of the neonates who failed the SSAF-N are shaded in grey. 2 = Time of ART initiation in relation to pregnancy.

4.2.3 Summary

The results of Objectives 2 and 3 were presented in this chapter. The feeding abilities of the 10 HEU neonates' were profiled. The feeding difficulties of the four neonates who failed the SSAF- were described and the clinical decision making regarding each neonate's feeding screening outcome was explained. The health of the mothers during pregnancy, including their CD4 counts and ARV use were presented in this chapter. These maternal health factors were depicted in relation to the corresponding neonate's feeding screening outcome. The results described in this chapter are discussed in Chapter 5.

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HIV-exposed uninfected neonates are at risk for feeding difficulties: A descriptive exploratory study in KwaZulu-Natal, South Africa

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Abstract

Background: HIV-negative children born to HIV-positive mothers demonstrate inferior development and health when compared to HIV-unexposed children. HIV exposure, without HIV infection, has adverse effects on neonatal outcomes. When examining the health of HIV-exposed uninfected (HEU) neonates, the ability to feed successfully is a crucial, yet unexplored, consideration. The aim of the study was to describe the feeding abilities of HEU neonates born to HIV-positive mothers accessing health care at a tertiary hospital in KwaZulu-Natal.

Methods: A descriptive exploratory study was conducted with 10 HEU neonates and their HIV-positive mothers. Neonates' feeding abilities were screened by using a developed feeding screening tool (SSAF-N). A retrospective review of mothers' health during pregnancy was done using hospital medical records. Results were analysed using descriptive statistical calculations on SPSS.

Results: Four out of the 10 neonates failed the feeding screening and presented with feeding difficulties such as prolonged feeding time (n = 1), reduced feeding time (n = 2), swallow-breathe discoordination (n = 2), weak sucking (n = 1), insufficient oral intake (n = 1), inappropriate state of arousal for feeding (n = 1), inspiratory stridor (n = 1), signs of distress (n = 1), and regurgitation (n = 1). Maternal CD4 count (n = 9) ranged from 205 – 820 cells/mm^3(µl). Five neonates were ARV-exposed from 24 weeks gestational age, three of whom failed the SSAF-N. All neonates were confirmed to be HIV-uninfected by HIV PCR test. Seven mothers experienced health concerns during pregnancy, including pregnancy related anaemia (n = 3), preterm labour without delivery (n = 2), vaginal warts (n = 2), vaginal ulcers (n = 1), asthma (n = 1), and epilepsy (n = 1).

Conclusions: The results of the study indicate that HEU neonates are at risk for feeding difficulties. The feeding difficulties observed in this study have potentially adverse health and developmental consequences in an already vulnerable population. Health care professionals should regard this population as at-risk and provide appropriate screening and follow up measures to prevent undernutrition and poor health outcomes.

(Word count: 333)

Keywords: HIV/AIDS, feeding, neonates, HIV-exposed uninfected

Background

Difficulties with feeding may lead to malnutrition as well as poor health and developmental outcomes (Black et al., 2013; Walker et al., 2007). Feeding difficulties involve a wide range of problems and may include sucking, swallowing or breathing deficits, or difficulties with the coordination between these components. Food refusal and gastro-oesophageal reflux are also types of feeding difficulties (Andrew & Sullivan, 2010; Arvedson, 2008; Van der Meer, Holden, & Van der Weel, 2005). The term 'dysphagia' refers to problems with any of the phases of swallowing which include the oral phase, pharyngeal phase, and oesophageal phase (Arvedson, 2008).

Virus exposure in-utero is potentially adverse on newborn health and development (Adams Waldorf & McAdams, 2013). The Human Immunodeficiency Virus (HIV) is no exception. Infants who are exposed to HIV (but are uninfected) during gestation have poorer development, immune irregularities and higher morbidity and mortality rates when compared to HIV-unexposed children (Brahmbhatt et al., 2006; Koyanagi et al., 2011; Van Rie, Mupuala, & Dow, 2008). Since feeding is essential for adequate nutrition and growth, the feeding abilities of HIV-exposed neonates warrant investigation (Black et al., 2013; Walker et al., 2007).

In low- and middle-income countries, the prevention of mother-to-child transmission (PMTCT) initiative has been a cornerstone of the HIV strategy and has significantly decreased vertical transmission rates (from 26% in 2009 to 17% in 2013) (World Health Organisation, 2014). A less publicised effect of PMTCT is the increasing number of children being born HIV-exposed and uninfected (HEU) (Filteau, 2009). It is estimated that 30% of all children in parts of Southern Africa are born HIV-exposed (Shapiro & Lockman, 2010). A child is considered to be HIV-exposed when they are born to an HIV-infected mother, or are breastfed by an HIV-infected mother (World Health Organisation, 2006). The HIV status of an infant is determined by an HIV polymerase chain reaction (PCR) test which is typically done between birth and 6 weeks of age. Until a neonate has had an HIV PCR test done and result confirmed, the infant is considered to be HIV-exposed (Republic of South Africa: Department of Health, 2015). A neonate is antiretroviral (ARV)-exposed when he or she is born to an HIV-positive mother who was given antiretroviral therapy (ART) during pregnancy to prevent mother-to-child transmission of HIV (Noguera et al., 2004).

In recent years, research has shown that HEU children have poorer health and developmental outcomes than HIV-unexposed children (Brahmbhatt et al., 2006; Kourtis et al., 2013; Koyanagi et al., 2011; Van Rie et al., 2008). Despite these research findings, global (UNICEF, World Health Organisation, Group World Bank, & United Nations, 2015; World Health Organisation, 2014) and local (Republic of South Africa: Department of Health, 2015) policies and guidelines on managing populations affected by HIV do not regard HEU neonates as a vulnerable population.

Development of HEU Children

Research on HIV exposure and development mostly investigate HIV-exposed infected (HEI) children rather than HEU children (Baillieu & Potterton, 2008; Boivin et al., 1995; Chase et al., 2000; Jeremy et al., 2005; Knight, Mellins, Levenson, Arpadi, & Kairam, 2000). HEI children have been found to have delays in cognitive development (Baillieu & Potterton, 2008), language development (Baillieu & Potterton, 2008), and motor development (Abubakar, Van Baar, Van De Vijver, Holding, & Newton, 2008; Baillieu & Potterton, 2008; Drotar et al., 1997). A Ugandan study found muscle tone, coordination and reflexes to be particularly delayed in HEI children (Drotar et al., 1997).

Very few studies investigate HEU children's development in comparison to a matched control group of HIV-unexposed children (Chase et al., 2000; Kandawasvika et al., 2011; Knight et al., 2000). A matched control group is critical in developmental studies as standardised assessments from first world countries will not be suitable to settings with resource constraints (Le Doare, Bland, & Newell, 2012). Studies that included a matched control group, found HEU children to have delays in cognitive skills (Boivin et al., 1995), motor skills (Drotar et al., 1997; Kerr et al., 2014; Van Rie et al., 2008), expressive language skills (Van Rie et al., 2008), verbal IQ and memory (Kerr et al., 2014).

Immune Development, Morbidity and Mortality

In addition to developmental concerns, HEU infants have differences in immune development, which is particularly relevant early in life (<28 days of age) when there is a period of increased susceptibility to infections (Reikie et al., 2014). A review done in 2013 suggests that the immune irregularities seen in these children, specifically increased cell apoptosis, indicate the presence of an inflamed intrauterine environment (Afran et al., 2014). In-utero inflammation is known

to have negative effects on foetal development and birth outcomes, such as neurological injury and lung damage (Adams Waldorf & McAdams, 2013; Elovitz et al., 2011).

HEU children also have higher morbidity and mortality rates. Studies found HEU infants to have more frequent severe infections (such as diarrhoea and pneumonia) requiring hospital admission than HIV-unexposed infants (Koyanagi et al., 2011; Slogrove et al., 2012; Slogrove, Cotton, & Esser, 2009). A study conducted in rural Uganda estimated the two year mortality rate of HEU infants to be 165.5 per 1000 children in comparison to HIV-unexposed infants (128 per 1000 children) (Brahmbhatt et al., 2006). Another study done in Uganda investigated the mortality of 351 HEU infants. Thirteen (3.7%) of the HEU infants died before 28 days of age, most of whom had died soon after birth (Ades et al., 2013). The causes of death included neonatal sepsis, congenital abnormalities, birth asphyxia, prematurity, convulsions and birth trauma. The mortality rate was higher for those neonates born to mothers with a CD4 count less than 800 cells/mm^3(µl). Low maternal CD4 count has also been correlated with an increase in severe infections in HEU children (Koyanagi et al., 2011).

Effects of ARV Exposure

In South Africa, HIV-positive pregnant women qualify for lifelong ART regardless of their CD4 count (Republic of South Africa: Department of Health, 2015). They are given a type of ART called fixed dose combination (FDC) which consists of 300 mg tenofovir disoproxil fumarate (tenofovir) (TDF), 200 mg emtricitabine (FTC) and 600 mg efavirenz (EFV) (Davies, 2013).

The ability of ARVs to cross the placenta is reviewed in Else et al., 2011. TDF is able to cross the placenta but there is insufficient data on FTC's ability to cross the placenta. In animal studies, EFV has been demonstrated to cross the placenta (Else et al., 2011). There is inconclusive evidence regarding EFV causing birth defects. Some case reports have found EFV-exposure in-utero to result in birth defects (Chersich et al., 2006) (such as brain or spine malformations) (Padmanabhan, 2006). Malformations of the brain could result in developmental delays and feeding difficulties (Rogers & Arvedson, 2005). Other studies however have found no significant increase in birth defects in children exposed to EFV in-utero (Bera et al., 2010; Bussmann et al., 2007).

ARV exposure in HEU infants has been found to cause mitochondrial toxicity (Afran et al., 2014), dysfunctional fatty acid metabolism (Kirmse et al., 2013), and altered growth and functioning

of the heart (Lipshultz et al., 2013). Dysfunctional fatty acid metabolism may result in skeletal muscle weakness (Hoffmann, Zschocke, & Nyhan, 2009) which could affect feeding abilities (Wolthuis-Stigter et al., 2015).

Feeding Difficulties and HIV

Feeding is an important consideration when investigating the growth and survival of children (Black et al., 2013; Walker et al., 2007). While children of all ages should be considered, neonates are of special interest as they have a higher risk of death (World Health Organisation, 2015). Up to two thirds of all neonatal deaths worldwide occur in the first week of life, making neonates (children less than 28 days of age) a particularly vulnerable population (UNICEF et al., 2015). Difficulties relating to feeding, are frequently seen in 'at risk' neonates with neurological impairments (such as cerebral palsy) (Arvedson, 2013; Rogers & Arvedson, 2005).

Although much research has been done on HIV-exposed neonates and feeding methods (Coovadia & Coutsoudis, 2007; Kuhn & Kroon, 2015; World Health Organisation & UNICEF, 2016), to the authors' knowledge (after a review of the literature), no published studies have investigated the feeding abilities of HEU children or neonates. However, a few studies have been conducted on HEI children's feeding abilities. Most of these studies however describe the causes rather than the nature of the feeding problems. These causes include: (a) candidiasis in the oral cavity, pharynx and/or oesophagus, resulting in odynophagia (Cooke, Goddard, & Brown, 2009; Loveland, Mitchell, van Wyk, & Beale, 2010), (b) oesophageal strictures (Cooke et al., 2009; Loveland et al., 2010; Sidler, Salzmann, Juzi, & Moore, 2006), (c) oesophageal ulceration (Cooke et al., 2009), and (d) gastro-oesophageal reflux (GOR) (Henderson et al., 1994).

A study conducted in South Africa investigated the feeding and swallowing of 25 HEI children (age range: 2.8 months to 7.6 years; median: 8 months) by means of a clinical feeding assessment and videoflouroscopy (Nel & Ellis, 2012). Twenty (80% of total sample) children presented with dysphagia: 11 showed oral phase dysphagia, four had dysphagia in the pharyngeal phase, and five demonstrated dysphagia in the oral and pharyngeal phases. In contrast, a retrospective review of 55 HEI children (age range: 3 months to 5.11 years) conducted in America, found that eleven of the children (20%) had mild to moderate dysphagia (Pressman & Morrison, 1988). The

children presented with prolonged feeding times and their nutritional intake was inadequate. Children also had difficulty in progressing to age appropriate consistencies. Fourteen (25%) children had severe feeding and swallowing difficulties in that they were unable to survive on oral feeds alone. The number of HEI children found to have dysphagia in these two studies differ greatly (45% versus 80%). This discrepancy may be as a result of the higher burden of disease and the resource constraints found in South Africa. The South African study only included children who were specifically referred to a swallowing clinic, therefore referral bias could have played a role in the differences in the number of HEI children with feeding difficulties in these two studies.

HEU children (including neonates) have a greater chance for developmental delays and poor health than HIV-unexposed children (Kourtis et al., 2013; Koyanagi et al., 2011; Reikie et al., 2014; Van Rie et al., 2008). Since feeding is crucial to survival and growth, the feeding abilities of HEU neonates should be investigated. The researchers therefore sought to answer the following question: What are the feeding abilities of HIV-exposed neonates who access health care services at a public sector hospital in KwaZulu-Natal? The objectives of this study were to:

1. Profile the feeding abilities of HIV-exposed uninfected (HEU) neonates in terms of their sucking, swallowing and breathing by using by using a developed neonatal feeding screening tool, the Screening for Swallowing And Feeding in Neonates (SSAF-N).
2. Describe the HEU neonates' mothers' health during pregnancy by gathering medical and biographical information as recorded in their hospital files.

Methods

The study was carried out at a tertiary care hospital in KwaZulu-Natal, South Africa. The hospital provides regional and tertiary services to KwaZulu-Natal (KZN) and the Eastern Cape (KwaZulu-Natal Department of Health, 2001). KZN Province has the highest prevalence of HIV in the country, where 39.5% of pregnant women were HIV-positive, in 2010 (Republic of South Africa, 2012). The hospital has a speech therapy department which provides services to in-patients and out-patients who fall in the catchment area.

Participant Recruitment and Selection

The following participant inclusion criteria were applied: (a) neonates born to mothers who are HIV-positive and (b) neonates born by normal vaginal delivery. Ten neonate and mother feeding pairs were included in the study using purposive and convenience sampling. Participants were identified and recruited by consulting with the HIV/AIDS counsellors at the hospital and by reviewing the labour ward birth registry and the maternity wards' admission books. Neonates who were (a) born by caesarean section, (b) non-oral feeders, (c) in the neonatal intensive care unit, (d) born prematurely (less than 37 weeks gestation), and (e) who had a low birth weight (less than 2500g) were excluded from the sample. All mothers gave informed consent for their neonates to participate in the study. During recruitment and data collection, an interpreter assisted the researcher in communicating with participants who did not speak English.

Participant Description

All of the mother and neonate pairs were Black African. Eight of the mothers were isiZulu first language speakers (chiShona, n = 1; isiXhosa, n = 1). The median age of the mothers was 26 years (range 19 – 42 years).

Of the 10 neonates, 70% (n = 7) were male. Six (60%) neonates were breast fed and four (40%) were cup fed with infant formula. The neonates' mean gestational age was 38.2 weeks (range 37 – 41). At the time of feeding screening, 90% were less than 48 hours old and 50% were less than 24 hours old (range: 10 – 51 hours, mean: 27 hours). Birth weight ranged from 2.61 to 3.57 kg (mean: 3.05, SD 0.35). In four neonates' hospital files, the attending doctor had recorded perinatal health concerns. These health concerns included respiratory distress (n = 2), poor sucking at birth (n = 1), prolonged rupture of membranes (n = 1), conjunctivitis (n = 1), and born before admission (n = 1). All 10 neonates were confirmed to be HIV-uninfected.

Data Collection

Data were collected from two sources: (a) a screening of neonates' feeding abilities using the SSAF-N (see Appendix 1) and (b) a retrospective review of the mothers' and neonates' hospital files. the SSAF-N was developed for the study by reviewing relevant literature (Arvedson, 2008; Cichero, 2006; Delaney & Arvedson, 2008). An expert reference group was consulted to refine the tool. The

SSAF-N assessed neonates' sucking, swallowing and the coordination between their respiration and swallowing. The following sections were included in the SSAF-N:

A. Feeding duration and intake: Included feeding time and oral intake
B. State and motor control: Included state of arousal and general motor control
C. Suck: Included feeding position, posture, oral tone, latching (lip seal, strength of suck), and coordination (suck-swallow-breathe for breastfed neonates and swallow-breathe for cup fed neonates
D. Breathing and swallowing: Included respiration at rest, baseline SpO_2 at rest (1 min), respiration during feeding, during feeding, swallowing, respiration after swallowing, SpO_2 1 min after feeding, and percentage difference in SpO_2

These feeding behaviours were assessed by means of:

- Direct observations during a feeding time which is a well-established clinical procedure during a feeding screening (Arvedson, 2008).
- Cervical auscultation (using a 3M™ Littmann® Classic II Pediatric Stethoscope, 3M™) to assist in determining each neonate's suck-swallow-breathe (SSB) pattern, to look for indicators of compromised swallowing safety, and to appraise each neonate's breathing before, during and after feeding. Cervical auscultation is an assessment of swallowing sounds and the related respiration sounds by using a stethoscope and is considered to be a useful adjunct to a feeding screening of neonates (Cichero, 2006).
- Pulse oximetry (using a Mindray patient monitor model iMEC12, Mindray Medical International Limited) to determine each neonate's oxygen saturation levels before, during and after feeding. Pulse oximetry is an appropriate and non-invasive measurement of neonates' prandial oxygen saturation levels (Cichero, 2006). Normal oxygen saturation levels for neonates should be between 95% and 100% (Cichero, 2006). A drop in oxygen saturation of 3% or more that is sustained for one minute indicates the presence of aspiration (Cichero, 2006).

Information regarding oral intake and feeding time was obtained by asking the mothers. A feeding time between 15-30 minutes was seen as appropriate (Arvedson, 2008). Oral intake was only applied to neonates who were cup fed as this cannot be determined for neonates who are breastfed. A feeding screening aims to determine whether a neonate is feeding safely and efficiently to ensure adequate nutrition and growth (Arvedson, 2008). The following condition was developed based on this aim:

- If a neonate displayed feeding difficulties in two or more components (A, B, C or D) of the SSAF-N, then that neonate may be at risk for not meeting nutrition and hydration requirements or may be at risk for feeding being deemed unsafe.

When a neonate met this condition, they failed the SSAF-N. Feeding skills demonstrated in each component in the SSAF-N were judged as appropriate or inappropriate based on predetermined criteria (as stated in the SSAF-N).

Measures were employed to increase the reliability of the study results:

- All the feeding screenings were conducted by the first author, a speech-language therapist (SLT).
- Nine of the ten SSAF-N forms (without pass/fail outcome) were reviewed blindly by an SLT experienced in feeding difficulties. The percentage agreement regarding pass/fail outcome between the reviewer and the first author was 89% which is considered acceptable (Meline, 2009).
- A medical doctor was consulted during the retrospective hospital file reviews to ensure that the first author recorded and interpreted all the relevant medical information correctly.

Data Analysis

Data from the SSAF-N was entered into Statistical Package for the Social Sciences (IBM SPSS Statistics 23.0, IBM). SPSS was used to perform descriptive statistical calculations on the data.

Ethics Committee Approval

The researchers followed the guidelines of the World Medical Association Declaration of Helsinki (World Medical Association, 2013). Permission to conduct the study was obtained from the

Biomedical Research Ethics Committee of the University of KwaZulu-Natal (ethical clearance number: BE 223/15). Permission was also obtained from the South African Department of Health, the Chief Executive Officer (CEO) of the hospital, and the KwaZulu-Natal Department of Health.

Results

Feeding Abilities of HEU Neonates

During the feeding screening, the HEU neonates demonstrated appropriate feeding abilities in terms of general motor control, feeding position, posture, tone, lip seal and respiration during feeding. The areas which neonates showed difficulties include feeding time, oral intake, state of arousal, strength of suck, swallow-breathe coordination, signs of distress, respiration before and after feeding, and prandial oxygen desaturation.

Four neonates (40%) demonstrated inappropriate feeding abilities and subsequently failed the SSAF-N (Neonates 1, 2, 3 and 7). Two of these neonates were cup fed and two were breastfed. Table 1 provides a description of all the HEU neonates including their observed feeding difficulties (where applicable).

Three neonates presented with problems regarding feeding duration and oral intake. Two of these neonates were reported (by their mothers) to have reduced feeding time and one neonate was reported to demonstrate prolonged feeding time. Neonates 1 and 2 demonstrated SB discoordination resulting in nasal regurgitation in Neonate 1, and signs of distress and regurgitation in Neonate 2. Of the six neonates who passed the SSAF-N, only one neonate (Neonate 10) had birth complications. These birth complications included born before admission, which is viewed as a risk factor for infection (Thaver & Zaidi, 2009), poor sucking at birth and conjunctivitis. This neonate was assessed at the age of 51 hours and his feeding was deemed adequate at the time of screening.

Table 1

Description of HEU neonates in relation to feeding difficulties

Participant No.	**Gender**	**GA (weeks)[1]**	**BW**	**CA (hours)**	**Birth complications / concerns**	**Feeding method[2]**	**Feeding difficulties observed during screening**
1	Female	39: Full term	2.72	20	Prolonged ROM, poor sucking at birth	Cup	Swallow-breathe (SB) discoordination and nasal regurgitation
2	Female	41: Late term	3.17	10	None	Cup	Lethargic and difficult to rouse for feeding, reduced feeding time and intake, SB discoordination, signs of distress and regurgitation
3	Male	38: Early term	2.73	38	BBA, mild respiratory distress	Breast	Prolonged feeding time (>30mins), poor sucking strength and inspiratory stridor
4	Male	37: Early term	2.61	40	None	Breast	None
5	Male	38: Early term	2.67	26	None	Breast	None
6	Male	38: Early term	3.43	23	None	Breast	None
7	Female	38: Early term	3.57	17	Signs of respiratory distress	Breast	Reduced feeding time (5 mins) and oxygen desaturation during feed
8	Male	37: Early term	3.19	18	None	Breast	None
9	Male	37: Early term	3.45	28	None	Cup	None
10	Male	39: Full term	3.00	51	BBA, poor sucking at birth, conjunctivitis	Cup	None

Note. CA: chronological age; BW: birth weight; GA: gestational age; prolonged ROM: prolonged rupture of membranes is breaking of foetal membranes for more than 18 hours before labour starts (Al-Qa'Qa' & Al-Awaysheh, 2005); BBA: born before admission (non-hospital delivery); 1 = early term: 37 – 38 weeks + 6 days; full term: 39 – 40 weeks + 6 days; late term: 41 – 41 weeks + 6 days; post term: 42 weeks and beyond (Spong, 2013); 2 = cup fed neonates were fed with infant formula.

HIV-Positive Mothers' Health during Pregnancy

Seven of the mothers demonstrated health concerns which were treated and managed during pregnancy. Table 2 provides an outline of the health of the mothers in relation to the neonates' screening result. The most common health concerns being anaemia (n = 3), preterm labour without delivery (n = 2), and genital warts (n = 2). The available CD4 counts of the mothers (n = 9) ranged from 205 to 820 cells/mm^3(µl) (median: 500 cells/mm^3(µl)). The mean CD4 count of mothers whose

neonates failed the SSAF-N was 398 cells/mm^3(µl), and the mean CD4 count of mothers whose neonates passed the SSAF-N was 570 cells/mm^3(µl).

All mothers were on FDC type of ART. Fifty percent of mothers started using ARVs during or after their sixth month of pregnancy. The neonates born of these mothers were therefore exposed to ARVs from their 24th week gestation until birth.

Table 2

Maternal health in relation to neonatal screening result

Participant no.[1]	Age	CD4 count	ART initiation[2]	Health concerns during pregnancy	Neonatal screening result
1	22	372	7th month pregnancy	None	Fail
2	24	299	7th month pregnancy	Anaemia, vaginal warts	Fail
3	30	368	1st month pregnancy	Preterm labour at 36 weeks (birth at 38 weeks)	Fail
4	28	500	>12 months prior pregnancy	None	Pass
5	19	608	4th month pregnancy	Preterm labour 34 weeks (birth at 38 weeks)	Pass
6	26	205	6th month pregnancy	Anaemia (blood transfusion at 36 weeks gestation), vaginal ulcers	Pass
7	32	553	6th month pregnancy	None	Fail
8	42	-	5 months prior pregnancy	Asthmatic (controlled with medication)	Pass
9	26	820	>12 months prior pregnancy	Slight anaemia	Pass
10	25	719	8th month pregnancy	Epilepsy, vaginal warts	Pass

Note. 1 = The participant numbers correlate to the neonates' participant numbers. The mothers of the neonates who failed the SSAF-N are shaded in grey. 2 = Time of ART initiation in relation to pregnancy.

Discussion

The aim of this study was to describe the feeding abilities of HEU neonates. Forty percent (n = 4) of the sample of HEU neonates demonstrated feeding difficulties. This could be compared to literature that reports feeding difficulties in 30-40% of children with neurodevelopmental impairments (Andrew & Sullivan, 2010). A South African study found that 29% of children with neurodevelopmental difficulties have feeding and/or swallowing deficits (Barratt & Ogle, 2010). The feeding difficulties observed in this study may be as a result of neonates experiencing neurological damage in-utero due to HIV exposure. Viral infections in the uterus can cause the body to produce an

inflammatory response (Adams Waldorf & McAdams, 2013; Romero, Gotsch, Pineles, & Kusanovic, 2007). Evidence from immunology studies suggests the presence of a proinflammatory intra-uterine environment in HIV-infected pregnant mothers (Afran et al., 2014). In addition, preterm labour is associated with inflammation in-utero (McAdams & Juul, 2012). Two of the mothers in this study experienced preterm labour without preterm delivery. This finding therefore provides further evidence for the presence of inflammation in-utero in HIV-infected mothers in this study. It is known that inflammation in-utero has adverse effects on foetal brain development (Adams Waldorf & McAdams, 2013). Neurological injury could be mediated by proinflammatory cytokines that are released as part of the body's inflammatory response (Adams Waldorf & McAdams, 2013; Afran et al., 2014; Spinillo, Iacobone, Calvino, Alberi, & Gardella, 2014). The feeding difficulties such as SB discoordination and weak sucking, which were found in this study, may result from prenatal or perinatal damage to the central nervous system (Da Costa, Van den Engel-Hoek, & Bos, 2008; Van der Meer et al., 2005).

In addition to neurological effects, exposure to a proinflammatory intrauterine environment could also result in altered respiratory and cardiac functioning in neonates (Galinsky, Polglase, Hooper, Black, & Moss, 2013; McAdams & Juul, 2012; Yanowitz et al., 2002). HEU neonates have been found to have abnormalities in their cardiac structure and function regardless of their HIV-infection status (Hornberger et al., 2000; Lipshultz et al., 2013). It is known that healthy lung function is a key component of feeding coordination and cardiovascular sufficiency is important for the timeous completion of feeds (Arvedson, 2008). Therefore it can be inferred that the neonates who demonstrated prolonged feeding times and SB discoordination in this study may have altered cardiac and respiratory functioning as a result of HIV exposure in-utero.

Some studies have suggested that exposure to ARVs (such as lamivudine and emtricitabine) can result in mitochondrial toxicity (Afran et al., 2014). Adequate mitochondrial functioning is necessary for muscle strength and endurance (Hoppeler & Fluck, 2003). Decreased muscle endurance could affect a neonate's ability to suck adequately for a sustained period thereby resulting in the reduced feeding times which was found in this study. However the neonates who passed the SSAF-N had, on average, longer exposure to ARVs than the neonates who did not pass the SSAF-N. The

mothers of the neonates who passed the SSAF-N also had a higher mean CD4 count than those mothers whose neonates failed the SSAF-N. This suggests that in this study, ARVs improved the mothers' health (as measured by CD4 count) and therefore in turn the neonates' feeding outcomes. This can be compared to the findings of Koyanagi et al., (2011) who found lower maternal CD4 count to have a negative influence on HEU infants' health.

Poorer neonatal outcomes (such as low Apgar scores, low birth weight and prolonged hospital stay after birth) are associated with advanced maternal age (older than 35 years) (Cleary-Goldman et al., 2005; Laopaiboon et al., 2014; Ludford, Scheil, Tucker, & Grivell, 2012). The mothers in this study whose neonates failed the SSAF-N were between 22 and 32 years old. The oldest mother was 42 years old and her neonate passed the SSAF-N. This indicates that maternal age did not influence feeding outcome in this study.

The results of this study indicate that HEU neonates are at risk for feeding difficulties as a significant percentage of neonates presented with feeding difficulties. Arguably however, some of the feeding difficulties observed in this study may be viewed as normal feeding behaviours (e.g. discoordination) for full term neonates (Delaney & Arvedson, 2008).

Strengths and Limitations

According to the authors' knowledge, no other published studies have investigated the feeding abilities of HEU neonates. This study therefore addressed a gap in the knowledge of HEU neonates.

Many confounding variables, such as low birth weight, which are recognised to have an influence on feeding ability (Dodrill, 2011; Rommel, De Meyer, Feenstra, & Veereman-Wauters, 2003) were excluded from the analysis. By controlling for these variables, the results are more valid. The SSAF-N, although not validated, is a useful framework for professionals working in public health care settings to identify neonates with feeding difficulties.

Limitations of this study include the subjective nature of data collection methods, and the reliability of recorded data from hospital files. It is known that healthy neonates may demonstrate feeding discoordination (Delaney & Arvedson, 2008) which may account for the SB discoordination observed in two of the neonates. However, as is typical in feeding screenings, the neonates were

observed for a short period of time. It was therefore not possible to determine whether the neonates' SB discoordination were transient or persisted.

Cervical auscultation and feeding observations are also subjective measurements and the reliability of these observations depends on the individual's clinical experience (Cichero, 2006). This could have affected the reliability of the results.

The reliability of mothers' reports on oral intake (as being appropriate or not) may depend on the mothers' previous feeding experience. It was not known whether the mothers in this study had other children and therefore it is not possible to determine the reliability of their reports.

As is typical with retrospective reviews of medical information, the quality of the data cannot be controlled and missing data is common. One mother's CD4 count was not available in her hospital file and could not be included in the analysis.

Recommendations for Future Research

Studies involving large longitudinal cohort studies of HEU neonates along with control groups would be valuable to provide richer descriptions of feeding difficulties. This type of study would also provide insight whether the feeding difficulties resolve with maturation or if they persist post neonatal age. Studies that use a comprehensive assessment instead of a screening assessment would provide more detail regarding the feeding abilities of HEU neonates. More detailed monitoring of ARV use and consequent CD4 count during pregnancy will enable for more definite findings regarding the effects of maternal health on feeding outcome.

Immunological studies investigating the processes and mechanisms of HIV and ARV exposure in-utero would provide a more comprehensive understanding of HIV and ARV exposure and their effects on neonates and children later in life.

Conclusion

The HEU newborn should not be equated with an HIV-unexposed neonate. HIV exposure may have adverse effects on neonates' cardiac, respiratory and muscular functioning. These systems are vital for successful feeding in neonates (Arvedson, 2008). The findings in this study suggest that HEU neonates are at risk for feeding difficulties.

The results have important clinical implications. Clinical guidelines on managing HIV-exposed children need to highlight HEU neonates as a vulnerable population to facilitate early identification. In contexts with resource and staff limitations, a quick and easy to administer screening tool is valuable for identification of neonates with feeding difficulties so that early intervention and monitoring takes place.

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Appendix 1: Screening for Swallowing And Feeding in Neonates (SSAF-N)

Screener conducted by: _____ Date: _____ Time: _____

Observed method of feeding (circle): Breast Cup

SCREENING ITEMS[4]		PASS CRITERIA	FAIL CRITERIA
A. FEEDING DURATION & INTAKE	A.1 Feeding time Reported: _____ minutes	□ Appropriate	□ Inappropriate
	A.2 Oral intake per feed (cup fed only) Reported: _____ml	□ Appropriate	□ Inappropriate
B. STATE & MOTOR CONTROL	B.1 State of arousal (during feeding)	□ Appropriate: Alert	□ Inappropriate: Lethargic, difficult to rouse
	B.2 General motor control (during feeding)	□ Appropriate: Adequate trunk and head control	□ Inappropriate: Poor trunk and head control
C. SUCK	C.1 Feeding position	□ Appropriate	□ Inappropriate
	C.2 Posture	□ Appropriate: Normal physiologic flexion	□ Inappropriate: Abnormal extension
	C.3 Oral tone	□ Appropriate: ○ Normal tone	□ Inappropriate: ○ Hypertonic / Hypotonic / Mixed
	C.4 Latching: (breastfed only) C.4.1 Lip seal C.4.2 Strength of suck	□ Appropriate: Adequate seal □ Appropriate: Adequate strength	□ Inappropriate: Poor seal □ Inappropriate: Weak strength
	C.5 Coordination Breastfed: SSB Cup fed: swallow-breathe	□ Appropriate: 3+ sucks : 1 swallow : 1 breath; coordinated	□ Inappropriate: < 3 sucks : 1 swallow : 1 breath OR/AND discoordinated
D. BREATHING & SWALLOWING	D.1 Respiration at rest	□ Appropriate: Regular, calm, controlled	□ Inappropriate: ○ Dyspnoea* ○ Fast (>60 breaths/min)* ○ Stridor/wet respiration
	D.2 Baseline SpO_2 at rest (for 1 min)	_____ %	
	D.3 Respiration during feeding	□ Appropriate: No apparent difficulty	□ Inappropriate: ○ Apnoea* ○ Dyspnoea*
	D.4 SpO_2 during feeding	_____ %	
	D.5 Swallowing	□ Appropriate: No apparent difficulty	□ Inappropriate: ○ Audible evidence of penetration (stridor, wet inspiration/expiration) ○ Delayed swallow ○ Other: _____
	D.6 Respiration after swallow	□ Appropriate: Normal tidal respirations (40-60 breaths/min)[5]	□ Inappropriate: ○ Bubbling ○ Coughing* ○ Increased respiration rate* ○ Crackles ○ Gurgling ○ Stridor
	D.7 SpO_2 1 min after feeding	_____ %	

[4] Screening methods used: clinical observation, cervical auscultation and pulse oximetry
[5] Hooker, et al., 1989; Hooker et al., 1992, cited in Cichero & Murdoch, 2006

	D.8 Percentage difference in SpO_2	□ **0-2% (aspiration not suspected)**	□ **3% or more (possible aspiration present)***
SCREENING RESULT (circle):		**PASS**	**FAIL**

Adapted from: Arvedson and Brodsky (2002); Cichero (2006); Wolf and Glass (1992).
*Signs of distress and/or unsteady state

CHAPTER 5: DISCUSSION, CRITIQUE AND CONCLUSION

5.1 Overview

In this chapter, the results for objectives 2 and 3 are discussed. Literature is used to develop and support the ideas that are proposed. A critical analysis of the study in terms of strengths and limitations is also provided. Finally, this chapter concludes with future research recommendations.

5.2 Discussion of Results

5.2.1 Objective 2: Profile of HEU neonates' feeding abilities

The HEU neonates in this study demonstrated adequate feeding abilities in terms of feeding position, posture, tone, lip seal (for those breastfeeding), general motor control and respiration during feeding. The areas in which 40% of the neonates showed difficulty relate to feeding endurance, state of arousal for feeding, coordination, and feeding inefficiency (i.e., weak sucking and prolonged feeding time).

5.2.1.1 Neonatal factors affecting feeding. It is known that in the first two to three days after birth, term infants may show feeding discoordination (Da Costa et al., 2010; Wolf & Glass, 1992), which could account for the SB discoordination that was observed in this study. Therefore the discoordinated feeding demonstrated by the two neonates could be argued as appropriate given the chronological age of the neonates (both under 24 hours old). Since the study did not rescreen the neonates' feeding, it was not possible to confirm or refute this possibility.

Gestational age is known to be a factor that influences feeding abilities (Dodrill, 2011; Hourani et al., 2011; Parikh et al., 2014). In accordance with the revised categories of term pregnancy (The American College of Obstetricians and Gynecologists, 2013), two of the neonates who failed the SSAF-N were early term, one was full term and one was late term. These results suggest that being born early term may negatively impact feeding outcomes. In addition the two neonates who were born early term showed signs of respiratory distress which is associated with early term birth (Parikh et al., 2014) and feeding difficulties (Arvedson, 2008).

Low birth weight neonates have a greater chance of displaying feeding difficulties than neonates with a birth weight appropriate for gestational age (Rommel et al., 2003). All the neonates in this study had birth weights over 2500g (United Nations Children's Fund & World Health Organisation, 2004) suggesting that birth weight did not contribute to the feeding difficulties observed in this study.

Complications at birth may influence neonatal feeding abilities. Two neonates in this study were born before admission (non-hospital deliveries) and one neonate experienced prolonged rupture of membranes before birth. Both of these birth concerns are risk factors for neonatal infection (Boskabadi et al., 2011; Thaver & Zaidi, 2009). Ill health from an infection may affect feeding abilities such as endurance and efficiency (Wolf & Glass, 1992). Two neonates who failed the SSAF-N showed signs of respiratory distress, one of which (neonate 3) was a non-hospital delivery.

Difficulties with respiration could affect feeding as a well-functioning respiratory system is vital for SB coordination (Van der Meer et al., 2005).

5.2.1.2 Neurological injury. Forty percent of the HEU neonates in this study displayed feeding difficulties which is comparable to a study that reported feeding difficulties in 30-40% of children who have neurodevelopmental impairments (Andrew & Sullivan, 2010). Similarly, a South African study found 29% of children with neurodevelopmental conditions to also have feeding and/or swallowing difficulties (Barratt & Ogle, 2010). A study done in the United Kingdom (UK) found a much higher incidence (90%) of children with neurological impairment to have feeding difficulties (Reilly, Skuse, & Poblete, 1996). This UK study was on children with cerebral palsy. In children with neurological conditions such as cerebral palsy, the extent of motor impairment determines the severity of the feeding problems which explains the report of higher incidence (Calis et al., 2008; Penagini et al., 2015).

The feeding difficulties of the HEU neonates who failed the SSAF-N may be explained by in-utero neurological damage mediated by HIV exposure. It is known that in HIV-positive mothers, proinflammatory cytokines arising from inflammation in-utero may cause neurological injury to the developing foetus (Adams Waldorf & McAdams, 2013; Afran et al., 2014; Spinillo et al., 2014). Weak sucking and SB discoordination, as observed in this study, are frequently seen in neonates who are neurologically immature or who have neurological deficits (Delaney & Arvedson, 2008; Dodrill, 2011). In addition, preterm labour, with or without preterm birth, is associated with a proinflammatory in-utero environment (McAdams & Juul, 2012). Two of the mothers in this study experienced preterm labour without preterm birth, of which one mother's neonate demonstrated feeding difficulties and failed the SSAF-N.

One neonate (Neonate 3) presented with inspiratory stridor as well as prolonged feeding time and weak sucking. Depending on the underlying cause, stridor may be accompanied by respiratory distress and feeding difficulties (Posod et al., 2016). The most frequent cause of stridor is laryngomalacia (Daniel & Cheng, 2011) which is as a result of neuromuscular hypotonia in the larynx (Thompson, 2007). A neurologic theory proposes that laryngomalacia may be as a result of an underdeveloped or abnormally integrated central and peripheral nervous system (Landry & Thompson, 2012; Thompson, 2007). It is therefore possible that the stridor observed in Neonate 3 is as a result of neurological injury mediated by HIV exposure in-utero. In non-severe cases, laryngomalacia (and the resultant stridor) generally resolves as the CNS matures (Landry & Thompson, 2012).

5.2.1.3 Altered cardiorespiratory functioning. Poor endurance to complete a feed or lacking endurance to finish a feed timeously could be a consequence of cardiorespiratory insufficiency (Arvedson & Brodsky, 2002; Wolf & Glass, 1992). Exposure to inflammation in-utero could result in altered respiratory and cardiac functioning in neonates (Galinsky, Polglase, Hooper, Black, & Moss, 2013; McAdams & Juul, 2012; Yanowitz et al., 2002). HIV-exposed neonates and ARV-exposed

neonates have been found to have abnormalities in their cardiac structure and function regardless of their HIV-infection status (Hornberger et al., 2000; Lipshultz et al., 2013). Two of the HEU neonates in this study presented with respiratory distress at birth which indicates that their respiratory systems were compromised in some way. It is known that healthy lung function is a key component of SB coordination and cardiovascular sufficiency is important for the timeous completion of feeds (Arvedson & Brodsky, 2002). Therefore it is possible that the neonates who demonstrated prolonged or reduced feeding times and SB discoordination in this study have altered cardiac and respiratory functioning as a result of ARV- and/or HIV exposure in-utero.

5.2.2 Objective 3: HIV-positive mothers' health during pregnancy

5.2.2.1 Maternal factors affecting neonatal feeding. Poor neonatal outcomes such as low Apgar scores (<7 at 5 minutes) and low birth weight (Cleary-Goldman et al., 2005; Laopaiboon et al., 2014; Ludford et al., 2012) have been linked with advanced maternal age (older than 35 years). The mothers whose neonates failed the SSAF-N ranged in age between 22 and 32 years. The oldest mother in this study was 42 years old and her neonate did not present with any feeding difficulties. Therefore in this study, maternal age does not appear to be a contributing factor to the observed feeding difficulties.

A person with a CD4 count of 500 cells/mm^3(µl) or less is expected to have compromised health (Lloyd, 1996). In this study, four mothers had a CD4 count of less than 500 cells/mm^3(µl). Of these, three mothers' neonates failed the SSAF-N. The CD4 counts of the mothers whose neonates passed the SSAF-N were overall higher than the mothers whose neonates failed the SSAF-N. These findings suggest that the maternal CD4 counts in this study affected the neonates' outcomes, specifically their feeding abilities. This correlates with a study done by Koyanagi et al., (2011) who found an inverse association between maternal CD4 count and HEU infant morbidity (measured by sick clinic visits and hospitalisations).

A study, investigating pregnancy and neonatal outcomes in HIV-positive pregnant women, compared women receiving ART to those not receiving ART (Tuomala et al., 2002). The results showed that ARV use is associated with better neonatal outcomes (e.g. higher Apgar scores). In the current study, three mothers whose neonates failed the SSAF-N only started ART during or after their sixth month of pregnancy. It is possible that in this study, the mothers' prolonged ART use during pregnancy improved neonatal outcomes.

Maternal health may affect neonates' feeding abilities at birth. Anaemia is very common during pregnancy, especially in HIV-positive mothers (Republic of South Africa: Department of Health, 2015b). Three mothers in this study had non-severe anaemia during pregnancy. Unless severe, anaemia does not hold increased risk for pregnancy outcomes (Republic of South Africa: Department of Health, 2015b).

As discussed above, preterm labour without preterm birth may result in fetal neurological injury (Adams Waldorf & McAdams, 2013; McAdams & Juul, 2012). This maternal health concern

may have contributed to the feeding difficulties observed in the one neonate who failed the SSAF-N and whose mother experienced preterm labour.

Epilepsy and epileptic medication (sodium valproate) have been shown to result in adverse neonatal outcomes such as small for gestational age, lower Apgar scores at 1 minute, greater need for neonatal care at birth and congenital malformations (Mawer et al., 2010; Viinikainen, Heinonen, Eriksson, & Kälviäinen, 2006). One mother in this sample had epilepsy. Her neonate was born with poor sucking at birth which could be as a result of epilepsy or the medication for epilepsy. This neonate was assessed at 51 hours after birth and passed the SSAF-N indicating that there were no lasting adverse effects of his mother's epilepsy on his feeding abilities.

5.2.3 Conclusion of discussion

This study investigated the feeding abilities of HEU neonates. A significant number of neonates (40%) demonstrated feeding difficulties as determined by the screening tool – SSAF-N. Most of these difficulties relate to feeding ineffectiveness which may hold adverse consequences for growth and development. In light of the known poorer development, as well as higher morbidity and mortality rates seen in this population (Brahmbhatt et al., 2006; Reikie et al., 2014; Van Rie et al., 2008), feeding abilities are critical and cannot be ignored.

Various factors may influence neonatal feeding abilities. In this study, the factors which appear to have influenced feeding behaviour are maternal health (CD4 count and duration of ART during pregnancy) and gestational age (being born early term). A higher CD4 count appeared to result in better neonatal feeding outcomes. Similarly, being born before 39 weeks gestation appeared to have a negative influence on neonatal feeding. Neonates whose mothers were on ART for a longer period, showed better feeding outcomes which suggests that ART use did not negatively influence the neonates' feeding abilities but rather resulted in improved outcomes.

The HEU neonates who failed the SSAF-N presented with feeding difficulties which may also be observed in neonates who have neurological injury, cardiorespiratory deficits and skeletal muscle weakness. If one used the conceptual framework (presented in Chapter 2) to understand HEU neonates' feeding abilities, it can be seen that HIV exposure could be implicated as one of the mechanisms that caused these deficits and the resultant feeding problems.

HEU neonates are a population at risk for feeding difficulties. Medical staff who lack training in identifying feeding difficulties may miss aberrant feeding patterns (Hawdon, Beauregard, Slattery, & Kennedy, 2000) such as those observed in this study. It is therefore essential that these neonates are regarded as more at risk than neonates not exposed to HIV. In order to facilitate for early identification, HEU neonates should be routinely screened for feeding difficulties by SLTs and other health professionals such as nurses or dieticians who have been trained to identify feeding difficulties.

5.3 Critical Evaluation of the Study

A critical evaluation of the study is essential in order to consider the validity and reliability of the results. By presenting the study's strengths, limitations and providing future research recommendations, other researchers can gain insight for their study design.

5.3.1 Strengths of the study

- The first strength of the current study is that several confounding variables were excluded from the sample. These variables include caesarean section birth, low birth weight, and neonatal illness. It is known, for example, that neonates born via caesarean section (i.e., medicated birth) have been shown to have differences in sucking ability when compared to neonates who are born without maternal pain medication or anaesthesia (Baumgarder et al., 2003; Ransjö-Arvidson et al., 2001). By excluding these variables, the observed feeding difficulties are not attributable to these factors that are known to have adverse effects on neonatal feeding outcomes.
- Several methods of obtaining information regarding neonates' feeding were included in the SSAF-N which increased the validity of the results. These methods include reports from the neonate's mother, direct observation of the feeding, and the objective measure of pulse oximetry.
- The subjective nature of data collection methods is valuable as feeding assessments require clinical reasoning and interpretation in order to reach a reliable conclusion. Even though the neonates were assessed in a single setting and time frame, the researcher still considered each neonate and mother as a unit, taking into consideration the reports from the mother as well as the medical history.
- The research findings are highly relevant for the local South African context where there is the largest epidemic of HIV/AIDS in the world (World Health Organisation, 2014). Therefore the research findings may lead to HEU neonates with feeding difficulties being identified early on which will improve these children's health, chance of survival and quality of life.
- Finally, the research is also relevant on a global level. The findings of this study are aligned with the global focus on neonate and child health as laid out in the SDGs of (a) ending all preventable deaths of neonates, (b) putting an end to all forms of malnutrition, and (c) ending the HIV/AIDS epidemic by 2030 (UNICEF et al., 2015). Therefore the research findings on HEU neonates may assist in decreasing malnutrition, poor health and mortality in this particular population.

5.3.2 Study limitations

- The first limitation of the study is the small sample size which prevents generalisability of the results. The reasons for not obtaining a larger sample are discussed in Chapter 3.
- The nature of a neonatal feeding screening is that each neonate is only observed for a short period. Therefore if the child is not very hungry or if the child is tired, it may not be a true representation of the child's feeding abilities. In addition, neonates who are healthy may present with SB discoordination in the first few days of life (Delaney & Arvedson, 2008). Therefore a

follow up assessment of the neonates who demonstrated SB discoordination would have revealed whether this feeding observation persisted or resolved.

- The components included in the SSAF-N are overall more suited to assess skills relating to breastfeeding than cup feeding. Even though the SSAF-N is adaptable to cup feeding, it overall functions better as a tool to assess breastfeeding.
- The lack of inter-observer reliability is a limitation in the study design. Due to time constraints and high caseloads, it was not possible for the SLT reviewer to observe the same neonates that the researcher observed which would have increased the reliability of the results (Maxwell & Satake, 2006). This was managed by incorporating a post-screening blind review of the completed SSAF-N forms in order to assess the researcher's accuracy of judgement.
- Another limitation is the subjective nature of the SSAF-N. All of the components in the SSAF-N, except for pulse oximetry, are subjective measures. This means that different interpretations of feeding behaviour are possible depending on the individual conducting the assessment. A section of the SSAF-N required mothers to comment on the appropriateness of their neonate's oral intake and/or feeding duration. The reliability of these comments depends on each mother's personal experience with feeding and their understanding of what typical feeding behaviour is. A question relating to whether mothers had other children or not was not included in the medical and biographical schedule. This question was initially included in the medical and biographical schedule but was subsequently removed following feedback from the expert review group.
- The medical records of the mothers were reviewed retrospectively and therefore the accuracy and completeness of the information recorded in the hospital files could not be controlled. The dates when the mothers' CD4 counts were tested were not consistently recorded in the hospital files. Also mothers' CD4 counts may have varied over the course of their pregnancy. Therefore the reliability of this data is questionable. Information regarding the mothers' viral load would have been more indicative of the level of infection and therefore the possibility of inflammation in-utero. This information was however not available in the medical records.

5.3.3 Implications for clinical practice

The results of this research study have implications for clinical practice. One of the outcomes of the research was to develop a neonatal feeding screening tool (SSAF-N). The SSAF-N could be validated in a future research project and used locally in public health care sectors as a screening measure to identify feeding difficulties in HEU neonates. In the South African context, time and staffing constraints call for effective and reliable screening measures in order to identify populations at risk. The SSAF-N could assist SLTs in identifying neonates with feeding difficulties in a time effective manner.

The outcomes of this study highlight the need for a focus on HEU neonates. This information is valuable for the formulation of clinical practice guidelines (such as the World Health Organisation

2016 guidelines on HIV and infant feeding) on managing the health of the HIV population (World Health Organisation & UNICEF, 2016). Changes in clinical guidelines will create awareness and provide health professionals with the information they require to adequately care for this vulnerable population.

5.3.4 Future research recommendations

Large longitudinal cohort studies of HEU neonates with matched control groups of HIV-unexposed neonates would enable for more in-depth descriptions of feeding difficulties as well as comparisons between groups. Studies conducting comprehensive feeding assessments and tracking maternal CD4 counts and ARV use during pregnancy more accurately may provide more conclusive findings regarding HEU neonates' feeding abilities and the influence that maternal health has on neonatal feeding outcomes.

Studies investigating how HIV- and ARV exposure in-utero, during and/or after birth result in poorer outcomes would be valuable in broadening the understanding of HIV- and ARV exposure. Information gained from studies such as these could pave the way for research on how to limit or prevent the health and developmental deficits of HEU neonates and children.

5.4 Overall Conclusion

Programmes for preventing mother-to-child transmission of HIV have been hugely successful in the South Africa (Republic of South Africa: Department of Health, 2015b). This has resulted in a significant number of HEU neonates being born to HIV-positive mothers (World Health Organisation, 2014). These HEU neonates make up a significant portion of the population of infants in the public health care sector (Filteau, 2009). Studies have indicated that these children have differences in their development, health and mortality rate when compared to HIV-unexposed children (Brahmbhatt et al., 2006; Reikie et al., 2014; Van Rie et al., 2008) indicating that this population is at risk for adverse health outcomes.

Poor developmental outcomes and ill health are associated with malnutrition (Black et al., 2013). Feeding difficulties have adverse consequences for a child's nutritional status which places them at greater risk for illness, disease, and poor health outcomes. In countries such as South Africa where health care services and resources are limited, there is a need to follow an early intervention approach. Children who are at risk need to be prioritised at various levels of health care and identified early on.

The aim of this study was to describe the feeding abilities of HEU neonates in a public sector hospital in KwaZulu-Natal. The results indicated that HEU neonates are at risk for feeding difficulties. The study's findings have clinical as well as future research implications. Clinical practice guidelines need to consider the HEU population as at risk for feeding problems and these guidelines should recommend the routine screening of HEU neonates.

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APPENDIX A: INFORMATION LEAFLET AND INFORMED CONSENT FORM FOR STUDY PARTICIPANTS

Information Sheet and Consent to Participate in Research

Date:

Dear Mother

My name is Tessa Eybers from the Speech Language Pathology Department of the University of KwaZulu-Natal.

You are invited to take part in a study I am doing about the feeding abilities of newborn babies who are born to mothers who are HIV-positive. The aim of the research is to describe the babies' feeding abilities. The study needs 60 participants from the hospital. It will involve a short screening of each baby's feeding abilities, which will not take longer than 30 minutes.

The study holds very little risk for the newborn babies as the feeding screening will mainly consist of observing a feeding session and this will be done by a qualified speech therapist. A small clip will be placed on the baby's foot which will give information about the baby's heart rate and oxygen levels. The baby's swallowing will also be listened to.

After the feeding screening, each mother will receive a pamphlet on feeding difficulties. We hope that this will help the mother to know if her baby has any feeding difficulties so that she can bring her baby to the hospital to get help early on. We also hope that the results of the study will help HIV-exposed infants with feeding difficulties to be identified early on so that they can eat and grow well.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (BREC reference number: BE 223/15).

If you have any concerns or problems with the study you can call the researcher or the UKZN Biomedical Research Ethics Committee (contact information below).

Participation is completely voluntary. Participants may choose to leave the study at any time and they will not lose out on treatment which they would normally have access to. If the potential participant chooses not to participate in the study, the medical treatment that she receives at the hospital will not be affected, nor will her access to health care services in the future be influenced as a consequence of her choosing not to participate.

Should a participant wish to withdraw from the study, they may inform the researcher verbally. The participants will be removed from the study if:

- The baby is very sick and is in an incubator or in the neonatal intensive care unit
- The baby is born premature (before 37 weeks)
- The mother is not able to safely walk to the room where the screening will take place
- The mother is not able to follow instructions reliably
- The mother is not present in the maternity ward at the time of data collection.

It will not cost the participants anything to participate in the study. Participants will also not be given any money to participate.

Please note the following:

- All personal information of participants will be kept private.
- The names of the participants will not be used during the data collection or written in the report. Each participant will be given a number instead of a name. The participants' names and the corresponding number will be kept in a secure file which has a password. Only the researcher and the supervisors will have access to the file.
- All clinical information will be kept in a locked cupboard which only the researcher and supervisors will have access to.
- Once the study is completed, all electronic data will be permanently deleted and all paper data will be shredded by the researcher and securely discarded.
- The only time a participant's name will be revealed is when the baby appears to have difficulty with feeding and the researcher thinks that the baby needs help from a speech therapist working in the hospital. This will be done with the mother's permission.
- The feeding screening will take place in a private room.

If you would like to participate in the study, please complete the consent section below.

CONSENT

I _____ have been informed about the study called "The feeding abilities of HIV-exposed neonates in KwaZulu-Natal: A descriptive exploratory study" by Tessa Eybers.
I understand what the study is about and how it will be done. I understand that my baby's feeding and swallowing will be assessed within 24 hours of being born.

I give Tessa Eybers permission to have access to my personal and medical information in my hospital file until the study is completed.

I also give Tessa Eybers permission to access my baby's medical information in their hospital file and to have access to their HIV PCR test results which will be done at 6 weeks of age.

I have been given an opportunity to ask questions about the study and I am satisfied with the answers I was given.

My participation in this study is entirely voluntary and I understand that I may leave the study at any time and my treatment or care that I would normally get will not be affected.

If I have any other questions or concerns about the study I understand that I may contact the researcher.

If I have any questions or concerns about my rights as a study participant, or if I am worried about a part of the study or the researcher then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 031 260 2489 - Fax: 031 2604609
Email: BREC@ukzn.ac.za

_____ _____

Signature of Participant **Date**

_____ _____

Signature of Witness (Where applicable) **Date**

_____ _____

Signature of Interpreter (Where applicable) **Date**

APPENDIX B: CONFIDENTIALITY AGREEMENT BETWEEN INTERPRETER AND RESEARCHER

INTERPRETER CONFIDENTIALITY AGREEMENT

I, _____ (insert your name) *agree to act as interpreter during the data collection phase for the Masters research project entitled: "The feeding abilities of HIV-exposed neonates in KwaZulu-Natal: A descriptive exploratory study."*

I understand that ALL information relating to this study needs to be kept confidential. I agree to not disclose any information relating to patients' identities and/or health to anyone outside the context of this study.

Interpreter:

_____ _____

Signature Date

_____

(Print name)

Witness:

_____ _____

Signature Date

_____

(Print name)

APPENDIX C: MEDICAL AND BIOGRAPHICAL SCHEDULE FOR MOTHER AND NEONATE

Information collected by (name): _____ Date: _____

Section 1: Maternal information:		
1.1 Mother DOB:	**1.2 Chronological age:**	**1.3 Language:** isiZulu English Other
1.4 Race:	**1.5 Date of HIV diagnosis:**	**1.6 Date of ART initiation:**
1.7 Type of ART:	**1.8 CD4 count and date of CD4 count test (if available):**	
1.9 Health problems during pregnancy as recorded in hospital file:		

Section 2: Neonate information:		
2.1 Gestational age: /40	**2.2 Gender:** Male / Female	**2.3 Race:**
2.4 D.O.B:	**2.5 Time of birth:**	**2.6 Birth weight:**
2.7 Medical concerns during or after birth as recorded in hospital file:		
2.8 Medication prescribed and reason:		
2.9 HIV PCR result:		

APPENDIX D: SCREENING FOR SWALLOWING AND FEEDING IN NEONATES (SSAF-N)

Screener conducted by: _____ Date: _____ Time: _____

Observed method of feeding (circle): Breast Cup

SCREENING ITEMS[6]		PASS CRITERIA	FAIL CRITERIA
A. FEEDING DURATION & INTAKE	**A.1 Feeding time Reported: _____ minutes**	□ **Appropriate**	□ **Inappropriate**
	A.2 Oral intake per feed (cup fed only) Reported: _____ml	□ **Appropriate**	□ **Inappropriate**
B. STATE & MOTOR CONTROL	**B.1 State of arousal (during feeding)**	□ **Appropriate: Alert**	□ **Inappropriate: Lethargic, difficult to rouse**
	B.2 General motor control (during feeding)	□ **Appropriate: Adequate trunk and head control**	□ **Inappropriate: Poor trunk and head control**
C. SUCK	**C.1 Feeding position**	□ **Appropriate**	□ **Inappropriate**
	C.2 Posture	□ **Appropriate: Normal physiologic flexion**	□ **Inappropriate: Abnormal extension**
	C.3 Oral tone	□ **Appropriate:** ○ **Normal tone**	□ **Inappropriate:** ○ **Hypertonic / Hypotonic / Mixed**
	C.4 Latching: (breastfed only) **C.4.1 Lip seal** **C.4.2 Strength of suck**	□ **Appropriate: Adequate seal** □ **Appropriate: Adequate strength**	□ **Inappropriate: Poor seal** □ **Inappropriate: Weak strength**
	C.5 Coordination Breastfed: SSB Cup fed: swallow-breathe	□ **Appropriate: 3+ sucks : 1 swallow : 1 breath; coordinated**	□ **Inappropriate: < 3 sucks : 1 swallow : 1 breath OR/AND discoordinated**
D. BREATHING & SWALLOWING	**D.1 Respiration at rest**	□ **Appropriate: Regular, calm, controlled**	□ **Inappropriate:** ○ **Dyspnoea*** ○ **Fast (>60 breaths/min)*** ○ **Stridor/wet respiration**
	D.2 Baseline SpO_2 at rest (for 1 min)	**_____ %**	
	D.3 Respiration during feeding	□ **Appropriate: No apparent difficulty**	□ **Inappropriate:** ○ **Apnoea*** ○ **Dyspnoea***
	D.4 SpO_2 during feeding	**_____ %**	
	D.5 Swallowing	□ **Appropriate: No apparent difficulty**	□ **Inappropriate:** ○ **Audible evidence of penetration (stridor, wet inspiration/expiration)** ○ **Delayed swallow** ○ **Other: _____**
	D.6 Respiration after swallow	□ **Appropriate: Normal tidal respirations (40-60 breaths/min)[7]**	□ **Inappropriate:** ○ **Bubbling** ○ **Coughing*** ○ **Increased respiration rate*** ○ **Crackles** ○ **Gurgling** ○ **Stridor**
	D.7 SpO_2 1 min after feeding	**_____ %**	

[6] Screening methods used: clinical observation, cervical auscultation and pulse oximetry
[7] Hooker, et al., 1989; Hooker et al., 1992, cited in Cichero & Murdoch, 2006

	D.8 Percentage difference in SpO_2	□ **0-2% (aspiration not suspected)**	□ **3% or more (possible aspiration present)***
SCREENING RESULT (circle):		**PASS**	**FAIL**

Adapted from: Arvedson and Brodsky (2002); Cichero (2006); Wolf and Glass (1992).
*Signs of distress and/or unsteady state

APPENDIX E: INFORMED CONSENT FORM FOR EXPERT REFERENCE GROUP

Information Sheet and Consent to Participate in Research

Date:

Dear Sir/Madam,

My name is Tessa Eybers from the Speech Language Therapy Department of the University of KwaZulu-Natal. (Contact details:).

You are invited to take part in a study which involves research about the feeding abilities of neonates who are born to HIV-positive mothers. The aim of the research is to describe the neonates' feeding abilities by conducting structured observations. In order to increase the validity of the structured observation schedule, I want to consult with three speech-language therapists (SLTs) who are considered to be experts in the field of feeding and swallowing disorders. The three SLTs will form an expert reference group who will be requested to provide expert guidance on the development and refinement of the structured observation schedule.

Each SLT will be required to review the structured observation schedule and to provide detailed comments on the following aspects:

- Observation schedule components
    - Is the level of detail appropriate for the aim of it being a feeding screening of neonates?
    - Should any other components be included?
    - Should any components be omitted?
- Appropriateness for study population
    - Do you believe that this observation schedule is an effective and appropriate screening of neonates' feeding abilities?
- Please comment on the framework's composition and clarity.

The study holds no risks for the participants and there are no direct benefits to participating in the study. The results of the study will make valuable contributions to the knowledge currently available about HIV-exposed neonates.

In order to participate in the study, potential participants will need to meet the following selection criteria:

Inclusion criteria

- **Recognised experts:** They are considered to be experts in the field of feeding and swallowing disorders by their academic peers. Therefore they would need to be recommended by their peers.
- **Clinical experience:** They have 3-5 years of clinical experience in the field of paediatric feeding and swallowing disorders.
- **Research experience:** They have 3-5 years of experience in conducting research in the field of paediatric feeding and swallowing disorders.

Exclusion criteria

- **Lack of availability:** They are not able to provide written and/or verbal feedback within 7-10 working days of receiving the structured observation schedule for review.

This study has been ethically reviewed and approved by the UKZN Biomedical Research Ethics Committee (approval number BE 223/15).

In the event of any problems or concerns/questions you may contact the researcher at ( ) or the UKZN Biomedical Research Ethics Committee, contact details as follows:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2602489 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Participation is completely voluntary. Participants may choose to leave the study at any time without facing any adverse consequences. Should a participant wish to withdraw from the study, they may inform the researcher in writing.

The following ethical considerations have been made:

- All personal information of participants will be kept confidential and will not be used in the research report or in an article submitted for publication, nor in any kind of presentation.
- SLTs will be given a code instead of a name. The participants' names and the corresponding codes will be kept in a secure password protected file to which only the researcher and the supervisors will have access to.
- All clinical information will be kept in a locked cupboard which only the researcher and supervisors will have access to.
- Once the study is completed, all electronic data will be permanently deleted and all paper data will be shredded by the researcher and securely discarded.

If you would like to participate in the study, please complete the consent section.

CONSENT

I _____ have been informed about the study titled "The feeding abilities of HIV-exposed neonates in KwaZulu-Natal: A descriptive exploratory study" by Tessa Eybers.

I understand the nature of the study and how it will be conducted. I understand what my role as part of the expert reference group will entail.

I understand that failure to respond within 7-10 working days of receiving the observation schedule will result in me being excluded from the research study.

I have been given an opportunity to ask questions about the study and I am satisfied with the answers I was given.

My participation in this study is entirely voluntary and I understand that I may leave the study at any time without any adverse consequences.

If I have any other questions or concerns about the study I understand that I may contact the researcher.

If I have any questions or concerns about my rights as a study participant, or if I am worried about a part of the study or the researcher then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 031 260 2489 - Fax: 031 2604609
Email: BREC@ukzn.ac.za

_____ _____

Signature of Participant **Date**

_____ _____

Signature of Witness **Date**
(Where applicable)

APPENDIX F: PULSE OXIMETRY PROTOCOL

Adapted from Cichero (2006) and Sherman, et al. (1999).

1. Secure the probe onto the neonate's foot with the red light against the foot arch. Ensure that it fits snugly.
2. Establish and record a baseline SpO_2 for one minute before feeding starts. SpO_2 baseline should not be lower than 90% (normal is between 95% and 100%). If it is lower, check that the probe is attached properly. The neonate should ideally be drowsy or in a calm alert state (not sleeping or active crying).
3. Instruct the mother to start feeding. Observe the SpO_2 reading during feed and note any drops in oxygen saturation equal to or greater than 3% that is maintained for one minute or longer.
4. Record the SpO_2 during feeding.
5. After feeding, observe oxygen saturation for at least one minute and note any drops in SpO_2 equal to or greater than 3% that is maintained for one minute or longer.
6. Record the SpO_2 after feeding.
7. Record percentage difference between baseline and lowest SpO_2 measurement. A percentage difference of 3% or more that was sustained for one minute indicates the presence of aspiration.

APPENDIX G: CERVICAL AUSCULTATION PROTOCOL

Adapted from Cichero (2006).

1. Using a paediatric or neonatal stethoscope, insert the ear pieces into your ears angled forward in the direction of the ear canal.
2. Turn the bell end and tap the diaphragm side to check that it is 'on'.
3. Position the diaphragm on the neck lateral to the larynx. If necessary, lift up the neonate's chin before placing the diaphragm and allow the chin to return to a flexed position over the edge of the diaphragm. Listen for breath sounds to determine whether diaphragm is placed correctly. If not, reposition the diaphragm until breath sounds can be heard clearly.
4. Listen for baseline respiration before feeding. Record any irregular breathing, rapid breathing, stridor and wet inspiration or expiration.
5. Instruct mother to start feeding. Listen for swallowing sounds. Sounds should be crisp, quick and clear. Listen for any delays in swallowing, sounds of regurgitation, and any audible evidence of penetration (such as stridor, or wet inspiration or expiration). Record any abnormalities.
6. After the feeding session, listen to breathing and record any abnormal sounds such as bubbling, coughing, crackles, gurgling, and stridor.

APPENDIX H: PAMPHLET ON FEEDING DIFFICULTIES

Who can help?

If your baby often has these difficulties and they are not feeding well or getting enough milk, you can contact the Speech Therapists at King Edward VIII Hospital at:

Telephone: 031 360 3491.
Address: Gate No. 1, 719 Umbilo Rd, Durban.

It is important to get help early on if you think your baby might have a feeding problem.

References

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Nature Baby (2013). *Could your baby have infant reflux disease?* Retrieved April 12, 2015, from http://www.babynature.co.za/nature-baby/index.php/could-your-baby-have-infant-reflux-disease/

HOW DO I KNOW IF MY BABY HAS A FEEDING PROBLEM?

(Bill and Melinda Gates Foundation, n.d.)

Feeding difficulties in babies

- Babies need to feed well and safely so that they do not get sick.
- They must not take too long to feed so that they can have enough energy to grow.
- Babies also need to enjoy feeding so that they gain enough weight.
- Feeding difficulties can include anything that makes it hard for a baby to drink milk.

A baby might have the following difficulties:

1. Cry or fuss a lot while feeding

("Is Colic Normal?," 2010)

2. Struggle to hold the nipple or bottle in the mouth
3. A lot of milk leaks out of their mouths while drinking
4. Turn their head away when you are trying to feed them
5. Gag or cough while feeding

(BabyCentre, 2015)

6. Vomit or have reflux during or after feeding

(Nature Baby, 2013)

7. Takes longer than 30-40 minutes to finish a feed or falls asleep before finishing a feed

(African American Breastfeeding Network, n.d.)

APPENDIX I: INFORMATION LEAFLET AND INFORMED CONSENT FORM FOR PILOT STUDY PARTICIPANTS

Information Sheet and Consent to Participate in Research

Date:

Dear Mother

My name is Tessa Eybers from the Speech Language Pathology Department of the University of KwaZulu-Natal.

You are invited to take part in a pilot study I am doing about the feeding abilities of newborn babies who are born to mothers who are HIV-positive. The pilot study is a smaller version of the main study. Its purpose is to see if there are any problems with the research process. The aim of the main research is to describe the babies' feeding abilities. The pilot study needs 6 participants from the hospital. It will involve a short screening of each baby's feeding abilities, which will not take longer than 30 minutes.

The study holds very little risk for the newborn babies as the feeding screening will mainly consist of observing a feeding session and this will be done by a qualified speech therapist. A small clip will be placed on the baby's foot which will give information about the baby's heart rate and oxygen levels. The baby's swallowing will also be listened to.

After the feeding screening, each mother will receive a pamphlet on feeding difficulties. We hope that this will help the mother to know if her baby has any feeding difficulties so that she can bring her baby to the hospital to get help early on. We also hope that the results of the study will help HIV-exposed infants with feeding difficulties to be identified early on so that they can eat and grow well.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (BREC reference number: BE 223/15).

If you have any concerns or problems with the study you can call the researcher the UKZN Biomedical Research Ethics Committee (contact information below).

Participation is completely voluntary. Participants may choose to leave the study at any time and they will not lose out on treatment which they would normally have access to. If the potential participant chooses not to participate in the study, the medical treatment that she receives at the hospital will not be affected, nor will her access to health care services in the future be influenced as a consequence of her choosing not to participate.

Should a participant wish to withdraw from the study, they may inform the researcher verbally. The participants will be removed from the study if:

- The baby is very sick and is in an incubator or in the neonatal intensive care unit
- The baby is born premature (before 37 weeks)

- The mother is not able to safely walk to the room where the feeding screening will take place
- The mother is not able to follow instructions reliably
- The mother is not present in the maternity ward at the time of data collection.

It will not cost the participants anything to participate in the study. Participants will also not be given any money to participate.

Please note the following:

- All personal information of participants will be kept private.
- The names of the participants will not be used during the data collection or written in the report. Each participant will be given a number instead of a name. The participants' names and the corresponding number will be kept in a secure file which has a password. Only the researcher and the supervisors will have access to the file.
- All clinical information will be kept in a locked cupboard which only the researcher and supervisors will have access to.
- Once the study is completed, all electronic data will be permanently deleted and all paper data will be shredded by the researcher and securely discarded.
- The only time a participant's name will be revealed is when the baby appears to have difficulty with feeding and the researcher thinks that the baby needs help from a speech therapist working in the hospital. This will be done with the mother's permission.
- The feeding screening will take place in a private room.

If you would like to participate in the study, please complete the consent section below.

CONSENT

I _____ have been informed about the study called "The feeding abilities of HIV-exposed neonates in KwaZulu-Natal: A descriptive exploratory study" by Tessa Eybers.
I understand what the study is about and how it will be done. I understand that my baby's feeding and swallowing will be assessed within 24 hours of being born.

I give Tessa Eybers permission to have access to my personal and medical information in my hospital file until the study is completed.

I also give Tessa Eybers permission to access my baby's medical information in their hospital file and to have access to their HIV PCR test results which will be done at 6 weeks of age.

I have been given an opportunity to ask questions about the study and I am satisfied with the answers I was given.

My participation in this study is entirely voluntary and I understand that I may leave the study at any time and my treatment or care that I would normally get will not be affected.

If I have any other questions or concerns about the study I understand that I may contact the researcher.

If I have any questions or concerns about my rights as a study participant, or if I am worried about a part of the study or the researcher then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 031 260 2489 - Fax: 031 2604609
Email: BREC@ukzn.ac.za

_____ _____

Signature of Participant **Date**

_____ _____

Signature of Witness **Date**
(Where applicable)

_____ _____

Signature of Interpreter **Date**
(Where applicable)

APPENDIX J: INFORMED CONSENT FORM FOR SLT REVIEWER

Information Sheet and Consent to Participate in Research

Date:

Dear Speech-Language Therapist

My name is Tessa Eybers from the Speech Language Therapy Department of the University of KwaZulu-Natal. (Contact details:).

You are invited to take part in a study which involves research about the feeding abilities of neonates who are born to HIV-positive mothers. The aim of the research is to describe the neonates feeding abilities by conducting a feeding screening using an informal tool. A pilot study will be conducted before the main study is conducted. The pilot study will require six participants and the main study will require 60 participants. All the participants will be gathered from Hospital.

Should you choose to participate, your role in the research will be to act as blind reviewer of the documented observations. You will be asked to independently review a selection of the completed screening forms with the screening result (pass or fail as per the researcher's clinical judgement) omitted. You will be required to use your clinical judgement as to whether each neonate should pass or fail the feeding screening based on their feeding abilities as recorded on their screening form. Thereafter, your judgements will be compared to the researcher's judgements. The blind review should not take more than 30 minutes of your time.

The study holds no risks for you if you choose to participate and there are no direct benefits to participating in the study. The results of the study will make valuable contributions to the knowledge currently available about HIV-exposed neonates.

In order to be included in the study, the SLT would need to meet the following selection criteria:

Inclusion criteria

- **Qualified:** Qualified SLT working in the field of paediatric feeding and swallowing disorders

Exclusion criteria

- **Lack of availability:** They are not able to conduct the post screening blind review.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (approval number BE223/15).

If you have any concerns or problems with the study you can call the researcher or the UKZN Biomedical Research Ethics Committee (contact information below).

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2602489 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Participation is completely voluntary. Participants may choose to leave the study at any time without facing any adverse consequences. Should a participant wish to withdraw from the study, they may inform the researcher in writing.

The following ethical considerations have been made:

- All personal information of participants will be kept confidential and will not be used in the research report or in an article submitted for publication, nor in any kind of presentation.
- SLT will be given a code instead of a name. The participant's name and the corresponding code will be kept in a secure password protected file to which only the researcher and the supervisors will have access to.
- All clinical information will be kept in a locked cupboard which only the researcher and supervisors will have access to.
- Once the study is completed, all electronic data will be permanently deleted and all paper data will be shredded by the researcher and securely discarded.

If you would like to participate in the pilot study, please complete the consent section.

CONSENT

I _____ have been informed about the study titled “The feeding abilities of HIV-exposed neonates in KwaZulu-Natal: A descriptive exploratory study” by Tessa Eybers.

I understand the nature of the study and how it will be conducted. I understand what my role in the study will entail.

I have been given an opportunity to ask questions about the study and I am satisfied with the answers I was given.

My participation in this study is entirely voluntary and I understand that I may leave the study at any time without any adverse consequences.

If I have any other questions or concerns about the study I understand that I may contact the researcher.

If I have any questions or concerns about my rights as a study participant, or if I am worried about a part of the study or the researcher then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 031 260 2489 - Fax: 031 2604609
Email: BREC@ukzn.ac.za

_____ _____
Signature of Participant **Date**

_____ _____
Signature of Witness **Date**
(Where applicable)

APPENDIX K: APPROVAL FROM BIOMEDICAL RESEARCH ETHICS COMMITTEE JULY 2015

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

07 July 2015

Ms T Eybers (215079490)
Speech-Language Pathology
School of Health Sciences
tessa.eybers@gmail.com

Protocol: The feeding abilities of HIV exposed neonates in KwaZulu-Natal: A descriptive exploratory study.
Degree: MMedSc
BREC reference number: BE223/15

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 08 May 2015.

The study was provisionally approved pending appropriate responses to queries raised. Your responses received on 06 July 2015 to queries raised on 10 June 2015 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval.

This approval is valid for one year from 07 July 2015. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its meeting taking place on **11 August 2015**

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor J Tsoka-Gwegweni
Chair: Biomedical Research Ethics Committee

cc supervisor, citawmi@ukzn.ac.za

Biomedical Research Ethics Committee
Professor J Tsoka-Gwegweni (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 2436 Facsimile: +27 (0) 31 260 4609 Email: brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

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APPENDIX L: APPROVAL FROM BIOMEDICAL RESEARCH ETHICS COMMITTEE JULY 2016

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI
RESEARCH OFFICE
Biomedical Research Ethics Administration
Westville Campus, Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za
Website http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

07 June 2016

Ms T Eybers (215079490)
Speech-Language Pathology
School of Health Sciences
tessa.eybers@gmail.com

Dear Dr Eybers

Protocol: The feeding abilities of HIV exposed neonates in KwaZulu-Natal: A descriptive exploratory study.
Degree: MMedSc
BREC reference number: BE223/15

RECERTIFICATION APPLICATION APPROVAL NOTICE

Approved:	07 July 2016
Expiration of Ethical Approval:	06 July 2017

I wish to advise you that your application for Recertification received **25** May 2016 for the above protocol has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse events occur **in the** project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written **BREC** approval for the change.

This approval will be **ratified** by a full Committee at its next meeting taking place on **12 July 2016.**

Yours sincerely

Mrs A Marimuthu
Senior Administrator: Biomedical Research Ethics

cc supervisor: pillaym1@ukzn.ac.za

APPENDIX M: PERMISSION TO CONDUCT RESEARCH AT HOSPITAL

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

OFFICE OF THE HOSPITAL CEO

Ref.:
Enq.
Research Programming

23 June 2015

Ms. T. Eybers
Speech – Language Pathology
School of Health Sciences
Westville Campus
UNIVERSITY OF KWAZULU-NATAL

Dear Ms. Eybers

Protocol: The feeding abilities of HIV exposed neonates in KwaZulu-Natal: A descriptive exploratory study. Degree-MMedSc; BREC Ref. No. BE223/15

Permission to conduct research at Hospital is provisionally granted, pending approval by the Provincial Health Research Committee, KZN Department of Health.

Kindly note the following:-

- The research will only commence once confirmation from the Provincial Health Research Committee in the KZN Department of Health has been received.
- Signing of an indemnity form at Room 8, CEO Complex before commencement with your study.
- Hospital received full acknowledgment in the study on all Publications and reports and also kindly present a copy of the publication or report on completion.

The Management of Hospital reserves the right to terminate the permission for the study should circumstances so dictate.

Yours faithfully

SUPPORTED/NOT SUPPORTED

25/6/2015

CHIEF EXECUTIVE OFFICER **DATE**

uMnyango Wezempilo . Departement van Gesondheid

Fighting Disease, Fighting Poverty, Giving Hope

APPENDIX N: APPROVAL FROM KWAZULU-NATAL DEPARTMENT OF HEALTH

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 102 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM 163/15
NHRD: KZ_2015RP44_174
Enquiries : Mr X Xaba
Tel : 033 – 395 2805

Dear Ms T. Eybers

Subject: Approval of a Research Proposal

1. The research proposal titled **'The feeding abilities of HIV exposed neonates in KwaZulu-Natal: A descriptive exploratory study'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at _ Hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

Dr E Lutge
Chairperson, Health Research Committee
Date: 03/07/15