NUTRITIONAL OUTCOMES OF BOTSWANAN INFANTS AND YOUNG CHILDREN AGED 6-24 MONTHS:

A focus on birthweight, HIV-exposure, feeding practices and the role of caregivers, older family figures and healthcare workers.

PAPHANI CHALASHIKA, BNutrDiet

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Supervisors:

Prof. Simon Langley-Evans

Dr. Judy A. Swift

Dr. Duane Mellor

Declaration

I, Paphani Chalashika, hereby declare that the work presented here is my own work and has not been submitted for any other degree. The sources of data used in this thesis have been acknowledged by referencing authors appropriately.



Mr. Paphani Chalashika

Dedication

I dedicate the work in this PhD to my wonderful mother (Idah Chalashika). I am here today, because you allowed me to pursue my dream and not to worry about anything else. You have always been truthful and honest, whether I am right or wrong. I could never ask for a more supportive and loving mother. This one is for you *mama.*

Original Papers

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Conference Proceedings

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Abstract

Background: A better understanding of the nutritional status of infants and young children who are HIV-Exposed-Uninfected (HEU) and HIV-Unexposed-Uninfected (HUU) during their first 1000 days is a key to improving population health, particularly in sub-Saharan Africa.

Methods: A mixed-methods approach (explanatory sequential design) was utilised to compare the nutritional status, feeding practices and determinants of nutritional status of HEU and HUU infants and young children residing in representative selected districts in Botswana. In addition, themes associated with perceptions of caregivers, older family figures and healthcare workers in achieving optimal nutritional outcomes in these infants and young children were identified. In the quantitative strand (413 infants and young children, 37.3% HIV-exposed) aged 6-24 months attending routine child health clinics were recruited. In the qualitative strand 25 caregivers, 9 older family figures and 10 healthcare workers were interviewed using a semi-structured questionnaire. Quantitative data including anthropometric, 24-hour dietary intake and socio-demographic data was collected. Anthropometric *z*-scores were calculated using 2006 WHO growth standards. Modelling of the determinants of malnutrition was undertaken using logistic regression. Qualitative data was analysed using an inductive, interpretive/latent thematic analysis approach.

Results: Overall, prevalence of stunting, wasting and underweight were 10.4%, 11.9% and 10.2% respectively. HEU infants and young children were significantly more likely to be underweight (15.6% vs. 6.9%), ($p<0.01$) and stunted (15.6% vs. 7.3%), ($p<0.05$) but not wasted ($p= 0.14$) than HUU infants and young children. HEU infants and young children tended to be formula fed (89.4%) whereas HUU infants

and young children tended to breastfeed (89.6%) for the first six months ($p<0.001$). In multivariate analysis, significant predictors of nutritional status were HIV exposure, birthweight, birth length, Apgar score and mother/caregiver's education with little influence of socioeconomic status ($p<0.05$). Qualitative thematic analysis revealed four themes; when "free choice" is an illusion: mother's infant feeding decisions; "These people are dangerous." negotiating access to healthcare services; "caring is how I show my baby love"; "our culture, our heritage".

Conclusions: HEU infants and young children aged 6-24 months had worse nutritional status compared to HUU infants and young children. Notably, birthweight was the main predictor of undernutrition in this population and, therefore optimisation of infants and young children' nutritional status should focus on the nutrition and health of women in the pre- and antenatal period. These interventions should focus on equipping caregivers with skills and knowledge but also address external factors such as influence of the older family figure, community norms and cultures and experiences associated with accessing healthcare services.

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Table of Contents

Declaration iii
Dedication iv
Original Papers v
Conference Proceedings v
Abstract vi
Acknowledgements viii
Table of Contents ix
List of Tables xii
List of figures xiii
List of Abbreviations and Acronyms xiv
Preface xvi
1.0 INTRODUCTION 1
1.1 STATEMENT OF THE PROBLEM 1
1.2 BOTSWANA: BACKGROUND 4
1.3 LITERATURE REVIEW 9
1.3.1 Growth and development monitoring in infants and young children 9
1.3.2 Child Undernutrition 14
1.3.3 Indicators of child undernutrition 15
1.3.4 Prevalence of, stunting, underweight and wasting 19
1.3.5 Determinants of child undernutrition 21
1.3.6 Development Goals and Undernutrition 26
1.3.7 Child Mortality and undernutrition 34
1.3.8 The first 1000 days 40
1.3.9 HIV/AIDS: General Introduction 42
1.3.10 Nutritional status of HEU and HUU infants and young children 50
1.3.11 Infant feeding practices in context of high HIV prevalence 56
1.3.12 Interventions to improve nutritional status of infants and young children .. 60
1.4 STUDY RATIONALE 64
1.5 AIMS AND OBJECTIVES OF THE STUDY 69
1.5.1 Quantitative study 69
1.5.2 Qualitative study 70
1.6 MIXED-METHODS APPROACH 70

2.0 Birthweight, HIV-exposure and infant feeding as predictors of malnutrition in Botswanan infants and young children. 74
SYNOPSIS 74
2.1 INTRODUCTION 77
2.2 METHODS 79
2.2.1 Study participants and Population 79
2.2.2 Sample Size 82
2.2.3 Ethical approval 86
2.2.4 Recruitment 87
2.2.5 Data collection processes and sources 88
2.2.6 Study and Data management 94
2.2.7 Laboratory assessment of nutritional content of cereals 95
2.2.8 Data Analysis 103
2.2.9 Statistical Analysis 104
2.3 RESULTS 110
2.3.1 Characteristics of participants 110
2.3.2 Feeding Practices 111
2.3.3 Nutritional content of cereals 111
2.3.4 Nutritional Outcomes 112
2.3.5 Determinants of nutritional status 116
2.3.6 Use of child health card 117
2.4 DISCUSSION 123
2.4.1 Prevalence of Undernutrition in HEU versus HUU infants and young children. 123
2.4.2 HIV-Exposure as a predictor of stunting 131
2.4.3 Low birthweight as the strongest predictor of undernutrition 133
2.4.4 Other predictors of undernutrition 136
2.4.5 Feeding practices 140
2.4.6 Use of the child health card 144
2.5 STUDY LIMITATIONS 146
2.6 CONCLUSIONS 148
3.0 Perceptions of caregivers, older family figures and healthcare workers 150
SYNOPSIS 150
3.1 INTRODUCTION 151

3.2 METHODS 153
3.2.1 Study participants and population 153
3.2.2 Sample Size 154
3.2.3 Ethical approval 155
3.2.4 Recruitment 156
3.2.5 Data Sources and Collection Processes 157
3.2.6 Data Quality Controls 158
3.2.7 Study Management 158
3.2.8 Data Analysis 159
3.3 RESULTS 163
3.3.1 Characteristics of Participants 163
3.3.2 Study epistemology and reflexivity 164
3.3.3 Themes 166
3.3.4 Summary of findings 189
3.4 DISCUSSION 192
3.5 STUDY LIMITATIONS 203
3.6 CONCLUSIONS 204
4.0 GENERAL DISCUSSION 206
5.0 RECOMMENDATIONS 215
6.0 SUMMARY 224
7.0 REFERENCES 226
8.0 APPENDICES 268
Appendix 1: Child Health Card 269
Appendix 2: Ethical Approval letters 280
Appendix 3: Quantitative Questionnaire 288
Appendix 4: Dietary diversity measure 305
Appendix 5: Qualitative Interview Guide 306
Appendix 6: Journal Articles, Conference Proceedings and Posters 345
Appendix 7: Nutritional Analysis of cereals-output 349
Appendix 8: Pictures of Tsabana and Malutu 354

List of Tables

Table 1.1: Deaths attributed to undernutrition globally in children aged under 5 years……. 39
Table 2.1: Profile of selected districts……... 81
Table 2.2: Selected population data for each district…… 82
Table 2.3: Minimum and Maximum sample size required per district……. 84
Table 2.4: Sample size per health facility in each district (using minimum sample size)…… 85
Table 2.5: Operating conditions for the Gerhardt 2000…… 98
Table 2.6: Operating conditions for the Perkin Elmer Clarus 600 GC for measurement of FAME…….. 100
Table 2.7: Variables in the study……... 107-109
Table 2.8: Total analysis of sorghum samples…….. 112
Table 2.9: Characteristics of HEU and HUU infants and young children from selected districts in Botswana (N= 413)…… 113-114
Table 2.10: Feeding practices of infants and young children by HIV-exposure from selected districts in Botswana……. 115
Table 2.11: Logistic regression model of predictors of underweight in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)……... 119
Table 2.12: Logistic regression model of predictors of stunting in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)…….. 120
Table 2.13: Logistic regression model of predictors of wasting in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)…… 121
Table 2.14: Percentage of missing data in the child health card for selected variable 122
Table 3.1: Characteristics of participants and the infants and young children…….. 165
Table 3.2: Themes and sub-themes emerging from the data……. 167
Table 5.1: Issues identified in the study and recommendations to address them… 218-219

List of figures

Figure 1.2.1: Map of Africa showing Botswana and locations of data collection…….. 5
Figure 1.3.1: Definition and types of malnutrition in children……... 15
Figure 1.3.2: Conceptual framework of the determinants of child undernutrition……... 24
Figure 1.3.3: Under-Five mortality rate, 1990 - 2015 (Deaths per 1000 live births)…… 31
Figure 1.3.4: Under five mortality rate 1990-2015 in Botswana…….. 33
Figure 1.6.1: Timeline for the quantitative and qualitative studies…….. 73
Figure 2.1.1: Flow diagram showing selection of participants 83
Figure 2.1.2: Prevalence of underweight, stunting and wasting in infants and young children per HIV-exposure…… 116
Figure 3.1.1: Data analysis process (Creswell, 2014; Corbin and Strauss, 2015)……... 159

List of Abbreviations and Acronyms

AIDS	Acquired Immunodeficiency Syndrome
APGAR	Appearance, Pulse, Grimace, Activity, and Respiration
ART	Anti-Retroviral-Therapy
ARV	Antiretrovirals
BWP	Botswana Pula
CDC	Centre for Disease Control and Prevention
CG	Care Giver
CI	Confidence Interval
CSO	Central Statistics Office (*of Botswana*)
GDP	Gross Domestic Product
HCW	Healthcare Worker
HEA	Health Education Assistant
HEU	HIV-Exposed-Uninfected
HIV	Human Immunodeficiency Virus
HUU	HIV-Unexposed-Uninfected
LAZ	Length-for-Age
MCH	Mother Child Health
MDG	Millennium Development Goal
MOH	Ministry of Health and Wellness *(Botswana)*
MTCT	Mother To Child Transmission *(of HIV)*
MUAC	Mid-Upper-Arm-Circumference
NCHS	National Centre for Health Statistics
NHS	National Health Service
OFF	Older Family Figure
OR	Odds Ratio
PhD	Doctor of Philosophy
PMTCT	Prevention of Mother-To-Child Transmission
QUAL	Qualitative
QUAN	Quantitative
SDG	Sustainable Development Goal
UK	United Kingdom

UN	United Nations
UNAIDS	The Joint United Nations Programme on HIV and AIDS
UNICEF	The United Nations Children's Fund
USA	United States of America
WAZ	Weight-for-Age
WLZ	Weight-for-Length
WHO	World Health Organisation

Preface

"Children are our greatest treasure. They are our future"

Nelson Mandela

"Investing in girls and women's health and rights is not only the right thing to do; it's the smart thing to do"

Ban Ki-Moon

This subject area of my PhD came into mind before securing funding for my PhD. This was an area of concern where I worked. However, I was not, at the time, aware of the scale of undernutrition in HEU versus HUU infants and young children, let alone the predictors of such nutritional outcomes. Therefore, after securing the scholarship, I knew which area I would focus on. My literature search indicated a number of studies demonstrated that there was growth disparity between HEU and HUU infants and young children. However, these settings were vastly different from Botswana in terms of provision of ART for HIV positive women, provision of free formula and the availability and rigour of monitoring of growth and health in HEU infants and young children. Interestingly, the mortality rate of HEU infants and young children in Botswana was comparable or higher compared to those found in these settings. I realised early on that the methodology for this required PhD a mixed methods approach, whereby a quantitative study is conducted first followed by a qualitative study. This exploratory sequential method allowed us to determine the "scale of the problem". Therefore, shaping the explorations made in the qualitative study. This, I believe sharpened the focus of our investigation (and thus the findings) into the nutritional outcomes of HEU and HUU infants and young children within the first

1000 days in Botswana by providing deeper insights into the observed findings from the quantitative study.

1.0 INTRODUCTION

The clinical and public health need for the issues and themes developed in this thesis were initially identified when the PhD student was practising as a clinical dietitian in Selebi-Phikwe (Botswana). Selebi-Phikwe, is a small mining town, and at the time had a very high prevalence (27.5 %) of HIV infection (CSO, 2013). It was noticeable during routine clinical audits that HIV-exposed but uninfected infants and young children made up a disproportionate cohort of the total number of infants and young children seen in the dietetics clinic for undernutrition. Subsequently, this led to a, thorough search of the literature, using a number of databases (Medline, ProQuest, PubMed, Google scholar and EBSCO Host) and combination of keywords including; undernutrition, malnutrition, HIV- exposed, HIV, infants and young children, children, poor growth, determinants of malnutrition, Botswana, were used to identify literature relevant to the study. This search found that the growth and nutritional status of HIV-exposed but uninfected infants and young children was a major issue in a number of sub-Saharan countries. This introduction aims to set out the current evidence and rationale for the research questions employed in this study.

1.1 STATEMENT OF THE PROBLEM

The first 1000 days of an infant's life are widely considered to be the most important period with respect to health and achieving maximum potential in any person's whole life (1,000 days, 2017). The impact of sustained disturbances to their nutrition and health during this stage has a long term impact on their future development and therefore health. (UN, 2015: Black et al., 2013). The first 1000 days are typically defined as the period between conception and an infant's second birthday (Leroy et al., 2014). Optimising

maternal and infant nutrition and health during these first 1000 days reduces all-causes mortality in children under the age of five by approximately 15% (1,000 days, 2017). This is of critical importance, because in 2015 alone, six million children aged five years or younger died (WHO, 2017).

Globally, mortality in children (defined as deaths under the age of 5 years) has declined from 90 to 43 deaths per 1000 live births respectively between 1990 and 2015 (WHO, 2016). However, in 2015, sub-Saharan Africa had the highest mortality rate of 86 deaths per 1000 live births in the world (WHO, 2016). Undernutrition is an important risk factor for mortality in under-fives globally, accounting for over 45% of lives lost (Black et al., 2013: UN, 2015). Undernutrition is still a significant problem for many children globally, especially in sub-Saharan Africa and southern Asia (UNICEF, 2013). Globally, over 23.2% of all children were stunted in 2015 (WHO, 2016), with stunting being even more prevalent in Africa (37.8%) during this time (WHO, 2016). Stunting is a chronic form of undernutrition (definition and discussion on stunting will follow in section 1.3.3). Stunting is increasingly becoming an important indicator of nutritional status in children, because it is associated with diminished cognitive and physical development in adulthood (UNICEF, 2013: Victoria et al., 2008). This has dire consequences for these children, their families, communities and nations because they are less likely to reach their full potential as adults (UNICEF, 2013: Victoria et al., 2008). Unfortunately, effects of stunting are difficult to reverse after the first 1000 days (Victoria et al., 2008). Therefore, efforts should be concentrated on preventing it as early as possible in life (Ruel et al., 2008: Leroy et al., 2014).

Other indicators of undernutrition, primarily underweight and wasting, also affect millions of children globally (UN, 2015). Underweight, a composite form of undernutrition, indicating both wasting and stunting affects approximately 90 million children worldwide aged five years or younger (UN, 2015). Being underweight is associated with an increased risk of death from diseases such as diarrhoea and pneumonia (Dewey and Mayers, 2011). Ironically, being underweight is in itself a risk factor for these diseases (UN, 2015: Dewey and Mayers, 2011).

Consequences of undernutrition either in the short- or long-term highlights the importance of need to tackle undernutrition especially in the context of other existing global challenges to society, namely high HIV prevalence, energy and environmental security, conflict and security, and the global economic downturn (McDonald et al., 2012: UNICEF, 2013). However, this is a monumental task because the underlying factors and causes of undernutrition are diverse and complex (UNICEF, 2013). These factors are unique and vary according to each setting (Kimani-Murage et al., 2011: Bhutta et al., 2008). HIV/AIDS is an important factor to consider when addressing undernutrition in areas with high HIV prevalence because the high prevalence of HIV influences infant feeding policy (Ruel et al., 2013). Infant feeding practices are one of the most important determinants of undernutrition in children (UNICEF, 2013).

Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) is a major health challenge globally, particularly in sub-Saharan Africa (WHO, 2016). In 2015 approximately 36.7 million people globally were HIV positive, with more than half of them living in eastern and southern

Africa (UNAIDS, 2017). Botswana, a southern African country of about 2.2 million people has one of the highest prevalences (22.2%) of HIV globally (WHO, 2017). In response, to this growing health challenge, various strategies have been developed and put in place in Botswana, as they have in many other countries too (UNAIDS, 2017). These strategies aim to reduce the transmission and burden of HIV across the life course (UNAIDS, 2017). These include free HIV counselling and testing, free anti-retroviral therapy and a combination of strategies to prevent mother-to-child transmission (PMTCT) of HIV (UNAIDS, 2017). PMTCT of HIV has been highly successful in a number of sub-Saharan countries including; South Africa, Uganda, Swaziland, Nambia and Botswana, where mother to child transmissions of HIV has been reduced from 22.4% to 8.9 % in the last seven years (UNAIDS, 2017). In contrast, without PMTCT, HIV transmission can be as high as 25% (UNAIDS, 2017). Due to the success of PMTCT, the population of HIV-exposed but uninfected infants and young children has increased significantly over the years (Filteau 2009). The health and nutritional consequences of this exposure to date have not been well-documented (Evans et al., 2016: McGrath et al. 2012: Filteau 2009), therefore justifying the need for this line of enquiry.

1.2 BOTSWANA: BACKGROUND

Botswana is located in the southern part of Africa, bordered by Namibia to the north and west, South Africa to the south and south east, Zimbabwe and Zambia to the north east (CSO, 2015). As shown in Figure 1.2.1, Botswana is landlocked and has no access to the sea. It is approximately the size of France and lies approximately 1,100 metres above sea level (Botswana Tourism, 2013).

The eastern hardveld which runs along the eastern side of the country is where at least 80% of the population live (CSO, 2015). This area has favourable climate conditions, thus receives more rainfall than other locations in the country (CSO, 2015). The Kalahari Desert stretches west of the eastern hardveld and covers 84% of the country (Mosalagae and Mogotsi, 2013).

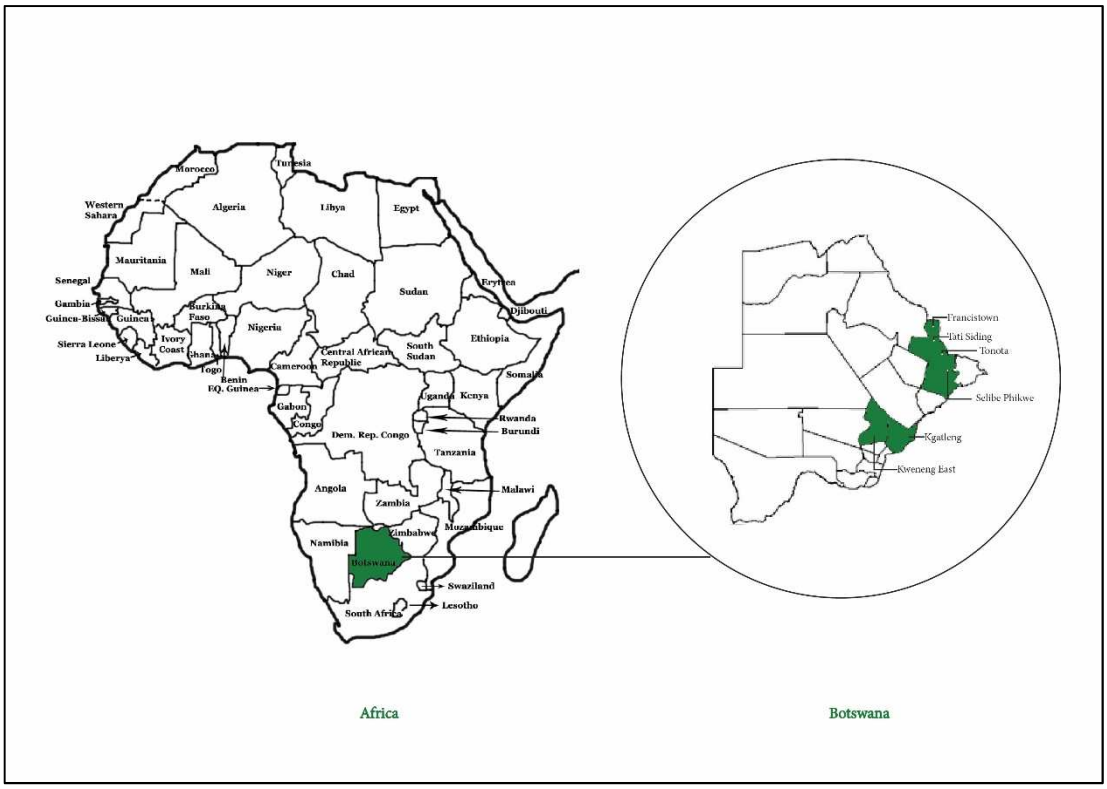


Figure 1.2.1: Map of Africa showing Botswana and locations of data collection

Source: Designed by Mbako Matenge, Laleo Designs (2017)

History and subsequent development

Botswana gained independence in 1966 following 80 years under the British protectorate (Moepeng et al., 2016). Prior to the discovery of diamonds, Botswana was one of the poorest countries in the world (Bolt and Hillbom,

2016). Fuelled by diamonds, relatively stable political landscape and prudent governance, Botswana's economy grew significantly in the mid-1980s to becoming an upper-middle income country it is today (World Bank, 2017: Bolt and Hillbom, 2016). This has benefitted a significant number of Batswana through provision of free universal education and healthcare, however the country is still faced with high levels of poverty and inequality especially in rural dwellers (Mogalakwe and Nyamnjoh, 2017). In addition, this high level of investment in education (9% of GDP) has not translated into a skilled workforce capable of diversifying away from a mineral based economy. Unemployment is currently at 17.8% (World Bank, 2017). This issue is exacerbated by high levels of HIV/AIDS in the country (UNAIDS, 2017: World Bank, 2017).

Demographics

The total population of Botswana was approximately 2.2 million at the latest census, of which 64.1% live in urban areas (CSO, 2015: CSO, 2014). This total population is made up of approximately 12% of children aged 0-4 years old (CSO, 2014). This age group saw an increase from the 2001 population census to become a dominant age group in 2011 (CSO, 2014). This is attributed to the success of PMTCT and free provision of ART, which increased survival of infants and young children and children in this age group (CSO, 2014).

Generally, women outnumber men by a ratio of 100 to 95.5, except in the 35-39 age group where there are fewer women relative to men. This has been attributed to maternal and HIV/AIDS related deaths (CSO, 2014). A typical

household in Botswana has seen a reduction in the number of people in each household from six to approximately four (CSO, 2014).

Access to healthcare

Botswana's healthcare system is in many aspects similar to the National Health System (NHS) in the United Kingdom, where the government sponsors universal healthcare for all citizens (Grosios et al., 2010). However, the healthcare system in Botswana (unlike in the UK) is more centrally controlled and regulated at the Ministry of Health and Wellness (MOH), which sets the strategy, policy and management and clinical care (MOH, 2012). Approximately 95% of the country's population live within a 5-8 km radius of some type of health facility (CSO, 2017). However, in rural areas, there is no public transport, therefore access to health facilities still presents a challenge (Hardon et al., 2007).

Botswana's healthcare system like the UK's NHS has primary, secondary and arguably tertiary care levels (Grosios et al., 2010). Primary care is set up in the community consisting of health posts, clinics and primary hospitals. These are equivalent to community care and/or general practitioners care in the NHS (CSO, 2017: Grosios et al., 2010). A typical clinic should include a doctor, nurse, laboratory scientists, pharmacists/pharmacy technicians, health education assistants and auxiliaries. However, health facilities in rural and some urban areas are often staffed with nurses and health education assistants only. A clinic offers a number of services, including outpatient care for adults and children, sexual and reproductive health services, maternal and child health

services, provision of anti-retroviral therapy and adherence counselling (MOH, 2010).

Currently, there are 195 clinics without beds, 104 clinics with beds and 17 primary hospitals (CSO, 2017). Clinics with beds also have a maternity wing, where uncomplicated maternity cases are seen (MOH, 2017). Secondary care consists of 18 hospitals, of which two can be considered tertiary hospitals providing specialist care for renal and oncology (CSO, 2017: MOH, 2017).

Mother and Child Health services

Mother and child health (MCH) clinics provide mainly preventive services aimed at improving the health of pregnant women, mothers and their children (MOH, 2017). These services are available in all clinics, health posts and in some primary and main hospitals. Services offered include growth and health monitoring, immunisations, deworming, supplementation and provision of fortified foods in infants and young children and children aged 0-59 months. In addition, pregnant women are seen for their ante-natal care in this setting. In most parts of the country these services have been moved from hospitals to clinics in order to improve efficiency and also to ensure that larger health facilities focus on treatment of complex cases. Essentially, the first point of contact for the majority of people in Botswana would be a health post or a clinic.

Growth and health monitoring services for children

Every month all caregivers of children aged 0-59 months are expected to bring their child to the MCH clinic mainly for growth and monitoring. Growth and monitoring is considered compulsory, however no penalties exist for

caregivers who do not bring their children each month. Growth monitoring consist mainly of measurement of weight each month and measurement of length/height at least twice a year (Nnyepi et al., 2011). These clinics are normally run by Health education assistants (HEA). After weight and/or length is taken, it is a recorded in each child's health card. The HEA then plots this weight and/or length in the growth chart to determine the child's linear growth. Each child in Botswana is given a health card which also contains important information such as their birthweight and length (See Appendix 1). After weight and/or length has been taken, a child is immunised by a nurse if they are due for one. Children attending these clinics are also provided with a ration of foods appropriate for their age such as *Tsabana, Malutu*, cooking oil and/or beans (See Appendix 8).

1.3 LITERATURE REVIEW

1.3.1 Growth and development monitoring in infants and young children

Normal growth and development in infants and young children and children is especially important in the first 1000 days, therefore, accurate and consistent monitoring of their growth, development and health is vital to ensure that problems are identified early and thus corrected (De Onis et al., 2004: Black et al., 2013).

Growth Monitoring: transition to WHO growth standards

Growth monitoring in children has been and remains an important indicator of growth and development in children (Prabha et al., 2017). Growth monitoring varies between countries, ranging from compulsory periodical clinics where growth monitoring is conducted by healthcare workers to optional ones where

parents monitor the growth of their children at home (Onyango et al., 2007: Garner et al., 2000). Despite, country variations, growth monitoring is now largely based on similar growth standards which seek to identify over and undernutrition at individual and population levels (De Onis et al., 2003). However, these standards have not always been consistent, leading to commissioning of an international growth reference study in 1993 by the World Health Organisation (Garza and De Onis, 2004). Data from this multicentre study was used in the development of the WHO child growth standards (WHO Multicentre Growth Reference Study Group, 2006). However, prior to this development of the WHO child growth standards, there were varying standards in use (Onyango et al., 2007). Most countries used either the National Centre for Health Statistics/WHO international growth reference (NCHS reference) or the Centre for Disease Control and Prevention (CDC) 2000 growth charts (De Onis et al., 2007: De Onis et al., 2006: De Onis, 2003).

National Centre for Health Statistics/WHO international growth references were commissioned for use in 1970 (WHO Multicentre Growth Reference Study Group, 2006). This reference was relatively popular, adopted by almost 100 countries (De Onis et al., 2004). However, there were problems with the use of the NCHS reference because the sample used to construct this standard was predominantly formula-fed (De Onis et al., 2006). This was an issue because these infants and young children' growth patterns deviated significantly from those who were breastfed (De Onis et al., 1996). This often led to inappropriate interventions by healthcare workers as they tried to 'correct growth' in breastfed infants and young children based on this flawed standard

(Garza and De Onis, 2004). This standard was flawed because it implied that breastfed infants and young children, otherwise raised in optimal conditions were not growing appropriately (De Onis et al., 2006). This was inconsistent with existing evidence showing the clear benefits of breastfeeding in the growth and development of children (Victoria et al., 2016). Therefore, it became apparent that there was a need for new growth standards derived from a sample that was breastfed and also raised under optimal conditions (WHO Multicentre Growth Reference Study Group, 2006). Thus the WHO child growth standards were developed (WHO Multicentre Growth Reference Study Group, 2006). Later on as expected, it was found that growth patterns in infancy were different when growth was assessed using WHO standards and NCHS reference (De Onis et al., 2006). Large variations in terms of weight for age, length for age and weight for length in infants and young children were found (WHO Multicentre Growth Reference Study Group, 2006). These variations were mainly due to differing feeding practices in samples used to construct these standards (De Onis et al., 2006). In addition, measurement of growth was not frequent enough in the NCHS sample, where weight and length was measured every three months (De Onis et al., 2006). In comparison in the WHO growth standards study, measurements of growth were conducted every two weeks in the first two months and then monthly thereafter (WHO Multicentre Growth Reference Study Group, 2006). Therefore, the reduced monitoring in the NCHS sample may have missed crucial growth spurts in the first six months of life in this sample resulting in a flawed standard (De Onis et al., 2006).

The CDC 2000 growth charts were an alternative growth monitoring tool used mainly in United States of America (De Onis and Onyango, 2003). The CDC growth charts were developed using various surveys from 1963 to 1994 (De Onis et al., 2007). It was found that breastfed infants and young children' growth was more rapid in the first two months of life but slowed down from three to 12 months when assessed using CDC growth charts (De Onis and Onyango, 2003). Therefore, there was a clear divergence in growth patterns of healthy breastfed infants and young children and those used in a sample to construct CDC growth charts (De Onis and Onyango, 2003). This indicated a need to construct a new reference based on breastfeeding infants and young children raised in optimal conditions (De Onis and Onyango, 2003). After the development of the WHO growth standards, differences between the CDC growth standard and the WHO growth standards for weight-for-age, age group and other growth indicators were found (De Onis and Onyango, 2003). This is mainly attributed to sample and measurement intervals and also differences in feeding methods, where a larger proportion of CDC sample was formula-fed (De Onis and Onyango, 2003).

Inadequacies of the NCHS reference and CDC growth charts led to the development and subsequent implementation of the WHO child growth standards in April 2006 (WHO Multicentre Growth Reference Study Group, 2006). Botswana was one of the first African countries to adopt this new standard (De Onis et al., 2012). Botswana like many other countries, chose to adopt weight-for-age indicator, sex-specific charts and the *z*-score classification (De Onis et al., 2012). The preference for weight-for-age was most likely influenced by the need to align with Millennium development goal

four (indicator four), which sought to halve the prevalence of underweight in children aged five or less (UN, 2015). However, in Botswana, this unintentionally resulted in less focus in assessing stunting, because length measurements are only conducted twice a year in most health facilities. This level of monitoring is inadequate, considering that stunting is more prevalent and also has a lasting impact on the future development of children than underweight and wasting (Leroy et al., 2014).

Gross motor development monitoring

Gross motor development is an important part of early childhood (Kit et al., 2017: Wijnhoven et al., 2004). Gross motor development is important because it assesses an infant's interaction with the environment and has also been linked to their communicative development (Kit et al., 2017: LeBarton & Iverson, 2016). Therefore, timely monitoring of gross motor development is important in order to address problems early if identified (Kit et al., 2017). Motor development in children is assessed based on the age they are able to reach set milestones (Ghassabian et al., 2016). It is also important to understand the sequence in which they achieve these milestones (Ghassabian et al., 2016: Wijnhoven et al., 2004). To this effect, The WHO multicentre growth reference study also assessed gross motor development by following infants and young children from United States, Ghana, India, Norway and Oman from four months until they could walk independently (Wijnhoven et al., 2004). This study identified six gross motor milestone which included sitting without support, hands-and-knees crawling, standing with assistance, walking with assistance, standing alone and walking alone (Wijnhoven et al., 2004). The

Ministry of Health and Wellness in Botswana adapted these milestones and included them in the child health card (See Appendix 1).

It is therefore important that the child health card is audited periodically to ensure that growth and developments of infants and young children are done correctly. This especially relevant in context of improving nutrition and health outcomes in infants and young children because a child health card can be useful for clinical practice, research and policy planning (Hawley et al., 2014).

1.3.2 Child Undernutrition

Malnutrition refers to deficiencies, excessive or inadequate intake of energy and/or other nutrients leading to undernutrition, overnutrition and/or micronutrient deficiencies (WHO, 2017). Figure 1.3.1 shows the definition and types of malnutrition in children. Undernutrition is one form of malnutrition whereby there is an inadequate intake and/or utilisation of nutrients leading to stunting, wasting and/or micronutrient deficiencies (Soeters et al., 2017: Black et al., 2013). Even though the classification of undernutrition has transitioned from kwashiorkor and marasmus in areas with endemic malnutrition, the underlying causes have not changed (Soeters et al., 2017). It is still mainly caused by inadequate intake of energy and/or protein (Soeters et al., 2017). Undernutrition remains one of the main underlying causes of deaths in children aged five years or younger in developing countries accounting for over 45% of these deaths (Black et al., 2013: UNICEF, 2013).

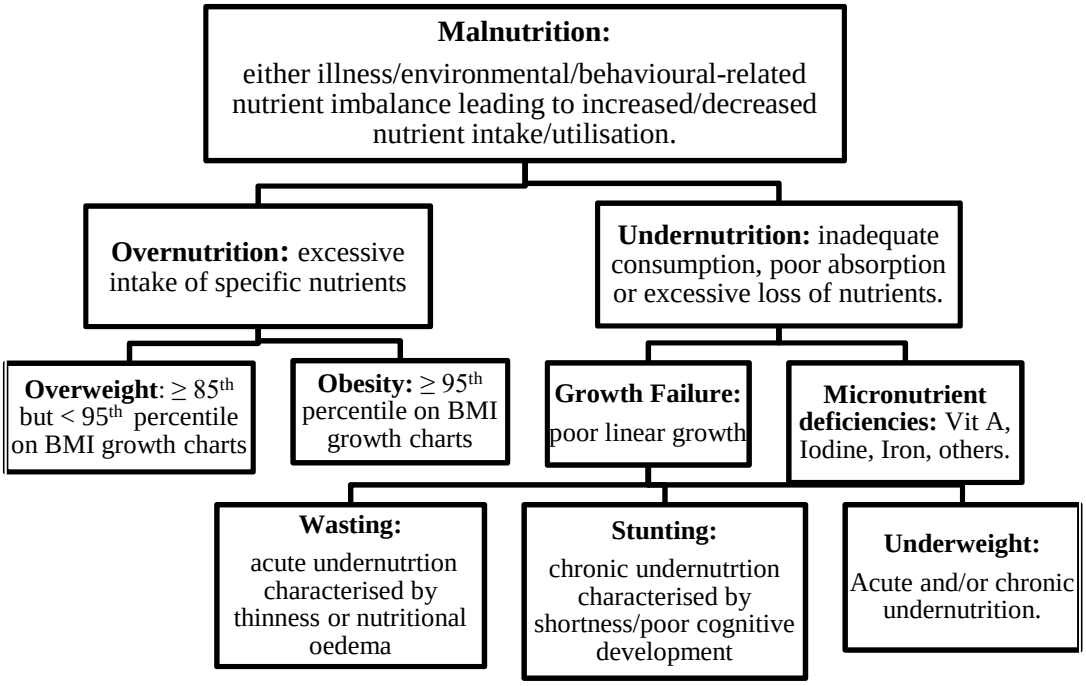


Figure 1.3.1: Definition and types of malnutrition in children

Source: Framework designed using definitions from Corkins (2017), Javed et al., (2013), Saunders et al., (2015), De Onis and Branca (2016) and Black et al., (2013).

1.3.3 Indicators of child undernutrition

There are a number of indicators used to measure and interpret undernutrition in children (WHO, 2006). These indicators rely on measurement of weight, height (taken whilst a child is standing for children aged above 24 months/ taller than 85 cm) or length (taken in recumbent position for children aged less than 24 months or ≤ 85 cm) (WHO, 2006). Other measurements not routinely taken include mid-upper-arm-circumference (MUAC), waist circumference, skinfolds and head circumference (WHO, 2006). These measurements are then used to develop indices which are in turn used to construct indicators (WHO, 2006). These indicators provide a comprehensive measure and

understanding of a child's nutritional status (WHO, 2006). Indices often utilise more than one measurement in order to develop an indicator (WHO, 2006). Commonly used indices include length/height-for-age, weight-for-age and weight-for-height/length (WHO, 2006). These indices are often reported using *z* scores, percentiles or percent of median (WHO, 2006). Many countries globally including Botswana have adopted use of *z* scores as their preferred indices (De Onis and Onyango, 2003). *Z* scores, also known as a standard deviation score from a reference population indicates how much a child's value for example for weight-for-age deviates from the median value of the reference population (WHO, 2006).

When these indicators are lower than they should be, they are referred to as low-weight-for height/length, low height/length-for-age and low weight-for-age, indicating wasting, stunting and underweight respectively (WHO, 2006). The cut-offs used for all the indicators is a z-score of < -2, which signify that a child is either wasted, stunted or underweight (WHO, 2006). A score of ≤ -3 indicates an even worse state of undernutrition, referred to as severe (WHO, 2006). These three indicators are discussed below;

> *Low weight-for-height/length (Wasting):* wasting is measured using weight and height/length (WHO, 2006). Therefore, a score of <-2 SD indicates a state of wasting which signifies acute and rapid weight loss usually due to an acute episode of disease and/or starvation (Collins et al., 2006). Wasting is also indicated by bilateral pitting oedema or MUAC of <110 mm in children aged 1-5 years (Collins et al., 2006).

Low height/length-for-age (Stunting): stunting is a chronic indicator of poor nutrition compared to wasting mainly due to prolonged inadequate intake (Collins et al., 2006). Stunting is whereby a child's stature is smaller than expected for their age (UNICEF, 2013). Stunting has become an important indicator of undernutrition in the last few years, mainly due to its association with poor brain development (De Onis and Branca, 2016).

Low weight-for-age (Underweight): Underweight is a composite form of undernutrition which indicates both wasting and stunting (Collins et al., 2006). The use of underweight as an indicator is on the decline as a focus on stunting increases (De Onis and Branca, 2016).

Focus on stunting as the best indicator

Global focus on stunting has grown over the years (UN Sustainable Development, 2017). This has been reinforced by the adoption of stunting as one of the targets in the SDG's (UN Sustainable Development, 2017). Therefore, a number of countries are now adopting stunting as the main indicator of their progress in improving nutritional status of their infants and young children (UN Sustainable Development, 2017: De Onis and Branca, 2016).

Stunting has, for many years been under-diagnosed especially in areas where being short stature is considered normal or inherited as opposed to being due to chronic intergenerational undernutrition (De Onis and Branca, 2016). In addition, the difficulty in intuitively recognising stunting and also the limited routine assessment of height/length has

allowed stunting to largely grow without intervention (De Onis and Branca, 2016). In Botswana, for example measurement of height/length in children is conducted only twice a year. Therefore, more focus on stunting as an indicator of undernutrition would be welcome, mainly because stunting affects more children globally than wasting and underweight (UN, 2015). In addition, stunting is associated with poor cognition thus poor educational performance resulting in adults who are unable to reach their full potential (Arabena, 2014). Stunting as an indicator also links well with the first 1000 days, during which children's linear growth is most vulnerable to poor nutrition and other environmental factors (De Onis and Branca, 2016). Therefore, preventing stunting within the first 1000 days is one way of providing children with the best start to life (De Onis and Branca, 2016). However, addressing stunting is a challenge because it is caused by a number of factors such as household, environment, socioeconomic and cultural (Walker et al., 2007).

Other indicators of undernutrition

Other indicators of undernutrition in children aged less than five years include micronutrient deficiencies, mid-upper arm circumference lower than 110 mm and low body mass index for age (WHO, 2006). However, these are not routinely measured in health settings in Botswana.

1.3.4 Prevalence of, stunting, underweight and wasting

Undernutrition in children, in its three forms (wasting, stunting and underweight) affects millions of children globally (Black et al., 2008). The prevalence of undernutrition is based on a number of national surveys from at least 139 countries (Black et al., 2013). These surveys used comparable methods based on the 2006 WHO growth standards (Black et al., 2013).

Stunting in decline globally

The prevalence of stunting has declined worldwide, however the level of decline is inconsistent across WHO regions (UN, 2015). Globally, stunting affected 23% of all children in 2016 (WHO, 2017). This translates to at least 54 million children (WHO, 2017). Stunting declined by 36% in the last two decades (WHO, 2017). East Asia and the pacific experienced the greatest reduction (approximately 70%) in prevalence of stunting during this period (UN, 2015). However, the African region still had the highest prevalence of stunting at 33.5%, only managing to reduce prevalence of stunting by approximately 17% by end of 2016 (WHO, 2017).

Southern Africa experienced a steeper decline in prevalence of stunting compared to other sub-Saharan African regions (WHO, 2017). In addition, in 2016 Southern Africa had the lowest prevalence of stunting at 28.4 % amongst other sub-Saharan countries (WHO, 2017). Botswana as other countries in southern Africa has seen a decline in prevalence of stunting in the last two decades (WHO, 2017). Stunting declined from 35.1 in mid-1990's to approximately 31.4% in 2008

(WHO, 2017). Currently, approximately 31.3% of children aged five years or less in Botswana are stunted (WHO, 2017). Therefore, stunting did not decline significantly in Botswana compared to other sub-Saharan African countries in the last two decades.

Underweight in decline but MDG target not met in all regions

In 2015 when MDG's transitioned into the new development goals, underweight was in decline globally (UN, 2015). It was estimated that the prevalence of underweight had been reduced by almost 50% from 1990 to 2015 (UN, 2015). Therefore, MDG 1 target of halving the number of under-fives who are underweight was achieved globally (UN, 2015). However, regions such as sub-Saharan Africa were less successful, not managing to meet this target because underweight was reduced by only 31% during this period (UN, 2015). It was estimated that globally, 90 million children were underweight in 2015 (UN, 2015). Approximately, 90 % of these children lived in southern-Asia or sub-Saharan Africa (UN, 2015).

Overall, Botswana saw a decline in prevalence of underweight between 1996 and 2008 from 15.1% to 11.2 % (WHO, 2017), therefore, not achieving the 50% reduction.

Wasting burden inconsistent across WHO regions

Moderate and severe wasting affects millions of children worldwide (WHO, 2017). Even though wasting declined globally by 11% between 1990 and 2011, more than 29 million under-fives were still wasted (UN, 2015). The burden of wasting is highly variable across the world, 25 of

the 52 million children live in India (UN, 2015). Sub-Saharan Africa also has high number disproportionate number of children who are wasted, one in every ten wasted children lives in this region (UN, 2015). Despite a decline in wasting over the last two decades in this region, the number of wasted children has increased to a third due to population growth (UN, 2015). Wasting in under-fives has declined in Botswana from 13.2% in 1996 to 7.4% in 2008 (WHO, 2017). Currently, wasting in under-fives is estimated at 7.2% (WHO, 2017).

1.3.5 Determinants of child undernutrition

Determinants of undernutrition are captured in the UNICEF conceptual framework (Figure 1.3.2). Causes of undernutrition though multiple can be clustered into three main groups; food, health and care (UNICEF, 2013). Food factors are those that relate to the nutritional intake and thus nutritional status of the child (UNICEF, 2013). In order to achieve optimal nutritional status, a child requires access to diverse and nutrient-rich food (UNICEF, 2013). In addition, appropriate maternal and child-care practices are required to ensure optimal health of the mother and the child (UNICEF, 2013). Adequate access to health services, healthy environment, safe drinking water, sanitation and hygienic practices are also required for optimal nutritional and health status of children (UNICEF, 2013). According to this framework the causes of undernutrition can be seen as interconnected with one set of causes having an impact on other causes. Basic causes include inadequate financial, human, physical and social capital (UNICEF, 2013). Countries with inadequate capital in these areas are likely to have higher prevalence of undernutrition (UNICEF, 2013). Inadequate capital results in inadequate household access to adequate

and quality resources such as land, education, employment and income (UNICEF, 2013).

Basic causes have an impact on the underlying causes of undernutrition. Underlying causes have been studied extensively with a number of studies conducted in Africa showing that food insecurity at the household level leads to undernutrition in children (McDonald et al., 2012; McGrath et al., 2012; Kiwani-Murage et al., 2011). Food insecurity causes undernutrition because when there is lack of adequate, quality and varied foods in the home it leads to lack of intake of various nutrients, most often energy and protein (Cordeiro et al., 2012). Food insecurity is mainly due to poverty because households with less income to spend on food have a higher risk of food insecurity (Thorne-Lyman, 2010; Osei et al, 2010). Poverty has been identified as the major determinant of undernutrition in all regions of the world (UN, 2015).

Other underlying causes include inadequate feeding and care practices and lack of sanitation (UNICEF, 2013). Poor feeding practices lead to an inadequate intake of nutrients required for optimal growth, often leading to undernutrition (McDonald et al, 2012). A study by Mokori and Orikushaba (2012) demonstrated that poor feeding practices such as lack of feeding and poor dietary choices correlated with poor nutritional status in children aged 6 -23 months.

Poor sanitation has also been associated with undernutrition because poor sanitary practices such as inappropriate disposal of excreta and poor hand washing often leads to diarrhoeal diseases (Fewtrell et al., 2005). Repeated episodes of diarrhoeal disease in turn cause undernutrition because of poor

absorption of nutrients in the gut and also due to inadequate oral intake during an episode of diarrhoea (Dewey et al., 2011). Poor sanitary practices are common in developing countries, where a large number of households do not have appropriate means of disposing human waste (Fewtrell et al., 2005). This is more likely to lead to contamination thus causing diarrhoea (Fewtrell et al., 2005).

Underlying causes have a direct impact on the immediate causes of undernutrition (UNICEF, 2013). Immediate causes include inadequate dietary intake and disease (UNICEF, 2013). Inadequate dietary intake thus inadequate nutrition to meet requirements leads to undernutrition (Mokori and Orikushaba, 2012). Inadequate intake is mainly due to three factors; household food insecurity, inadequate care and poor feeding practices and disease (UNICEF, 2013). As indicated above, food insecurity deprives a child of the required nutrients in the right amounts (Thorne-Lyman, 2012).

Disease causes undernutrition through a twofold effect, diseases such as diarrhoea cause poor absorption of nutrient in the gut resulting in loss of nutrients (Dewey, 2011). In addition, disease also results in undernutrition by causing poor oral intake, a child who is unwell is often unable to take adequate amounts of foods orally leading to inadequate intake (Dewey, 2011). The same effect is induced by poor feeding practices as this also results in disproportionate intake of various nutrients leading to undernutrition (Mukhopadhyay et al., 2013).

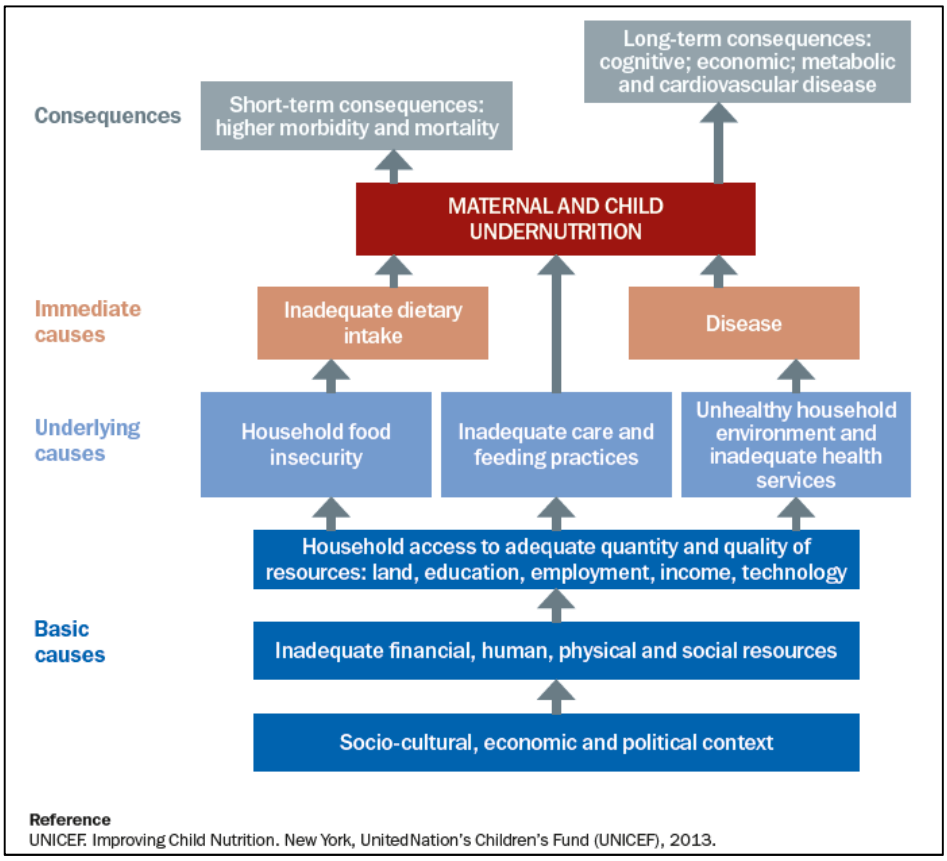


Figure 1.3.2: Conceptual framework of the determinants of child undernutrition

Source: UNICEF (2013)

Barker-Hypothesis and relevance to subsequent growth and development of infants and young children

Barker hypothesis states that increased risk of diseases in adulthood can be attributed to adverse influences during the early development especially during the intrauterine life (de Boo & Harding, 2006). Barker and his colleagues found that high infant mortality in 1921-1925 was associated with high rates of ischaemic heart disease 47-53 years later in same geographical locations

(Barker & Osmond, 1986). The commonly registered cause of mortality during this time was low birthweight, this resulted in the hypothesis that low birthweight infants and young children who have survived are at a higher risk of coronary heart disease later in life (Barker, 2012: de Boo & Harding, 2006). Subsequent studies have indicated that normal term (as opposed to premature) decreased birthweight did increase the risk of heart disease later on life (Barker et al., 1993). Other studies have also further advanced this hypothesis by showing a relationship between reduced birthweight and other diseases such as hypertension, type-2 diabetes mellitus and hyperlipidaemia (de Boo & Harding, 2006).

This hypothesis has important implications for low-middle income countries because a great majority of low birthweight infants and young children are born in these countries (de Onis et al., 1995). This hypothesis is especially relevant in these countries because obesity even though increasing significantly, has not risen to a level that has resulted in larger mothers and babies, as evidenced by high rates of low birthweight (WHO, 2003). It is therefore crucial that birthweight is improved in these countries to ensure that infants and young children have a better chance of optimal growth and development and to also reduce their risk of chronic diseases later in life (Adair & Prentice, 2004). This can be achieved by ensuring adequate nutrition and health of adolescent girls and women of child bearing age (Barker, 2012).

The individuals from developing countries are vulnerable to poor nutrition as shown in four phases; phase one occurs due to nutritional deprivation (common in developing countries), leading to what is termed thrifty genotype (Neel, 1962). Phase two, is whereby due to the previous nutritional deprivation,

women fail to grow to their full genetic potential thus imposing uterine restrictions on the developing foetus (Hales & Barker, 1992). The third and fourth phases are the fetal and postnatal phases in which the growth and development of the child can be affected (Hales & Barker, 1992). The second, third and fourth phases are known as thrifty phenotype whereby the metabolic and endocrine systems are not well adapted to later nutritional excess due to earlier adaptation to meagre substrate supply (Hales & Barker, 1992).

1.3.6 Development Goals and Undernutrition

Development goals are a useful framework within which countries can implement programmes that can improve the wellbeing of their populations (UN, 2015). As observed from the MDGs and the current SDGs, specific goals have been set aside to improve the health and wellbeing of children especially those aged under five years (UN, 2015). In order to achieve these development goals, adequate investment at a global and national levels in the health and nutritional status of infants and young children is crucial (Kimani-Murage et al., 2011). Central to this investment is the need to sufficiently address the challenges of undernutrition, in order to significantly reduce mortality due to undernutrition in these children (UN, 2015, UNICEF, 2013). In addition, it is important to concentrate this investment in the first 1000 days of a child's life in order to get the best value for money (UN, 2015: Arabena, 2014).

1.3.6.1 Millennium Development Goals

Millennium Development Goals (MDGs) were developed by members of the United Nations at the millennium summit in September 2000 (UN, 2015). The leaders of various member states adopted the UN Millennium Declaration, a commitment of nations to a global

partnership that aimed to reduce poverty, improve health, and promote peace, human rights, gender equality and environmental sustainability (UN, 2015).

These millennium development goals were time-specific and aimed to address the above stated issues (UN, 2015). The timeline set for the achievement of these goals was 15 years, the end of MDGs period was in 2015 (UN, 2015). Two of the eight MDGs (Goal 1 and 4) directly addressed the nutritional status, morbidity and/or mortality of under-fives. It should be noted that other goals have an indirect impact on the morbidity and/or mortality of children under five years of age. Goals 1 and 4 and their relevant targets will be discussed below;

Millennium Development Goal 1: Eradicate extreme poverty and hunger

Millennium development goal one (MDG 1) aimed to eradicate extreme poverty because people who are extremely poor are more likely to suffer from hunger (UN, 2015). Hunger exists in individuals who on a number of occasions do not have access to adequate quantity and quality food and/or nutrients (Hickel, 2016). Extreme poverty is defined as living on less than $1.25 a day (UN, 2015). In 1990, two billion people lived on less than $1.25 day (UN, 2015). This has declined significantly over the years, however 1.01 billion people are still extremely poor (UN, 2015). The first of the three targets of MDG 1 aimed to halve, between 1990 and 2015 the proportion of people whose income was less than $1 day per day (UN, 2015). This income

was later revised to less than $1.25 per day (UN, 2015). This target was achieved in 2015 because the number of people living in extreme poverty fell by more than half, from 1.9 billion in 1990 to an estimated 836 million in 2015 (UN, 2015). However, this may be misleading because this success was not replicated in all parts of the world, since most gains were made in eastern Asia particularly in China (UN, 2015). Sub-Saharan Africa had the least improvement towards achieving this target, only managing a reduction of 28% by 2015 (UN, 2015). Therefore, more than 40% of all people living in sub-Saharan Africa were still living in extreme poverty by 2015 (UN, 2015).

The third target for MDG 1 aimed to halve the proportion of people who suffered from hunger between 1990 and 2015 (UN, 2015). Prevalence of hunger as measured by undernutrition of all people, significantly shifted downwards globally, with a number of regions achieving marked reductions since 1990 (UN, 2015). However, these downward shifts in undernutrition were not replicated in southern Asia and sub-Saharan Africa (UN, 2015). Both regions did not manage to achieve the third target for MDG 1 (UN, 2015).

For children aged under five years, prevalence of underweight was used as an indicator for the third target of MDG 1 (UN, 2015). In 2015, it was estimated that the number of children aged under five who were underweight had been reduced by almost half (UN, 2015). However, a number of world regions including sub-Saharan Africa, were unable to reduce by half the number of under-fives who were moderately or severely underweight by 2015 (UN, 2015).

Extreme poverty and hunger are directly related to poor nutritional outcomes in all individuals including children (UNICEF, 2013). Poverty results in food insecurity which in turn causes undernutrition (Tanumihardjo et al., 2007). Children who live in circumstances of extreme poverty are unlikely to have access to a varied diet that provides adequate nutrients for normal growth and development (Tanumihardjo et al., 2007). This situation is exacerbated by findings that indicates that women who are often caregivers are more likely to live in poverty compared to men in sub-Saharan Africa (UN, 2015).

MDG 1's target 2 aimed to achieve full and productive employment and decent work for all, including women and young adults by 2015 (UN, 2015). However, globally employment was not adequate to meet the ever growing labour force by 2015, as indicated by a decline in the employment to population ratio (UN, 2015). This ratio shows the proportion of the working age population that is employed (UN, 2015). The employment to population ratio fell from 62% in 1991 to 60% in 2015 (UN, 2015). This target relates to two other targets discussed above because full and productive employment for all is crucial for eradicating extreme poverty and hunger (UN, 2015). Mainly because, if employment opportunities diminish people are likely to be poor thus likely to go hungry (UN, 2015).

Millennium Development Goal 4: Reduce child mortality

In 2015 it was estimated that 16, 000 children aged less than five years died each day globally (UN, 2015). These deaths were much higher in

1990, which in turn prompted countries to commit to reduce by two thirds (approximately 67%), the number of under-fives dying from preventable causes between 1990 and 2015 (UN, 2015). The latest estimates indicate that globally, child mortality has declined by more than half (approximately 50%), falling from 90 to 43 deaths per 1000 live births between 1990 and 2015 (UN, 2015). However despite these impressive reductions in mortality, at the current rate of decline, it will take approximately ten years to meet the global target in reduction of child mortality (UN, 2015). As shown in Figure 1.3.3, of all the nine world regions, only eastern Asia managed to achieve this goal by 2015 (UN, 2015).

Developed regions such as Europe, Northern America, Australia and New Zealand have lower child mortality rate than less developed regions (UN, 2015). Since 1990, countries in developed regions have reduced mortality rate in under-fives by over 60%, resulting in mortality rate of 6 deaths per 1000 live births (UN, 2015). Less developed regions which include large parts of Asia, Africa, Caribbean, South and Central Americas are much farther away from the target (UN, 2015). Since 1990 less developed regions only managed to reduce under-fives mortality rate by 53%, falling short of the required 67% (UN, 2015).

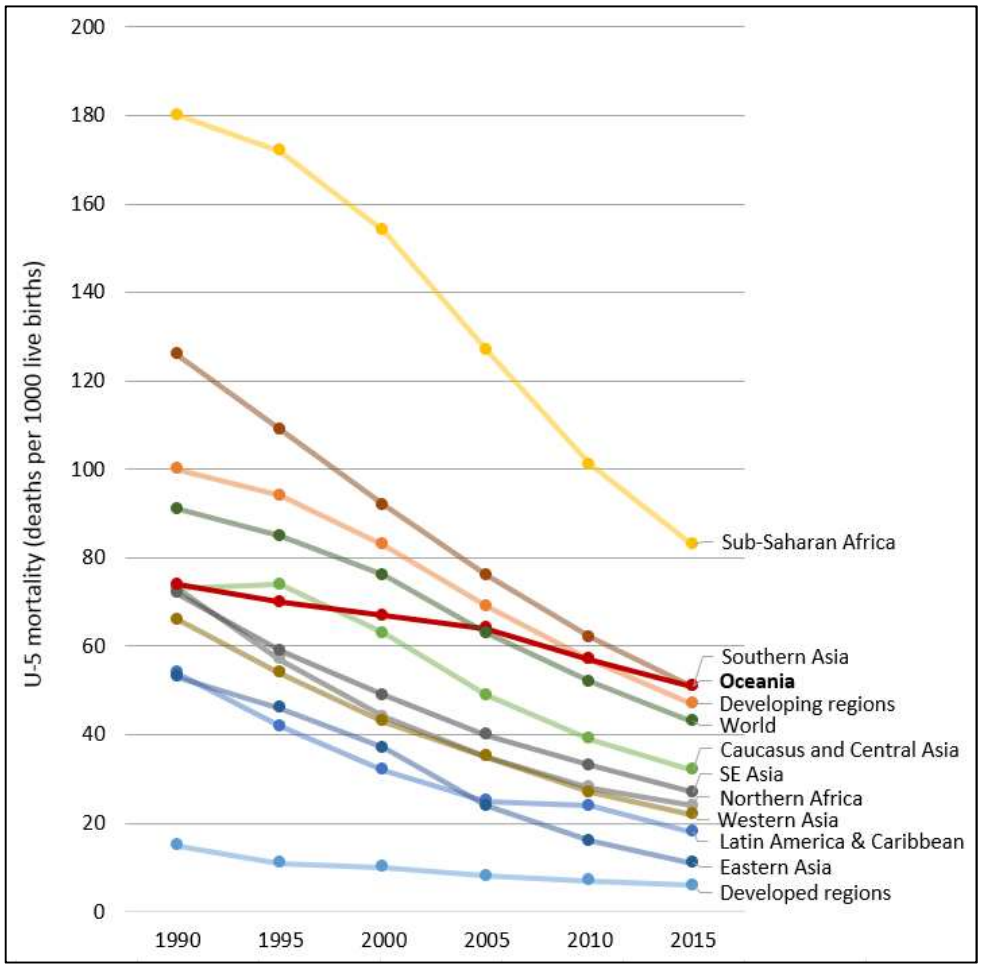


Figure 1.3.3: Under-Five mortality rate, 1990 - 2015 (Deaths per 1000 live births)

Source: UN (2015)

Child Mortality in sub-Saharan Africa

Sub-Saharan countries reduced child mortality by 52% from 1990 to 2015 (UN, 2015). This is below the 67% target reduction set in 1990. Of all the six million children who died globally in 2015, half were from sub-Saharan Africa (UN, 2015). Therefore, children aged less than five years are more likely to die of preventable causes (see section1.3.5) in sub-Saharan Africa than any other major region in the world (UN, 2015). Furthermore, of all the world regions, sub-Saharan Africa is the only world region which is

expected to see an increase in the number of live births and children aged under five (UN, 2015). Therefore, absolute child mortality is expected to increase over the next decade, unless advances are made in reducing this mortality rate, faster than the increase in population (UN, 2015).

Child Mortality in Botswana

Under five mortality in Botswana has generally declined over the years (Figure 1.3.4). Child mortality was 54.2 per 1000 live births in 1990 and then rose gradually before reaching a peak of 82.9 per 1000 live births in 2000, it then gradually declined to 43.6 by 2015 (WHO, 2015). This decline was achieved mainly by implementing MDG and its associated initiatives (WHO, 2015). However, despite this success, Botswana like many other sub-Saharan Africa countries, was not able to reduce the mortality rate of under-fives by two thirds by 2015 (UN, 2015). The target under-fives mortality rate for Botswana was 17.9 per 1000 live births however as shown in Figure 1.3.4, Botswana had 43.6 per 1000 live births in 2015 (WHO, 2015). This is more than two and half times the target. Therefore, sub-Saharan Africa and Botswana did not meet MDG 4 by 2015 however, Botswana did worse because the African region managed to reduce child mortality by 52% while Botswana only managed a paltry 19.6% (UN, 2015). This may be due to the fact that Botswana experienced a sharp rise in mortality rate in 2000 to 82.9% 8 (see Figure 1.3.4). Therefore, Botswana had to work harder to reduce this higher mortality over the following years.

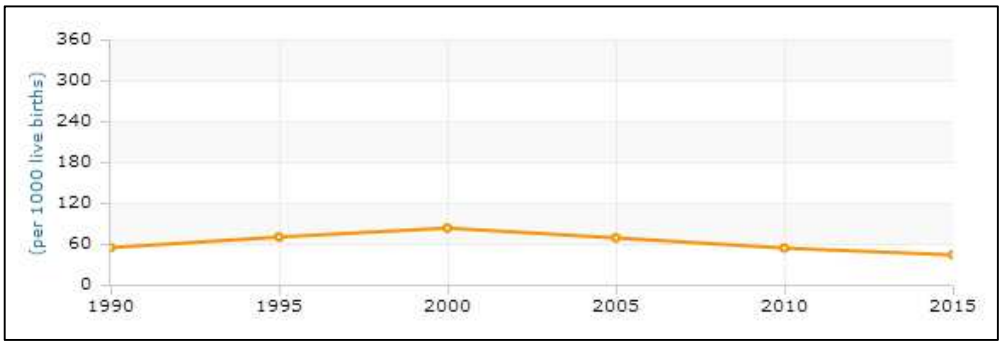


Figure 1.3.4: Under five mortality rate 1990-2015 in Botswana

Source: WHO (2015)

1.3.6.2 Sustainable Development Goals

Sustainable development goals, commonly known as SDGs were developed to replace the Millennium Development Goals (MDGs) which ended in 2015 (UN, 2015). These goals were hailed as the world's 2030 agenda for sustainable development aiming to "transform our world" (UN, 2015). SDGs are in many ways an expansion on MDGs because they consist of 17 goals, this is more than twice the size of the MDGs. However, they also sought to complete what was not accomplished in the MDGs (UN, 2015).

SDGs have a number of targets for each goal (UN, 2015). Two of the SDGs (Goal 2 and 3) also directly addresses the nutritional status, morbidity and/or mortality of under-fives. Other goals have an indirect impact on the morbidity and/or mortality of children younger than five years and are designed to work in synergy to allow achievement of these goals. Sustainable development goals 2 and 3 and their relevant targets will be discussed in brief.

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

This goal is a repetition of MDG's goal 1 with an added element of promoting sustainable agriculture. It should be noted that this target has changed to align with new evidence that recommends the use of stunting as a measure of nutritional status for children aged under five years. This was in response largely to ground breaking work done by Black et al (2008).

Goal 3 Ensure healthy lives and promote well-being for all ages
This goal was adapted from the MDG 4 which aimed to reduce child mortality (UN, 2015). Target 2 of this goal aims to "end preventable deaths of new-borns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births by 2030" (UN, 2015). This target is important because despite strides made in the 15 years to 2015, all world regions except Asia were not able to achieve this target (UN, 2015).

1.3.7 Child Mortality and undernutrition

Undernutrition is strongly associated with mortality in children (Black et al., 2013). It was estimated that undernutrition defined in various forms such as poor foetal growth, stunting, wasting, underweight, micronutrient deficiencies and sub optimal breastfeeding accounted for 45% of all deaths in children in 2011 (Black et al., 2013).

Table 1.1 shows the contribution of various forms of undernutrition to mortality in children aged less than five years. Stunting, accounted for over 14% of all deaths (1.02 million) (Black et al 2013). Other forms of undernutrition such poor foetal growth, wasting, underweight, micronutrient deficiencies and sub optimal breastfeeding caused a further 2.28 million deaths (Black et al., 2008). This resulted in approximately 3.1 million deaths in children equalling approximately 45% of all deaths in children at this age (Black et al., 2013).

Foetal growth restriction

Foetal growth restriction, indicated by being small for gestational age (SGA) for babies born pre term or full term caused over 800 000 deaths in children aged less than 5 years (Black et al., 2013: Black et al., 2008). SGA is indicated when a foetus or new-born infant's weight and/or crown to heel length is smaller than expected for their gestational age and sex (Saenger et al., 2007). SGA was previously measured using low birthweight due to lack of population- based birthweight and gestational age data (birthweight of less than 2500g), however use of low birthweight as a measure for SGA is not accurate as it includes premature infants and young children who are small but actually have weight and length appropriate for their gestational age (Saenger et al., 2007: Black et al 2008). SGA was estimated to have affected over 32.4 million children in 2010 (Black et al., 2008). Risk of mortality is higher in infants and young children born SGA compared to those born with appropriate weight and/or length for their gestational age (Katz et al., 2013). In addition, the attributable risk of SGA for outcomes of stunting

and wasting in children is 20% and 30% respectively (Christian et al., 2013).

Underweight, Stunting and Wasting

Underweight, stunting and wasting collectively caused most deaths in under-fives compared to other nutritional disorders (Black et al., 2008). Children with a *z* score of less than -2 have a higher risk of death compared to those with normal *z* score (Black et al., 2008). In addition, this risk of death increased significantly as the *z* scores declined further (Black et al., 2008). Using data sets from eight low income countries in Africa, Asia and south Asia it was found that odds ratio for mortality was 9.7, 4.1 and 9.4 for underweight, stunting and wasting respectively for causes of death including diarrhoea, pneumonia, malaria and measles (Black et al., 2008). Of all these conditions, diarrhoea had the highest risk for death, indicating that a child's risk of death increased significantly if they presented with diarrhoea and a low *z* score for underweight, wasting or stunting (Black et al., 2008: Black et al., 2013).

Underweight, stunting and wasting cause mortality in children aged under five years by acting as a precursor through synergistic association with infectious diseases (Black et al., 2008). Therefore, a child who is underweight, stunted or wasted is more likely to die from diarrhoea, pneumonia, malaria and/or measles (Black et al., 2008). By treating these forms of undernutrition, at least 30% of deaths due to diarrhoea, pneumonia, malaria and measles can be prevented (Black et al., 2008).

Breastfeeding and undernutrition

Sub-optimal breastfeeding in children aged 0 -23 months resulted in over 800 000 deaths in 2011 (Black et al., 2013). This is equivalent to 11.6% of total deaths in these children (Black et al., 2013). Exclusive breastfeeding for the first 6 months of life and continued breastfeeding even through to a child's second birthday is recommended (WHO, 2017). Most world regions are struggling to achieve exclusive breastfeeding in majority of their populations; 47-57% of African, Asian and Latin American mothers managed to exclusively breastfeeding their infants and young children for only 2 months (Black et al., 2008). This declines gradually to about 6% continued breastfeeding when the infants and young children are 6-11 months in Africa (Black et al., 2008). The risk for mortality increases gradually for children who predominantly receive breastmilk to those who are not breastfed (Arifeen et al., 2001: Bahl et al., 2005: Edmond et al., 2006). Children who have never breastfed are 14 times more likely to die from all-cause mortality (diarrhoea and pneumonia) than those who predominantly breastfeed (Arifeen et al., 2001: Bahl et al., 2005: Edmond et al., 2006). The benefits of breastfeeding have been studied extensively. Evidence shows that breastmilk confers protection against infections by helping an infant build a stronger immunologic response, improves infant's nutritional status and also improves their neurodevelopment (Arifeen et al., 2001: Bahl et al., 2005: Edmond et al., 2006). Most of these benefits are protective against mortality

(Arifeen et al., 2001: Bahl et al., 2005: Edmond et al., 2006: Black et al., 2013).

Micronutrient deficiencies

Micronutrient deficiencies of iron, zinc and vitamin A are also linked to mortality in children aged under five years (Black et al., 2008). However, they contribute much less to mortality compared to other causes; estimated to have contributed 1.7% and 2.3 % to under-fives mortality respectively in 2011 (Black et al., 2013). Globally, over 33.3%, 18.1% and 17.3% of children are deficient in vitamin A, iron and zinc respectively (WHO, 2017: Andersson et al., 2012: Wessels and Brown, 2012). Of all the world regions, the African region has the highest prevalence's of micro nutrient deficiencies, with figures above global ones for all deficiencies (WHO, 2017: Andersson et al., 2012: Wessels and Brown, 2012: Stolzfus et al., 2004).

Table 1.1: Deaths attributed to undernutrition globally in children aged under 5 years

Indicator for undernutrition	Attributable deaths with UN prevalences[1]	Proportion of total deaths of children younger than 5 years	Attributable deaths with NIMS prevalences[2]	Proportion of total deaths of children younger than 5 years
Foetal growth restriction (<1 month)	817 000	11.8%	817 000	11.8%
Stunting (1 -59 months)	1, 017 000	14.7%	1, 179 000	17.0%
Wasting (1-59 months)	999 000	14.4%	1, 180 000	17.0%
Severe wasting (1-59 months)	875 000	12.6%	800 000	11.5%
Zinc deficiency (12 -59 months)	516 000	7.4%	540 000	7.8%
Vitamin A deficiency (6-59 months)	116 000	1.7%	116 000	1.7%
Suboptimum breastfeeding (0 - 23 months)	804 000	11.6%	804 000	11.6%
Joint effects of foetal growth restriction, suboptimum breastfeeding in neonates	1, 348 000	19.4%	1, 348 000	19.4%
Joint effects of foetal growth restriction, suboptimum breastfeeding, stunting, wasting, and vitamin A and zinc deficiencies (< 5 years)	3, 097 000	44.7%	3, 149 000	45.4%

Sources:

Table adapted from Black et al (2013): Stevens et al (2012). Data is rounded to the nearest thousand.

Prevalence estimates from UN (2015).

Prevalence estimates from Nutrition Impact Model Study (Stevens et al., 2012)

1.3.8 The first 1000 days

The first 1,000 days of an infant's life are important as discussed in section 1.1. Therefore, if infants and young children receive optimal nutrition in the first 1000 days, they are as adults able to contribute significantly more to the economic and social development of their families, communities and nations (UNICEF, 2013: Leroy et al., 2014: Martorell, et al., 2009).

A shift of focus to the first 1000 days is based on various sources of evidence including a longitudinal study by Schroeder et al (1995) where Guatemalan children aged 3-84 months were randomised to either receive supplementation with higher energy and protein or one with limited energy (Schroeder et al., 1995). It was found that high protein/energy supplementation resulted in higher weight and length gains especially in infants and young children aged less than 24 months compared to older ones (Schroeder et al., 1995). Other studies have since demonstrated other benefits of optimal nutrition in the first 1000 days; these benefits include physical, cognitive, educational, health and socioeconomic productivity outcomes into adulthood (Leroy et al., 2014: Hoddinott et al., 2008: Martorell et al., 2009).

Optimal nutrition in the first 1000 days results in better outcomes, because linear velocity is greatest in the first two years of life at approximately 20cm per year and declines gradually to 12 -9 cm and to approximately 7 cm in the second to third year and from fourth to seventh year respectively (Schroeder et al., 1995). This is one of the main reasons why stunting is difficult if not impossible to reverse in older children (Leroy et al., 2014). In addition, sensitive periods for optimal development of sensory pathways for hearing and vision, language and higher cognitive function peak within the first 1000 days

(Arabena, 2014). Moreover, the prevalence of infectious diseases such as diarrhoea peaks around the time when infants and young children are weaned, around 4-6 months (Schroeder et al., 1995). Therefore, by ensuring optimal nutrition during this time, the negative effects of infectious diseases on infants and young children' nutritional status can be counteracted (Schroeder et al., 1995: UNICEF, 2013).

The key lifecycle stages in the first 1000 days can be divided into four distinct stages; adolescence and pregnancy, birth, 0-5 months and 6 -24 months (UNICEF, 2013). These lifecycle stage have been used to develop key nutrition interventions which are aimed at improving the nutritional status of the mother and the infant (UNICEF, 2013). These interventions seek to delay conception in adolescents whilst ensuring that women-of-reproductive age are in optimal nutritional and health status prior to pregnancy (Bhutta et al., 2013). There is also a focus on neonates, infants and young children and children where interventions such as the promotion of breastfeeding and optimal care practices, supplementation and prevention and timely treatment of diseases are recommended (Bhutta et al., 2013). The effectiveness of these interventions have been assessed by estimating the impact on lives saved, against the cost of implementation (Bhutta et al., 2013). The number of under-fives deaths can be reduced by 15% if these interventions can be scaled up to cover at least 90% of the population (Bhutta et al., 2013). In addition, implementing these interventions within the first 1000 days has yielded the highest rates of return in human capital (Silburn et al., 2011).

The lifecycle approach to nutrition is a cornerstone of the SUN movement and is a useful approach because it addresses the basic, underlying and immediate

causes of undernutrition (UNICEF, 2015: Bhutta et al., 2013). This is more effective as it now incorporates nutrition-sensitive approaches (UNICEF, 2015). Nutrition-sensitive are important because they address the underlying determinants of undernutrition such as household food insecurity, inadequate care and feeding practices and unhealthy houshold environment and inadequate health services. This lifecycle approach has to be augmented with treatment and prevention of HIV/AIDS by use of ART and further integration HIV/AIDS and maternal and child nutrition services (Lindegren et al., 2012).

1.3.9 HIV/AIDS: General Introduction

Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) has become one of the major public health issues since its official recognition in the 1980s (UNAIDS, 2017). Even though sub-Saharan countries were mostly affected initially, there has been a steady decline in the number of people dying from HIV/AIDS related illnesses over the last three decades (UNAIDS, 2017). Therefore, the progression of HIV to AIDS has been reduced considerably mainly due to the enrolment of millions of individuals in anti-retroviral therapy (ART) (UNAIDS, 2017). Prior to the discovery of ART an HIV diagnosis was essentially a death sentence since there were no viable medical treatment at the time (UNAIDS, 2017).

HIV is a type of virus that attacks a specific type of immune system cell in the body called CD4 helper lymphocyte cells (Buchbinder et al., 1994). This makes it hard for the body to fight infections, whatever they may be, rendering HIV infected individuals unable to fight off even minor infections (Fauci and Lane, 2005). HIV also uses these CD4 cells to make more of the virus (Langford et al., 2007). There are three clinical stages to HIV; first stage is the acute

infection stage whereby an infected individual has flu like symptoms two to four weeks following infection (Langford et al., 2007: Fauci & Lane, 2005: Miedema, 2006). The second stage is the clinical latency period whereby there are no symptoms, this stage lasts for a number of years (Langford et al., 2007). Lastly there is the AIDS stage where the CD4 cell count falls below 200 cells/mm^3, at this stage the individual is vulnerable to opportunistic infections (Langford et al., 2007: Fauci & Lane, 2005: Miedema, 2006).

Prior to the dissemination of ART the progression from HIV infection to AIDS was approximately 7-10 years in adults and shorter for infants and young children and elderly individuals (Lui et al., 1988: Murray et al., 1989). However, with the introduction of ART the progression of HIV to AIDS has been extended significantly, with some studies showing survival beyond 15 years (Schuetz et al., 2014: Calvert & Ronsmans, 2015: Ananworanich et al., 2016).

Pregnancy and progression of HIV

Mother to child transmission of HIV is whereby the woman infects her child with HIV during pregnancy, childbirth (during delivery) or through breastfeeding (UNAIDS, 2017). These three different points of transmission are therefore subject to interventions in order to reduce the risk of mother to child transmission of HIV (Calvert & Ronsmans, 2015). Central to these interventions is the provision of ART to the mother and her infant at different time points (WHO, 2016). In order to successfully prevent mother to child transmission of HIV, three conditions should exist; firstly, HIV should be detected as early as

possible during pregnancy, secondly there should be provision of ART during pregnancy and during birth, lastly, infants and young children born to HIV positive women should also receive ART (and antibiotics) post-partum for 4-6 weeks (WHO, 2016). Early detection of HIV and subsequent provision of ART is crucial as it improves the health of HIV positive women rendering them to symptomatic free for many years, thus allowing them to be able to care for their children (Wall et al., 2017: Matthews et al., 2016: Calvert & Ronsmans, 2015).

Early detection of HIV in pregnant women is one of the most successful population based testing of HIV (WHO, 2016). Early detection of HIV during pregnancy is perhaps the most step in preventing mother to child transmission of HIV because this allows the mother to receive ART timely thus reducing risk of transmission during pregnancy and birth (WHO, 2016). Countries such as Botswana have been so successful in testing for HIV in pregnant women that they have managed to achieve over 95% ART coverage in all HIV positive pregnant women (UNAIDS, 2017).

Provision of ART during pregnancy, birth and post natally to the mother and infant if breastfeeding is a crucial part of preventing mother to child transmission of HIV (WHO, 2016). However, provision of ART especially initially is heavily reliant on early detection of HIV through appropriate and reliable testing (WHO, 2016).

Various testing algorithms have been setup for testing of HIV in mothers, infants and young children (WHO, 2016). This includes

routinely offering HIV testing at the mother's first ante-natal visit (WHO, 2016). Currently in Botswana this is routinely done where a pregnant woman is offered an HIV test before being enrolled into an ante natal care program. In addition, HIV testing should be repeated in the third trimester and post-partum or during labour in HIV negative mothers (WHO, 2016). This further ensures that women who were infected during pregnancy are identified (WHO, 2016). In Botswana, HIV negative pregnant women are offered HIV testing every three months until they give birth. It is recommended that HIV testing is conducted in the HIV exposed infants and young children 4-6 weeks post natally (WHO, 2016). Currently in Botswana HIV exposed infants and young children are tested for HIV at 6 weeks. In addition if the mother (HIV positive) is breastfeeding the infant is also tested 6 weeks following cessation of breastfeeding (WHO, 2016). All infants and young children regardless of HIV exposure are also tested for HIV at 18 months (WHO, 2016).

Prevalence, burden and response

Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) is a major health challenge worldwide, affecting 36.7 million people (WHO, 2016). Approximately 52% of these people live in eastern and southern Africa (UNAIDS, 2017). In 2015 approximately 1.1 million people died from AIDS-related illnesses globally (WHO, 2016). However, the number of deaths has decreased by over 43% as the number of people enrolled in

antiretroviral treatment has increased over the last decade (UNAIDS, 2017).

Botswana, has one of the highest prevalence (22.2%) of HIV globally, only third to Lesotho and Swaziland (WHO, 2016: UNAIDS, 2017). Despite a slight increase in the prevalence of HIV in the last 10 years, new HIV infections have declined in all ages in Botswana (UNAIDS, 2017). The burden of HIV in terms of number of deaths has also decreased drastically, from 15 000 in mid-2000 to around 3200 in 2015 (UNAIDS, 2017). In addition, the number of orphans has also reduced to its lowest level of 60 000 in 2015 (UNAIDS, 2017).

Global response to HIV/AIDS

Three main interventions that were implemented in response to the HIV/AIDS pandemic are HIV testing and counselling, provision of antiretroviral therapy for all and prevention of mother-to-child transmission of HIV (WHO, 2017).

Free HIV/testing and counselling was made available in many countries in order to encourage individuals to test for HIV (UNAIDS, 2017). Early testing allows individuals to seek timely treatment if they are infected with HIV (UNAIDS, 2017). Regionally, North America has the highest percentage (86+ %) of people with HIV who know their status (UNAIDS, 2017). East and southern Africa has highest number of people with HIV, however only 62% of these individuals are aware of their statuses (UNAIDS, 2017). In contrast, Botswana has a higher proportion (80%) of people living with HIV who know their statuses

(UNAIDS, 2017). This indicates the increased availability of HIV testing and counselling services in Botswana.

Provision of antiretroviral therapy (ART) is one the most of important responses to HIV/AIDS because ART prevents progression of HIV to AIDS, improves patient's clinical outcomes and also decreases transmission of HIV (Gunthard et al., 2016). Provision of ART has increased steadily from around 24% in east and southern Africa in 2010 to around 54% in 2015 (UNAIDS, 2017). Botswana, as the first country in Africa to provide ART has managed to increase provision of ART from 50% to 78% between 2010 and 2015 (UNAIDS, 2017).

Prevention of mother-to-child transmission (PMTCT) of HIV aims to ensure that children born to HIV-positive women do not seroconvert (UNAIDS, 2017). PMTCT consists of ART provision to HIV positive mothers and their infants and young children and implementation of infant feeding and care policies (UNAIDS, 2017). PMTCT has been successful globally with the coverage of pregnant women with ART high in most parts of the world (UNAIDS, 2017). This coverage is even higher in east and southern Africa, with about 90% of HIV positive mothers having access to ART (UNAIDS, 2017). This has translated to mother-to-child transmission (MTCT) of HIV of less than 5% in some of the countries in sub-Saharan Africa (UNAIDS, 2017). However, a number of countries have failed to reach this target, for example Nigeria has MTCT rates of over 23% (UNAIDS, 2017). Botswana has managed to reduce MTCT of HIV by approximately 63% in order to achieve a final transmission rate of 2.6% (UNAIDS, 2017). However, this is

above the target of less than 2% since Botswana is a non-breastfeeding global plan priority country (UNAIDS, 2017).

Transition from option B to option B+ regimen

Option B+ regimen is whereby HIV positive women are offered lifelong ART as soon as they are diagnosed with HIV instead of waiting for their CD4 count to reach a certain level as it was the criteria in the option B regimen (UNAIDS, 2017). Therefore, option B+ allows more HIV positive women to start ART without delay therefore they are more likely to be healthier and able to protect their infants and young children and partners from HIV infection (UNAIDS, 2017). The transition to option B+ may also reduce the final MTCT of HIV (UNAIDS, 2017). Currently in most sub-Saharan countries there is a large disparity between six-week and final MTCT of HIV (UNAIDS, 2017). In some countries such as Chad, Angola and Nigeria the final MTCT is almost double that of the six-week transmission rate (UNAIDS, 2017). This has been attributed to non-adherence to treatment and feeding choices and also loss to follow-up especially in breastfeeding mothers (UNAIDS, 2017). In Botswana, option B+ regimen may help reduce the final transmission to below the target of 2% from its current level of 2.6% (UNAIDS, 2017).

Option B+ regimen is crucial for the reduction in the disparity between 6 week and final MTCT of HIV, thus resulting in even less new infections in infants and young children (UNAIDS, 2017). In addition, switching to option B+ is also consistent with the updated infant

feeding guidelines in areas with high prevalence of HIV (WHO, 2016). The updated infant guidelines recommend that women should breastfeed for at least 12 months and for even longer, provided they are fully covered by ART (WHO, 2016). Option B+ regimen provides the required cover (UNAIDS, 2017).

The increase in population of HIV-exposed-uninfected infants and young children

The success of PMTCT in countries such as Botswana has resulted in the population of HIV-exposed but uninfected infants and young children steadily increasing over the years (Rosala-Hallas et al., 2017: Filteau 2009). The population of these infants and young children is set to increase even further as countries such as Botswana transition from option B to option B+ treatment of HIV (Morden et al., 2016). The numbers of new infections avoided due to PMTCT in east and southern Africa has increased from 130 000 to 220 000 between 2010 and 2015 (UNAIDS, 2017). Therefore, as the number of these infants and young children increases it has been recognised that these infants and young children are likely to have a unique health needs which sets them apart from their non-exposed counterparts (Evans et al., 2016). Research on the health needs of HIV-exposed-uninfected infants and young children has gained momentum over the last few years (Evans et al., 2016). It has been demonstrated that HIV-exposed-uninfected infants and young children have higher mortality and higher risk of all-cause morbidity and hospitalisation (Rollins et al., 2013: Chopra et al., 2008: Shapiro et al. 2007).

1.3.10 Nutritional status of HEU and HUU infants and young children

Interest in the nutritional status of HIV-Exposed-Uninfected (HEU) compared to HIV-Unexposed-Uninfected (HUU) infants and young children has increased in the last few years mainly due to the increase in the population of HEU infants and young children (Evans et al., 2016: UNAIDS, 2017). In addition, a higher risk of mortality in HEU compared to HUU infants and young children as documented by a number of studies (Shapiro et al., 2007: Marinda et al., 2007: Brahmbhatt et al., 2006) has prompted a further focus on understanding the nutritional status of these infants and young children especially since nutritional status is an important modifiable risk for mortality as described in section 1.3.7 (UNICEF, 2013).

A number of studies have looked at different aspects of growth and development including birthweight of HEU compared to HUU infants and young children (Sofeu et al., 2014: Ramokolo et al., 2014: Patel et al., 2010: Bailey et al., 1999). A study of Cameroonian infants and young children followed from birth found that low birthweight was significantly higher in HEU infants and young children (6.3% vs. 3.5%) compared to HUU infants and young children (Sofeu et al., 2014). Birthweight is a strong predictor of subsequent nutritional outcomes (McDonald et al., 2012). In addition, low birthweight among HEU infants and young children increases their risk of mortality 2.5 -12 times compared to HUU infants and young children (Landes et al., 2012: Kuhn et al., 2010: Wei et al., 2004: Kourtis et al., 2013).

Postnatal growth in HEU and HUU infants and young children has been investigated by a number of studies (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016: Moraleda et al., 2014: Ramokolo et al., 2014:

Muhangi et al., 2013, Landes et al., 2012: Osterbauer et al., 2012: Patel et al., 2010: Makasa et al., 2007: Henderson et al., 1996: Bailey et al., 1999: Sherry et al., 2000: Lepage et al., 1996). Generally, most recent studies do show differences in postnatal growth between HEU and HUU infants and young children (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016). However, some studies especially those conducted during the pre-ART era, do not show any differences in postnatal growth between these infants and young children (Ramokolo et al., 2014: Landes et al., 2012: Bailey et al., 1999: Lepage et al., 1996).

Stunting

Stunting as a measure of undernutrition was found to be more prevalent in HEU infants and young children compared to HUU infants and young children in several studies conducted in sub-Saharan countries (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016: Osterbauer et al., 2012: Magezi et al., 2008). A study conducted in Botswana found that HEU infants and young children aged 12 months and 24 months had 85% and 41% (respectively) higher risk of being stunted compared to HUU infants and young children (Sudfeld et al., 2016). However, in the same study it was found that HUU infants and young children had increased prevalence of stunting (56%) in the ages 1-2 (Sudfeld et al., 2016). Some studies that found higher risk of stunting in HEU infants and young children, only did so at ages below 6 months, and were not able to find significant differences in later ages (Sherry et al., 2000: Lepage et al., 1996). Other studies conducted in South Africa, Uganda, Malawi and Democratic Republic of Congo did

not find any differences in length-for-age between HEU and HUU infants and young children at all ages (Ramokolo et al., 2014: Muhangi et al., 2013: Landes et al., 2012: Patel et al., 2010: Bailey et al., 1999).

Underweight

HEU infants and young children were found to have a higher risk of being underweight compared to HUU infants and young children in studies conducted in Zambia, Zimbabwe, Uganda and Botswana (Rosala-Hallas et al., 2017: Evans et al., 2016: Sudfeld et al., 2016: Magezi et al., 2008). ART was provided to HIV infected mothers and their infants and young children in some of the studies (Sudfeld et al., 2017: Magezi et al., 2008). In the largest study of HEU and HUU infants and young children ever conducted during the pre-ART era, HEU and HUU infants and young children were followed until 24 months (Evans et al., 2016). It was found that HEU infants and young children had 55%, 52% and 37% higher risk of being underweight at 6 weeks, 6 months and 12 months respectively. However, other studies found no differences in underweight between HEU and HUU infants and young children (Ramokolo et al., 2014: Muhangi et al., 2013: Landes et al., 2012: Osterbauer et al., 2012: Patel et al., 2010: Bailey et al., 1999: Lepage et al., 1996). Interestingly in all these studies except one, ART was not provided to HIV infected mothers and their infants and young children. In a longitudinal study in South African infants and young children, no differences in mean weight-for-age between HEU

and HUU infants and young children at 3 weeks, 6 or 9 months were found (Ramokolo et al., 2014).

Wasting

Wasting as indicated by a low mean weight-for-length was found to be more prevalent in HEU compared to HUU infants and young children (Evans et al., 2016: Osterbauer et al., 2012: Magezi et al., 2008: Sherry et al., 2008). A higher risk for wasting was found in HEU infants and young children from birth to 12 months in a cohort of Zimbabwean infants and young children (Evans et al., 2016). However, no significant differences were found at 18 and 24 months (Evans et al., 2016). Other studies have not found significant differences in wasting between HEU and HUU infants and young children at all ages (Sudfeld et al., 2016: Ramokolo et al., 2014: Patel et al., 2010: Bailey et al., 1999).

Most of the more recent studies of postnatal growth in HEU and HUU infants and young children demonstrated poor nutritional outcomes (underweight, stunting and wasting) in HEU infants and young children compared to HUU infants and young children (Sudfeld et al., 2016: Rosala-Halla et al., 2017: Evans et al., 2016: Moraleda et al., 2014: Magezi et al., 2008: Makasa et al., 2007: Sherry et al., 2000). However findings from other studies contradict this (Ramokolo et al., 2014: Muhangi et al., 2013: Landes et al., 2012: Osterbauer et al., 2012: Patel et al., 2010: Bailey et al., 1999: Lepage et al., 1996). The heterogeneity of findings from these studies may be due to differences in methodology. These includes small sample size as employed in some

studies. Small samples can result in reduced statistical power thus the true effects of HIV-exposure on nutritional outcomes are not identified (Evans et al., 2016). Another methodology issue is the use of an inappropriate comparison group of HUU infants and young children or having a sample in which the proportion of HEU to HUU infants and young children is not reflective of the population (Muhangi et al., 2008: Patel et al., 2010). The comparison group (HUU infants and young children) chosen for some of these studies was not matched on all important factors such as socio economic status and social background (Muhangi et al., 2008: Patel et al., 2010). It is crucial that that an appropriate comparison group that is demographically comparable is included in order to reduce the impact of confounding on the outcome of interest (Evans et al., 2016: Isanaka, 2009). This consideration is important as it allows understanding of growth patterns of HEU compared to HUU infants and young children in the context of health, care and the social environment (Isanaka, 2009). Therefore, the fundamental differences in designs of these studies may explain the variability observed in the outcomes of undernutrition between HEU and HUU infants and young children. More studies are needed to ascertain the prevalence of undernutrition in HEU infants and young children. In Botswana, even fewer studies have investigated the growth of HEU infants and young children against comparable HUU infants and young children.

ART was not available to mothers in some of the studies reviewed (Evans et al., 2016: Ramokolo et al., 2014: Bailey et al., 1999: Lepage

et al., 1996). The availability of ART in itself is a complicating factor because the use of ART as either a single dose of Nevirapine during birth or long term has been associated with increased risk of mortality in HEU compared to HUU infants and young children (Shapiro et al., 2007). However, other studies do not show this increased risk in infants and young children exposed to ART (Rollins et al., 2013: Chopra et al., 2009). In studies where ART was available, different formulations were used (Sudfeld et al., 2016: Moraleda et al., 2014: Landes et al., 2012). The duration of use of ART and the types used are important factors to consider because prevalence of low birthweight has declined with an increased use of ART (Schulte et al, 2007). In addition different types of ART have different impacts on virologic suppression and on birthweight outcomes of infants and young children (Shapiro et al., 2010: Shapiro et al., 2007). Use of ART has become routine and its use will be more widespread as countries switch to option B+ (UNAIDS, 2017). In addition, formulations of ART have changed over the years (UNAIDS, 2017). Therefore, there is need to conduct studies in settings which better reflect the current level of access to ART and also taking into account the types of ART in use.

The other factor that complicates interpretation of findings from these studies is the vast differences in feeding practices between HEU and HUU infants and young children within and also between studies. The level of breastfeeding in HEU infants and young children differs from one study to another, with some studies reporting high levels in the first 9-12 months (Rosala-Hallas et al., 2017: Moraleda et al., 2014: Patel et

al., 2010), while some studies reported very low levels (Landes et al., 2012: Sudfeld et al., 2016). The duration of breastfeeding also varies considerably between these studies ranging from no breastfeeding to almost 12 months of breastfeeding in HEU infants and young children (Rosala-Hallas et al., 2017: Ramokolo et al., 2014: Sudfeld et al., 2016: Landes et al., 2012: Osterbauer et al., 2012). Therefore, this makes it difficult to extend findings from these studies to other settings due to the differing feeding practices (Evans et al., 2016). In addition, different levels of breastfeeding between HEU and HUU infants and young children makes it difficult to disentangle feeding modalities from HIV-exposure. This is especially relevant in Botswana where the infant feeding policy adopted has inadvertently undermined support for breastfeeding by providing free formula to HIV positive mothers who choose to formula feed (Chopra & Rollins, 2008).

1.3.11 Infant feeding practices in context of high HIV prevalence

World Health Organisation (2010) guidelines on HIV and infant feeding state that infant feeding practices in HIV context should ensure that the transmission of HIV to the child is prevented. In addition, these practices should ensure that the child receives adequate nutrition and protection against non-HIV morbidity and mortality (WHO, 2010). Therefore, countries are advised to set recommendations for infant feeding which advise the mother to breast feed exclusively for six months whilst taking ART or avoid all breastfeeding and ensure that the child receives appropriate and adequate replacement feeding (WHO, 2010). These feeding guidelines have been updated recently. The current guidelines state that women living with HIV can breastfeed for at least

12 months and for longer provided they are well covered by ART (WHO, 2016). In addition, mixed feeding is allowed provided the mother is taking ART (WHO, 2016). These updated recommendations are in effect advocating for increased breastfeeding in HEU infants and young children. Currently, Botswana's infant and young child feeding policy continues to follow the 2010 recommendations (MOH. 2012). Interestingly, a large majority of HIV positive women in Botswana prefer to formula feed instead of breastfeeding (Shapiro et al., 2007). A study by Shapiro et al (2007) found that by 5 months only 17.5% of HIV positive mothers were exclusively breastfeeding. The choice amongst HIV positive women to formula feed can be due to a number of factors, however it may be due to the Government of Botswana's policy of providing free formula to HIV positive women who opt to formula feed as part of the PMTCT program (Chopra & Rollins, 2008). This free formula is provided for twelve months if the mother chooses exclusive formula feeding or for six months if the mother exclusively breastfeeds for the first six months (MOH, 2012).

Feeding practices have a direct impact on the infant‘s nutritional status (Parker et al., 2013). In a HIV context it is even more relevant to evaluate the impact of different feeding methods on the growth of infants and young children but at the same time ensuring HIV free survival (Patel et al., 2010). As indicated in Botswana, there is still a low uptake of exclusive breastfeeding in the first six months, despite the known numerous benefits (to the mother and the infant) attributed to breastfeeding (Parker et al., 2013; Patel et al., 2010; Shapiro et al., 2007). Patel et al (2010) found in his study that exclusively breastfed HIV-exposed infants and young children despite lower birthweight managed to

achieve growth patterns similar to non-HIV-exposed infants and young children. They concluded that exclusive breastfeeding can therefore erase the weight disparity between HIV-exposed and non-HIV-exposed infants and young children (Patel et al., 2010). Furthermore, it was also found that even with the introduction of complementary feeds, breastfeeding infants and young children still managed to maintain good growth patterns (Patel et al., 2010).

According to the World Health Organisation (2010) guidelines on HIV and infant feeding, if after six months the replacement feeds are not adequate, it is recommended that the mother should continue breastfeeding for the first 12 months of infant's life or further until a point where adequate replacement feeds are available. The importance of replacement feeding cannot be overstated because a child who is weaned from breastfeeding and is not provided with appropriate replacement feeds will have a deficit of about 400Kcal and 9.5 grams of protein per day (van der Horst et al, 2009). The impact of poor replacement feeds on weight was demonstrated by Parker et al (2013) where lack of adequate and appropriate replacement feeds resulted in poor growth patterns in HEU infants and young children compared to HUU infants and young children. In Botswana's context it can be argued that the lack of adequate and appropriate replacement feeds at six months is not a problem since the government provides free formula for HIV-exposed infants and young children (MOH, 2012). However, other factors that are crucial for successful implementation of formula feeding such as feasibility and safety have not been well documented in Botswana.

It therefore, becomes important to evaluate feeding practices and the nutritional intake of HEU and HUU infants and young children in Botswana. This will

reveal patterns in these children's diet which may explain the prevalence of undernutrition in this population. These findings will inform policy regarding infant feeding practices to ensure HIV free survival and prevention of undernutrition.

For purposes of this thesis the following terms will be defined as follows;

Exclusive breastfeeding: This is whereby the infant only receives breast milk. No other liquids (including water) are given during this period. However, rehydration solutions, medicine and/or vitamin drops are allowed (WHO, 2018).

Partial breastfeeding: this is when the infant is given some breastmilk and some other feeds such as formula and or other feeds (WHO, 2018).

Mixed feeding: this is whereby breastfeeding is combined with formula feeding. Therefore the infant receives breastmilk some of the time and then receives formula the rest of the time. No other foods are given (WHO, 2018).

Formula (replacement) feeding: this is whereby the infant is given formula exclusively (WHO, 2018).

Complementary feeding: this is defined as the transition from exclusive breastfeeding (or formula feeding) to family foods. This period covers the period between 6-24 months of age (WHO, 2018).

Weaning: weaning is the process by which the baby gradually gets accustomed to eating family foods and thus relies less and less on breastmilk (or formula) (WHO, 2018).

1.3.12 Interventions to improve nutritional status of infants and young children

Interventions targeting the nutritional status of infants and young children have transformed over the last decade mainly due to a changing global nutrition landscape (UNICEF, 2015). Therefore, there has been a recognition that there is need for better integration between sectors to ensure an efficient and effective sustainable impact on the health and nutrition of infants and young children (Mbuagbaw et al., 2016). The need for integration between multiple sectors has resulted in the combination of nutrition-specific and nutrition-sensitive interventions that are thought to have more impact on the nutritional status of infants and young children (UNICEF, 2015). The focus on nutrition-specific and nutrition-sensitive interventions has been encouraged mainly by the Scaling Up Nutrition (SUN) movement and other related programs (Scaling Up Nutrition, 2017). Moreover, these inteverntions also reflect the importance of addressing non-nutrition causes of undernutrition (especially stunting) mainly inadequate care, unhealthy household environment and inadequate health services (UNICEF, 2015).

Nutrition-specific interventions are designed to specifically target stunting, micronutrient deficiencies and wasting as well as the risk of overweight and obesity (UNICEF, 2015). Nutrition-sensitive interventions are designed to address the underlying determinants of undernutrition (household food insecurity, inadequate care and feeding practices and unhealthy household environment and inadequate health services) (UNICEF, 2015). In addition, nutrition-sensitive approaches also addresses future overweight and obesity (UNICEF, 2015). Nutrition-specific and nutrition-sensitive approaches are

synergistic in that nutrition-sensitive approaches can be used as platforms for nutrition-specific inteverntions (UNICEF, 2015).

Nutrition-specific interventions

There are a number of nutrition-specific interventions that aim to improve the nutritional status of infants and young children (Bhutta et al., 2013). These interventions can be grouped into three main groups based on the lifecycle they are targeting (UNICEF, 2015). These includes, adolescent girls, women of child bearing age, pregnant and lactating women and infants and young children (Bhutta et al., 2013: UNICEF, 2015). Evidence has shown that improving the nutrition and health of adolescent girls ensures that pregnancy is delayed and that they reach child bearing age in their most optimal health and nutrition state (UNICEF, 2015). In addition, ensuring that pregnant and lactating women's health and nutrition states are optimal ensures the birth of healthy infants and young children and ensures that these mothers are able to provide their infants and young children with the best start to life (UNICEF, 2015). There is also a need to specifically target the nutrition and health of infants and young children to ensure that they continue growing optimally during and beyond the first 1000 days (Bhutta et al., 2013: 1,000 days, 2017).

Nutrition-specific interventions targeting adolescent girls include providing nutritional support for those with infectious diseases (UNICEF, 2015). This include providing micronutrient supplements, energy and protein supplements to ensure balanced energy and protein intake to prevent undernutrition (UNICEF, 2015). In addition, nutrition education should be provided to prevent overweight and obesity in this age group (Bhutta et al., 2013).

Nutrition-specific interventions targeting women of reproductive age, pregnant and lactating women includes folic acid, iron, iron-folate, calcium and/or micronutrient supplementation (Bhutta et al., 2013). This is crucial for prevention of neural tube defects, anaemia and low birthweight (Bhutta et al., 2013). In addition, balanced energy protein supplementation which aims to provide 25% of the total energy as protein should be provided in order to prevent adverse perinatal outcomes for malnourished women (Imdad & Bhutta, 2012: de Onis et al, 1998).

Nutrition-specific interventions targeting infants and young children include breastfeeding promotion to ensure prolonged breastfeeding, appropriate and timely complementary feeding promotion in children aged 6-24 months, preventive vitamin A supplementation, zinc and micronutrient supplementation in children (Sguassero et al., 2012:Bhutta et al., 2013). These interventions are important because breastfeeding and complementary feeding are important for child survival, growth and development (UNICEF, 2015). In addition, prevention and treatment of severe acute malnutrition is also important because severe acute malnutrition is still the major cause of mortality in children aged 5 years or younger low to middle income countries (UNICEF, 2015).

Nutrition-sensitive interventions

Nutrition-sensitive interventions are quite similar across three main lifecycles (adolescent girls, pregnant and lactating women and infants and young children) (UNICEF, 2015). These interventions includes social protection for adolescent girls to ensure that age to first pregnancy is delayed, prolonging

inter-pregnancy, abortion care and psychosocial support (Bhutta et al., 2013). Social protection should also be provided to pregnant and lactating women to ensure that they have access to resources to ensure a safe pregnancy (UNICEF, 2015). WASH (Water, Sanitation, and Hygiene) principles for all these groups to ensure that there is clean water, proper sanitation and hygiene such as handwashing with soap to prevent contamination of food and diarrhoeal diseases (Mbuagbaw et al., 2016: UNICEF, 2015: Bhutta et al., 2013). Sustainable food security should be encouraged for mothers to ensure adequate nutrition for the mother and her children (UNICEF, 2015). The health of adolescent girls, pregnant and lactating women and infants and young children should also be optimised for example the treatment of malaria, de-worming, obesity prevention and diarrhoea prevention and treatment (UNICEF, 2015). Optimisation of health of these groups should also aim to integrate HIV/AIDS and maternal, neonatal, child health and nutrition services (Lindgreen et al., 2012).

Scaling Up Nutrition (SUN) Movement

The SUN movement has embodied the principles of nutrition-specific and nutrition-sensitive approaches to improving the nutrition of infants and young children (UNICEF, 2015). The SUN movement arose mostly due to the recognition that international efforts targeting undernutrition were not effective (Scaling Up Nutrition, 2017). Therefore, following the Copenhagen Consensus in 2008, SUN was formed (Scaling Up Nutrition, 2017). The SUN movement currently has over 50 countries (including Botswana), working together to improve nutrition outcomes in their infants and young children by applying nutrition-specific and nutrition-sensitive interventions (Scaling Up Nutrition,

2017). These efforts are centred on the vision that all forms of malnutrition are eradicated by 2030 (Scaling Up Nutrition, 2017). The strength in the SUN movement is perhaps due to allowing governments in each respective countries to address the nutritional and health issues using context based solutions (Scaling Up Nutrition, 2017). However, the outcomes are assessed using common measures (Scaling Up Nutrition, 2017).

1.4 STUDY RATIONALE

Understanding nutritional status and its determinants in all infants and young children during their first 1000 days of life, regardless of their HIV-exposure, is vital in order to help them reach their full health potential (Arabena, 2014). In addition, differentiating nutritional status of HEU and HUU infants and young children in Botswana is crucial to determine if differences exist. This will help to inform policies and interventions to achieve comparable growth and development between HEU and HUU infants and young children and thus reduce the risk of mortality in HEU infants and young children. This is especially relevant in Botswana where the risk for mortality in HEU infants and young children is higher (6.7%) compared to HUU infants and young children (1.6%) (Shapiro et al., 2007). In addition, the population of HEU infants and young children is increasing steadily in Botswana (UNAIDS, 2017).

It is important to understand the nutritional status of HEU infants and young children compared to HUU infants and young children, against the backdrop of their feeding practices (Beiersmann et al. 2013: Filteau, 2009). Feeding practices in HEU and HUU infants and young children are affected by a number of factors including government's infant feeding policy for HEU infants and young children (WHO, 2016). The feeding practices in HEU infants and young children in Botswana are different to those seen

in other sub-Saharan African studies of HEU and HUU infants and young children (Rosala-Hallas et al., 2017: Moraleda et al., 2014: Patel et al., 2010). It is therefore crucial that the nutritional status of HEU and HUU infants and young children be investigated in context of these feeding practices in order to allow adjustment for the differing practices if they exist, in order to properly study the relationship between HIV-exposure and nutritional outcomes.

It is also important to establish country/context specific determinants of nutritional status because they tend to be unique to each setting (Kimani-Murage et al. 2011). Studies conducted in other African countries comparing the nutritional status of HEU and HUU infants and young children show heterogeneous results (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016: Moraleda et al., 2014: Ramokolo et al., 2014: Muhangi et al., 2013, Landes et al., 2012: Osterbauer et al., 2012: Patel et al., 2010: Makasa et al., 2007: Henderson et al., 1996: Bailey et al., 1999: Sherry et al., 2000: Lepage et al., 1996). These heterogeneity is mainly due to disparities in methodology and context specific factors. The majority of studies were conducted before anti-retroviral therapy was widely and freely available to mothers and infants and young children. Botswana is a unique location to study because anti-retroviral therapy (ART) is widely available to pregnant mothers where 92% of HIV positive pregnant women have access to ART (UNAIDS 2016). In addition, the nutrition and health surveillance system for children aged 0-59 months is accessible country-wide for all children (Nnyepi et al. 2011). . However, despite this rigorous monitoring of infant health and nutrition, the level of mortality in HEU infants and young children in Botswana is comparable or higher than in other sub-Saharan African countries (Shapiro et al., 2007).

A good quantitative understanding of the prevalence of undernutrition, feeding practices and the determinants of undernutrition is important because it provides an overview of the extent of undernutrition and its determinants in HEU and HUU infants and young children. However, equally as important is the need to understand what caregivers consider to be important knowledge, their attitudes and consequent behaviours or practices that may explain the observed disparities in undernutrition between HEU and HUU infants and young children (Aubel, 2012). This is important because caregivers may have the knowledge on how to achieve optimal nutrition in their infants and young children, but due to constraining factors may not be able to put this knowledge into practice (Fergusson et al., 2009). If we have a clear understanding of the drivers of the observed practices we are able to target these 'drivers' in effect changing practices (Aubel, 2012). It should be recognised that caregivers and their infants and young children do not exist in isolation, because most caregivers in Botswana have other family members (especially older) who provide advice and other forms of support. It is therefore, useful to explore the influence these older family figures have on the care giver's choices in terms of infant's care and feeding practices.

Children aged five years and less in Botswana are monitored monthly at their local health facility (MOH, 2017). However, as indicated earlier, measurements of measures of undernutrition such as length/height are only conducted twice each year, therefore an accurate prevalence of stunting in Botswana is not known. According to Ministry of Health and Wellness's department of Public Health the national average attendance at these health facilities is approximately 85- 95% (MOH, 2017). Therefore, a large majority of infants and young children have access to a healthcare worker at least once a month. Healthcare workers have an opportunity to influence caregivers' perceptions regarding infant care and feeding. Thus it is vital to explore this influence and also

evaluate how caregivers perceive their influence. Healthcare workers are often seen as source of knowledge but can also be source of reprimand for caregivers who are seen not be 'following orders' (Ritchie et al., 2016). Exploring this interaction between healthcare workers and caregivers and assessing its influence on practices that have an impact on infant's nutritional status is worthwhile. This is especially relevant as this will be done in the backdrop of the influence exerted by older family figures, who naturally have more access to caregivers compared to healthcare workers. The work described in this thesis was therefore performed in two phases-an initial quantitative study and a second qualitative study.

In the quantitative study, nutritional status of HEU and HUU was compared in order to determine if HIV-exposure is an important determinant of nutritional outcomes. It is important to explore the perceptions of caregivers of HEU infants and young children in regards to their nutritional and health status. Closely looking at what caregivers are doing to ensure optimal nutrition for their infants and young children but also ensuring that their infants and young children are not infected with HIV, may help explain the observed differences in nutritional status between HEU and HUU infants and young children if they exist.

The qualitative study assisted in developing a profile of the underlying causes of undernutrition in HEU and HUU infants and young children in Botswana by revealing the perceptions of caregivers, older family figures and healthcare workers. Results from this study will thus explain some of the findings found in the quantitative study. This is crucial as it provides more understanding of the nutritional status of HEU infants and young children compared to HUU infants and young children, especially in the first 1000 days. The nutritional and health status of HEU infants and young children in Botswana is becoming more relevant because the success of PMTCT has

resulted in number of HEU infants and young children increasing significantly over the years. Therefore, any health challenges that may be experienced by these infants and young children will be of considerable public health importance. This is especially pertinent in Botswana where another study has shown higher mortality rate in HIV exposed infants and young children compared to non-HIV exposed infants and young children (Shapiro et al., 2007). Better understanding of their nutritional status, health status and determinants of these will put clinicians, public health practitioners and policy makers in a better position to develop targeted interventions that have better chance of lowering mortality and improving health and development in these infants and young children.

The findings from both these studies will add more knowledge in this area in Botswana. Thus in the short term the findings are expected to argue a case for examination of the current practices in managing these infants and young children. This is especially important as Botswana will seek to determine if it adopts the updated HIV and infant feeding guidelines. In the long term, the findings of this study, other studies and other sources of evidence will impact on policies that will have a positive impact on the nutritional status of HEU and HUU infants and young children within the crucial first 1000 days in Botswana. This in turn should contribute to the reduction of mortality in infants and young children aged five years or less.

1.5 AIMS AND OBJECTIVES OF THE STUDY

1.5.1 Quantitative study

Main Objectives

- To compare the nutritional status (and other characteristics) assessed in HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children aged 6-24 months.
- To identify predictors of observed nutritional status in the combined population of HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children aged 6-24 months.

Research Questions

1. What are the characteristics of stunting, wasting and underweight in HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children?
2. What is the relationship between stunting, wasting or underweight with a priori identified variables in Botswanan infants and young children aged 6-24 months?
3. What is the nutritional intake (energy, protein) in HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children?
4. How effective is the child health card as a child nutritional monitoring tool?

1.5.2 Qualitative study

Main Objective

To explore how perceptions of primary caregivers , older family figures and healthcare workers influences practices related to nutritional status of infants and young children aged 6-24 months from selected districts in Botswana.

Specific Objectives

1. Evaluate how primary care giver's perceptions influences their knowledge, attitudes and practices related to nutritional status of their infants and young children.
2. Explore the role of older family figures in influencing perceptions of primary caregivers in relation to nutritional status of infants and young children.
3. Explore the healthcare workers role in affecting the perception of the primary care giver regarding infant's nutrition status.
4. Evaluate how infant HIV-exposure influences care giver's perceptions in relation to optimal nutritional status of infants and young children.

1.6 MIXED-METHODS APPROACH

In order to effectively address these research objectives a mixed-methods approach was chosen. Mixed-methods research aims to explain phenomena by combining quantitative and qualitative methods in one research study (Creswell and Plano-Clark, 2011: Teddlie and Tashakkori, 2010). There are six types of mixed-methods research designs; Convergent parallel, explanatory sequential, exploratory sequential, embedded, transformative and multiphase (Zoellner and Harris, 2017). These types are based on the timing and implementation of the quantitative and qualitative strands

(Zoellner and Harris, 2017). An explanatory sequential design was adopted in this study. In this approach, the quantitative component is conducted first, followed by the qualitative component (Zoellner and Harris, 2017).

Why the mixed-methods approach?

The main rationale behind combining quantitative and qualitative methods is so that weaknesses in one method are compensated by strengths in the other method (Zoellner and Harris, 2017). Quantitative methods are useful in establishing, or at least describing, the nature and magnitude of issue under study and with appropriate sampling the results can be generalised to the population (Zoellner and Harris, 2017). This method takes an objective approach to investigating truth and facts (Zoellner and Harris, 2017). Therefore, relationships between variables can be investigated and cofounding can be controlled for (Creswell and Plano, 2011). This approach was required for the first part of our study because the prevalence of undernutrition in HEU and HUU infants and young children within the first 1000 days in Botswana was not known at the time of study conception. In addition, the determinants of undernutrition in this group of infants and young children were not known at the time. Therefore, an explanatory sequential approach allowed the determination of the prevalence of undernutrition in HEU and HUU infants and young children. In addition, independent variables such as HIV exposure, maternal education level, energy and protein intake and other sociodemographic variables were investigated for relationships with outcomes of undernutrition (underweight, stunting, wasting).

It was crucial to include a qualitative strand after this quantitative approach because qualitative approach allows the explanation of some of the quantitative results in depth (Zoellner and Harris, 2017). A qualitative approach is appropriate because it assumes truth and facts have subjective elements based on the perceptions and meanings assigned by people (Zoellner and Harris, 2017, p.686). Within our study a number of variables such as feeding practices, access to healthcare services and care practices have been shown to partly influence perceptions of caregivers (Fischer and Olson, 2014: Hurley et al., 2016). Therefore, in order to understand better these practices we needed to understand the perceptions underlying these practices thus the use of qualitative methods after the quantitative approach was implemented. Qualitative data was collected in order to promote a more comprehensive description of nutritional outcomes in HEU and HUU infants and young children including caregivers' perceptions, meanings they attach to practices and their overall experience as their infants and young children succeed (or fail) to achieve optimal nutritional status. In addition, older family figures and healthcare workers were also included in this qualitative study because they are an external influence on the caregiver's perception which may impact on the caregivers' feeding and care giving practices. In addition, the study also looked at how views and opinions of different groups may influence the finding seen in the first study and allow for responsive recommendations to be made for future interventions.

Probability sampling was used in the quantitative part of the study. Data was then collected, analysed and interpreted first before the qualitative study could be implemented. In the qualitative strand, sampling was purposeful based

mainly on data and findings from the quantitative part. In addition, data collection procedures for the qualitative strand were also based mainly on the data from the quantitative strand. The timeline for the whole study showing the implementation of the quantitative and qualitative strands is shown in Figure 1.6.1

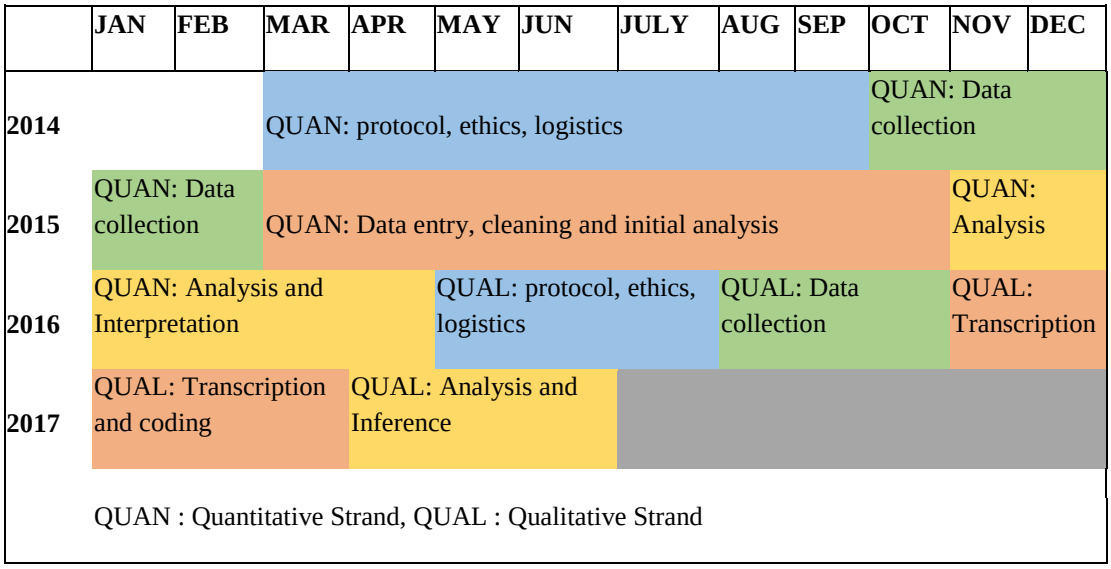


Figure 1.6.1: Timeline for the quantitative and qualitative studies

2.0 Birthweight, HIV-exposure and infant feeding as predictors of malnutrition in Botswanan infants and young children.

SYNOPSIS

Introduction	A better understanding of the nutritional status of infants and young children who are HIV-Exposed-Uninfected (HEU) and HIV-Unexposed-Uninfected (HUU) during their first 1000 days is a key to improving population health, particularly in sub-Saharan Africa.
Research Questions	1. What are the characteristics of stunting, wasting and underweight in HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children? 2. What is the relationship between stunting, wasting or underweight with a priori identified variables in Botswanan infants and young children aged 6-24 months? 3. What is the nutritional intake (energy, protein) in HIV-exposed-Uninfected and HIV-Unexposed-Uninfected infants and young children? 4. How effective is the child health card as a child nutritional monitoring tool?
Methods	▪ This cross-sectional study compared nutritional status, feeding practices and determinants of nutritional status of HEU and HUU infants and young children residing in representative selected districts in Botswana during their first 1000 days of life. ▪ 413 infants and young children (37.3% HEU), aged 6-24 months attending routine child health clinics were recruited.

	▪ Anthropometric, 24-hour dietary intake and socio-demographic data was collected. ▪ Anthropometric *z*-scores were calculated using 2006 WHO growth standards. ▪ Modelling of the determinants of malnutrition was undertaken using logistic regression. ▪ Use of child health cards was assessed by determining the level of completeness for selected variables.
Results	▪ Overall, prevalence of stunting, wasting and underweight were 10.4%, 11.9% and 10.2% respectively. ▪ HEU infants and young children were more likely to be underweight (15.6% vs. 6.9%), ($p<0.01$) and stunted (15.6% vs. 7.3%), ($p<0.05$) but not wasted ($p= 0.14$) than HUU infants and young children. ▪ HEU infants and young children tended to be formula fed (89.4%) whereas HUU infants and young children tended to breastfeed (89.6%) for the first six months ($p<0.001$). ▪ Significant predictors of nutritional status were HIV exposure, birthweight, birth length, Apgar score and mother/caregiver's education with little influence of socioeconomic status. ▪ Completion of child health records cards varied with overall completeness at 72%.
Discussions	▪ Finding that HEU infants and young children have worse outcomes compared to HUU infants and young children is consistent with other studies in sub-Saharan Africa. ▪ Factors such as lack of breastfeeding, use of ART, low birthweight, HIV-exposure, mother/caregiver's education level and younger age may account for some of the growth disparity observed between HEU and HUU infants and young children. ▪ Feeding practices are significantly different, where HEU infants and young children tend to formula feed and HUU

	infants and young children tend to breastfeed in the first 12 months may be significantly influenced by Botswana government's infant and young child feeding policy. ▪ Dietary diversity which indicates the quality of the diet is low for both HEU and HUU infants and young children and this may result in inadequate intake of micronutrients. ▪ Use of child health cards very low for some of the variables and this is influenced mainly by organisational culture which encourages healthcare workers to focus on variables that are required in reports and the lack of shared responsibility results in healthcare workers not completing variables which they do not deem important for their interventions.
Study Limitations	▪ Indices such as micronutrient deficiencies were no considered. This could be prevalent especially looking at the low dietary diversity in this sample. ▪ Maternal nutrition and health variables were not assessed due to the cross sectional nature of the study. ▪ There is a very limited chance that some of the infants and young children classified as HIV-exposed may have seroconverted at some point. ▪ The parity of the mother was not considered in the logistic regression due to the unreliability of the data provided by other caregivers.
Conclusions	▪ HEU infants and young children have poor nutritional outcomes compared to HUU infants and young children. ▪ Birthweight was the main predictor of all forms of undernutrition. ▪ Interventions should also specifically target HEU infants and young children in order to eliminate growth disparity between HEU and HUU infants and young children.

2.1 INTRODUCTION

Under-five mortality declined from 90 to 43 deaths per 1000 live births between 1990 and 2015 globally (UN, 2015). However, although still seeing improvements during this time, in sub-Saharan Africa under-five mortality still remains higher at 86 deaths per 1000 live births (UN, 2015). Mortality in children aged less than five years is mainly attributed to undernutrition, with 45% of these deaths being preventable through optimal nutrition, especially in the first 1000 days (Black et al., 2013: Morris et al., 2008: Victoria et al., 2008). Optimisation of the nutritional status of the target groups of female adolescents, pregnant women, and infants and young children from birth to 24 months is recognised as key to reducing the excess mortality (UNICEF, 2013: Beiersmann et al., 2013: Kimani-Murage et al., 2011).

Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) is a major health challenge in Botswana where approximately 18.5% of Botswana's 2.2 million population is currently living with HIV (WHO, 2016: CSO, 2013). Strategies including, prevention of mother-to-child transmission (PMTCT) of HIV have been highly successful in Botswana, reducing mother-to-child transmission rates to approximately 2.6% (UNAIDS, 2017). Without PMTCT strategies, HIV transmission from mother to child could be as high as 25% (UNAIDS, 2017). However, this success has resulted in the population of HIV-exposed but uninfected (HEU) infants and young children steadily increasing over the years (Rosala-Hallas et al., 2017). The population of these infants and young children is set to increase even further as Botswana transitions from option B to option B+ treatment of HIV (Morden et al., 2016). Therefore, health and/or nutritional issues unique to HEU infants and young children will have major population health implications as their numbers increase (McGrath et al., 2012: Rollins et al., 2013). Currently, the health and

nutritional consequences of HIV-exposure are largely under study (Filteau et al., 2009: Rollins et al., 2013). However, a higher risk for mortality in HEU compared to HIV-unexposed uninfected (HUU) infants and young children has been previously reported (Shapiro et al., 2007: Marinda et al., 2007: Brahmbhatt et al., 2006: Taha et al., 1995). A longitudinal study conducted in Botswana found that by 24 months of age, mortality in HEU infants and young children was 6.7% compared to 1.7% in HUU infants and young children (Shapiro et al., 2007).

Findings from a number of studies conducted in sub-Sahara Africa, comparing the nutritional status of HEU and HUU infants and young children show a high level of heterogeneity (Rollins et al., 2013: McDonald et al., 2012: Patel et al., 2010: Magezi et al., 2008). Majority of these studies were conducted before ART was widely available to mothers and infants and young children (Rollins et al., 2013: McDonald et al., 2012: Patel et al., 2010: Magezi et al., 2008). In contrast, approximately 92% of pregnant women in Botswana have access to ART (UNAIDS, 2017). In addition, monitoring and management of infant health and nutrition is rigorous and widely accessible (Nnyepi et al., 2011). The same conditions are often not present in other sub-Saharan African countries with high HIV prevalence. However, the level of mortality in HEU infants and young children in Botswana is comparable or higher than in other sub-Saharan African countries (Shapiro et al., 2007). Furthermore, Botswana Government has adopted infant and young child feeding policy that has inadvertently undermined breastfeeding by providing free formula (Chopra & Rollins, 2008). Currently, the nutritional status of HEU and HUU in Botswana have not been well documented. Therefore, this first study sought to investigate the patterns of undernutrition per HIV-exposure within context of feeding practices in infants and young children aged 6- 24 months during their first 1000 days in selected districts in

Botswana. This study, also aimed to identify determinants of stunting, wasting and underweight in these infants and young children. In addition, an assessment of the child health card was conducted in order to determine if healthcare workers complete all the crucial data timely.

2.2 METHODS

This quantitative study was largely exploratory in nature as the aim was to better understand the nature of undernutrition and its interaction with HIV-exposure in infants and young children in Botswana. Therefore, the methods employed sought to provide a foundation of knowledge and thus help to inform the following qualitative study (Chapter 3.0).

2.2.1 Study participants and Population

The study was conducted across four districts in Botswana using a comparative cross-sectional study design. Data was collected from the beginning of December 2014 to end of February 2015 in 19 health facilities of varying sizes (Hospital, primary hospital, clinics and/or health posts). This was done in order to cover a variety of settings. Each district has a unique combination of health facilities which provides services to infants and young children aged 0-59 months. Therefore, in some districts these services would be provided in a hospital and/or primary hospital in addition to clinics and/or health posts. These health facilities were located across four districts namely Kweneng East, Kgatleng, Selebi-Phikwe and Francistown (See Figure 1.2.1). A profile of each district is provided in Table 2.1. The selection of these districts was designed to ensure a representation of urban, semi-urban and rural locations. All of the districts were accessible by road, most of which is tarred. Some of the locations were relatively remote, therefore did not have a tarred road but were still

accessible by car from the nearest main tarred road. These four districts were selected as they have a higher prevalence of HIV in pregnant women than the rest of Botswana (Table 2.2) Areas with higher prevalence of HIV were selected to ensure adequate representation of HIV-exposed infants and young children in the sample. Piloting of this study was conducted in Kweneng district.

Table 2.1: Profile of selected districts

Health District	Type of Residence	General description
Francistown	Urban (city)	Francistown city is the second largest city located in the northern part of Botswana.[1] It is the commercial and government administrative centre for this part of the country.[1] The city's economy is driven by the mining industry, however it has experienced a downturn recently as some of the mines closed.[2]
Selebi Phikwe	Urban (Town)	Selebi Phikwe was established as a mining town in the 1960's after the discovery of copper and nickel. It is located near a number of South African borders[1]. Recent closure of the only mine in the town, has had knockdown effect in other industries resulting in thousands of layoffs in this town, neighbouring villages and Francistown.
Kgatleng	Semi-urban	Kgatleng district is located near the capital city of Gaborone. Its administrative capital is called Mochudi. Mochudi's socio-economic status is much better relative to villages surrounding it.[1]
Kweneng east	Rural/Semi-urban	Kweneng East is the other half of Kweneng district. Its administrative capital is Molepolole, a relatively large village evolving into a town. It is relatively close to Gaborone, thus some people who work in Gaborone live in Molepolole[1]

Sources:

1. Botswana government (2016)
2. Closure of Francistown mines worries councillors (Mmegi, 2016)

Table 2.2: Selected population data for each district

District	Total Population[1]	Total <5 population[2]	HIV prevalence[3]
Francistown	98, 961	11,634	32.7%
Selebi Phikwe	49, 411	5, 512	39.6%
Kgatleng	91, 660	9635	33.9%
Kweneng East	256, 752	26, 001	26.3%

1.

Sources:

1. Total population as per the population census of 2011 (CSO, 2015)
2. Total population of children aged less than five years (CSO, 2015).
3. Prevalence of HIV in Pregnant women (CSO,2015)

2.2.2 Sample Size

Sample size was estimated in order to facilitate a logistic regression analysis, and was calculated assuming a medium-sized relationship between the dependant variables (underweight, stunting and wasting) and independent variables and, $\alpha = 0.05$ and $\beta = 0.20$ was taken to be $N \geq 50 + 8m$ (where m is the number of independent variables) (Green 1991). Forty-four potential independent variables were identified *a priori* to the data collection; resulting in a minimum sample size of 402 caregiver-infant dyads. An oversampling by 10% was employed to counter missing data. The potential determinants used in the regression model were identified from previous studies in infants aged 24 months or younger (McDonald et al., 2012: McGrath et al., 2012: Kiwani-Murage et al., 2011). In addition, the UNICEF conceptual framework was also used to identify other known variables that affect nutritional and health outcomes of infants and young children (UNICEF, 2013).

A representative sample of infants and young children in selected districts were stratified according to the population of the infants and young children aged under five years in each district based on data supplied by the Ministry of Health in Botswana (Nutrition and Food Control division). Therefore, a district with a higher population of under-fives would have a larger representation within the total sample (Table 2.3). The size of the population of under-fives was used to stratify the sample because data regarding the numbers of children aged 6-24 months was unavailable at the time of study.

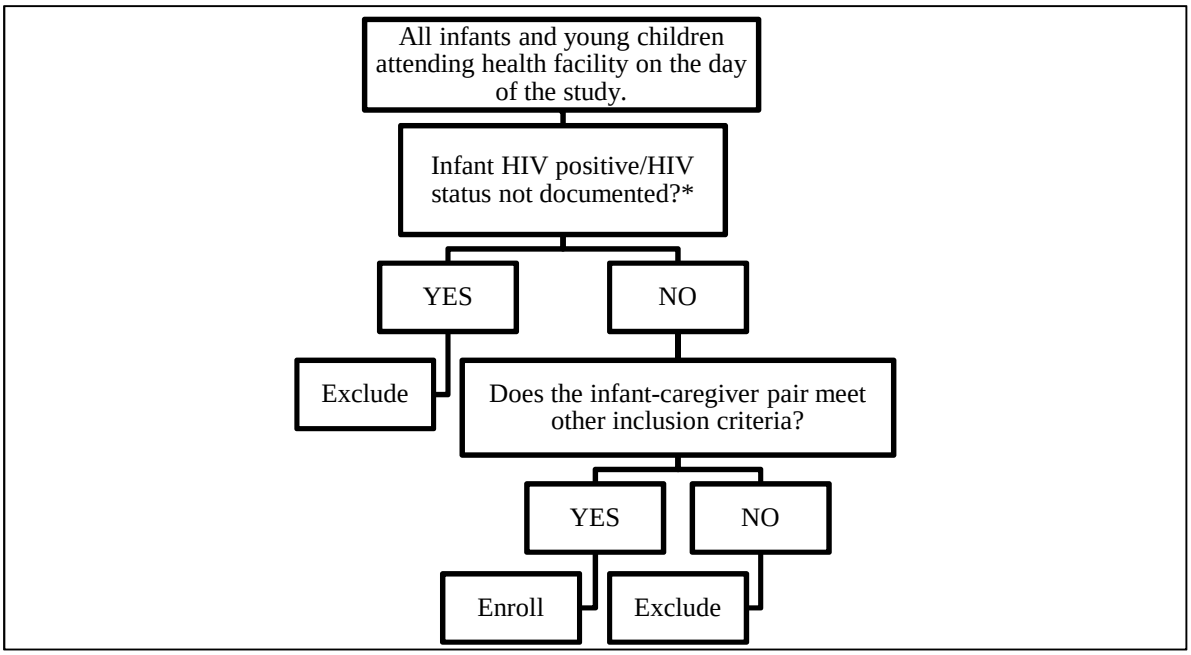


Figure 2.1.1: Flow Diagram showing selection of participants

***** HIV testing conducted at the following time points:

- Testing point 1: Mother's initial antenatal visit (If HIV positive enrolled into PMTCT)
- Testing point 2 – 4: Mother tested at 3, 6 months and before or during labour (only HIV negative mothers tested here)
- Testing point 5: Testing of the neonate at 6 weeks postnatal.
- Testing point 6: Testing 6 weeks post breast feeding cessation (only for breastfeeding infants is mother is HIV positive)
- Testing point 7: Testing at 18 months for all infants

Source: WHO (2016)

Table 2.3: Minimum and Maximum sample size required per district

District	Total <5 population (0 – 59 months)[3]	% of total sample[1]	Minimum-Maximum Sample Size required[2]
Selebi Phikwe	5, 512	11	44- 49
Kgatleng	9635	18	72 - 80
Francistown	11,634	22	88- 97
Kweneng East	26, 001	49	198-216
Total	**52, 782**	**100**	**402-442**

1. % of total sample = Total <5 population (0 – 59 months) / Total (e.g. Francistown = 11634/52782 x 100 = 22%)
2. Total minimum sample= 402, Total maximum sample = 442 [e.g. Francistown Min. sample (22% x 402 = 88) and Max. sample (22% x 442= 97)]
3. **Source:** Ministry of Health and Wellness (Food and Nutrition Control Division)

Since the number and type of health facilities differed in each district, there was a need to stratify the sample further based on the total population of infants and young children attending each type of health facility within each district. This resulted in a sample size per each type of health facility being proportional to the number of infants and young children seen in that type of health facility. In Francistown, Selebi Phikwe and Kgatleng districts child health and growth monitoring services were offered in clinics and/or health posts but not in hospitals. In Kweneng east, in addition to clinics and health posts these services were also offered in the main hospital and the primary hospital. Since there were several clinics and health posts in each district, randomisation was used to select a clinic or health post for data collection. At least three clinics and/or health posts were selected in each district. However, since there was only one hospital and one primary hospital in Kweneng East district, these were purposely included in the sampling frame for this district. Table 2.4 shows this stratification of total sample based on the type of health facility in each district. Therefore, a type of health facility receiving more children had a larger sample size. In each health facility, the total sample represented both HEU and HUU infants and young children, of which final proportion

was determined by their presentation to the clinic during the day of data collection. All infants and young children attending on a sampling day were eligible for inclusion.

Overall five infants and young children with an undocumented HIV status and/or missing PCR DNA/rapid HIV tests were not enrolled into the study. In addition, only one participants declined to take part in the study. No infant or young child screened were HIV positive.

As shown in figure 2.1.1 all infants attending and young children who were attending the health facility on the day of the study were screened for eligibility. All infants and/or young children who were HIV positive or had their HIV status not documented were excluded from the study. In addition any infant who did not meet the inclusion criteria were also excluded from the study. HIV status was ascertained using the latest documented test depending on the age of the infant or young child at the time of the study. As shown in figure 2.1.1 there are 7 testing points for testing of HIV of which the most important one is the first one (during the first ante natal visit).

Table 2.4: Sample size per health facility in each district (using minimum sample size)

District	**Total Sample Size required per health facility type**				
	Minimum sample required	**Hospital**	**Primary Hospital**	**Clinics[1]**	**Health Post**
Selebi Phikwe	44	-	-	44	
Kgatleng[2]	72	-	-	50	22
Francistown	88	-	-	88	
Kweneng East	198	30	50	88	30
Total	**402**	**30**	**50**	**270**	**52**

1. Since there were several clinics in each district, at least 3 clinics were selected per each district. This sample size for the clinics was divided equally between the numbers of chosen clinics.
2. Kgatleng as an example: 69% of under-fives are seen in clinics and 31% are seen in health posts thus sample size for clinics: 69% x 72= 50 and sample size for health posts: 31% x 72 = 22

2.2.3 Ethical approval

Ethical approval was sought and received separately from the University of Nottingham's Medical School Research Ethics Committee and the Health Research and Development Committee in Botswana (see Appendix 2 for ethical approvals). The participant was then given a copy of this informed consent form and the original was retained for study records. Informed consent was directed to parents and/or legal guardians. Information sheets about the study were provided in English and Setswana and participants were given 30 minutes to decide whether they wanted to participate in the study. Posters were provided to the health facilities detailing the specific of the study at least a month prior to data collection. Support in reading or completing consent forms was provided to the participants as required. If poor or inappropriate feeding, under or over nutrition were identified the caregiver was briefly counselled by the PhD student, who is also a registered dietitian in Botswana. The caregiver was then referred to the health facility for further follow-up and this was documented in the child's health card to ensure continuity of care.

Inclusion/Exclusion Criteria

The following inclusion and/or exclusion criteria were used when enrolling participants into the study;

Inclusion criteria

a. The mother /care giver should have consented for the study.
b. Participants should be healthy infants and young children aged at least 7 months but no more than 24 months.
c. The infant should either be HIV-exposed (born to HIV-positive mother) or non-HIV-exposed (born to HIV-negative

mother). They should be attending a routine child welfare clinic visit and not a sick visit.

d. The mother /care giver should be aged at least 18 years of age.
e. The mother /care giver should be a citizen of Botswana.
f. The infant should have not participated in the study previously either in another clinic or the current clinic.
g. The mother /care giver should not have been part of this study with another infant.
h. The mother /care giver should be willing and capable to provide information about the infant, thus should be currently living with the infant.

Exclusion criteria

a. Participants who do not meet the criteria stated above.

2.2.4 Recruitment

Caregivers routinely bring infants and young children for health and growth monitoring once each month but the health facility does not know which caregiver comes when. The health facility however, has a total number of caregivers that they expect each month. Therefore, it was not possible to notify potential participants at least 24 hours in advance about the study before recruitment. Posters about the study were made available at the child welfare clinic at least a month prior to data collection in order to inform caregivers about the study. In addition, health facilities were contacted to advertise the study by word of mouth during their morning education sessions with caregivers.

On the day of data collection, the officer in charge of the facility announced the study to the mothers/legal guardians with children aged 6-24 months attending the clinic and asked those interested to go to a separate area where they were then approached individually by the study personnel who discussed the study with them and invited them to consider participating.

The study personnel then screened the participants for eligibility for enrolment after the participant gave verbal consent to participate in the study. This was done by reviewing each infant's health card. If the participants were eligible, they were enrolled into the study following signed consent being given, prior to any data collection. When more caregivers who met the inclusion criteria than required expressed an interest in participating in the study, individuals were randomly selected to participate in the study. However, this was rarely required, because the numbers of caregivers with infants and young children aged 6-24 months presenting to the clinic were manageable in terms of total numbers and flow, thus were all recruited if they fit the inclusion criteria. This process continued until the required sample size was achieved. However, since a certain amount of time was allocated for data collection in each location, data collection continued at the next location if the required sample size was not reached by the time allocated. Oversampling was applied in subsequent locations in order to make up for shortfall in the previous location.

2.2.5 Data collection processes and sources

Data were collected from various sources (see section 2.2.5.2) using appropriate tools. Anthropometric measures were completed for all infants and young children aged 6 – 24 months. Additional data were also collected through interviewing caregivers using a structured questionnaire. This questionnaire was also used to record all information from all data sources. A 24-hour dietary recall (see *twenty-four hour dietary recall* in

section 2.2.5.2) was used to assess each infant's intake on the previous day. A review of each infant's health card was also conducted. A study team consisting of a lead researcher (PhD student) and two research assistants, worked together to collect various components of data for each participant. The lead researcher was trained in the UK in all the required aspects of data collection prior to collecting data in Botswana. In turn, the lead researcher trained the research assistants in their roles for data collection including how to complete anthropometric measures and also how to interact and build rapport with caregivers. The lead researcher was in contact every week with the supervisors in the University of Nottingham to report on the progress of the study and for resolving any issues. Important issues, in particular with regard to those that had potential to lead to deviation from protocol were discussed immediately with the supervisory team.

2.2.5.1 Data collection Process

Data was collected in the health facility from each participant following completion of a written consent form. After enrolment into the study, a research assistant would complete some of the information in the questionnaire by extracting data from the child welfare card and interviewing the caregiver. This was done in the same room where the anthropometric measurements were taken as per protocol. Therefore, while one research assistant was completing the questionnaire the other assistant would be taking anthropometric measurements, assisted by at least one healthcare worker. After anthropometric measurements were taken, the caregiver and the infant would then go to a different room where the interview would be completed by the lead researcher. The lead researcher would then complete the extraction of information from the child welfare

clinic card as per the questionnaire and also conduct screening for gross motor development. Finally, the lead researcher administered the 24-hour dietary recall as per the protocol (Raper et al., 2004). This whole process, from the time the participant signed a consent form to participate in the study to the time they finished the interview with the lead researcher, took approximately 45 minutes.

If the research assistants were having difficulties completing any part of the questionnaire and/or conducting anthropometric assessment they would notify the lead researcher and he would advise them accordingly.

2.2.5.2 Data sources

Data sources including child health card, anthropometric measures, twenty four hour dietary recall, and interview data from caregivers were used to collect data in the study. The collection of this data was conducted as per the data collection process described in section 2.2.5.

Child Health card

Each infant's health card was reviewed in detail prior to enrolment to ensure eligibility. In addition, important variables such as latest DNA/PCR or rapid HIV test result were derived from the health card. The health card also contained a number of variables of interest such as date of birth, birthweight and length, immunisation records, gross motor development progress, previous weight and length/height and infant feeding history. HIV-exposed infants and young children' health cards also had PMTCT follow-up history completed. In addition, the health card also contained a detailed history of the infant's outpatient visit to the health facility. This was used to determine

each infant's history of morbidity including the frequency of diarrhoea per month. The diagnosis of diarrhoea was made by the consulting doctor or the family nurse practitioner when the infant/young child presented to the health facility. This was then documented in the child's health card.

A detailed review of the health card was also conducted by the lead researcher in order to ascertain the ability of the healthcare workers to complete important variables in the health card. These important variables included immunisation schedule, gross motor development milestones, weight and height/length measurements, follow-up of PMTCT and infant feeding. These variables were checked for completeness because they have implications for advice given to the caregiver and/or management of the infant. If a section was not completed in the health card it was marked incomplete in the questionnaire.

Anthropometric Measures

Anthropometric measures of length/height and weight were measured in duplicate from all the infants and young children in accordance WHO standard procedure (WHO Anthro, 2005). Weight was measured to the nearest 0.05g using calibrated Seca® Scales 385 and 875 (Seca gmbh & co, Hamburg, Germany) and length/height was measured to the nearest 1 mm using Seca® measuring board 417 (Seca gmbh & co, Hamburg, Germany) and Seca® stadiometer, Seca 217 (Seca gmbh & co, Hamburg, Germany). Length for age *Z*-scores (*LAZ*), weight for age *Z*-scores (*WAZ*) and weight for length *Z*-scores (*WLZ*) were calculated according to the 2006 WHO child growth standards using the WHO Anthro 2005 programme, Beta version (WHO, 2005). Stunting, underweight and wasting was determined at *Z* score

< -2 SD based on LAZ, WAZ and WLZ respectively. These measures were used to create a binary classification (Yes/No) for the main outcomes (i.e. stunting, wasting and underweight). The values of the binary data are dependent on the selecting a meaningful cut off based prevalence of <-2 SD as outlined by the classification of child growth and development (WHO, 2018). Prevalence based data are usually reported as cut-off value (<-2 or >+2 Z scores). This represents the normal range within which 95% of the population would fall in (WHO. 2018).

Anthropometric measurements were carried out by the study assistants after thorough training prior to data collection. This training included practicing under the supervision of the lead researcher during piloting. However, it should be noted that practical difficulties do exist when measuring length of infants and young children mainly due to the infant or young child being uncooperative and thus not fully straightening their legs. This was mitigated by following the guidelines on measuring growth whereby the mother is used to assist in calming the child when taking the length and explaining to her clearly what to do in order to help calm the child down (WHO, 2008).In addition, in our study since the infants were already aged 6 months or more, the caregivers had relatively more experience in assisting with taking of length and/or height for their infants and/or young children.

Calibration of the existing scales used in each health facility was also undertaken. This allowed for the use of the weight measures at previous attendances at the clinic by each infant as measured by the healthcare workers.

Twenty four hour dietary recall

A USDA 5 Pass 24-hour dietary recall protocol (Raper et al., 2004) was used to record and estimate the infant's nutritional intake; this was recall was by the caregiver. This was done by first asking the caregiver to recall without interruption the foods the infant ate in the last 24 hours preceding the interview, starting with the last meal eaten (Raper et al., 2004). The caregiver was then probed in order to remember foods that they may have forgotten to mention in the first recall such as snacks and drinks (Raper et al., 2004). The caregiver was then asked to recall the time and/or occasion the food eaten (Raper et al., 2004). This was done to further prompt the caregiver of other foods that the infant ate but they may have forgotten. The fourth step detailed how much each food was eaten, it also sought to derive more information about the food eaten such as foods that were eaten with that food (Raper et al., 2004).This is especially useful for helping caregivers remember addition of condiments, milk or fat to other foods. Finally, a last probe was done to ensure that no other foods were forgotten. The 24 hour dietary recall was completed by the study lead researcher only, in order to ensure consistency.

In order to improve the accuracy of portion sizes typical household bowls, cups, spoons and children's cutlery was used to prompt the caregiver to indicate how much portion sizes she was providing to the infant or young child. In other instances the caregiver brought with them utensils such as sip cups which further improved the estimation of amount the infant/young child had eaten.

Interview of caregivers

Socio-demographic data, feeding practices and other important variables (see Table 2.7) were derived from the caregiver through an interview. This was completed by administering a questionnaire covering areas such as caregiver and household characteristics and infant feeding practices. The interview focused on different aspects of the questionnaire thus was administered by the lead researcher and the research assistants. Interviews were conducted using the local Setswana language. All the members of the study team were fluent in this language. However, in Francistown, a small number of caregivers preferred to use Ikalanga, though they spoke and understood Setswana. Therefore, the lead researcher administered a larger portion of the questionnaire to these caregivers since he was fluent in this language.

The interviewer would ask the mother questions as indicated in the questionnaire and then would record the response in the questionnaire. The applicability and consistency of the questionnaire was tested during piloting and questions which were ambiguous were either corrected or were asked by the lead researcher only. See Appendix 3 for the questionnaire used for the interview.

2.2.6 Study and Data management

The study was managed by the lead researcher and his supervisors who were all housed in the Division of Nutritional Sciences (University of Nottingham, UK). During the data collection phase in Botswana the study was primarily managed by the lead researcher. During this period the lead researcher was the leader for the research and was responsible for regularly updating the rest of the team in The University of

Nottingham. The main supervisor of this study was responsible for the overall management of the study.

All personnel involved with the study especially the research assistants ensured that the rights of the participants to privacy and informed consent were protected. They adhered to the *Data Protection Act, 1998*. The surveyors strictly collected only data relevant to the study. All the data (paper and electronic form) was kept in a secure environment through the use of locked cupboards and bags for physical data or a password protected computer for electronic data. Electronic data was also encrypted to ensure enhanced security. The lead researcher during data collection phase was responsible for ensuring that, all data was kept in a confidential location. They also ensured that authorised access to data was by study personnel only. All data stored in a database was only accessible by a username and password held by the lead researcher whilst collecting data and also when data was transferred to the main study site. Since the data collected was sensitive information from medical records it was treated with utmost confidentiality. Each participant was given a subject number. This number was used as an identifier in the electronic database and was anonymised for transfer of data to the UK. This database used the participant's date of birth. The data will be kept for seven years in secure archives before it is destroyed as per The University of Nottingham code of research conduct and research ethics guidelines.

2.2.7 Laboratory assessment of nutritional content of cereals

Cereals such as sorghum and fortified sorghum were consumed by majority of infants and young children but nutritional content of these foods were not available. Therefore, samples of a combination of commercially available sorghum meal and fortified sorghum cereal were analysed in the laboratory to derive primarily energy, fat, fatty

acids, salt, nitrate and protein content per 100 grams. This assessment was completed with the assistance of the department's technicians (Christine Essex and Calum Greenhalgh).

Preparation of samples

Sorghum meal samples were cooked, weighed, frozen then freeze dried (RC 3 Super Modulyo freeze-dryer; Biopharma Process Systems Ltd, Winchester) to remove the moisture. Samples were then crushed into a powder using a coffee grinder (Braun) and stored in a desiccator until it was required for analysis. Samples of the cooked sorghum were used for salt and nitrate analysis and all other analyses were carried out using the dry ground samples. To determine the total water content, samples of the freeze dried material were oven dried to remove any residual water at 100°C overnight.

Salt

The salt content was determined using an Atago digital salt meter ES-421 (Atago USA Inc. WA98005 USA). Triplicate NaCl standards 0 – 2.0% were measured to produce a linear standard curve (see Appendix 7). After cleaning the sensor and zeroing the machine using pure (Elix) water, standards or triplicate samples were applied to the sensor up to the sample line (less than this would give rise to erroneous measurements), using a plastic Pasteur pipette (so as not to scratch the sensor). The start button was pressed giving rise to arrows in the window flashing 3 times before the measure of salinity was shown as a percentage. In between samples the sensor was cleaned using pure water and the machine zero setting was checked.

Nitrate

Nitrate content was measured using a Soeks self-calibrating digital nitrate meter (Soeks FL 33334 USA). This was done in triplicate by placing the probe into the sorghum (at least 10mm) and the meter gave nitrate content in mg/kg. In between samples the probe was washed with ethanol on soft tissue, then pure water and the probe was dried.

Fat

Fat was extracted by the Soxhlet method using a Gerhardt Soxtherm 2000 (Gerhardt UK Ltd, Brackley). Duplicate samples of 1g of dry sorghum were weighed onto 11 cm Qualitative Q125 filter papers and folded into an envelope, placed into an extraction thimble and topped with an absorbent cotton wool plug. The thimbles were placed in a wire holder in a pre-weighed extraction vessel containing three boiling stones and 162 ml petroleum ether (40-60 fraction). The vessels were then sealed in place on the hotplates in the Soxtherm 2000 and run using the standard extraction program (Table 2.5). When the extraction was complete the flasks were removed and placed in an oven at 100°C for 1 hour. They were then placed in a desiccator to cool before being re-weighed. Samples were dissolved in hexane and kept at -20°C until analysed. Samples of lard were extracted to check the recovery of the method (99.7%).

Table 2.5: Operating conditions for the Gerhardt 2000

Running temperature	150°C
Temperature limit	200°C
Boiling time	35 minutes
Solvent recovery A	6 x 15ml
Extraction time	50 minutes
Solvent recovery B	15 minutes
Solvent recovery C	Nil
Interval	4 minutes
Pulse	4 seconds

Fatty acids

Direct Synthesis of Fatty Acid Methyl Esters: Fatty acids were extracted and methylated by a method based on that of O'Fallon et al. (2007). Duplicate 0.2 ml fat extract samples were placed in to screw topped methylation tubes and 0.7ml of 10M potassium hydroxide and 5.2ml methanol were added. The tubes were vortexed for 5 seconds and incubated at 55°C for 90 minutes with a 5 second vortex mix every 20 minutes. They were placed in a bath of cold water for 10 minutes and vortexed again. 0.58ml 12M sulphuric acid was added, samples were then vortexed and incubated for 90minutes at 55°C. These samples were vigorously shaken every 20 minutes and cooled in a cold water bath. 3ml hexane was then added to the samples, vigorously mixed and centrifuged at 1500rpm for 5 minutes. The top layer was carefully removed into a solvent resistant tube and 1ml of this transferred to a gas chromatography tube, capped and stored at -20°C until it was analysed.

Fatty Acid Methyl Ester (FAME) Analysis by Gas Chromatography (GC): FAME analysis was carried out using a Perkin Elmer Clarus 500 GC (Perkin Elmer Inc. Buckinghamshire, UK) fitted with an autosampler and flame ionisation detector using TotalChrom software. Separation was achieved using a 100m CP-Sil 88 capillary column (Varian Walton on Thames, Surrey, UK). Operating conditions are shown in Table 2.6. The fatty acids were identified against a C4-C24 reference standard (Supelco 18919-1AMP). The results are reported as the proportion of each individual fatty acid as a percentage of the total fatty acids reported (see Appendix 7).

Table 2.6: Operating conditions for the Perkin Elmer Clarus 600 GC for measurement of FAME

Column specifications	
Type	CP-Sil 88 (FAME)
Manufacturer	Varian (Walton on Thames)
Length	100 m
Internal diameter	0.25 mm
Film thickness	0.20 µm
Injector temperature	250°C
Detector temperature	250°C
Detector type	Flame ionisation
Air flow rate	450 ml/min
Carrier gas	Hydrogen
Hydrogen flow rate	45 ml/min
Inlet pressure	37.5 PSIG
Split ratio	100 : 1
Injection speed	Normal
Injection volume	1.0 µl
Syringe capacity	5.0 µl
Pre-injection solvent washes	2
Sample pumps	6
Post-injection solvent washes	2
Oven program	
Initial temperature	45°C – hold for 3min
Ramp 1	13°C/min to 175°C – hold for 20min
Ramp 2	4°C/min to 200°C – hold for 4min
Ramp 3	10°C/min to 215°C – hold for 25min
Total run time	66.6min
Maximum temperature	255°C
Equilibrium time	2min

Protein

The nitrogen content of the samples was determined using a FLASH EA 1112 elemental analyser (Thermo Fisher Scientific, Loughborough Leicestershire) set up to measure nitrogen only and using Eager 300 software. Triplicate 50mg dry samples were weighed and sealed in tin foil capsules, placed in to 24 well plates which were kept in a desiccator until analysis. They were placed into the auto-sampler of the machine along with sucrose blanks and aspartate standards (10.52 % N) which introduces the sample in to the reaction chamber. The analyser operates according to the dynamic flash combustion method (modified Dumas method) of the sample for the determination of nitrogen. A small amount of oxygen is added to the furnace (900 – 1000°C) to help the sample burn converting it in to elemental (simple) gases. A column to separate and a detector allows the quantitative determination of the nitrogen. The results were converted to protein values using the conversion factor of 6.25.

Energy

The energy content was measured using a Parr 6300 bomb calorimeter (Parr Instrument Co., Moline, Illinois, USA). Duplicate dry 1g samples were weighed and compacted in to metal crucibles which were kept in a desiccator until analysed. The samples were placed in to the bomb head, a cotton thread attached to the fine wire and touching the sample and the head placed into the calorimeter to combust in an oxygen atmosphere. The heat created by the combustion process is transferred to the surrounding water which is insulated by an outer water jacket. Benzoic acid was used as a standard (26.43kJ/g).

Crude Fibre

The fibre was determined using a Gerhardt Fibretherm (Gerhardt UK Ltd, Brackley) and the fibre bag technique. The determination was carried out on the dried de-fatted samples remaining after the Soxhlet extraction. The fibre bags were dried in an oven at 100°C for 4 hours and desiccated to cool for 5-10 minutes. The fibre bags were weighed and duplicate 1g samples were weighed in to them, a spacer inserted and the bags placed in to the carousel. 360ml 0.128M sulphuric acid was added to the first extraction beaker and the carousel lowered in to it, mixed by rotating the carousel for 1 minute and placed on a cold hotplate. The condenser was fitted and the solution brought to the boil and the setting adjusted to obtain a simmer. This digestion removed the starch and sugars. After 30 minutes, the beaker was removed from the hotplate, the carousel removed and the acid drained. The liquid was discarded and the beaker filled with 300ml hot (near boiling) water, the carousel placed in it and vigorously rotated. This water wash was then repeated until the final wash was neutral to pH paper. 360ml of hot 0.313M sodium hydroxide was added to the beaker, the carousel lowered in to it and placed on the hot plate, brought back to the boil and the setting reduced to a simmer. After 30 minutes, the beaker was removed, the carousel lifted and the liquid discarded. This digestion removed the protein. The samples were washed with hot water, 0.1M hydrochloric acid and twice more with water. The spacer was washed with a jet of distilled water and removed from the bag whilst rinsing. The bags were placed on tissue for 5-10 minutes to completely drain.

When the process was complete, the bags were first dried in an oven (Genlab Ltd, Widnes, Cheshire) at 100°C for 4 hours, desiccated for 15 minutes, cooled and weighed. The bags were placed in to a pre-weighed tall form beaker and placed in a muffle furnace (Thermo Fisher Scientific, Waltham, MA. USA) at 600°C for 4 hours to ash and the beakers were then desiccated and re-weighed. Blank determinations were carried out using empty bags.

2.2.8 Data Analysis

2.2.8.1 Anthropometric data

Anthropometric data collected was classified as discussed in section 2.2.5.2. This resulted in three outcomes of interest including stunting, wasting and underweight. These three outcomes are the study dependant variables and are categorical. Therefore an outcome of stunting for example was assigned 1 and absence of stunting was assigned 0.

2.2.8.2 Twenty four hour dietary recall data

Data derived from 24-hour dietary recall was analysed in order to derive energy and protein intake of infants and young children and indicators of infant and young child feeding. Diet recalled was analysed using Nutritics© software (Nutritics, 2011), to derive energy and protein intake of each infant. Nutritional content of foods consumed was entered in Nutritics© as per nutritional information on packaging and where nutritional information was not available, South African Composition Database (SAFOODS 2015) and McCance and Widdowson the composition of foods databases (Finglas

et al. 2014) were used. In addition, values of energy and protein determined from the laboratory analysis of cereals were also input into Nutritics©.

Indicators of infant and young child feeding of interest included dietary diversity, meal frequency, minimum acceptable dietary and consumption of iron-rich or iron-fortified foods. These were assessed as per the measures of Infant and young child feeding practices (WHO, 2008). See Appendix 4 for definition of each indicator.

2.2.8.3 Use of child health card

Use of child health card by healthcare workers was analysed by checking the completeness of each child's health card for selected variables including vaccinations, birthweight, birth length, APGAR score, gross motor development at 6 months, weight and length for the first 6 months. Therefore, for each variable the level of completeness for each variable is taken as a percentage. The maximum percentage of completeness expected is 100% for each variable.

2.2.9 Statistical Analysis

Data was analysed using Statistical Package for Social Sciences, SPSS version 22 (IBM Corp, Armonk, NY, 2013). Following screening and cleaning of data, continuous variables were assessed for normality using Kolgorov-Smirnov test. Variables used in the study are shown in Table 2.7.

2.2.9.1 Descriptive data analysis

Baseline data was described as per HIV exposure. Chi square test for independence, was used to test for differences between the two groups (HIV-

exposed and non-HIV-exposed infants and young children) for a number of descriptive variables including birthweight classification, caregivers education level, marital status of caregivers and primary water source. Independent samples t-test or Mann-Whitney U test were used to test for differences between the HIV-exposed and non-HIV-exposed infants and young children for parametric and non-parametric variables respectively. Statistical significance was taken at $p < 0.05$.

2.2.9.2 Comparison of HIV-exposed and non-HIV-exposed infants and young children

Chi square test for independence was used to compare HIV-exposed and non-HIV-exposed infants and young children in terms of variables such as feeding practices and prevalence of undernutrition. Statistical significance was taken at $p < 0.05$.

2.2.9.3 Logistic regression

Forward logistic regression was performed to determine predictors of stunting, underweight and wasting (dependant variables) in the sample. In order to ensure adequate number of cases per each independent variable for logistic regression, categories with limited cases were either collapsed or deleted (Pallant, 2013). Multicollinearity was checked using collinearity diagnostics and variables found to have high correlations with other variables were either removed or redone (Tabachnick and Fidell, 2013). Statistical significance was taken at $p < 0.05$ and at 95% confidence interval.

2.2.9.4 Treatment of missing data

Cases with missing values for some of the independent variables were excluded. For descriptive data analysis and comparison of HIV-exposed and non-HIV-exposed infants and young children, cases were excluded pairwise, where cases were only excluded in the analysis when they were missing the data required for that specific analysis. However, for logistic regression analysis, cases were excluded listwise thus cases where included in analysis only if they had full data on all of the independent variables of interest. On this basis 86.2% of cases (n= 356) with no missing values were included in the analysis for each of the three dependent variables (stunting, underweight and wasting). Variables with missing data included feeding method at < 6 months (2.6%), feeding method at 6-12 months (6.1 %), birthweight (4.1%), Apgar score (2.9%), and age at which complementary feeds were introduced (2.4%).

Table 2.7: Variables in the study

Variable	Definition	Variable type	Data Source
Dependant variables			
Wasting	Yes: WLZ < -2 No: WLZ ≥ -2	Categorical	Anthropometric data
Stunting	Yes: LAZ < -2 No: LAZ ≥ -2	Categorical	Anthropometric data
Underweight	Yes: WAZ < -2 No: WAZ ≥ -2	Categorical	Anthropometric data
Independent variables			
1. HIV-exposure	Yes: HIV-exposed No: non-HIV-exposed	Categorical	Health card
2. Gender	0= Females 1=Males	Categorical	Health card/interview of caregiver
3. Feeding method at < 6 months	0= Formula feeding 1= Breast Feeding	Categorical	Health card/interview of caregiver
4. Feeding method 6- 12 months	0= Formula feeding 1= Breast Feeding	Categorical	Health card/interview of caregiver
5. Consumption of at least one source of iron?	0= No 1= Yes	Categorical	24 hour dietary recall
6. Diet diverse?	0= No 1= Yes	Categorical	24 hour dietary recall
7. Gross development delay at assessment	0= No 1= Yes	Categorical	Assessment/ interview of caregiver
8. Does the child live in an environment where a child has died?	0= No 1= Yes	Categorical	Interview of caregiver
9. Infant Primary care giver	Parent (1) vs. Otherwise (0)	Categorical	Interview of caregiver

	Grandmother (1) vs. Otherwise (0)		
10. Is mother alive	0= No 1= Yes	Categorical	Interview of caregiver
11. Caregivers education level	0= 0-7 years 1= ≥ 8 years	Categorical	Interview of caregiver
12. Caregivers marital status	0= single/divorced/widowed 1= married/partnered	Categorical	Interview of caregiver
13. Caregivers employment status	Not employed (1) vs. Otherwise (0) Formally employed vs. Otherwise (0)	Categorical	Interview of caregiver
14. Caregivers income per month	0-599 BWP[1] (1) vs. Otherwise (0) 600-999 BWP[1] (1) VS. Otherwise (0)	Categorical	Interview of caregiver
15. Primary water source	0= Not-Piped 1= Piped	Categorical	Interview of caregiver
16. Toilet type in homestead	0= Pit latrine 1= Flush	Categorical	Interview of caregiver
17. Health facility type	Hospital/primary hospital (1) vs. Otherwise (0) Clinic (1) vs. Otherwise (0)	Categorical	Observation
18. District	Kweneng East (1) vs. Otherwise (0) Francistown (1) vs. Otherwise (0) Selebi Phikwe (1) vs. Otherwise (0)	Categorical	Observation
19. Age in months at assessment	Age in months at time of data collection	Continuous	Health card/interview of caregiver
20. Birthweight	Weight as recorded in the health card	Continuous	Health card
21. Birth Length	Length as recorded in the health card	Continuous	Health card
22. APGAR Score	Measure of the physical condition of a new-born infant for heart rate, respiratory effort, muscle tone, response to stimulation and skin colour. Max score = 10	Continuous	Health card

23. Age introduced complementary feeds	Age in months first started on other foods besides milk.	Continuous	Health card/interview of caregiver
24. Number of servings of Tsabana[2] per week	Frequency of servings of Tsabana regardless of serving size per week.	Continuous	24 hour dietary recall
25. Number of consultations for diarrhoea (health card)	Frequency of consultation of diarrhoea as recorded in the health card in the previous month. Counted as one consultations per each date.	Continuous	Health card
26. Number of days with episode of diarrhoea (caregiver)	Number of days with diarrhoea as recalled by the caregiver in the previous month.	Continuous	Interview of caregiver
27. Number of feeds given yesterday	Frequency of feeds solid, semi-solid or soft food received during the previous day	Continuous	24 hour dietary recall
28. Energy intake	Energy intake as determined from the 24 hour dietary intake recall.	Continuous	24 hour dietary recall
29. Protein intake	Protein intake as determined from the 24 hour dietary intake recall.	Continuous	24 hour dietary recall
30. Mother's age at birth	The age that mother was when she gave birth to the infant.	Continuous	Health card/interview of caregiver
31. Number of people in the household	All people who resides in the household within which the infant lives and who also share meals as a family unit.	Continuous	Interview of caregiver
32. Number of siblings/relatives living with infant aged < 5 years	All infants and young children aged < 5 years currently living in same home (thus sharing meals) with infant.	Continuous	Interview of caregiver

1. BWP= Botsuana Pula (1U$ = 10.18 BWP, Xe Exchange)

2. Tsabana is a fortified sorghum meal provided for free to all infants and young children as part of their monthly ration when they attend health and growth monitoring clinic

2.3 RESULTS

This section presents the results of the quantitative study as per the objectives. Therefore, initially characteristics of the participants will be compared based on HIV-exposure. Feeding practices including feeding methods before 6 months and between 6-12 months, age introduced to complementary feeds, energy and protein intake will also be presented. This will be followed by the nutritional outcomes of interest including underweight, stunting and wasting. The determinants of nutritional outcomes will be presented per each nutritional outcome. Use of the child health card will be presented showing the level of completeness for selected variables. Lastly, the nutritional content of cereals as analysed in the laboratory will also be presented.

2.3.1 Characteristics of participants

A total of 413 caregiver-infant dyads were recruited, of which 154 were HEU (37.3%) and 259 were HUU (62.7%). Table 2.9 shows the characteristics of participants by HIV-exposure. No significant differences were found between HEU and HUU infants and young children in terms of age, proportions of sex, birthweight or length nor birthweight classification. However, HEU infants and young children had significantly more siblings compared to HUU infants and young children ($p<0.001$). In addition, HEU infants and young children were more likely to have had a sibling who died compared to HUU infants and young children ($p <0.05$). The age distribution of infants and young children as per the age group shows that there is no significant difference between HEU and HUU infants.

As shown in Table 2.9, HIV positive mothers tended to be older at the time of the infant's birth ($p<0.001$). In addition, the primary caregivers of HEU infants and young children had significantly lower education levels ($p<0.001$). No significant differences were found in other mother/caregiver and household characteristics including marital

status, employment status, monthly income, number of people in the household, primary water source and toilet type in homestead between the two groups.

2.3.2 Feeding Practices

Table 2.10 shows feeding practices of infants and young children per HIV-exposure from birth to age at time of data collection. These feeding practices were self-reported by the caregiver and corroborated using data from each child's health card, where possible. HEU infants and young children were more likely to be formula fed from birth and at 6-12 months compared to HUU infants and young children ($p<0.001$). The remainder of the infants and young children ($n=11$) not breastfeeding or formula feeding in the first twelve months were taking cow's milk. Of those infants and young children aged more than 12 months, it was found that HUU infants and young children were more likely to be breastfed compared to their HEU counterparts ($p<0.001$). There were no significant differences between HEU and HUU infants and young children in age at which the infant was introduced to complementary feeds. Average energy and protein intake was found to be higher in HEU compared to HUU infants and young children for females and *vice versa* for males. However, both these differences did not reach statistical significance. Overall all infants and young children' diet was not diverse. Even though HEU infants and young children had a more diverse diet compared HUU infants and young children, there was no significant difference ($p=0.17$).

2.3.3 Nutritional content of cereals

The nutritional content of sorghum and fortified sorghum samples (Tsabana) for chosen nutrients are shown in Table 2.8. It was found that fortified sorghum had more energy and protein per 100 grams compared to sorghum. This nutritional analysis output was

then entered into Nutritics© where a recipe was created in order to determine the energy and protein intake each infant consumed from sorghum and/or fortified sorghum.

Table 2.8: Total analysis of sorghum samples

Nutrient	Sorghum	Fortified Sorghum	Sample analysed
Salt (g/100g)	0.04	0.12	cooked
Nitrate (mg/100g)	1.8	12.3	cooked
Fibre (g/100g)	1.19	1.85	dry meal
Fat (g/100g)	2.87	7.22	dry meal
Energy (kcal/100g)	443	468	dry meal
(kJ/100g)	1852	1959	
Protein (g/100g)	10.67	17.97	dry meal

2.3.4 Nutritional Outcomes

The prevalence of underweight was higher in HEU infants and young children (Figure 2.1.1; $p<0.01$). In addition, HEU infants and young children also had significantly higher prevalence of stunting compared to HUU infants and young children (15.6% vs. 7.3 %, $p<0.05$). Wasting prevalence was higher in HEU infants and young children; however this did not reach statistical significance ($p=0.14$).

Table 2.9: Characteristics of HEU and HUU infants and young children from selected districts in Botswana (N= 413)

Characteristic	Total (N= 413)	HEU infants and young children (n= 154)	HUU infants and young children (n=259)	*P- value*
Infant's characteristics				
Age in months [Median,(IQR)] [1,3]	14.00 (9.00)	14.00 (9.00)	14.00 (9.00)	0.96
Sex [%][2]				
Females	52.3	50.6	53.3	0.68
Males	47.7	49.4	46.7	
Birthweight in Kg [Mean ± SD][3]	3.01 ± 0.47	2.96 ± 0.50	3.03 ± 0.46	0.15
Birth Length in cm [Mean ± SD][3]	50.01 ± 3.87	49.71 ± 3.96	50.19 ± 3.80	0.23
Birthweight classification [%][2]				
Low: < 2.5Kg	2.1	12.3	12.1	1.00
Normal: ≥ 2.5 kg	87.4	87.7	87.9	
Number of siblings [Median,(IQR)][3]	1.00 (2.00)	2.00 (2.00)	1.00 (1.00)	**<0.001**
Siblings who have died? [%][2]				
Yes	7.7	11.7	5.4	**0.03**
No	92.3	88.3	94.6	
Age groups (months)				
6-11	154	56	98	
12-17	130	52	78	0.74
18-24	129	46	83	
Mother/caregivers characteristics				
Mother's age at birth [Median,(IQR)][3]	26.00 (9.00)	30.00 (8.00)	25.00 (7.00)	**<0.001**
Primary care-giver's education level [%][2]				
0-7 years	9.9	17.5	5.4	
≥ 8 years	90.1	82.5	94.6	**<0.001**

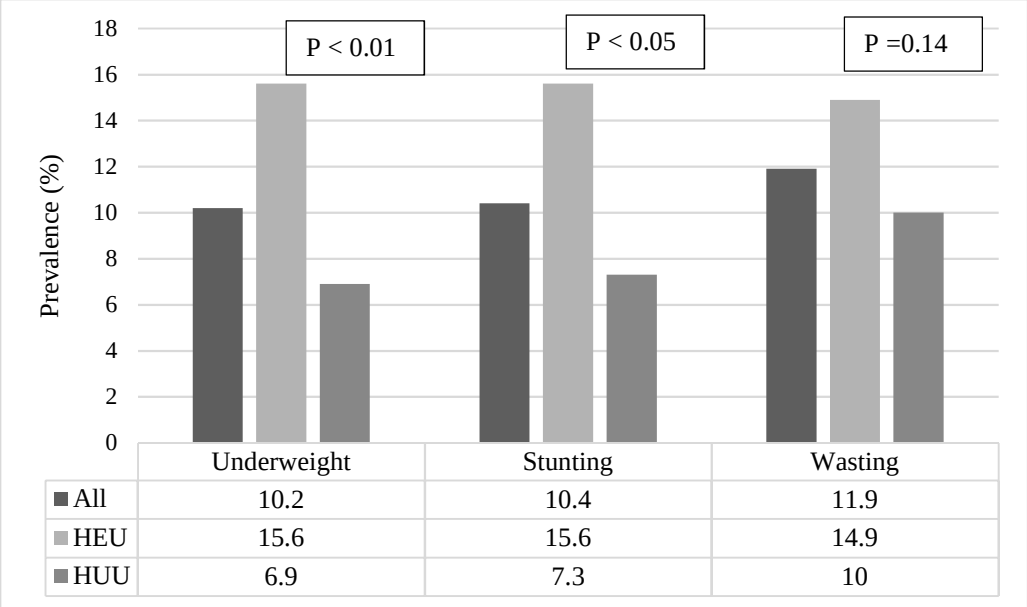
Primary care-giver's marital status [%][2]				
Single/widowed/divorced/ other	79.2	76.0 %	81.1	0.27
Married/lives with partner	20.8	24.0 %	18.9	
Primary care-giver's Employment status [%][2]				
Not employed	75.8	77.3	74.9	
Self-employed	3.9	4.5	3.5	0.63
Formally employed	20.3	18.2	21.6	
Primary care-giver's monthly income [%][2]				
0-599 BWP[4]	69.0	68.8	69	
600-999 BWP	5.1	5.8	5.1	0.86
1000+ BWP	25.9	25.3	25.9	
Characteristics of the household				
Number of people in the household [Median,(IQR)][3]	6.00 (4.00)	6.00 (4.00)	6.00 (4.00)	0.88
Primary water source [%][2]				
Piped	99.5	99.4	99.6	
Not piped	0.5	0.6	0.4	0.71
Toilet type in homestead [%][2]				
Flush	25.6	21.6	28	
Pit latrine	74.4	78.4	72	0.18

1. Age at the time of data collection
2. Chi square was used to test difference in proportions [%] between HEU and HUU infants and young children for various variables.
3. Mann-Whitney U test/ t-test was used to test for differences between HEU and HUU infants and young children for non- parametric and parametric variables respectively.
4. $1 = 10.30 BWP (Botswana Pula) at the time of data collection
5. **Abbreviations:** HEU:HIV-exposed-uninfected, HUU: HIV-unexposed-uninfected; SD: Standard Deviation; IQR: Inter Quartile Range

Table 2.10: Feeding practices of infants and young children by HIV-exposure from selected districts in Botswana

Feeding practice	Total	HEU infants and young children (n= 154)	HUU infants and young children (n=259)	*P- value*
Feeding method at < 6 months [%][1]				
Breastfeeding [BF]	n= 260 [63.0]	n= 27 [17.5]	n= 233 [94.0]	**<0.001**
Formula Feeding [FF]	n= 142 [34.3]	n= 127 [82.5]	n= 15 [6.0]	
Feeding method between 6-12 months [%][1]				
Breastfeeding [BF]	n= 192 [46.5]	n= 0 [0]	n= 186 [72.0]	
Formula Feeding [FF]	n= 188 [45.5]	n= 154 [100]	n= 40 [15.0]	**<0.001**
Mixed Feeding [MF]	n=33 [8.0]	n= 0 [0]	n=33 [13.0]	
Feeding method at 12+ months [%][1]				
Breastfeeding [BF]	n= 29 [19.0]	n= 0 [0]	n= 29 [30.2]	
Formula Feeding [FF]	n= 12 [7.9]	n= 7 [12.5]	n= 5 [5.2]	**<0.001**
Cow's milk	n= 111 [73.0]	n= 49 [87.5]	n= 62 [64.6]	
Age introduced complementary feeds in months[2]				
[Median,(IQR)]	n= 413 6.00 (0.00)	n= 154 6.00 (0.00)	n= 259 6.00 (0.00)	0.92
Average Energy Intake in Kcal [Mean ± SD][3]				
Females	n= 216 [1684.9 ± 867.7]	n= 78 [1778.5 ± 855.4]	n= 138 [1632.0 ± 878.7]	0.23
Males	n= 197 [1810.3 ± 830.6]	n= 76 [1747.7 ± 716.8]	n= 121 [1849.6 ± 895.4]	0.38
Average Protein Intake in grams [Mean ± SD][3]				
Females	n= 216 [53.2 ± 27.5]	n= 78 [56.5 ± 26.9]	n= 138 [51.3 ± 27.7]	0.18
Males	n= 197 [57.5 ± 28.0]	n= 76 [56.4 ± 26.8]	n= 121 [58.2 ± 28.9]	0.65
Dietary Diversity [%][4]	n= 413	n= 154	n= 259	
Diet diverse	[16.8]	[20.1]	[14.8]	0.17
Diet not diverse	[83.2]	[79.9]	[85.2]	

1. Chi square was used to test for differences in proportions of feeding method between HEU and HUU infants and young children.
2. Mann-Whitney U test was used to test for differences in age introduced complementary feeds.
3. Independent-samples t-test was used to test for differences in energy and protein intake between HEU and HUU infants and young children per gender.
4. **Dietary diversity:** Proportion of children 6-23 months of age who receive foods from 4 or more food groups (Food groups: Grains, roots & tubers, Legumes & nuts, Dairy products, Flesh foods, Eggs, Vitamin A rich fruits and vegetables, Other fruits and vegetables).
5. **Abbreviations:** HEU:HIV-exposed-uninfected, HUU: HIV-unexposed-uninfected; SD: Standard Deviation; IQR: Inter Quartile Rang



	Underweight	Stunting	Wasting
All	10.2	10.4	11.9
HEU	15.6	15.6	14.9
HUU	6.9	7.3	10

Figure 2.1.2: Prevalence of underweight, stunting and wasting in infants and young children per HIV-exposure.

HEU: HIV-Exposed-Uninfected infants and young children, **HUU:** HIV-Unexposed-Uninfected infants and young children

2.3.5 Determinants of nutritional status

The results of logistic regression to identify the determinants of underweight, stunting and wasting are shown in Tables 2.11-2.13.

Underweight

Table 2.11 shows the determinants of underweight. The analysis revealed that infants and young children living in homes where a child had previously died were over three times more likely to be underweight (adjusted OR 3.205, 95% CI 1.097- 9.362). However, a higher birthweight or birth length was negatively associated with underweight ($p<0.001$, $p=0.03$ respectively). Each kilogram higher weight reduced risk of underweight by 82% (OR 0.182, 95% CI 0.073 - 0.450). Similarly, a 1cm increase in birth length reduced risk by 10% (OR 0.899,

95% CI 0.818 -0.988). Importantly, HIV-exposure, infant nutrient intakes, maternal and household factors were not associated with risk of underweight.

Stunting

Predictors for stunting, as shown in Table 2.12, were consistent with the simple chi square analysis of prevalence. HEU infants and young children were found to be more than twice as likely to be stunted compared to HUU infants and young children (adjusted OR 2.361, 95% CI 1.105 -5.046). In addition, a lower level of mother/caregiver's education, and lower birthweight was associated with stunting. Again, nutrient intakes and other maternal and household factors were not significantly associated with risk of stunting.

Wasting

Wasting was more likely in infants and young children with a high Apgar score, however residing in Kweneng East district (rural/semi urban) and having a higher birthweight was negatively associated with wasting (Table 2.13). Each kilogram extra weight at birth reduced risk of wasting by 58% (adjusted OR 0.423, 95%CI 0.205-0.872). HIV-exposure, infant nutrient intake and other household and maternal factors were not significantly associated with risk of wasting.

2.3.6 Use of child health card

As shown in Table 2.14 most variables in the health card were not fully completed by healthcare workers. Of all the variables shown, only DPT vaccine was fully completed (100%) at 2 months for all the infants and young children. Most of other vaccine records were completed averaging over 97%. However, some of the vaccines records for Hepatitis B (at 2 months) and initial vitamin A vaccine were not completed in most

health cards, with low levels ranging from 6.8-14.5%. Healthcare workers also completed most of the variables in the child health cards including birthweight, where 99.5% of all health cards were completed for this variable. However, the level of completeness for birth length was slightly lower (94.4%). Recording of monthly birthweight averaged 98% for the first 6 months. In contrast, birth length was only recorded in only 11% of the child health cards in the first 6 months. Gross motor was not assessed by most healthcare workers because only 5.1% of the child health cards had this variable completed.

Table 2.11: Logistic regression model of predictors of underweight in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)

							95% C.I.for odds ratio	
		B	**S.E.**	**Wald**	***P-value***	**Odds ratio**	**Lower**	**Upper**
Step 1	Birthweight	-2.091	.410	25.981	.000	.124	.055	.276
	Constant	3.836	1.127	11.589	.001	46.346		
Step 2	Primary water source	-2.696	1.468	3.375	.066	.067	.004	1.198
	Birthweight	-2.144	.416	26.510	.000	.117	.052	.265
	Constant	6.646	1.939	11.749	.001	769.770		
Step 3	Primary water source	-2.689	1.456	3.412	.065	.068	.004	1.179
	Birthweight	-1.694	.460	13.567	.000	.184	.075	.453
	Birth Length	-.104	.048	4.811	.028	.901	.821	.989
	Constant	10.475	2.661	15.498	.000	35411.123		
Step 4	Primary water source	-2.821	1.459	3.738	.053	.060	.003	1.040
	Infant lives in home where a child has died	1.165	.547	4.537	.033	3.205	1.097	9.362
	Birthweight	-1.706	.463	13.550	.000	.182	.073	.450
	Birth Length	-.106	.048	4.902	.027	.899	.818	.988
	Constant	10.610	2.665	15.852	.000	40537.131		

Model 1: R^2 = 16.3%, X^2=30.25, *df*= 1, p< 0.001: Model 2: R^2 = 17.8 %, X^2=33.03, *df*= 2, p< 0.001: Model 3: R^2 = 20.0 %, X^2=37.46 *df*= 3, p< 0.001: Model 4: R^2 = 22.0 %, X^2=41.48, *df*= 4, p< 0.001

Other independent variables entered into the model are: HIV exposure, gender, feeding method at < 6 months, feeding method at 6-12 months, Infant primary care giver, is mother alive?, mother/caregivers education, mother/caregiver's marital status, mother/caregiver's employment status, mother/caregiver's income per month, toilet type in homestead, health facility type, district, consumption of at least one source of iron rich food?, dietary diversity, age in months , APGAR score, age introduced complementary feeds, number of servings of Tsabana per week, number of consultations with diarrhoea, number of feeds given yesterday, energy intake, protein intake, mother's age at birth, number of people in household and number of siblings/relatives living with infant aged <5 years.

Abbreviations: C.I: Confidence Interval, WAZ: Weight for Age; APGAR (Appearance, Pulse, Grimace, Activity and Respiration). APGAR test is usually given to a baby twice, a minute after birth and then five minutes after birth.

Table 2.12: Logistic regression model of predictors of stunting in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)

							95% C.I.for Odds ratio	
		B	**S.E.**	**Wald**	***P-value***	**Odds ratio**	**Lower**	**Upper**
Step 1	Birthweight	-1.519	.393	14.945	.000	.219	.101	.473
	Constant	2.142	1.099	3.800	.051	8.516		
Step 2	Mother/care giver education	-1.429	.478	8.954	.003	.239	.094	.611
	Birthweight	-1.588	.400	15.740	.000	.204	.093	.448
	Constant	3.563	1.228	8.417	.004	35.276		
Step 3	Mother/care giver education	-1.475	.481	9.410	.002	.229	.089	.587
	Primary water source	-2.845	1.457	3.814	.051	.058	.003	1.010
	Birthweight	-1.637	.406	16.295	.000	.194	.088	.431
	Constant	6.552	2.006	10.661	.001	700.311		
Step 4	HIV exposure	.859	.388	4.913	.027	2.361	1.105	5.046
	Mother/care giver education	-1.257	.498	6.376	.012	.284	.107	.755
	Primary water source	-2.797	1.441	3.769	.052	.061	.004	1.027
	Birthweight	-1.637	.413	15.728	.000	.195	.087	.437
	Constant	5.902	2.025	8.499	.004	365.789		

Model 1: R^2 = 9.1 %, X^2=15.64, *d*f= 1, p< 0.001: Model 2: R^2 = 13.4 %, X^2=23.40, *d*f= 2, p< 0.001: Model 3: R^2 = 15.1 %, X^2=26.45 *d*f= 3, p< 0.001: Model 4: R^2 = 17.8 %, X^2=31.44 *d*f= 4, p< 0.001

Other independent variables entered into the model are: gender, feeding method at < 6 months, feeding method at 6-12 months, Infant primary care giver, is mother alive?, mother/caregiver's marital status, mother/caregiver's employment status, mother/caregiver's income per month, toilet type in homestead, health facility type, district, does infant live in environment where a child has died?, consumption of at least one source of iron rich food?, dietary diversity, age in months, birth length, APGAR score, age introduced complementary feeds, number of servings of Tsabana per week, number of consultations with diarrhoea, number of feeds given yesterday, energy intake, protein intake, mother's age at birth, number of people in household and number of siblings/relatives living with infant aged <5 years.

Abbreviations: C.I: Confidence Interval, LAZ: Length for Age; APGAR (Appearance, Pulse, Grimace, Activity and Respiration). APGAR test is usually given to a baby twice, a minute after birth and then five minutes after birth.

Table 2.13: Logistic regression model of predictors of wasting in infants and young children aged 6-24 months in selected districts in Botswana (n= 356)

							95% C.I.for Odds ratio	
		B	**S.E.**	**Wald**	***P-value***	**Odds ratio**	**Lower**	**Upper**
Step 1	Residing in Kweneng East district	-.908	.349	6.750	.009	.404	.203	.800
	Constant	-1.596	.197	65.697	.000	.203		
Step 2	Residing in Kweneng East district	-.924	.352	6.890	.009	.397	.199	.791
	Birthweight	-.807	.354	5.188	.023	.446	.223	.894
	Constant	.775	1.043	.553	.457	2.172		
Step 3	Primary water source	-2.734	1.454	3.536	.060	.065	.004	1.123
	Residing in Kweneng East district	-1.002	.361	7.679	.006	.367	.181	.746
	Birthweight	-.834	.358	5.435	.020	.434	.215	.876
	Constant	3.588	1.848	3.768	.052	36.152		
Step 4	Primary water source	-2.517	1.456	2.989	.084	.081	.005	1.400
	Residing in Kweneng East district	-1.053	.365	8.332	.004	.349	.171	.713
	Birthweight	-.860	.369	5.437	.020	.423	.205	.872
	Apgar score at birth	.582	.283	4.247	.039	1.790	1.029	3.115
	Constant	-2.106	3.330	.400	.527	.122		

Model 1: R^2 = 3.9%, X^2=7.30, *d*f= 1, p< 0.001: Model 2: R^2 = 6.6 %, X^2=12.50, *d*f= 2, p< 0.001: Model 3: R^2 = 8.0 %, X^2=15.36 *d*f= 3, p< 0.001: Model 4: R^2 = 10.7 %, X^2=20.61, *d*f= 4, p< 0.001

Other independent variables entered into the model are: HIV exposure, gender, feeding method at < 6 months, feeding method at 6-12 months, Infant primary care giver, is mother alive?, mother/caregivers education, mother/caregiver's marital status, mother/caregiver's employment status, mother/caregiver's income per month, toilet type in homestead, health facility type, district, does child live in environment where a child has died?, consumption of at least one source of iron rich food?, dietary diversity, age in months, birthweight, birth length, age introduced complementary feeds, number of servings of Tsabana per week, number of consultations with diarrhoea, number of feeds given yesterday, energy intake, protein intake, mother's age at birth, number of people in household and number of siblings/relatives living with infant aged <5 years.

Abbreviations: C.I: Confidence Interval, WLZ: Weight for Length; APGAR (Appearance, Pulse, Grimace, Activity and Respiration). APGAR test is usually given to a baby twice, a minute after birth and then five minutes after birth.

Table 2.14: Percentage of missing data in the child health card for selected variable

Variable	% health cards completed
Birthweight	99.5
Birth length	94.4
Gross Motor development at 6 months	5.1
Weight	
1 month	98.5
2 months	97.8
3 months	97.8
4 months	97.3
5 months	96.9
6 months	97.1
Length	
1 month	11.4
2 months	12.8
3 months	5.6
4 months	11.4
5 months	5.6
6 months	20.8
Vaccinations	
BCG	99.5
Hepatitis	
birth	99.8
2 months	6.8
DPT (Diphtheria)	
2 months	100.0
3 months	99.3
4 months	97.6
Polio	
2 months	99.5
3 months	99.5
4 months	97.8
Rotavirus	
2 months	99.5
3 months	99.0
Pneumonia	
2 months	99.5
3 months	98.3
4 months	95.4
Vitamin A (Initial)	14.5

2.4 DISCUSSION

The aim of this study was to investigate the patterns of undernutrition within the context of feeding practices in HEU and HUU infants and young children aged 6-24 months. In addition, this study also sought to identify predictors of nutritional status in these infants and young children. The use of the child health card was also investigated in order to determine the level at which healthcare workers completed selected variables in the child health card. This discussion will address the objectives as set out in section 1.5.1 whilst highlighting main findings. Prevalence of undernutrition in HEU and HUU infants and young children will be discussed first, followed by discussion on the predictors of undernutrition such as HIV-exposure and birthweight. The use of the child health card by healthcare workers will also be discussed.

2.4.1 Prevalence of Undernutrition in HEU versus HUU infants and young children.

Overall, prevalences of stunting, wasting and underweight were 10.4%, 11.9% and 10.2% respectively. HEU infants and young children were more likely to be underweight (15.6% vs. 6.9%), ($p<0.01$) and stunted (15.6% vs. 7.3%), ($p<0.05$) but not wasted ($p= 0.14$) than HUU infants and young children.

This study demonstrated that HEU infants and young children aged 6-24 months have poor nutritional status compared to HUU infants and young children. Data from 154 HEU and 259 HUU infants and young children living in selected districts in Botswana demonstrated that HEU infants and young children had higher prevalence of underweight and stunting. These findings are consistent with findings from a number of studies conducted in Zambia, Kenya, South Africa, Zimbabwe, Uganda and Tanzania (Rosala-Hallas et al., 2017: Evans et al., 2016: Sudfeld et al., 2016: Moraleda et al., 2014: Osterbauer et al., 2012: Magezi et al., 2008: Makasa et al., 2007: Sherry et al.,

2000). A large cohort study in Zimbabwe found that HEU infants and young children had lower mean length for age at 12 months and also had a higher risk for stunting at birth, 6 weeks, 6 months and at 12 months (Evans et al., 2016). Prevalence of stunting in our study between HEU and HUU infants and young children was similar to one found in a study of Ugandan infants and young children enrolled into PMTCT (Magezi et al., 2008). Therefore, our bivariate analysis of the prevalence of stunting and underweight is consistent with the larger body of literature. However, other studies conducted in sub-Saharan African countries such as South Africa, Uganda, Malawi, Democratic Republic of Congo and Rwanda did not find any differences in postnatal growth between HEU and HUU infants and young children for stunting, underweight and/or wasting (Ramokolo et al., 2014: Muhangi et al., 2013: Landes et al., 2012: Osterbauer et al., 2012: Patel et al., 2010: Bailey et al.,: Lepage et al., 1996). Most of the studies found that even though HEU infants and young children were born smaller than their HUU counterparts, they managed to quickly catch up in weight and length (Patel et al., 2010: Bailey et al., 1999: Isanaka et al., 2009). It can therefore be concluded that the data on postnatal growth of HEU versus HUU is heterogeneous. There are differences between these studies and our study, these differences include feeding practices, use of ART and sociodemographic factors.

Feeding practices and growth disparity between HEU and HUU infants and young children

Breastfeeding levels were much higher in HEU infants and young children in a number of studies compared to our study (Landes et al., 2012: Patel et al., 2010: Bailey et al., 1999). In a retrospective cohort study of Malawian infants and young children, it was found that most HIV positive women chose to breastfeed exclusively for the first 6 months (Landes et al., 2012). In contrast, in our study 27.5% and 0% of HEU infants

and young children were breastfeeding at 6 and 12 months respectively. Therefore, most infants and young children in our study were formula fed in the first 12 months. Feeding practices, either exclusive use of formula or early cessation of breastfeeding do reduces HIV transmission from the mother to the child (Rollins et al., 2013). However, early cessation of breastfeeding or use of formula is associated with increased mortality and morbidity in infants and young children (Rollins et al., 2013: Kuhn et al., 2010: Fawzy et al., 2011: Kafulafula et al., 2010). The effects of early cessation of breastfeeding were studied in Malawian infants and young children and it was found that HEU infants and young children who have never been breastfed were almost twice as likely to be ill and/or admitted to hospital (Taha et al., 2011). In addition, replacement feeding such as formula feeding has been associated with higher risk of morbidity compared to breastfeeding in a number of studies in Africa (Newell et al., 2004: Asbjornsdottir et al., 2015: Coutsoudis et al., 2002: Bork et al., 2014). A trial of infants and young children from Kenya, South Africa and Burkina Faso found that formula fed HEU infants and young children were six times more likely to contract serious infections compared to those who were breastfed (Bork et al., 2014). However, in our study analyses of hospitalisation, diarrhoeal and other diseases did not show any significant differences between HEU and HUU infants and young children.

Feeding practices in our study were starkly different between HEU and HUU infants and young children, where HEU infants and young children are more likely to formula feed and HUU infants and young children are more likely to breastfeed in the first 12 months. This may have contributed to the growth disparity seen between HEU and HUU infants and young children, especially since feeding practices have a direct impact on morbidity in infants and young children (Bork et al., 2014). Morbidity in infants and young children affects their growth and development, especially in the crucial first 1000

days (Locks et al., 2017: Petry et al., 2016). It should however, be noted that in our regression modelling mode of feeding in the first year of life was not a statistically significant predictor of undernutrition. Nonetheless, feeding practice is an important factor that needs to be considered because the recommendations for feeding in areas with high HIV prevalence have been updated recently (WHO, 2016). These new recommendations if adopted will require profound changes in the government of Botswana's infant and young child feeding policy because they encourage initiation and continued breastfeeding in HEU (WHO 2016). Currently, the government of Botswana has inadvertently undermined support for breastfeeding by providing free formula to HIV positive mothers who choose to formula feed (Chopra & Rollins 2008). The new recommendations, encourage breastfeeding in HEU infants and young children even beyond 12 months provided these mothers are covered with appropriate and adequate ART (WHO 2016). The so called option B+, where HIV positive women are offered lifelong supply of ART as soon as they are diagnosed with HIV, supports prolonged breastfeeding for HEU infants and young children (Evans *et al.* 2016). Option B+ can be used to reassure mothers that they can breastfeed as long as possible whilst the risk of MTCT of HIV remains very low.

There exists a confounding effect of the difference in feeding method(s) (Breastfeeding, formula feeding or mixed feeding) in HEU versus HUU infants and young children when attempting to isolate the effect of exposure to HIV infection on nutritional outcomes. Feeding methods have an impact on nutrition outcomes and development of infants and young children (Kramer et al., 2008: Makumbi et al., 2011). Therefore, it is important to separate the effects of feeding on nutritional outcomes of infants and young children from the effects of HIV exposure on nutritional outcomes. This is difficult to do so because evidence does show that formula feeding contributes to higher

mortality (Sudfeld et al., 2016). However, a very small number of HEU infants were breastfed and a relatively small number of HUU infants were formula fed at least in the first 12 months, thus making it difficult to separate the effects of feeding methods and HIV exposure. In order to disentangle the effects of feeding modalities from HIV exposure more research is needed in separate groups of HEU and HUU infants who are breastfeeding, formula feeding and mixed feeding. Having an adequate sample of HEU infants who are exclusively breastfeeding would allow controlling of feeding modality and /or HIV exposure thus be able to fully understand the impact of these variables on nutrition outcomes of infants and young children (Sudfeld et al., 2016).

This was difficult to achieve in our study because the cross-sectional study design would not be able to support this line of inquiry. A longitudinal study following groups of infants after birth enrolled as per their feeding modalities would be able to elicit more information and produce data which can separate the impact of feeding methods from HIV exposure.

It should be noted that infant and young child feeding policies in Botswana and other countries are changing to be in line with the 2016 recommendations which state that HIV positive women can breastfeed for at least 12 months and even beyond 24 months while being covered by ART (WHO, 2016). This will result in an increase of HEU infants and young children who are breastfed and thus provides an opportunity to study a population whose numbers were initially limited by the preference of mothers to choose formula feeding over breastfeeding (WHO, 2016). Ideally this study should start in the antenatal phase in order to fully take into account the impact of maternal helath and nutrition on subsequent nutritional outcomes of infants and young children.

The use of antiretroviral therapy and its impact on growth of HEU infants and young children

The use of ART during pregnancy, post-birth and during breastfeeding reduces MTCT of HIV (UNAIDS 2017). This has clearly been successful in many countries including Botswana, where MTCT of HIV has declined rapidly in the last decade (UNAIDS 2017). All HEU infants and young children in our study were exposed to ART in-utero, post-birth and if applicable during breastfeeding. However, ART was not available to mothers or their infants and young children in a number of other African studies investigating the growth of HEU and HUU infants and young children (Rosala-Hallas et al,. 2017: Evans et al., 2016: Ramokolo et al., 2014: Muhangi et al., 2013: Patel et al., 2010). This may explain why these studies did not find any differences in growth between HEU and HUU infants and young children, because prolonged exposure to ART during conception and during breastfeeding is associated with reduced growth and development in some studies (Powis et al., 2016: Townsend et al., 2010). A prospective cohort study conducted in Botswana found that infants and young children exposed in-utero to ART were more likely to be stunted and underweight (Powis et al., 2016). In addition, use of ART, especially protease inhibitors, is also associated with low birthweight (Sugandhi et al., 2013). It should be noted that birthweight was lower in HEU compared to HUU in our study, however this difference did not reach statistical significance. This may have been due to inadequate power in our sample to detect small differences in birthweight between the two groups. Other studies have not found any effect of ART on growth outcomes in HEU infants and young children (Ford et al., 2011).

The use of ART can be a confounding factor when determining the effect of HIV exposure on nutritional outcomes of HEU infants and young children. This is more so

because all infants in our study were exposed to ART in utero. This is as per the WHO guidelines on provision of ART for maternal health and/or as a prophylaxis to prevent MTCT of HIV (WHO, 2010). It is recommended that pregnant women irrespective of their CD4 count are started on ARV's as soon as they are diagnosed with HIV and then continue on the regimen for life (WHO, 2012). This new third option also called option B+ maximises uptake of PMTCT as it begins in the antenatal clinic when the mother presents for the initial visit (WHO, 2012). In Botswana, majority of women present to the clinic for their initial antenatal visit, where testing of HIV is the first step. This therefore means that HEU infants are more likely to be exposed to ARV for longer with the rollout of option B+. In addition, the updated infant and young child feeding in areas of high HIV prevalence state promotes breastfeeding for longer (WHO, 2016). This further exposes infants and young children to ART through breastfeeding

Exposure to ART in utero and postnatal has been investigated in a number of studies and the majority indicates some adverse effect to the growth and/or health aspect of the infant and young child (Powis et al., 2016: Chen et al., 2012: Powis et al., 2011: Sibiude et al., 2014). These studies have shown that in utero exposure to ART especially highly active antiretroviral therapy (HAART) resulted in low birth weight, mitochondrial toxicity, birth defects, pre-term delivery, still birth, small for gestational age, and low length for age and low weight for age (Powis et al., 2016: Chen et al., 2012: Powis et al., 2011: Sibiude et al., 2014: Brogly et al., 2007: Heidari et al., 2011). A study conducted in Botswana found that at 24 months infants who had been exposed in-utero and during breastfeeding had significantly lower weight for age and weight for age (Powis et al., 2016). In addition, it was also found in another study in Botswana that the effects are more pronounced in infants exposed to HAART or the triple ARV (Chen et al., 2012). However, such findings should be balanced against the benefits of ART

because they do provide prevention against MTCT of HIV (WHO, 2012). Therefore, there should more studies looking at the long term impact of using ART on the nutritional and health outcomes of infants and young children. This is more so because some studies have indicated that there is no adverse outcomes due to being exposed to ART, this is more so for monotherapy type of ART such as Zidovudine (Culnane et al., 1999: Briand et al., 2009: Williams et al., 2009). A study following HEU infants living in United States found that exposure to Zidovudine in utero and neonatal did not have any long term effects over five years later (Culnane et al., 1999). In addition, a study in Botswana found that there were short term impact on growth outcomes in HEU infants as they rapidly gained weight in the first 6 months of their lives (Powis et al., 2011). Therefore, long term exposure as conferred by breastfeeding should be studied further in order to understand its impact on nutritional outcomes of infants and young children. This is especially as there is a move towards option B+ and longer duration of breastfeeding in HIV positive women and HEU exposed infants respectively (WHO, 2012). Both these changes will result in longer exposure to ART for HEU infants.

Therefore, pending more evidence showing long term effects of in utero, neonatal exposure and breastfeeding exposure to ART the use of ART should continue because the efficacy of ART in preventing HIV pre, during and post pregnancy has been well documented (Shapiro et al., 2008: Marazzi et al., 2009: Chasela et al., 2010). However, this should be balanced against the documented risks that are associated with continued exposure to ART (Sugandhi et al., 2013). This will become essential as more infants and young children are exposed to ART *in utero* due to more HIV positive women enrolling in the option B+ regimen and also breastfeeding for longer (Powis et al., 2016).

2.4.2 HIV-Exposure as a predictor of stunting

HEU infants and young children were found to be more than twice as likely to be stunted compared to HUU infants and young children (adjusted OR 2.361, 95% CI 1.105-5.046).

HEU infants and young children in this study were vulnerable to poor nutritional outcomes, especially stunting because even after adjusting for other variables, HIV-exposure remained a strong predictor for stunting. This finding is consistent with a number of studies conducted in Zambia, Botswana, Zimbabwe, Uganda, Kenya and Rwanda (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016: Osterbauer et al., 2012: Magezi et al., 2008: Makasa et al., 2007: Sherry et al., 2000: Lepage et al., 1996). A large cohort study of Zimbabwean HEU and HUU infants and young children followed for up to 2 years found that HEU infants and young children were at higher risk of stunting compared to HUU infants and young children (Evans et al., 2016). The risk of stunting in HEU infants and young children in our study is similar to one found in a study of Ugandan infants and young children were HIV-exposure resulted in over twice the risk of stunting (Evans et al., 2016). It should be noted that in some of these studies, HIV-exposure tended to increase risk of stunting in the first 12 months of life (Rosala-Hallas et al., 2017: Sudfeld et al,. 2016: Evans et al., 2016: Makasa et al., 2007). However, unlike in our study, the risk of stunting due to HIV-exposure diminished or was not existent from 12 months onwards (Rosala-Hallas et al., 2017: Sudfeld et al., 2016: Evans et al., 2016: Makasa et al., 2007).

Stunting, a largely an irreversible form of undernutrition if identified after the first 1000 days, is caused by inadequate nutrition and repeated infections during the crucial first 1000 days of an infant's life (WHO, 2017). It has also been found that infants and young

children born with a low birthweight are more likely to be stunted (Sudfeld et al., 2016). In a study of infants and young children aged 0-59 months in Botswana it was found that over 65% of stunting was attributed to low birthweight (Sudfeld et al., 2016). Birthweight was lower in HEU infants and young children in our sample however, this did not reach statistical significance. Nonetheless, other studies have demonstrated that HEU infants and young children were more likely to be have lower birthweights compared to HUU infants and young children (Sudfeld et al., 2016: Ramokolo et al., 2014: Sofeu et al., 2014: Patel et al., 2010: Lepage et al., 1996: Bailey et al., 1999). Birthweight was found to be the strongest predictor of all forms undernutrition in our study. This is discussed in section 2.4.3.

Inadequate nutrition, especially lack of breastfeeding and/or cessation of breastfeeding is associated with stunting as discussed in section 2.4.1 (Bork et al., 2014). It has also been found that there is a sharp increase of prevalence of stunting when breastfeeding is ceased (Sudfeld et al., 2016). In addition, longer duration of breastfeeding in HEU infants and young children protects and promotes optimal growth in HEU infants and young children (Sudfeld et al., 2016: Arpadi et al., 2009). In our study, most HEU infants and young children were not breastfed (whilst HUU infants and young children were), therefore it was not possible to determine the effect on risk of stunting, of stopping breastfeeding in HEU infants and young children. However, the longer duration of breastfeeding in HUU infants and young children could have acted as protection against weight loss especially during weaning when these infants and young children were introduced to complementary feeds. The importance of continued breastfeeding especially when complementary foods are introduced has been well documented (Lanigan & Singhal 2009: Imdad et al., 2011: Carletti et al., 2017).

There was no significant difference in the distribution as per age groups between HEU and HUU infants and young children. Further analysis of this data also indicates that this had no effect on the developmental milestones of these infants as there was no significant differences in delayed developmental milestones between HEU and HUU infants.

2.4.3 Low birthweight as the strongest predictor of undernutrition

Each kilogram of higher weight reduced the risk of underweight by 82% (OR 0.182, 95% CI 0.073-0.450). Each kilogram extra weight at birth reduced the risk of wasting by 58 %(OR 0.423, 95% CI 0.205-0.872). Each kilogram of higher weight reduced stunting by 81% (OR 0.195, 95% CI 0.087-0.437).

Low birthweight was a strong and consistent predictor for poor nutritional status (underweight, stunting and wasting). Infants and young children with low birthweight tend to be more vulnerable to poor nutrition and/or diseases effect (Marinda et al., 2007: McDonald et al., 2012). The findings of the current study show that birthweight is a more powerful predictor of later nutritional status than nutrient intakes from complementary feeds, breastmilk versus formula feeding, household and environmental factors including number of people living in a household, primary water source and income level. These findings are consistent with those of other studies conducted in South Africa, Tanzania and Kenya where low birthweight was found to be a predictor of undernutrition in infants and young children (Slyker et al., 2014: Morden et al., 2016: Ramokolo et al., 2014: McDonald et al., 2012: Ndirangu et al., 2012: Kimani-Murage et al., 2011: Bailey et al., 1999). A study of Tanzanian infants and young children found that the risk of stunting was two times higher for infants and young children born small for their gestational age (Sania et al., 2015). This was also true for other outcomes of

nutritional status including wasting and underweight where low birthweight was associated with higher risk of wasting and/or underweight (Slyker et al., 2014: Aheto et al., 2015: Rahman et al., 2016: Christian et al., 2013).

Birthweight can be regarded as the culmination of foetal growth (Christian et al., 2013: Black et al., 2013). Low birthweight as the end result of foetal growth does influence childhood growth with its prenatal origins (Christian, 2009). Foetal growth restriction is probably the most important contributor to stunting and wasting in children (Black et al., 2013). A meta-analysis by Black et al. (2013) found that infants and young children born small for gestational age or preterm were more than twice as likely to be stunted later on life. Often, high levels of low birthweight exist, alongside high levels of stunting and other forms of undernutrition in developing countries (Black et al., 2008). Low birthweight is mainly due to intrauterine growth restriction and prematurity (Locks et al., 2017: Christian et al., 2013). Intrauterine growth restriction is commonly defined as small-for-gestational age (SGA), where birthweight as per sex is below the 10^{th} percentile for the infant's gestational age of reference standard (Christian et al., 2013: Saenger et al., 2007). An analysis of the odds ratio of childhood stunting, wasting and underweight associated with SGA and preterm birth from data from over 19 low and middle class income countries found infants and young children born SGA or preterm were 4.5 times more likely to be stunted later in life (Christian et al., 2013: Black et al., 2013).

There are various factors that influence intrauterine growth including maternal nutrition and health, placental size and function, parity and maternal age, smoking, genetic factors, sex of the foetus and endocrine factors (Saenger et al., 2007). Maternal nutrition and health is one of the most important influencers of intrauterine growth (Saenger et al., 2007: Sania *et al.* 2015: Black et al., 2008). This includes calorie restriction,

inadequate maternal weight gain during pregnancy and level of CD4 count/viral load for HIV positive mothers (Saenger et al., 2007: Sania et al., 2015: Morden et al., 2016: Slyker et al., 2014). A South African cohort study comparing HIV positive and negative mothers found that HIV positive mothers had higher chance of giving birth to a child who is SGA (Ndirangu et al., 2012). Other studies have also found a higher risk of SGA in mothers with a higher viral load and/or low CD4 count (Slyker et al., 2014: Morden et al., 2016: Ramokolo et al., 2014). Even though the mechanisms resulting in low birthweight in HIV positive women are not fully understood. Maternal and vaginal infections, use of ART and associated sociodemographic characteristics such as low educational status or unemployment are associated with low birthweight in HIV positive women (Slyker et al., 2014: Morden et al., 2016: Ramokolo et al., 2014). In our study maternal HIV status and lower educational level in HIV positive women were found to be predictors of stunting.

Maternal health factors such as calorie restriction and/or poor weight gain and associated sociodemographic factors during pregnancy also contribute to low birthweight (Saenger et al., 2007). This impact dependents on the stage of pregnancy (Langley-Evans, 2015). A study of birth outcomes during the Dutch hunger famine found that malnourished mothers in their last trimesters, gave birth to infants and young children with low birthweight (Stein et al., 1975). In addition it has been found that sociodemographic factors such as maternal poverty do contribute to poor birthweight because of inadequate calorie and nutrient intake during this period (Black et al., 2013). Maternal nutritional deficiencies of iron, zinc, vitamin A, iodine and folic acid are all associated with lower birthweight in infants and young children (Black et al., 2013). Due to the cross-sectional nature of the current study, maternal characteristics before and during pregnancy were not measured. However, a number of studies in sub-Saharan

Africa have studied the impact of maternal nutrition on birthweight and have found that mothers with poor weight gain and/or nutritional deficiencies were more likely to give birth to infants and young children who were small-for-gestational age, or with low birthweight (Aheto et al., 2015: Morden et al., 2016: Slyker et al., 2014).

Other maternal factors such as placental size and function, parity and maternal age, smoking and genetic factors have also been associated with birthweight (Saenger et al., 2007). For example it has been found that birthweight tends to be lower for the first pregnancy and for younger mothers (Monte et al., 2011: Rijken et al., 2014: Restrepo-Mendez et al., 2015).

2.4.4 Other predictors of undernutrition

- **Lower level of mother/caregiver's education and younger age was associated with stunting.**
- **Wasting was more likely in infants and young children with a high Apgar score.**
- **Residing in Kweneng East district (rural/semi urban) was negatively associated with wasting.**

Other predictors of nutritional outcomes in these infants and young children included birth length, mother's education level, residing in Kweneng East district and Apgar score. Even though birth length was not significantly lower in HEU compared to HUU infants and young children, birth length remained a predictor for underweight, indicating that a lower birth length increased the risk of underweight in these infants and young children. This is consistent with findings from some studies where birth length is a significant intermediary of growth in infants and young children (Wilkinson

et al., 2015: Powis et al., 2016: Sudfeld et al., 2016). Also consistent with a number of studies, it was found that mother/care giver's education level was a predictor for stunting after adjustment for other variables (Kimani-Murage et al., 2011: Rollins et al., 2013: McDonald et al., 2012: Abuya et al., 2012). In addition, HIV positive mothers were significantly older than HIV negative mothers. Younger age and higher education level are associated with better nutritional outcomes because these caregivers tend to have more knowledge about optimal feeding, hygiene and child caring practices (Rollins et al., 2013: McDonald et al., 2012: Abuya et al., 2012). These caring practices may especially be useful in settings (such as Botswana) where HEU infants and young children tend to formula feed (McDonald et al., 2012). However, it should be noted that some of the maternal data especially during the antenatal phase were not available mainly due to the cross-sectional nature of the study. In addition, some of the maternal historical data such as viral load and CD4 cell count were difficult to obtain due to the requirement of a separate study protocol and thus another study ethics application. Therefore, the interpretation of the role of maternal characteristics is to an extent limited due to the lack of some of this antenatal data on maternal health and nutrition. It is important to consider the antenatal health and nutritional status of the mother as it has been shown to have an impact on nutrition and health outcomes of infants and young children (Black et al., 2013: Black et al., 2008: Ruel et al., 2013). Consideration of these antenatal factors would provide a more comprehensive determination of the predictors of nutrition and health outcomes in infants and young children.

It can also be argued that the difference in the mothers' age of HEU and HUU infants may point to a period of lack of access to better education and/or ART not being consistently available. This should be looked into context of when these mothers were introduced to ART. In Botswana, majority of pregnant HIV positive women had access

to HAART by 2012 to prevent MTCT of HIV (MOH, 2014). At the time, treatment was based on the CD4 count of ≤ 350 (WHO, 2012). Moreover, if the mother's CD4 count was higher than 350 she would still receive ART as early as week 14 of gestation (WHO, 2012). Therefore, it can be argued that ART has consistently been available to HIV positive women in Botswana. Therefore, these women being older may have rather resulted in them accessing ART early thus exposing their infants to ART in utero. In addition, as per the PMTCT protocol HEU neonates also receive ART for 4-6 after being born (WHO, 2012).

It should also be noted that these women were on average five years older than their HIV negative counterparts. In addition, there were less likely to have received more years of education compared to their HIV negative counterparts. Therefore, their age may be directly related to their lower level of education thus not being able to assimilate knowledge and skills that are essential for optimal infant care and feeding practices. Research has shown that younger age is associated with better understanding of the ability to assimilate knowledge and being able to adapt this to improve care and feeding for infants and young children (Rollins et al., 2013: McDonald et al., 2012: Abuya et al., 2012).

The difference in age can be a possible confounding factor on the conclusion that HIV exposure results in worse nutritional outcomes of infants and young children. However, this is better studied in a longitudinal study where the maternal health and nutrition status during the antenatal phase can be considered. Antenatal health and nutrition status of the mother may be an important factor that separates HIV positive and negative women. This study if done on a large scale may be able to elicit adequate amount of data and power in order to determine if matched case-controls HIV positive women

based on educational status and access to ART results in differing nutritional outcomes within HEU infants.

It was also found that HEU infants and young children had significantly more siblings than HUU infants and young children. A higher number of siblings is associated with poor nutritional outcomes in children (Biswas & Bose, 2011).

Infants and young children who resided in Kweneng East had a lower risk of wasting compared to those in other districts. It is should be noted that Kweneng East district was the only district where growth and health monitoring services were still offered in the main and primary hospital. Other districts have moved these services to smaller clinics and/or health posts. Therefore, infants and young children in Kweneng East district may have benefited from having close access to a multidisciplinary team of health professionals such as paediatricians and dietitians. These health-care workers are not typically accessible in smaller clinics. Accessibility to specialised care is important to the management of wasting because wasting is an acute form of undernutrition, characterised by rapid weight loss due to acute inadequate intake and/or disease (WHO, 2017). Therefore, infants and young children in Kweneng East district were more likely to have accessed swift and specialised care upon being diagnosed with wasting compared to other districts. A higher Apgar score increased the risk of wasting in these infants and young children almost two-fold. This was not expected because a higher Apgar score is associated with better nutritional outcomes (Trivedi et al., 2016). However, a study in Asian Indian infants and young children found that Apgar is a poor prognosis for growth and development in infants and young children (Lee et al., 2010).

2.4.5 Feeding practices

- **HEU infants and young children were more likely to be formula fed from birth and at 6-12 months compared to HUU infants and young children ($p<0.001$).**
- **Of those infants and young children aged more than 12 months, HUU infants and young children were more likely to be breastfed compared to their HEU counterparts ($p<0.001$).**
- **Average energy and protein intake was found to be higher in HEU compared to HUU infants and young children for females and *vice versa* for males. However, both these differences did not reach statistical significance.**
- **Dietary diversity was low for all infants and young children, and there was no significant difference between HEU and HUU infants and young children.**

Feeding practices are an important determinant of nutritional outcomes as demonstrated in a number of studies (Morden et al., 2016: McGrath et al., 2012: McDonald et al., 2012: Aheto et al., 2015). Feeding practices in the first 12 months in our study differed between HEU and HUU infants and young children, because HEU infants and young children tended to formula feed while HUU infants and young children were more likely to breastfeed. This is inconsistent with a number of African studies where HEU infants and young children had much higher levels of breastfeeding (Evans et al., 2016: Rosala-Halas et al., 2017: Moraleda et al., 2014: Landes et al., et al., 2012). This therefore makes Botswana a unique setting in sub-Saharan Africa in terms of how it implements the WHO's infant and young child feeding policy. The government of Botswana through its provision of free formula for HIV positive mothers who choose

to formula feed (as discussed in section 2.4.1) has unintentionally undermined breastfeeding in HEU infants and young children (Chopra & Rollins, 2008). It should however be noted that our regression modelling surprisingly indicated that mode of feeding in the first year of life, was not a statistically significant predictor of undernutrition in our study. Other sub-Saharan African studies have demonstrated that longer duration of breastfeeding is associated with better nutritional outcomes in HEU infants and young children (Morden et al., 2016: McGrath et al., 2012: McDonald et al., 20112: Aheto et al., 2015). In addition, some studies have also demonstrated that despite being born with a lower birthweight, HEU infants and young children are able to catch up in growth to HUU infants and young children, especially if they are breastfeeding (Patel et al., 2008: Bailey et al., 1999).

Average energy and protein intake was found to be higher in HEU compared to HUU infants and young children, however this difference was not statistically significant. It should be noted that the higher energy and protein intake of HEU infants and young children may have been likely due to intake of formula. Approximately 85% and 100% of HEU infants and young children in our sample were formula fed at 6 and 12 months respectively while HUU were breastfeeding. The quantification of energy and protein intake for HUU infants and young children did not take into account the contribution of breastmilk, thus we may have underestimated their energy and protein intake. The decision to ignore the contribution of breastmilk was due to the fact that infant were seen at one point in time and thus limited our ability to use methods to assess amount of breastmilk taken. However, the amount of the breastmilk intake of breastfeeding infants and young children can be estimated using methods such as weighing the infant before and after the feed, measuring the number of the minutes of breastfeeding, using the prescribed volume for each infant, finding the difference between the prescribed

volume and chartered intake or ignoring the contribution of breastmilk altogether (Greenslade et al., 2015: McLeod et al., 2013: Cooke et al., 2001: Cormack et al., 2006: Ernst et al., 2003: Radmacher et al., 2003). Most of these methods were not practical in context of our study therefore a decision was made to ignore the contribution of breastmilk to energy and protein intake in the previous 24 hours. This methods would be practical if a subset of the breastfeeding sample was chosen in order to estimate the amount of breastmilk taken.

For both HEU and HUU infants and young children it was found worryingly, that dietary diversity was low, where it was lower than a score of four for most of these infants and young children. Dietary diversity is calculated by allocating a score for consumption of food from one of the seven food groups (Grains, roots and tubers: Legumes & nuts: Dairy products: Flesh foods: Eggs: vitamin A rich fruits and vegetables: other fruits and vegetables) in the preceding 24 hours (WHO, 2008). Therefore, resulting in a maximum possible score of 7, an infant's diet scoring 4 or more is considered diverse (WHO, 2008). Dietary diversity is a better indicator of the quality of the diet as opposed to the calorie intake which quantifies the quantity of the food eaten (WHO, 2008: Kimani-Murage et al., 2011).

The strengths and limitations of using a 24 hour recall should be taken into account when measuring dietary intake in this population. This was deemed the most appropriate method in this study mainly due to the low level of variability in the diets of infants and young children in Botswana. It is acknowledged that the 24 hour dietary recall method better captures between-day variability, seasonal variability and foods rarely consumed if multiple recalls are conducted (DAPA, 2018). In the current study, only one 24 hour dietary recall was conducted. This limited amount of recalls limits the ability to capture between day variabilities which may have an impact on the overall

intake of the infants and young children (Baxter et al., 2003). However, since the aim of this research was to quantify the average consumption, a single 24 hour recall is deemed adequate (DAPA, 2018).

Since a single recall was used to collect data on the average intake of infants and young children, a number of measures were taken to further enhance the quality of data collected, including portion sizes and ensuring recalling of all foods eaten in the previous 24 hours. Firstly, the use of typical household measures further helped improve the estimation of portion sizes by providing the caregivers with a practical measure of how much they fed their child the previous 24 hours. Use of typical household measures can improve the estimation of portion sizes (Livingstone & Robson, 2000). Secondly, the use of multiple pass method was also useful in further enhancing the quality of the data collected. The use of the multiple-pass method has been shown to reduce bias in estimation of energy and nutrient intake of groups (Moshfegh et al., 2008: Blanton et al., 2006).

Nutritics® software was used to primarily assess the energy and protein intake of each infant. This was subsequently used to estimate the average energy and protein intake of all infants and young children in the study. Nutritics® software utilises a number of databases such as the Australian AUSNUT 2016, US USDA 28 and the UK 2015 database. However, infants in our study consumed local foods (sorghum porridge) and packaged foods mostly from South Africa. Therefore, to improve estimation the nutritional content of each packaged food was entered into the database in order to create a new food or a recipe was created from a combination of foods. In addition, nutritional analysis of the sorghum porridge was conducted in order to input this into Nutritics to create a sorghum porridge recipe. To ensure consistency of the product a

mixture of all commercially available sorghum meals (four) was used to analyse the nutritional content.

2.4.6 Use of the child health card

- **Some of the important variables including vaccinations, weight and length were not fully completed by healthcare workers ,**
- **On average, amongst the selected variables, healthcare workers completed only 72% of these variables in the child health cards.**

The child health card is a form of a health record that is very useful for clinical practice, research and policy planning (Hawley et al., 2014). Audit of the child health cards was assessed in this study in order to determine the level of completeness or missing data from each child's health card. This is a valuable source of data as it provides insight into the completeness of the dataset. Even though most of the data required for the analysis was available, some of the data was not completed such as the length. This is valuable set of data that could have provided us with longitudinal view of the growth and development of infants and young children in this study.

Important variables were selected and as discussed in section 2.3.6 and a highly variable level of completeness for each variable was found. This, indicated that healthcare workers in selected districts in Botswana do not fully complete the child health records as expected. Other studies have investigated the level of completeness of health records and have found varying levels of completeness of health records (Wright et al., 2015: Mlambo et al., 2014: Hawley et al., 2014). A study in Nkangala district in South Africa found that PMTCT data was completed only 25% of the time by healthcare workers (Mlambo et al., 2014). The level of completeness was higher in a multicentre study when electronic records were used, where level of completeness averaged 78.2%

(Wright et al., 2015). Currently, the child health card in Botswana is paper based. There has been an introduction of electronic records such as the Integrated Patient Management Systems (IPMS) by the Ministry of Health and Wellness.

There are various factors that affect the completeness of health records by healthcare workers including financial incentives, problem-oriented charting, gap reporting, shared responsibility, links to billing codes and organisational culture (Wright et al., 2015). Most of these factors were are not applicable to healthcare workers in Botswana since the healthcare system is mostly provided free of charge to patients, therefore there are no financial incentives or use of billing codes. In addition the child health card does not encourage a problem oriented charting, because healthcare workers are not encouraged to record the patient's problem before recording any other variables (Wright et al., 2015). Instead, the child health card encourages healthcare workers to record history, examination and other variables before recording the problem the patient has. There is also lack of gap-reporting because there are no designated officers to generate regular reports detailing level of completeness (Wright et al., 2015). Instead, organisational culture and shared responsibility tends to be the main influencers of level of completeness of child health cards in Botswana. As shown in a study by Mlambo et al. (2014) all healthcare workers are expected to complete a number of registers/records which are then summarised and sent to a central location, in case of Botswana to Ministry of Health and wellness. Therefore, there is an organisational culture where healthcare workers tend to fully complete variables that they know that will be required in such reports. Therefore there was an element of lack of shared responsibility where healthcare workers tend to complete information in a health card if they perceived that information to be important or if that information affected their next intervention (Wright et al., 2015: Mlambo et al., 2014). For example, in our study 100% of

healthcare workers completed the infant's HIV status in the child's health card because the child's HIV status determines various subsequent interventions such as feeding counselling, provision of ART and formula. In contrast, gross motor development was only completed in 5.1% of the health cards. This data is not routinely used nor required in the reports sent to Ministry of Health and Wellness therefore healthcare workers tend to avoid assessing and thus recording this variable.

The lack of completeness of health records is also associated with lack of auditing (Doherty et al., 2009). There is little or no audit of completeness of child health records in Botswana, because designated officers are often clinicians with other core duties. It has been shown that when there is a designated officer responsible for collating, auditing and training staff on completion of health records then completeness of health records increases (Mphatswe et al., 2012). In addition, feedback to healthcare workers should also be provided so they can understand the disparity between their current completeness level and the expected level (Otwombe et al., 2007). There should also be quality assessment plans in place that targets important aspects of data collection including accuracy, validity, reliability, completeness and timeliness (WHO, 2003).

2.5 STUDY LIMITATIONS

It is important to note the following limitations about the current study. We have only considered the impact of HIV exposure, infant feeding, maternal and household factors upon nutritional status using the most extreme outcome measures of stunting, wasting and underweight as determined by anthropometry and reference to WHO cut-offs for *z* scores. Indices such as micronutrient deficiencies were not included and we also did not focus on lower variance from cutoffs in terms of growth. Contribution of HIV-exposure may be greater at these subclinical levels and thus the *z* scores may be lower in HEU compared to HUU infants and young children. Due to the cross-sectional study design, we did not have access to maternal

nutrition and health indicators variables such as weight, height, CD4 count and use of ART pre-and post-natally. There is also a possibility, albeit a limited one, that some of the infants and young children who were classified as HEU may have been HIV-infected after 6 weeks, since testing of HIV in these infants and young children in Botswana is done at 6 weeks, post weaning if the mother was breastfeeding (6 months) and at 18 months. Some of the infants and young children in our study were not yet 18 months, at the time of data collection. However, a majority of these infants and young children were formula feeding, therefore it was highly unlikely that they would have seroconverted. The parity of the mother was not considered in logistic regression. Parity is associated with nutritional outcomes such as stunting (Abuya et al., 2012). In addition, we have to acknowledge the cross-sectional nature of this study especially in regards to HIV-exposure and nutritional outcomes. Longitudinal studies are therefore required to elicit more data which will allow us to disentangle feeding modalities from HIV-exposure and also to derive more information on maternal nutrition and health during pregnancy. In context of the current study some data that was collected previously as documented in the child health card such as weight and length could have been used to make longitudinal assessment of the growth of infants and young children in this study. However, this was mainly limited by significant missing of length measurements (over 75%). In addition, some of the weight data was also missing (over 5%). Using previously collected data also introduces measurement bias because it was completed by multiple number of people at different time points using different scales and measuring boards. Even though we calibrated the scales we found in the health facilities that we went to, there is a possibility that some of these were changed in between the recorded measurements.

It is also important to acknowledge the ethical implications of allowing participants only 30 minutes to read the information about the study and then decide if they wanted to participate. This may be considered inadequate as ideally the participants should have been accorded some

time at least 24 hours in order to consult with other family members before participating in the study. However, due to the cross sectional nature of the study, it was not practical to do so. To mitigate this, posters about the study were provided at least a month prior the data collection in each health facility, in order to sensitise the caregivers about the study. In addition, healthcare workers were encouraged to tell the caregivers about the study so that these caregivers were well informed about the study prior to data collection.

2.6 CONCLUSIONS

In Botswana, HEU infants and young children aged 6-24 months have poor nutritional status compared to HUU infants and young children. Although mode of feeding was not a statistically significant factor determining risk of undernutrition, HEU infants and young children tended to formula feed while HUU infants and young children tended to breastfeed for the first twelve months of life. Therefore, HEU infants and young children are missing out on the well documented benefits of breastfeeding. Therefore, by reviewing the current Botswana government's infant feeding policy in order to align with the new 2016 recommendations by WHO may be an important step in promoting breastfeeding in HEU and HUU infants and young children. Furthermore, this study demonstrated that the strongest predictor of nutritional outcomes was birthweight. More studies preferably longitudinal studies are required in order to investigate nutrition and health outcomes in infants and young children. This studies should being preferably at the mother's first presentation at the ante natal clinic. This research also needs to incorporate the HIV/AIDS services that are offered to those who are HIV positive. In addition, this research should seek to disengage the effects of feeding modalities on HIV exposure and use of ART. The generation of new data will allow the development of strategies designed to optimise infants and young children' nutritional status in the first 1000 days should aim to improve birthweight and other variables as identified by the research.

Further specific research should focus on how PMTCT strategies in Botswana can be refined, so that optimal nutritional outcomes in HEU infants and young children are prioritised in addition to prevention of MTCT of HIV. This requires investigating the impact of integrating nutrition-specific and -sensitive interventions as it is currently implemented in the SUN program. In addition, there is need to reassess through research and consultation if the variables that are included in the child health card and if they are deemed important there should be retraining of staff so that they can fully complete these and other important variables in the child health card. Botswana's healthcare system infrastructure, PMTCT strategies and growth surveillance for infants and young children is rigorous enough to enact these changes.

3.0 Perceptions of caregivers, older family figures and healthcare workers

SYNOPSIS

Introduction	Caregivers' perceptions and what influences them is important for better understanding of determinants of nutritional status of infants and young children in their first 1000 days. A better understanding of these determinants allows implementation of effective interventions which are targeted, responsive and culturally appropriate.
Main Objective	To explore how perceptions of primary caregivers , older family figures and healthcare workers influences practices related to nutritional status of infants and young children aged 6-24 months from selected districts in Botswana.
Methods	Semi-structured qualitative interviews were conducted with caregivers (n=25), older family figures (n=9) and healthcare workers (n=10). An inductive, interpretive/latent thematic analysis approach was used.
Results	Four themes emerged from this data and this includes; 1. When "free choice" is an illusion: mothers' infant feeding decisions. 2. "These people are dangerous…": negotiating access to healthcare services. 3. "Caring is how I show my baby love" 4. "Our culture, our heritage!"
Discussions	Caregivers strived to achieve optimal nutritional and health outcomes in their infants and young children, thus made efforts to implement infant care practices that sought to reduce risk of disease whilst promoting growth. Caregivers were also responsible for initial and subsequent choice and implementation of feeding practices for their infants and young children. However, these were subject to influences from their experiences when accessing healthcare and influence of older family figures.

Study Limitations	▪ Lack of access to fathers, therefore their views regarding their role and thus influence on infant nutrition and care was not adequately captured. ▪ Potential sources of bias exist due to the lead researcher previous work as a dietitian in this area, however measures were taken to prevent this.
Conclusions	Successful infant's nutritional and health outcomes depend on more than the caregiver's knowledge and skills as acquired from healthcare workers. Other external factors such as influence of the mother, community factors and experiences associated with accessing healthcare services should also be taken into account.

3.1 INTRODUCTION

The quantitative study as outlined in chapter 2, sought to gain an understanding of the prevalence of undernutrition in infants and young children within their first 1000 days. This was crucial because it allowed the identification of both the prevalence of undernutrition in HEU and HUU infants and young children as well as the determinants. This provided opportunities to identify challenges or gaps that may be addressed in order to improve nutritional and health status of infants and young children. However, the understanding of the caregivers 'perceptions regarding infant nutrition and health and how this influences their consequent behaviours or practices in ensuring optimal nutritional status for their infants and young children is equally important (Aubel, 2012). Caregivers may have the knowledge on how to achieve optimal nutritional status in their infants and young children, however due to external factors, may face challenges when putting this knowledge into practice (Fergusson et al, 2009). A clear understanding of these drivers of the caregivers' practices, allows a targeted effort at changing practices, thus improving nutritional outcomes in infants and young children (Aubel, 2012).

Caregivers and their infants and young children do not live in isolation, because most caregivers in Botswana have other family members (mostly older), who provide advice and other forms of support. It is therefore, useful to explore the influence these older family figures have on the caregiver's practices including infant's care and feeding practices. In addition, approximately 90% of all **c**hildren aged five years or younger in Botswana, are monitored monthly at their local healthcare facilities. Therefore, a large majority of infants and young children have access to a healthcare worker at least once a month. Health Workers have an opportunity to influence caregivers' perceptions regarding infant care and feeding during this visits. Therefore it is important to evaluate how caregivers perceive this influence. Healthcare workers are often seen as a source of knowledge, but can also be source of reprimand for caregivers who are seen not be 'following orders' (Ritchie et al., 2016). The influence of healthcare workers will be explored in the context of the influence exerted by older family caregivers, who by default have more access to caregivers compared to healthcare workers. The findings in this study (and the previous study) will add more knowledge in infant nutrition and care in Botswana, thus in the short term the findings are expected to argue a case for examination of the current practices in the management of these infants and young children. In the long term, the findings from this study will contribute to the evidence-base that will impact on policies, having a positive impact on the nutritional status and thus the mortality rates of HEU and HUU infants and young children in Botswana. Therefore this qualitative study aims to explore how the perceptions of caregivers as influenced by their sociocultural context, structural conditions, older family figures and healthcare workers influences their knowledge, attitudes and practices associated with nutritional outcomes of their infants and young children.

3.2 METHODS

This qualitative study was conducted as the second part of the explanatory sequential mixed-methods approach. The focus of investigation- was largely based on the findings from the first quantitative study.

3.2.1 Study participants and population

This study was undertaken in the north-east district of Botswana within two clinics in Tonota and one clinic in Tati-Siding. These locations were purposively selected to recruit participants- because they are semi-urban and, therefore, were able to provide the required groups of participants (caregivers, older family figures and healthcare workers). It was observed in the first study that older family figures were generally concentrated in semi-urban and rural areas (See Appendix 8). Caregivers (mothers) were more concentrated in urban areas. Furthermore, health facilities in rural areas have fewer types of healthcare workers since they are mostly staffed by nurses and health education assistants (MOH, 2010). Other healthcare workers are also important to access as they work also with infants and young children aged 6-24 months. With a balanced mix of caregivers, older family figures and healthcare workers, a semi-urban location ensured that the participants, as per their group gave as many views as possible to ensure saturation of meanings or views (Creswell, et al, 2013).

Tonota and Tati-Siding are both thriving semi-urban locations located close to Francistown, the second largest city in Botswana (CSO, 2015). They are partly urban, probably due to their close proximity to Francistown (Figure 1.2.1). Access to Francistown from these two locations has drastically improved recently, with completion of a dual carriageway (Sunday Standard, 2016). A large number of people who work in Francistown live in Tati-Siding and Tonota either because of lower cost accommodation or because their close relatives live there. These two locations can also

be considered partly rural because they have a relatively large population of older people, some of whom are still practising pastoral and arable farming or a mix of both (CSO, 2015). Data were collected from the 22nd of August to the 15th of September 2016.

This study, like the preceding study, focused on infants and young children aged 6-24 months within child welfare clinics where all children aged 0-59 months are routinely seen each month. Participants in this study included the following;

- **Caregivers;** these were legal guardians of the infant who fit the inclusion criteria. For the purposes of this study the caregivers were defined as the mother, father or aunt but not grandmother or any other older family figure. They were the **primary caretaker of the infant.**
- **Older Family figures:** a broad definition that was culturally appropriate was used which included not just grandmothers/fathers, but also aunts/uncles or other older family figures who lived and cared for the infant on most days or had cared for the infant in the past.
- **Healthcare workers;** these were midwives, nurses, healthcare assistants and counsellors who worked directly with pregnant women, caregivers and/or their infants and young children. Therefore, they provided various services such as vaccinations, nutrition and health education, weight and height monitoring and/or feeding practices counselling and HIV testing and counselling.

3.2.2 Sample Size

Participants were purposively selected to participate in the study up to a point where no new findings were revealed. Saturation is a term from Grounded theory and although

this did not employ grounded theory, it is a useful concept as it indicates that now new beliefs are forthcoming or emerging and does justify collection of more data (Creswell, 2013). Theoretical sampling was used in this study because it maximises opportunities to develop concepts in a study (Corbin & Strauss, 2015)

As per the recommendation of Baker & Edward (2014) approximately 10 participants were to be recruited as per study group i.e. caregivers (HIV-exposed and non-HIV-exposed), older family figures and healthcare workers. Therefore a total of 40 participants were required for the study. However, this number was to be revised up or down depending on the achievement of saturation during data collection. However, as indicated by Baker & Edward (2014) marginal benefits of upward increase in sample size, should be balanced against the marginal costs of endless data collection.

It was more likely that a smaller sample of healthcare workers would be required compared to the other two groups. It was recognised from the preceding study that approximately 2-5 healthcare workers worked directly with population of interest in each health facility. Therefore, there may be a need to revise down the sample size from 10. However if point of saturation was not reached there was a need to collect data from a second or a third health facility.

3.2.3 Ethical approval

Ethical approval was sought and received from the University of Nottingham's Medical School Research Ethics Committee and the Health Research and Development Committee in Botswana as an extension of the previous ethics approval. Informed consent was obtained from all caregivers. The participant and the lead researcher both signed and dated the informed consent form prior to data collection. The participant was then given a copy of this informed consent form, the original was retained for study

records. Informed consent was directed to parents and/or legal guardians. Information sheets about the study were provided in English and Setswana and participants were given 30 minutes to decide whether they wanted to participate in the study. Support in reading or completing consent forms was provided to the participants as required.

Participation in the study was voluntary, therefore participants' right to withdraw from the study anytime during data collection was emphasized. When poor or inappropriate feeding, under or over nutrition were identified the caregiver was briefly counselled by the PhD student, who is also a registered dietitian. The caregiver was then referred to the health facility for further follow-up and this was documented in the child's health card to ensure continuity of care. The inclusion and exclusion criteria is as outlined in section 2.2.3.

3.2.4 Recruitment

The study was advertised to caregivers, older family figures and healthcare workers at least a month prior to collecting data. The health facilities were notified about the study and encouraged to advertise the study to the caregivers. On the day of data collection the officer in charge of the health facility announced to the caregivers and older family figures about the study and allowed the lead researcher to give a brief overview of the study. Healthcare workers were notified about the study in their morning staff meeting during the day of data collection. Since healthcare workers tended to be busy in the morning they were recruited and after consenting were interviewed in the afternoon or when they were not attending to patients.

The officer in charge and the lead researcher screened potential participants by looking at the health card following consent by the caregiver. If the participant fit the inclusion criteria, they were recruited into the study, following which they signed a consent form

after consenting. Initially, the plan was to recruit participants (caregivers and older family figures) in the clinic and then conduct the interview at their homes. However, it became apparent during data collection that this was not feasible, because home visits could only be conducted with the assistance of healthcare educators as they knew the location of homes of the recruited participants. Health education assistants were unable to do home visits before lunch and most afternoons. Therefore, it was decided that all interviews would be conducted in the clinic and home visits would be conducted whenever the health education assistants were available.

3.2.5 Data Sources and Collection Processes

Data was collected using interviews. This study was completed by the lead researcher with assistance of healthcare workers in each health facility.

Interviews

The study used interview as the main tool for data collection. This interview was semi-structured with open ended questions in order to elicit maximum views regarding the topic of study. These open-ended questions aimed to explore the views of the participants in order to reveal their perceptions regarding knowledge, attitudes and practices related to infant nutrition in the first 1000 days (See Appendix 5 for interview guides).

The interview questions were derived from the research questions, in order to ensure that all objectives were addressed adequately for each group of participants. These questions were used as guide, however, in order to maximise theoretical saturation, questions were refined as the study progressed. This was essential after analysing the views of the previous participants, thus some questions required refining to elicit more information. Interviews were recorded using a digital tape recorder (Olympus DSS

PlayerPro, Stock Road, UK). The interviews were conducted in the national language (Setswana) and in some areas Ikalanga.

3.2.6 Data Quality Controls

The lead researcher was trained in a number of areas including interviewing and other qualitative methods. The lead researcher also practiced using the interview guides prior to collecting data. The lead researcher periodically reviewed the audio recordings after each day, in order to assess whether saturation point was reached and also to identify areas which required further exploration. This was done reiteratively throughout the collection of data.

3.2.7 Study Management

The lead researcher was responsible for the management of the study including, liaising with Francistown DHMT to get approval for access to clinics and associated logistics of the study during data collection. The overall management of the study was based in the University of Nottingham in the Division of Nutritional Sciences, where the two supervisors were located at the time.

The lead researcher ensured that all the participants' rights such as privacy and informed consent were protected at all times. The study adhered to the protection of data as set out by legislation (*Data Protection Act 1998*). All the data (audio recording and paper) was kept in a secure environment through the use of locked cupboards and bags. The digital audio files were backed up in a password secured laptop. The lead researcher also ensured that access to data was by authorised personnel only.

Since data collected included sensitive information, such as audio recordings which could potentially identify individuals, it was treated with outmost confidentiality. Each participant's interview transcript was given a subject number. The data will be kept for

7 years in secure archives before it is destroyed as per the University of Nottingham code of research conduct and research ethics guidelines.

3.2.8 Data Analysis

Data was organised and prepared and then analysed following the process shown in Figure 3.1.1 NVivo 11 Software was used to manage data analysis (QSR International Pty Ltd, version 11, 2016). Data analysis in this study used an inductive approach, whereby the themes identified were strongly linked to data (Patton, 1990). In addition, data was analysed to ensure that themes were interpreted at a latent or interpretative level i.e. underlying ideas, assumptions made and conceptualisations and associated ideologies as influencing the semantic content of the data (Braun & Clarke, 2006).

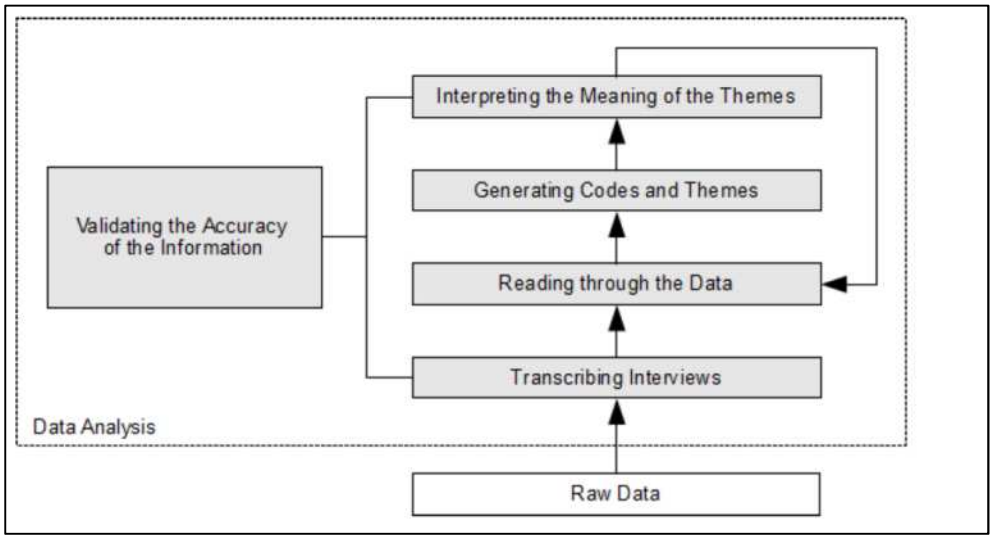


Figure 3.1.1: Data analysis process (Creswell, 2013; Corbin and Strauss, 2015).

3.2.8.1 Transcription

Audio files were transcribed verbatim by translating directly from Setswana (or Ikalanga) to English. This was completed by typing into Microsoft Word as the audio was listened to. Measures were put in place in order to preserve the spoken context in the typed transcript by going back to the recording to check if the

translated interpretations were consistent with the audio recordings (Gibbs, 2007). In addition, significant body language and actions and the overall feel of the interview, were captured as much as possible in the transcript by inserting action words. Direct words were included when there was no direct translation into English (Gibbs, 2007). Participants were anonymised by using false names in the transcripts. The completed typed transcript was then read carefully to correct for grammatical mistakes and also to ensure clarity. If lack of clarity was identified, the audio recording was listened to again and corrections were made. Transcription was completed by the lead researcher.

3.2.8.2 Data Checking and familiarisation

After transcription was completed, data was read and reviewed intensively by the lead researcher. This was completed by reading through each transcript and ensuring consistency of the typed transcript. Therefore, the lead researcher immersed themselves in the data by reading actively whilst searching for meanings and patterns was completed (Braun & Clarke, 2006). The aim was to get an overall familiarity with the depth and breadth of the data. Notes were taken in order to capture initial ideas about themes. This was preparatory work for coding.

3.2.8.3 Generating initial codes

According to Rossman & Rallis (2012) coding organises data into bracketed chunks and writing a word/phrase that represents a category. It also involves segmenting sentences or images into categories and labelling those categories with a term (Gibbs, 2007). The aim was to code texts of the transcript, which exemplified the same theoretical or descriptive idea with the same code. This allowed an establishment of a framework consisting of thematic ideas about it

(Gibbs, 2007). The generated codes were then used to generate descriptions of the setting or people, as well as categories or themes for further analysis. In order to get the coding process going, a number of questions were continually asked as the transcripts were read intensively (Charmaz, 2003). These included;

1. What is going on in terms of what is said by the participant?
2. What is the participant really saying and doing?
3. Are participant's statements taking something for granted or implies something?
4. How do structure and context serve to support, maintain, impede or change the participants' actions and statements?

For each transcript the aim was to move from descriptive to more categorical and analytic level of coding. Analytic coding was achieved by carefully interpreting participants' response thus going beyond what the participant is describing (Gibbs, 2007). Coding was mainly data driven, because there were no codes to start off with (Gibbs, 2007). Therefore, the researcher made sure that they were constantly aware of preconceptions that they might bring to this interpretation of participants' views. It should be noted that since this qualitative study followed the quantitative study, the researcher had ideas on some of the possible codes. To overcome this, each code generated was justified. Justification of each code ensured consistency of usage of the code within each transcript or between different transcripts. Coding was completed by the researcher within NVivo 11 Software (QSR International Pty Ltd, version 11, 2016).

3.2.8.4 Searching for themes

After all the data had been coded and organised, a list of codes were produced. During this stage, the aim was to shift from coding and start developing themes. This was completed by sorting the codes into potential themes and organising relevant data extracts within each of the potential themes (Braun & Clarke, 2006). This was completed using NVivo 11 Software (QSR International Pty Ltd, version 11, 2016). Thematic maps were used to visualise the development of themes. Therefore, initial thematic maps were developed at this stage. This assisted the lead researcher to start developing relationships between codes, themes and different levels of themes (Braun & Clarke, 2006). This allowed refining of themes whereby some of the themes were made into sub-themes or removed.

3.2.8.5 Reviewing themes

The themes generated in the first step were then reviewed further and some of the themes were discarded or collapsed into each other. This was done so that there was consistency between themes and their sub-themes. Reviewing of themes was done at two levels as per the recommendation by Braun & Clarke (2006). On the first level, themes were reviewed at the level of coded extracts, thus developing a thematic map. The second level applied the same process but covered the entire data set, whereby each theme is validated, thus fine tuning the thematic map. This was repeated, up until a point where further work was deemed to be unnecessary.

3.2.8.6 Defining and naming themes

The final steps employed in the analysis of this qualitative data included defining the themes in the final thematic map. In addition, data was analysed

further within each theme (Braun & Clarke, 2006). According to Braun & Clarke (2006), further defining and refining the themes is whereby the core message of each theme is determined. The aspect of the data the theme is capturing is also outlined (Braun & Clarke, 2006). A story for each theme was then developed so that it fit with the overall story of the data yet also consistent with the main aim of the study. Sub-themes were used to give structure and depth to each theme. At the end of this exercise, each theme was clearly defined. The themes and sub-themes were then named to reflect what the theme is all about.

3.3 RESULTS

This section presents the results of the qualitative study. This data is presented as themes addressing the objectives of the study. Data from 25 caregivers, 9 older family figures and 10 healthcare workers were analysed in order to determine perceptions of these individuals in relation to achieving optimal nutritional outcomes in infants and young children. To the author's knowledge, this is the first study conducted in Botswana, seeking to explore perceptions of caregivers, older family figures and healthcare workers and how these perceptions interact to influence behaviour and practices of these individuals as they seek to achieve optimal nutritional status for infants and young children.

3.3.1 Characteristics of Participants

The characteristics of all the participants are shown in Table 3.1. Majority of caregivers were mothers and were mostly aged around 30-39 years. Most of these caregivers were single and also unemployed. Older family figures interviewed in the study were mostly maternal grandmothers. All the older family figures who participated in this study were

all single (Table 3.1). Most of the healthcare workers in this study were female and aged less than 40 years (Table 3.1).

3.3.2 Study epistemology and reflexivity

Interviews with caregivers, older family figures and healthcare workers was conducted in an allocated office within a health facility. Caregivers and older family figures had infants and young children and other children with them during the interview. Toys and colouring books were used to occupy the infants and young children during the interview in order to avoid distracting the caregiver or the older family figure. On average caregivers, older family figures and healthcare workers' interview lasted 28, 26 and 35 minutes respectively. The data from these interviews were used to generate themes as outlined in section 3.3.3.

The lead researcher used to work in similar settings as a dietitian, whereby they mainly offered therapeutic dietetic services to patients including children. The lead researcher relied on previously acquired skills to build rapport with participants. This was helpful because it allowed most participants to comfortably and freely express their opinions, thus allowing their wide ranging views to be captured. This was evident in a number of interviews where participants were laughing and interactive.

Table 3.1: Characteristics of participants and the infants and young children

Caregivers (CG)	**25**
Age	
20-29	6
30-39	15
40-49	4
Infant's HIV-exposure	
HEU	7
HUU	18
Caregiver's Gender	
Male	1
Female	24
Employment Status	
Not employed	14
Self-employed	7
Formally employed	4
Caregiver's marital Status	
Single/widowed/divorced/ other	21
Married/lives with partner	4
Infant's Gender	
Male	13
Female	12
Infant's age (in Months)	
6-12	13
13-18	8
19-24	4
Older Family Figures (OFF)	**9**
Age	
40-49	1
50-59	2
60-69	5
70+	1
Infant's HIV-exposure	
HEU	3
HUU	6
OFF type	
Aunt	2
Grandmother	7
OFF's Gender	
Male	0
Female	9
Employment Status	
Not employed	5
Self-employed	3
Formally employed	1
Marital Status	
Single/widowed/divorced/ other	9
Married/lives with partner	0

Infant's Gender	
Male	7
Female	2
Infant's age (in Months)	
6-12	6
13-18	2
19-24	1
Healthcare workers (HCW)	**10**
Age	
20-29	1
30-39	6
40-49	1
50-59	1
60-69	1
Gender	
Male	2
Female	8
Role	
Nurse/Midwife	3
Health Education Assistant	3
Counsellor/Healthcare Assistant	4

3.3.3 Themes

Caregivers used a range of indicators such as weight gain, absence of illness and the infant being happy and playful, to shape their understanding of their infant's optimal growth and development. Four main themes related to participants' perceived influences of their infant's growth and development were described in Table 3.2, then expanded upon and supported with verbatim quotes. These themes focused on the caregivers' perspectives with consideration of how older family figure and healthcare workers disputed or corroborated these perceptions. The wellbeing of the infant and in some instances the wellbeing of the mother was central to perceptions influencing practices, behaviours and/or interventions as applied by the three groups (caregivers, older family figures and healthcare workers). However, each group had different ideas about how to safeguard the wellbeing of the infant and/or the mother.

Table 3.2: Themes and sub-themes emerging from the data

Main Themes	**1. When "free choice" is an illusion: mothers' infant feeding decisions.**	**2. "These people are dangerous..": negotiating access to healthcare services**	**3. "Caring is how I show my baby love"**	**4. "Our culture, our heritage!"**
Sub-themes	a. Fear overrules rational infant feeding choices	a. Growth monitoring; a measure of good parenting but also an opportunity for the infant.	a. "Prevention is better than cure"	a. Older family figures as "custodians of culture"
	b. Feeding choices: easier said than done.	b. Deprivation of resources breeds fear and anxiety.	b. "Burden of care is mine and mine alone to carry."	b. Traditional support system for the caregiver.
	c. "I was told when to feed my baby."	c. "The ball is in their court……"		c. When cultural practices and health align.
	d. Weaning food choices: interaction of culture, texture and nutrition.			

Theme 1: When free choice is an illusion: mothers' infant decisions.

Choice of infant feeding practices was a recurring theme, throughout the caregivers talk. Caregivers portrayed infant feeding choices as free and indicated that they were responsible for making such choices. However, this choice may not necessarily be free, despite this being portrayed as something with more than one outcome. Healthcare workers substantiated this by indicating that they provided mothers with facts, thus they believed that they adequately equipped these mothers with information to make choices. Feeding was explicitly linked to development of the infants and young children and not just the growth of the infants and young children because caregivers depicted feeding as central to optimal growth and development of their infants and young children. Feeding choices were mainly influenced by the mother's HIV status and fear of MTCT of HIV. Choice of feeding practices were also influenced by the age of the infant, caregiver's circumstances, culture and their perception of appropriate food characteristics. Four sub-themes emerged from this main theme;

Sub-theme 1a: Fear overrules rational infant feeding choices

The choice of initial feeding practices were mainly influenced by the mother's HIV status with caregivers who are HIV positive tending to choose to formula feeding.

"I did not breastfeed because of my HIV status" (CG 68)

This choice of feeding in HIV positive mothers was influenced by the fear of infecting their infant with HIV and this fear overruled more 'rational' infant feeding choices as caregivers were fully aware of the benefits of breast-feeding compared to formula feeding. Furthermore, they were also aware that conditions

permitting, they could breasted if they chose to which indicates that the advice of Healthcare workers did not modify this fear.

> *"I live with the virus (HIV positive), therefore at first I had agreed to breastfeed but then I was scared that I may infect her with HIV. So I only breastfed her for 6 weeks then when I came for check-up I told them I was stopping breastfeeding." (CG 84)*

> *"Most of them choose to formula feed……. When I speak with the HIV positive women about breastfeeding, you find that they tend to agree to breastfeed. It takes time and making sure that the woman understands. Some are still afraid of infecting the child with HIV, they often say let me go and think about it first…" (HCW 6)*

However, some (though very few) HIV positive mothers managed to overcome these fears and were able to exclusively breastfeed for 6 months. In those cases, attaining the benefits of breastfeeding were seen as more important than the risk of transmitting HIV from the mother to the child.

> *"I was advised in the clinic by the counsellor and they explained to me both options and then I chose to breastfeed and then the baby was tested for HIV after I changed to formula……...I chose to breastfeed because I didn't want my child to get diseases, because breastfeeding is best for the baby more than tinned milk." (CG 70)*

Healthcare workers played an important role in decisions mothers made regarding how they fed their infants and young children after birth, because different routes of infant feeding advice for HIV positive women exist.

Healthcare workers also viewed HIV test as a pivotal moment, which provided the necessary context for infant and young child feeding counselling

> *"First visit is HIV testing and as she progresses she comes to us and at 36 weeks she comes to us for the final test where we also talk about infant feeding and where we explain to the mother that since she is expecting a child we explore with here her infant feeding intentions taking into context her HIV status. And then she decides whether she wants to formula feed and thus we will give her formula or she decides to breastfeed for the first 6 months." (HCW 3)*

> *"If she is HIV positive, in fact for everyone our counselling start talking about infant feeding. So by the time she tests she should understand feeding options for her baby, so that she understands how to feed when she is HIV negative or positive in terms of the baby's feeding. This is done before we know the result for HIV test." (HCW 1)*

Healthcare workers considered their advice to be fair and balanced and restricted themselves to providing facts. This was consistent with the depictions provided by HIV positive women, regarding their experiences of counselling sessions on infant and young child feeding.

> *"Actually I am HIV positive. When I was pregnant at the clinic I was given an option to either breastfeed or formula feed.……The counselling session was all right. I was not forced to choose formula. I understood that I could breastfeed." (CG 75)*

"……they (healthcare workers) supported my decision, and they said they will support me on the choice that I made." (CG 70)

Even though healthcare workers seem to be convinced of the ability to choose breastfeeding, they were also aware of other factors that influences the caregiver's free choice regarding infant feeding practices. This awareness did not, however, challenge their belief in the pivotal role of education in behaviour change.

"…….… When you look at many things that people end up doing or the decisions they end up making its mainly because of lack of understanding of certain things. Because there are certain hidden things that the mother needs to know so that the baby won't be infected through breastfeeding." (HCW 3)

Sub-theme 1b: Feeding choices; easier said than done.

Mothers', irrespective of their HIV status- were much more cognizant of other factors as they experienced challenges when implementing the feeding method of their choice. HIV negative mothers who were breastfeeding had (or regarded) challenges in continually breastfeeding associated with employment and education. This, therefore, indicated that the choice of feeding method was only the beginning of a successful implementation of infant feeding.

"…….I now had a job therefore I had to stop breastfeeding him." (CG 72)

"I was breastfeeding initially, then started giving him formula when I started going to work……I wanted to breastfed him up to 6 months. However, I started working when he was 4 months old." (CG 81)

The limited duration of breastfeeding due to caregivers' work commitments is also exacerbated by the fact that strategies suggested to prolong breastfeeding, such as expression and storage of breastmilk (Ortiz et al., 2004), are not culturally acceptable for these mothers and/or their other family members.

"Aaaah. That (expressing breastmilk), my mum does not want that, where you leave breastmilk. No..... She said the milk will go bad or it will separate, she said a lot of things." (CG 73)

"What you find is that they are not accepting of such practice because in our culture, our Setswana culture, breastmilk, when I grew up breastmilk was associated with dirt. Therefore, we still have that belief that breastmilk cannot be stored in the fridge where food is stored. As you know, a breastfeeding woman cannot share utensils with the rest of the family members." (HCW 8)

HIV positive mothers also experienced challenges when implementing their chosen method of feeding such as safely implementing formula feeding. However, these mothers recognised this risk, and actively took steps to mitigate it. Caregivers' descriptions also demonstrated how they spontaneously justify their behaviour, most often citing the infant's good health.

"I did use bottles to feed him……. But I made sure that at all times when he has finished the milk in the bottle, I boil it. Before using it to make him another bottle." (CG 92)

"I gave him formula using a bottle, I did have a steriliser. I used the one which steams the bottles. So I would wash the bottles, soak in hot water then put them in a steriliser, I only removed them when I needed to use them.…… she never had diarrhoea." (CG 84)

However, the caregivers' positive experiences with use of bottles were not echoed by healthcare workers. They cited their experiences of home visits to describe how formula was often not hygienically prepared and stored, and not given to the infant using a cup (as per the recommendation of WHO, 2007).

"Another issue, is the bottles that they use to feed the children are not clean. Not everyone is able to clean them adequately, because they don't sterilise them." (HCW 4)

"I have had two clients where I went to their homes, to see what the problems were. I found that the setting where the formula is made is not clean and also measuring bottles were not appropriate and they were also mixing feeds." (HCW 3)

Sub-theme 1c: "I was told when to feed my baby."

In contrast to initial decisions on feeding methods, where the mother was provided with at least two options, complementary feeding advice only had one outcome. Complementary feeding advice was didactic and caregivers took the advice of healthcare workers without question, despite professing ignorance as to the rationale for this advice. This appeared to be because it aligned with their own perceptions of their infant's readiness to start on solid feeds.

"That's what we were taught in the clinic, that a baby should start eating at 6 months." (CG 84)

"I was doing as directed at the clinic where they said I should start feeding my child at 6 months.…… his body is ready, because he can adapt to food at this age." (CG 63)

Not all caregivers followed this didactic advice they had received on complementary feeding. These caregivers were clearly aware that they were going against this didactic advice and sought to justify their behaviour, by indicating that their decision to start complementary feeds earlier than directed, had no adverse effect on their infant's growth/health outcomes. Starting complementary feeding early was attributed to older family figures' advice or challenges with implementing breastfeeding.

"It was my mother who said that we should start feeding him sorghum porridge at 4 months.……" (CG 92)

"I realised that I was not producing enough breastmilk to satisfy her at that age (four months). So when she ate sorghum porridge and also breastfeeding, I noticed she was satisfied and was growing well." (CG 65)

"I started feeding him at 4 months…..I know in the clinic they say 6 months, for me as I have raised my children from my first child, my mother started feeding them at 4 months and there were no issues. So I continued as well giving them at four months." (CG 76)

All caregivers (irrespective of their HIV status), are given the same advice regarding when to start complementary feeds by healthcare workers. This is in contrast to the context based advice given when making the initial choice of feeding. Therefore, there seems to be convergence in messaging for all caregivers at this stage, thus no influence of mother's HIV status.

"The government said all children should be fed at 6 months ……... I try to show them that a child's digestive system is not ready when you feed a child early and that this may adversely affect the child." (HCW 4).

Sub-theme 1d: Weaning food choices; interaction of culture, texture and nutrition

The choice of first weaning food was overwhelmingly sorghum porridge which represented an interaction of the influence of culture and the caregiver's need to provide the right texture and adequate nutrition for infants and young children.

"I chose sorghum porridge, because I thought it was the best food for the baby to start on. That's because sorghum porridge is soft and it has the nutrients than most foods." (CG 68)

Caregivers seem to disregard healthcare workers' direct advice in implementing complementary feeding, despite readily accepting their advice on when to commence complementary feeds.

"I started feeding him sorghum porridge, because my mother said it was best for the baby because it strengthens their digestive system." (CG 75)

"We want to see how and what the mother is feeding the child and we then advise her on how she should feed the child. We encourage them to feed the child at least 4-5 times per day and also to give a variety of foods, not only sorghum porridge." (HCW 4)

Influence of choice of weaning foods is also indirect, whereby the mother, themselves being raised (by an older family figure) on sorghum porridge, thus through transfer of knowledge, felt it was best food for their baby.

"I fed sorghum porridge because I was raised on sorghum porridge. I grew well, therefore I don't want my child to not benefit from it as I did. I want to feed her so that she grows well as I did, can you see how I am." (CG 71)

"I chose sorghum porridge because, it is our traditional food that we are used to unlike this modern foods." (OFF 66)

Theme 2: *"These people are dangerous"*; negotiating access to healthcare services

Caregivers had various opportunities to access healthcare services, from a range of healthcare workers which requires them to negotiate various aspects of healthcare services including attitudes of healthcare workers.

Subtheme 2a: Growth monitoring; a measure of good parenting but also an opportunity for the infant.

Caregivers considered healthcare services such as the monthly growth monitoring as very important, because it provided them with an objective measure of their infant's growth and development. Caregivers used this feedback as a measure of their care towards their baby, thus a proxy measure of their parenting. However, they also saw this as an opportunity for the baby to receive interventions from healthcare workers if required.

"I bring her so that I can check if she is growing well. I want to see if she is gaining weight." (CG 64)

"They do help us because, if there was no clinic or weighing, we wouldn't know if he is growing well or not." (CG 73)

Healthcare workers were regarded by caregivers as instrumental in both identifying and intervening if there were problems. In turn healthcare workers who performed this role

considered growth monitoring and the identification of poor growth as one of their most important roles, especially since it took more of their time on a typical day.

> *"They do assess how a child grows. In the growth monitoring chart there is a red line and the black line. When they are not growing well they go below the black line. So the healthcare workers do help us to understand how my child is growing." (CG 71)*

> *"My role is to do growth monitoring in children and also look at the children who are not growing well, malnutrition and underweight." (HCW 5)*

Subtheme 2b: Deprivation of resources breeds fear and anxiety.

The main issues caregivers encountered when accessing healthcare services, was lack of medication and/or vaccines and the service provided not meeting their expectations. This often resulted in fear and anxiety for caregivers because they felt that their infant was left vulnerable to diseases. Lack of these resources often resulted in caregivers seeking alternative treatment from pharmacies and/or traditional healers. In addition to want of guaranteed safety, this also distracted caregivers from having useful conversations with healthcare workers regarding what they can do to improve their infant's health.

> *"…….… she was supposed to get her polio vaccine at 18 months but she is now 20 months old, they always say it's not there. At the end of the day you wonder if it if is okay for the child to have not received her polio vaccine, because I know polio is dangerous. It's almost 3 months and she has not received her polio vaccine, I wonder if it's okay or not." (CG 84)*

"They (healthcare workers) didn't help me. When my child was sick they gave me Panado, though my child was really sick, he was vomiting and all that. They just gave me those medications, I then went back home and it did not get better. The traditional doctor really helped me. That's why I went to see them after I realised that I was not getting the help I need. My child was very sick, after the traditional doctor helped me, he started gaining weight." (CG 93)

Caregivers also had challenges in accessing healthcare services due to the long distance between the health facility and their home.

"I do live far from the clinic. Therefore I have to take a taxi whenever I come to the clinic." (CG 65)

"Sometimes when I am concerned looking at how the baby is not growing well or they are not collecting formula consistently then I would often go to their home. However, in some instances it's not possible to go to their homes, especially those that live far as in cattle posts." (HCW 3)

It emerged from talk with healthcare workers that, systematic issues such as lack of staffing, lack of equipment and lack of transport existed. These issues were felt to limit their ability to provide quality services. Often, healthcare workers used great creativity and their personal resources to reach caregivers whom they considered at most risk.

"Our clinic has a lot of workload because our clinic has low staff numbers. Because when there is an emergency in maternity I am expected to go and help. Because we have a maternity wards, women deliver here and hospitalise theme here. We do everything, after I help in maternity, I have to come back here and continue my work" (HCW 8)

"Domiciliary …..…we travel by foot and sometimes I use my car to see some of the mothers, especially if there were problems during birth or maybe I was concerned by her personal hygiene when they are in the clinic." (HCW 7)

Subtheme 2c: "The ball is in their court……"

Accessing healthcare services may also have been impeded by the attitude of some healthcare workers. Some healthcare workers held explicit and negative preconceived ideas towards the caregivers, particularly those women who were HIV positive. Healthcare workers cast these caregivers as uncooperative or uncommitted, mainly because these caregivers did not conform to their standards. These healthcare workers portrayed themselves as having done everything they can, thus the onus was on the caregiver to help themselves. The negative attitudes of healthcare workers were acutely experienced by caregivers, some of whom avoid judgement by providing false information.

"Most of them, they tend to be HIV positive. Those are the people who should be more proactive about their health, buy they don't. You will find that she has another baby and then she gets pregnant. Those people who are HIV positive are very dangerous, even though it is said that we discriminate against them." (HCW 7)

"However, if it's some of these not so serious mothers who comes and register late, that would be putting a child in great risk. It's putting tomorrow's generation at risk. Because we may end up with lots of HIV positive infants and young children. That's why we need a committed mother." (HCW 10)

"Yes they (healthcare workers) did ask if I had started feeding my baby and I would tell them I haven't fed her yet, though I was feeding her. I didn't want to complicate things, I didn't want to answer a lot of questions." (CG 76)

Theme 3: "Caring is how I show my baby love"

Caregivers spoke freely about the ways in which they implemented care practices to ensure that the child was free from disease and/or safe, and thus grew and developed optimally. Caregivers-regardless of HIV status- portrayed the act of giving care as an important way of showing society that they loved their child.

Theme 3a: "Prevention is better than cure"

Caregivers described a number of routines as infant care practices; cleaning the home environment, washing the infant's clothes and cooking utensils and, ensuring that the infant was free from danger. Infant care practices were framed by caregivers as 'the right thing to do' as they prevented diseases and/or harm and, ensured optimal growth for their child. In particular, caregivers associated a dirty environment with an increased risk of diarrhoea which in turn they indicated could adversely affect their infant's growth.

"I make sure she grows in a clean environment. I make sure that her clothes have been washed and her utensils are clean. I also make sure that she is clean and that where she is playing is clean and her toys as well, I clean them from time to time…….. I want to avoid her getting diseases such as diarrhoea and flu." (CG 64)

Furthermore, caregivers took specific steps to ensure that food was prepared safely in order to prevent contamination. The aim as above was explicitly described as necessary for the prevention of diarrhoea.

> *"I make sure that before I touch her food, I wash my hands with soapy water. I give her warm food at all times. I feed her freshly made food, I don't feed her leftovers……Because feeding her leftovers could make her unwell for example it could cause her to have diarrhoea. Diarrhoea can cause dehydration and the baby may end up dying." (CG 71)*

Theme 3b: "Burden of care is mine and mine alone to carry…."

Even though, the older family figures often acted as a replacement for the mother (discussed in sub-theme 4b), the mother remained as the primary caregiver, carrying a greater burden of care for the infant. This was not, however, resented.

> *"No I am not working at the moment, I will only go when he turns 12 months, I am self-employed I normally buy and sell clothes from South Africa. I am waiting for him to turn a year, then I will go back to work." (CG 79)*

> *"Yes, I am his only carer, I am his mother. I don't work at the moment….." (CG 70)*

The father was not described as an active contributor to the infant's care and this was accepted as an important cultural norm, enforced by older family figures, (see sub-theme 4a). Fathers tended to stepped in as carers, if they lived with the mother and often when the mother was ill or at work.

"There were taboos that I followed, because when the child was born his father moved away from the house. When his umbilical cord fell he was called so that a bonding ceremony between him and his son could be performed." (CG 70)

"When I had given birth, I was brought by his father to the hospital to give birth. But he was not allowed to come collect me, so my son came to collect me instead, because according to his family they have taboos. When he came to see the child at 2 months, he came bringing things that is meant to create a bond between the father and the child and me as well." (CG 78)

"Today, I (the father) brought them to the clinic because their mother has been unwell. Therefore I decided to bring them to the clinic for growth monitoring." (CG 94)

Fathers also played a limited role during pregnancy, whereby they rarely accompanied the caregiver to the healthcare facility for services such as HIV testing. This increased the burden on the caregiver, as they were tasked with making a number of decisions including decisions on infant and young child feeding, without the support of their partner.

"*When you talk to the mother about bringing the partner, you can tell from her initial reaction that he won't come. It's only a few of them that are able to bring their partner. When they both come for testing, or maybe I get two couples, I get excited because it's so unusual. In a week most times we get no couples, if you lucky two." (HCW 6)*

Theme 4: "Our culture our heritage!"

Older family figures (OFFs), typically maternal grandmothers, played a significant role in the growth and development of infants and young children, from pregnancy to complementary feeding of infants and young children. This role was often grounded on preserving cultural practices, beliefs and norms.

Sub-them 4a: Older family figures as "custodians of culture"

Older family figures were regarded by caregivers as important advisors for practices relating to cultural taboos and beliefs. According to OFFs, these beliefs/taboos were associated with the health and wellbeing of the mother and her infant, but, they did not explain to caregivers why such taboos and beliefs were important.

> *"These are taboos which we observe when a woman has given birth such as avoiding having intimate contact with the father before the baby has grown. Because if she does the child gets some illnesses and then doesn't grow well." (OFF 7)*

Interestingly, the caregivers often accepted that these practices were, without question, harmless. Caregivers were willing to go along with the practices, therefore, were not hostile towards older family figures.

> *"She (my mother) said I should not eat while holding the baby. {Did she say why?} No I didn't ask why. [Laughter] she also said I should eat while lying on side of my stomach following birth." (CG 64)*

> *"I was also not allowed to eat salt, I only ate salt after the child had reached a certain milestone…..I am not sure why that taboo is for, I don't know what it means." (CG 65)*

Other beliefs/taboos promoted the isolation of the mother after birth as discussed in theme 3b, isolates the father. Isolation of the father as implied by caregivers was used as a form of birth control method, in order to allow optimal growth of the infant.

> *"I was told not to interact with the baby's father while the baby was young. I suspect this was done to prevent us from being intimate because we could end up making another baby while this one is still young! While this baby still needs my love. Therefore the baby will not grow well." (CG 71)*

> *"My interaction with most people was limited after birth. I spent most of the time in my room……It's meant to prevent anything adversely affecting the baby" (CG 64)*

Older family figures did consider themselves as custodians of culture by providing advice to their daughter. They viewed this as their responsibility in order to safeguard the baby and its mother. Their main concern (and rationale for enforcing these beliefs/taboos) was that if these beliefs/taboos were not followed the infant would not grow optimally.

> *"I advised her a lot, that she should understand that she is still a new mother (motsetsi). Despite the fact that she is away from her child, she should understand that she is still a new mother (motsetsi)……I did ask her to observes taboos because it would affect the baby, it affects the child's health, the child does not grow well, especially his weight." (OFF 1)*

> *"A new mother is kept indoors. It's our Setswana culture, that's what we found when we came to this earth……We want to make sure that the child*

grows well, that they baby does not get affected by things which are outside." (OFF 6)

"That's the taboos that I taught her, I told her that since she now has a child, she can't just do as she wishes. She has to follow certain rules in order to ensure that her child grows well and becomes a strong person. This includes not doing anything, not having intimate relations with anyone until the child grows. These are some of the taboos for a nursing mother." (OFF 4)

Therefore, older family figures often used taboos and beliefs to exert moral control on the caregivers because some of these taboos had no physiological basis.

"Because I knew that if she breastfeeds him that's the most important thing in the growth of a child. If I had said stop breastfeeding him and feed him formula…., I had the money to buy milk. I was looking at the fact that she is still young and when she gets to senior secondary she would think because she has stopped breastfeeding she would think since looking at her mates she would think she is free to do whatever and whatever she does will affect the baby especially since she is the mother." (OFF 4)

"She did advise me, she told me that when you are a motsetsi (new mother), you should not be in contact with a male that is being intimate especially when the baby is still small because it affects the child. The child may not grow well, for example if a child has diarrhoea this may be a sign that you have had intimate contact with a man, especially the one who is not the baby's father." (CG 68)

Subtheme 4b: Traditional support system for the caregiver

Older family figures also acted as an important support system for their daughter (infant's mother), during pregnancy and especially after birth where the OFF would often relocate to live with the caregiver in order to help care for her and the infant. Older family figures exerted their influence by providing advice and skills but also as, replacement mothers, whereby the mother would leave the baby with the OFF to work or study in another location.

> *"My mother cared for me after birth.…… She taught me, starting with how to care for stiches. She also taught me how often a child should be washed and also how to care for the umbilical cord." (CG 71)*

> *"She did stay in the house for over two months without going outside, as a motsetsi, she was not allowed to do any tasks. She was like a child, I was doing everything for her. I took a leave for a month so that I could help her to take care of the baby. I was worried that she would not manage for example washing the baby and so forth." (OFF 3)*

This support and thus influence tended to be stronger during the mother's first childbirth. When the caregiver had more children, they tended to rely more on their previous knowledge and experience. However, the OFFs still remained a crucial part of caregivers' and infant's lives especially during the first 2-3 months after birth.

> *"My aunt took care of me during Botsetsi. She didn't give me much advice since this was my fifth child. Even now she lives at her own home. She only came to see how I was doing since I had just given birth" (CG 70)*

Discordant advice from the OFF and the HCW and differing beliefs between the caregivers and the OFF, - often resulted in conflict. Caregivers found ways to resolve this conflict by either openly disregarding the advice from the OFF or pretending to take the OFF's advice but then do something else instead.

> *"I did teach her because she was a sort of person who did not believe in some of these things. You know how the new generation is, they don't believe in such things. When I told her to do or not to do something she would ask me why?" (OFF 3)*

> *"I took them (folic acid tablets), because I was told to take them at the clinic even though I was not sure what they were for. Even though older women said they would make the baby to grow inside the tummy (instead of outside)." (CG 73)*

> *"you know, an elder is an elder, sometimes when they tell me to do something that is different from I was told not to do at the clinic, I just keep quiet even though I know that I don't agree with her. So I secretly do what I was told in the clinic." (CG 79)*

Subtheme 4c: When cultural practices and health align

Cultural practices often aligned with optimal health outcomes for example older family figures were strong advocates for breastfeeding. Older family figures clearly stated that that breastfeeding was the best choice for feeding infants and young children but were also able to describe when circumstances when breastfeeding was not possible.

> *"She was very unwell when she gave birth to her child. She gave birth when she was older at 33 years. She got pre-eclampsia. She really struggled and she*

had oedema, after birth she tried to breastfeed however failed, she tried breast pumps to no avail. We ended up giving up and then gave the baby formula." (OFF 2)

OFFs also acted as advocates for other optimal practices such as accessing healthcare services. They often coordinated with healthcare workers to prompt caregivers to access healthcare services.

"I did advise her though when she was pregnant because the youth do like going to private doctors. I told her that she should not totally abandon government clinic and that she should make sure that she goes to the clinic, that's the main advice I gave her and she followed it." (OFF 2)

"They (OFF) are helpful because they will even report to you that the mother is not bringing the child for growth monitoring or that they have a pregnant woman at home who is refusing to register. They come to ask for help and then we would go to their home and counsel the mother." (HCW 4)

Therefore, there is an opportunity for transfer of knowledge from healthcare workers and the community, through older family figures and back again to the healthcare workers. In addition, OFFs have capacity for change, thus opportunity to modify undesirable advice they offer, because they do recognise that certain changes in traditional practices can achieve positive outcomes in infants and young children.

"We encourage the grandmothers or other caretakers to be able to see the signs that the mother is close to giving birth." (HCW 4)

"These days we don't use traditional medicine anymore we believe in God so that the child does not get sick" (OFF 8)

3.3.4 Summary of findings

In this study, we have focused on four themes that reflected caregivers' perspectives regarding factors influencing their infants and young children' growth and development. The four themes generated includes; when "free choice" is an illusion: mother's infant feeding decisions; "These people are dangerous." negotiating access to healthcare services; "caring is how I show my baby love"; "our culture, our heritage". Caregivers highlighted indicators that they used to determine if the growth of their infant is optimal, this included weight gain after growth monitoring at the health facility, absence of illness and the infant seen as happy and/or playful.

Choice of feeding practices was regarded by caregivers, as an important care practice for optimal growth and development of infants and young children. Choice of feeding practices was exercised on a day to day basis by the caregiver, however two significant time points were observed; first, before or immediately following birth and secondly, when complementary feeds were introduced. Caregivers highlighted that initial feeding choices were influenced mainly by their HIV status. This was also consistent with experiences of healthcare workers who used HIV test as a pivotal moment to influence caregivers' infant feeding choices. Healthcare workers were regarded as important for providing evidence based infant and young child counselling to caregivers. Therefore, even though choice of feeding was portrayed as a free choice for mothers, it was not always so. Caregivers' infant feeding choices, especially those living with HIV, were mostly influenced by fear of transmitting HIV to their infant. Both caregivers, irrespective of HIV status, had challenges in implementing feeding practices of their choice. All caregivers tended to introduce complementary feeding as per the advice of the healthcare workers. However, there was little understanding of the rationale behind this. Earlier introduction of complementary feeds was mostly due to the influence of

older family figure or due to issues with implementing breastfeeding. The choice of first weaning foods were almost homogenous and this was based on ensuring correct texture for the infant or based on the nutritional content of the food. In addition, choice of first weaning foods was influenced by older family figures directly and indirectly. Therefore, this represented an interaction of culture, texture and nutrition.

Caregivers negotiated access to healthcare services in order to achieve optimal health and nutritional outcomes for their infants and young children. Growth monitoring provided caregivers with an objective assessment of their infants and young children' growth and development. They used this feedback as a proxy measure of their parenting. They also regarded growth monitoring as an opportunity to access interventions for the infant. Caregivers experienced anxiety and fear when there was deprivation of resources due to systematic lack of resources. Healthcare workers' negative attitudes also emerged as a potential detriment to access to healthcare services by caregivers.

Caregivers implemented infant care practices in order to prevent diseases in infants and young children. Therefore, caregivers implemented various care practices which were centred on achieving hygiene and food and environmental safety. The act of giving care was equated to showing love to infants and young children. However, the burden of care rested mostly with caregivers, with little or no contribution from the infant's father. The limited role of the father may have been reinforced by cultural norms, beliefs and taboos which required physical isolation of the mother for at least 2-3 months after birth. These beliefs and taboos were imposed by older family figures. Furthermore, the father still played a limited role prior to birth of the child because it was indicated that they rarely accompanied the caregiver when accessing ante-natal health care services.

Older family figures have a unique type of influence over the caregivers. This influence stems from their role as custodians of culture, whereby they upheld and enforced beliefs and taboos. Older family figures were also seen traditionally as an important support system for the caregiver, often replacing the mother as the primary caregiver, when the mother had work or school commitments away from their infant. Even though some of their influences resulted in potentially harmful practices, older family figures' main interest is to safeguard the health and wellbeing of the caregiver and her infant. Older family figures also exerted influence by playing an advocacy role, through promotion of breastfeeding and other optimal practices. Therefore, this provided an opportunity to align cultural practices and health outcomes in mothers and their infants and young children through the use of older family figures.

3.4 DISCUSSION

The aim of this study was to explore how the perceptions of caregivers as influenced by their sociocultural context, structural conditions, older family figures and healthcare workers influences their knowledge, attitudes and practices associated with nutritional outcomes of their infants and young children. The discussion of the findings as summarised in section 3.3.4 will be discussed under each theme.

Choice of infant feeding practices

Findings in this study indicates that initial choice of feeding methods is affected mainly by HIV status of the caregiver and that HIV test is the pivotal moment in terms of the caregivers physical health, mental health (in terms of fear and stigma) and influence of infant's choice of feeding method (sub-theme 1a). This is consistent with findings from a study by Chintalapudi et al. (2017), which found that women as the main child caregivers were responsible for decisions regarding infant's feeding method and that HIV status of these women was an important consideration in the feeding method of their choice. Fear of MTCT of HIV is a significant determinant of infant feeding choices, because it was not affected by counselling provided by healthcare workers for most caregivers in our study. This is despite HIV positive caregivers understanding that they can breastfeed exclusively for at least 6 months if they received ART. However, the residual risk of HIV infection was still a factor in their decision of feeding method for their infants and young children. This is consistent with findings from a study conducted in Botswana, investigating the knowledge, attitudes and practices associated with infant feeding in HIV-infected women (Ndubuka et al., 2013). It was found that despite having knowledge of PMTCT and/or PMTCT related to breastfeeding, caregivers still believed breastfeeding transmitted HIV to the baby and thus avoided breastfeeding (Ndubuka et al., 2013). Healthcare workers in our study adopted an

impartial role when counselling caregivers on infant and young child feeding and instead focused on providing balanced information on available infant feeding options. This is an acceptable practice because, provision of balanced and unbiased information to caregivers allows them to make informed choices regarding their infant's feeding practices (Iwelunmor et al., 2014). However, there was a strong emphasis by healthcare workers, that the choice of feeding is the mother's prerogative. This may be ignoring other external factors that influences behaviour, because according to the socioecological model, there are other factors besides individual (caregivers) factors, which influences infant and young child feeding behaviours (McLeroy et al., 1988). This includes, interpersonal relationships caregivers have, the healthcare system that caregivers accesses and community factors that caregivers is subjective to (McLeroy et al., 1988). Therefore, it can be argued that these women are not empowered enough to make infant and young child feeding decisions. Simply providing them with facts on the two feeding options does not address these other external factors. A study reviewing challenges healthcare workers encountered in providing infant feeding counselling, found that successful counselling strategies took into account the needs of caregivers, thus were more tailored, meaningful and responsive (Tuthill et al., 2015). Empowering women economically, within their social and family environment and legally, improves multiple indicators of infant and young child feeding (Na et al., 2015).

Implementing tailored and responsive counselling strategies is important because it can also address some of the challenges associated with implementing both methods of feeding infants and young children (breastfeeding and formula feeding). In our study, HIV negative mothers experienced challenges in achieving continued breastfeeding due to work or study commitments. This is consistent with findings from a number of studies (Eldridge et al., 2017: Fischer & Olson, 2014: Hurley et al., 2016). Strategies

such as expression of breastmilk could be one of the ways to ensure continued breastfeeding, as demonstrated by Win et al., (2006), women who expressed breastmilk were 29% less likely to discontinue breastfeeding before 6 months. However, this practice is not culturally acceptable in *Setswana* culture because breastmilk is considered 'dirty'. This was consistent with findings from a Nigerian study which found that caregivers had misgivings about using expressed breastmilk, citing contamination as of the main reasons (Davies-Adetugbo, 1997). Interestingly, breastfeeding is considered the best method of feeding by caregivers, older family figures and healthcare workers in our study. Therefore, these incongruent views about breastfeeding, points to the adverse effect of beliefs and taboos on optimal practices. Successful implementation of breastfeeding as measured by longer duration, should therefore seek to effect change in the strong perceptions that breastmilk is dirty. This can be achieved by involving all stakeholders including caregivers, older family figures, fathers and the community by respecting the culture but use agents of change to influence this practice (Ver Beek, 2000).

HIV positive women indicated that they were aware of issues associated with safely implementing formula feeding. Therefore, they took steps to improve safety of formula feeding by ensuring that the bottles used were cleaned and/or sterilised. Healthcare workers experiences contradicted this, indicating that the biggest challenge they encountered, was lack of safe implementation of formula feeding. Safe implementation of formula feeding is one of the principles of AFASS (Acceptable, Feasible, Affordable, Sustainable, and Safe), which states that replacement feeds should be prepared correctly and hygienically and fed preferably using a cup (WHO, 2007). Safely implementing formula feeding is important, because it can reduce the risk associated with use of formula such as diarrhoea and pneumonia (Bork et al., 2014).

Introduction of complementary feeds is probably one of the most important milestone in an infant's life as it affects their growth and development (Alvisi et al., 2015). This was considered an important care practice by the caregivers in our study. This was mostly implemented (as per healthcare workers' advice) when the infant was 6 months old. This perhaps reflects the effectiveness of the campaign led by the Ministry of Health and Wellness in Botswana. The impact of healthcare messaging on this topic is also consistent with a study of Zambian infants and young children which found that 81.2% of caregivers knew when to introduce complementary feeds, this knowledge was acquired from healthcare workers (Katepa-Bwalya et al., 2015). However, there were other caregivers who introduced complementary feeds earlier than 6 months. These caregivers did so due to the influence of older family figures. This is consistent with a number of studies that found that older family figures such as grandmothers had influence on the timing and type of complementary feeds the infant were introduced to (Harrison et al., 2016: Nakumbi & Muliira, 2015). There were strong beliefs associated with the use of sorghum porridge, with almost all of the caregivers indicating that this was the best food to start the infant on. Caregivers indicated that the texture and nutritional content of sorghum porridge made it ideal for infants and young children. Traditionally, sorghum porridge is eaten by most people, especially children in Botswana (Jackson et al., 2013). Older family figures promoted the use of this food as one of the main first weaning foods. However, sorghum porridge does not contain adequate protein and/or other micronutrients to be fed as the only complement food to infants and young children without enrichment (Jackson et al., 2013). Therefore, there is need for further research into how the belief and tradition associated with the use of sorghum porridge can be honoured, but also ensuring better nutritional outcomes when this food is used. One option is to fortify the sorghum meal with other culturally

acceptable nutritious foods such as sugar beans as Jackson et al., (2013) did in their study. In addition, Jackson et al., (2013) tested the acceptability of such fortified food and found that it was culturally acceptable to the community. However, this is questionable because the government of Botswana, through the Ministry of Health and Wellness already provides as a food ration to all infants and young children similar products- fortified sorghum meals (*Tsabana and Malutu*). These were not well accepted by caregivers in our study because they indicated (or believed) that these fortified cereals caused diarrhoea in their infants and young children. Consequently, consumption of these fortified cereals by infants and young children was lower than recommended.

Negotiating access to healthcare services

Caregivers constructed their own subjective indicators of optimal growth and development, however they still required this objective measure of their infant's growth and development. They often used this objective feed as a proxy measure of their parenting. Furthermore, caregivers trusted healthcare workers to provide this service and also considered this the healthcare workers most important role in assisting them achieving optimal growth and development for their infants and young children. The use of growth monitoring program was regarded as important by Ghanaian mothers and was also associated with better nutritional outcomes because it improved nutrition knowledge and practices (Gyampoh et al., 2014). Healthcare workers were also considered source of knowledge for caregivers including advice to improve the care and thus optimal growth of the child in our study. This is consistent with findings from a mixed-methods study conducted in Malawian HIV positive women, where it was found that mothers trusted the healthcare workers' advice including infant and young child feeding advice (Flax et al., 2016). The impact of healthcare workers advice has

been documented in a number of studies where it was found that healthcare workers have opportunities to influence caregivers in various dimensions such as feeding, care and accessing healthcare services (Alvisi et al., 2015: Burns et al., 2016: Katepa-Bwalya et al., 2015). A mixed methods study of Zambian caregivers found that having access to a healthcare worker improved knowledge in various parameters of infant and young child feeding such as when to start complementary feeding (Katepa-Bwalya et al., 2015).

Traditionally, healthcare services are seen as important for providing medication to treat diseases and this is mainly influenced by the medical view of health (Betancourt et al., 2003). This is reflected in caregivers talk regarding this role of healthcare services, whereby they expect to be given medication in order to treat or manage disease. The aim for caregivers was to treat disease because they associated disease with poor growth outcomes, because they understood that a sick infant does not eat adequate of amounts of food. Vaccinations were regarded as the most important healthcare service (besides growth monitoring) for optimal growth of infants and young children. This was because vaccinations were regarded as crucial for preventing diseases. Caregivers regarded prevention as the best strategy in achieving optimal nutritional status of their infants and young children. This is inconsistent with the growing hesitancy associated with vaccines that is occurring in other parts of the globe (Larson et al., 2014). Caregivers in the current study do believe in the use of vaccines in protecting their infants and young children against diseases. This could be an opportunity to further improve access to healthcare or expand the reach of other healthcare programs by tying these initiatives to vaccinations.

Caregivers did however indicate deprivation of some resources when accessing healthcare services. This often led to fear and anxiety for caregivers especially in

relation to the health and growth outcomes of their infants and young children. Lack of resources included, lack of medication and/or vaccines, lack of improvement in child's health after consultation in the health facility and negative attitudes of healthcare workers. Lack of medication in healthcare facilities often led caregivers to access alternative treatment such as buying medicines from the pharmacy or accessing traditional doctors. Lack of vaccines often resulted in anxiety or fear in caregivers as they felt that their infants and young children were vulnerable to diseases. Lack of medication in health facilities was found to be one of the main reasons why patients often self-medicate, whereby they buy medication from pharmacies without consulting the doctor (Ocan et al., 2014). This was also exacerbated by long delays in the healthcare facility and/or whereby caregiver lives far from the health facility. Caregivers would often decide to buy the medication at the pharmacy in order to avoid delays. Lack of medication and delayed recovery of the child often led caregivers to seek traditional healers. This can be problematic because the safety of these healers, cannot be guaranteed. In addition, there may be delays in diagnosing and treating serious conditions if a child is seen by a traditional healer first (Afungchwi et al., 2017). These negative experiences were generally a product of systematic issues in healthcare facilities such as lack of staffing, lack of transport and/or lack of equipment. This were regarded as a barrier to providing high quality services.

Implementing Infant care practices

A number of infant care practices were implemented by the caregivers. This mostly centred on improving hygiene and safety of the environment the infant lived in and food safety. These care practices were done in order to prevent diseases in infants and young children, because caregivers indicated that dirty environment increased the risk of disease, which in turn results in poor growth and development for children. A review

by Hurley et al. (2016), found that caregivers equipped with best skills in nutrition and care including providing infants and young children with early learning, were more likely to achieve better growth and development goals for their infants and young children. Implementing best care practices such as improving sanitary practices and hygiene does prevent diseases such as diarrhoea (Fagundes-Neto et al., 2013: Machado et al., 2011: Kumar et al., 2017). Prevention of diarrhoea in children is important because children with repeated episodes of diarrhoea are more likely to be undernourished (Mondal et al., 2012).

The burden of implementing of this care rested with the mother. This is consistent with findings from a study by Chintalapudi et al., (2017) which found that mothers were primarily responsible for child care. In the current study older family figures often supported the caregiver or replaced the caregiver as the primary caregiver if she had other commitments. Similar to our study, Zambian fathers had limited role besides providing monetary support (Chintalapudi et al., 2017). Other studies have also demonstrated that the father's role tends to be limited to providing food and monetary support to the mother (Thet et al., 2016: Bilal et al., 2016: Cuco et al., 2015). It can be argued from the findings in our study that the cultural beliefs/taboos that restricts the father's access to his new-born child reinforces the father's limited role. However, as also indicated by healthcare workers in our study, fathers rarely accompanied mothers to healthcare facilities when the caregiver accessed prenatal services. Therefore fathers were missing out on HIV testing and infant and young child feeding counselling. This was consistent with findings from a study by Chintalapudi et al. (2017), where none of the father accompanied their partners to the clinic. This limits their role because they do not have adequate information, therefore are unable to adequately support the mother (Chintalapudi et al., 2017). The limited role of the father therefore places more burden

on the mother as the primary caregiver and often provides the older family figure with more influence on the mother's decision regarding care and infant and young child feeding (Bedell et al., 2014).

Expanding the role of the father especially in infant and young child feeding counselling can be beneficial to the mother and the infant' helath and nutritional outcomes by providing her with another source of support (Kalembo et al., 2013: Chintalapudi et al., 2017). The role of the father can be expanded by encouraging them to accompany the mother to the clinic through an invite, using male nurses in clinics, having weekend clinic hours and implementing community-based interventions (Kalembo et al., 2013: Morfaw et al., 2013: Osoti et al., 2014: Rosenberg et al., 2015: Jenkins et al., 2012).

Intersection of culture and health

Older family figures played a significant role in the growth and development of infants and young children. This bestows them with a significant amount of influence over caregivers' decisions on care, feeding and access to healthcare services. OFFs exert their influence by playing the role of custodians of culture, as a support system for the mother or as a replacement caregiver and also as an advocate for breastfeeding and other optimal care practices. The role of OFF as custodians of culture is consistent with findings from a number of studies conducted in sub-Saharan Africa (Mukuria et al., 2016: Kerr et al., 2008: Negin et al., 2016: Adama et al., 2017). A study by Aubel (2012) has identified grandmothers or other senior women as important influencers because they provide advice on issues related to maternal and infant nutrition or act as caregivers. Their role and thus their influence is important because it covers a significant period of the infant's first 1000 days; pregnancy, feeding and care of infants and young children (Aubel et al., 2008: Kerr et al., 2008). This was evident in our study,

where grandmothers used beliefs /taboos to guide the pregnant mother on how to care for herself. This influence continued when the mother gave birth, where older family figures continued applying beliefs/taboos to influence the mother's practices in caring for herself and her infant. Older family figures in our study unlike in a study by Kerr et al., (2008) tended to be maternal grandmothers. This perhaps reflects the marital status of the mothers in our study. Culturally in Botswana, when a mother gives birth to a child out of wedlock, maternal side of the family especially the grandmother, has more control over any decisions affecting the infant such as care and feeding. The child even takes the mothers surname. The reverse is true when the mother is married, whereby the paternal grandmother has more influence. Regardless of the mother's marital status, the older family figure is always an older woman.

Some of the caregivers in our study, whose mothers had passed away or were sick when they gave birth, hired an older women to help them following birth during *Botsetsi*. Older family figures are therefore a support system for the mother especially following birth. This period called *Botsetsi* (in *Setswana* language) is considered a sacred period where the mother is isolated from most people. The older family figure act as a gatekeeper during this period whereby they apply beliefs/taboos, thus controlling who has access to the mothers. They also influence caregivers' food choices, feeding practices and health-seeking behaviours. This is consistent with a study of Ghanaian grandmothers which found that they acted as gatekeepers for health-seeking behaviour of caregivers (Gupta et al., 2015). Older family figures provided different types of advice, providing care of the infant and often replacing the mother as the caregiver. It was found that the influence of the OFF tended to be stronger in first time mothers. This was reflected in a study of first time Kenyan mothers, which found that these mothers always had an older family figure to help with the care of the infant during the perinatal

period (Talbert et al., 2016). Majority of these mothers felt compelled to take the advice of the older family figure (Talbert et al., 2016). In our study, some caregivers indicated that conflicts arose (between them and an older family figure) when older family figure gave advice contradicting that of the healthcare worker. Most mothers especially first time mothers took the advice of the older family figure, however mothers who had more children tended to have more confidence to challenge discordant advice they received from older family figures. Some caregivers avoided the conflict altogether by pretending to be taking the older family figure's advice but instead adopted the healthcare worker's advice. Some of the advice that grandmothers in our study gave to caregivers contradicted healthcare workers' advice and was potentially harmful. Similar findings were shown in a Kenyan study, where older family figures often limited the mother's access to healthcare services by treating most problems at home without the consultation of healthcare workers (Talbert et al., 2016). Another study in Ghana found that some of the negative advice that grandmothers gave to caregivers often resulted in adverse health outcomes in preterm infants and young children (Adama et al., 2017).

However older family also influenced caregivers to implement positive practices for example, older family figures in our study emerged as advocates for breastfeeding and other optimal practices such as timely access to healthcare services. Therefore, if the role of older family figures is incorporated into healthcare interventions or programs they can be used to promote positive outcomes in infants and young children. This is especially relevant since their role and thus influence will always remain because caregivers value and trust their input and support (Aubel et al., 2012). In our study older family figures also served as caregivers especially when the mother had work/ school commitments. This was consistent with findings from other studies where

grandmothers acted as replacement mothers when the caregiver was not available (Aubel et al., 2012: Karmacharya et al., 2017: Negin et al., 2016). Therefore, health education and interventions need to take into account the role and influence of these important stakeholders (Kerr et al., 2008). A study by Negin et al., (2016) found that grandmothers have the capacity to influence exclusive breastfeeding. In addition, another study by Aubel et al., (2004), demonstrated that Senegalese grandmothers have the ability to learn and apply new information and thus can be used to positively influence optimal infant care and feeding practices. However, this would require deliberate inclusion of older family figures in future programs whilst also ensuring that these were culturally acceptable and responsive to their unique role and influence (Coetzee et al., 2017: Negin et al., 2016: Talbert et al., 2016: Kerr et al., 2008: Aubel et al., 2004). Currently in Botswana, as in a number of other African countries, healthcare systems often limits or ignores the role of older family figures (Kerr et al., 2008).

3.5 STUDY LIMITATIONS

The main limitation in this study was that there was no access to fathers or the caregivers' partners. Therefore, their views are not adequately presented. As indicated earlier, mothers tend to be the main caregivers, therefore tends to be the ones that access healthcare services. Attempts to recruit fathers through the mothers proved to be difficult because most of the fathers lived away from where the caregiver lived. However, the main focus of the study to explore the perceptions of caregivers was addressed. Further studies should specifically seek to actively fathers in order to capture their views so that their role can be explored fully.

The lead researcher who conducted the interview is also a registered dietitian and thus used to work in settings similar to where data was collected. This could be a source of bias, whereby the researcher comes with preconceived ideas that may influence the collection of data or its analysis. However, this was addressed by completing a reflective journal at the end of each day and reviewing recordings to determine if any issues of bias arose in the interviews. The researcher was also aware of themselves during that interaction with participants to avoid acting like a practitioner during the interview. During data analysis, the lead researcher was aware of their role in data collection and their previous experiences in this area, therefore took steps to be aware of this potential bias during analysis of the data. This included ensuring consistency in translating to English, coding of similar responses. This was checked thoroughly between different transcripts to ensure that there was consistent interpretation of messaging and conclusions. This provided a strength to the qualitative study because being aware of the role of the researcher and how their previous experiences influences their interpretation style and conclusions made.

3.6 CONCLUSIONS

Caregivers have developed indicators that they use to determine if the growth and development of their infants and young children is optimal. This indicates that caregivers are aware of the importance of growth and development in their infants and young children, thus taking steps to ensure that optimal growth and development is achieved. Four themes that emerged from our talk with caregivers, older family figures and healthcare workers included; when “free choice” is an illusion: mother’s infant feeding decisions; “These people are dangerous.” negotiating access to healthcare services; “caring is how I show my baby love”; “our culture, our heritage”. These four themes emerged as the main ones that related to the growth and development of infants and young children. These themes indicates that caregivers’ perceptions is influenced by other external factors beyond their

individual characteristics or factors. Other factors such as their interpersonal relationships with older family figures and their partners, their experiences when accessing the healthcare system and their community beliefs and norms should be considered when interventions or programs are implemented. This includes understanding the role and influence of the older family figures in caregivers' lives and thus deliberately include them in any health interventions that involve the mother and her infant. Engaging older family figures through education, mutual sharing and transfer of knowledge and skills whilst upholding culture can create a better link between healthcare services and the community. Older family figures can be tasked with the role of coordinating between the healthcare services and the community. In addition, the role of father should also be expanded in order to increase the support and thus reduce the burden of infant care for the caregiver Healthcare workers also need to be aware of the positive and negative experiences that caregivers encounter when accessing healthcare services. This is important because negative experiences may result in caregivers seeking unsafe alternative treatments which may have adverse impact on health and nutritional outcomes of the mother and her infant. In addition, positive experiences should be maintained and perhaps be used to counteract these negative experiences. Lastly, community factors such as social norms should also be taken into account when implementing programs such as infant and young child feeding counselling because caregivers exist as part of their community. By taking into account caregivers' stand in their community and their social interactions may result in successful implementation of interventions and/or programs.

4.0 GENERAL DISCUSSION

This thesis focuses on nutritional status assessed using measures of growth in Botswanan infants and young children within their first 1000 days. Quantitative and qualitative methods were employed to elicit findings regarding undernutrition in HEU and HUU infants and young children. These methods focused on investigating the level and determinants of undernutrition and influences associated with caregivers, older family figures and healthcare workers' perceptions. Prevalence and determinants of undernutrition in these infants and young children are presented in chapter 2. Perceptions of caregivers and the factors influencing these perceptions, thus knowledge, skills and practices are explored in chapter 3. This chapter aims to converge findings from these two related studies, in order to provide a comprehensive understanding of the nutritional outcomes in HEU and HUU infants and young children in Botswana. The purpose of the thesis was to investigate the nutritional status of infants and young children in Botswana. This study aimed to compare the characteristics of HEU and HUU infants and young children. Moreover, the aim was to identify determinants of nutritional status in the combined population HEU and HUU infants in Botswana.

Nutritional outcomes in HEU and HUU infants and young children

It was found that HEU infants and young children were more likely to be underweight and stunted but not wasted compared to HUU infants and young children. Overall these findings were consistent with a number of studies conducted in sub-Saharan Africa (Rosala-Hallas et al., 2017: Evans et al., 2016: Sudfeld et al., 2016: Moraleda et al., 2014: Osterbauer et al., 2012: Magezi et al., 2008: Makasa et al., 2007: Sherry et al., 2000). Poor nutritional outcomes in HEU infants and young children are associated with lack of breastfeeding, use of ART, low birthweight, HIV-exposure, low mother/caregiver education level and older maternal age (Rollins et al., 2013: Kuhn et

al., 2010: Bork et al., 2014: Powis et al., 2016: Sudfeld et al., 2016: Morden et al., 2016: Sania et al., 2015: Black et al., 2008: Kimani-Murage et al., 2011: McDonald et al., 2012). This was largely consistent with findings from our study which found that HIV-exposure, birthweight, birth length, APGAR score and mother/caregiver's education level and age, were significant predictors of nutritional status in HEU and HUU infants and young children. In the qualitative study it was found that caregivers of HEU and HUU infants and young children were engaged with infant feeding as a determinant of health and thus made efforts to achieve optimal nutritional outcomes in their infants and young children. Therefore, they developed indicators which they used to understand their infant's nutritional status. Caregivers implemented care and feeding practices and accessed healthcare services in order to ensure optimal health and growth of their infants and young children. However, factors such as personal beliefs/skills/knowledge, influence of older family figures and their experiences when accessing healthcare services, impacted their perceptions and practices which have an impact on the nutritional outcomes of their infants and young children.

Low birthweight as the strongest predictor of undernutrition

Low birthweight was a strong and consistent predictor for all forms of poor nutritional status (underweight, stunting and wasting). This was consistent with a number of studies conducted in Tanzania, South Africa and Kenya (Slyker et al., 2014: Morden et al., 2016: Ramokolo et al., 2014: McDonald et al., 2012: Ndirangu et al., 2012: Kimani-Murage et al., 2011: Bailey et al., 1999). Normal birthweight is mainly determined by optimal intrauterine environment, mainly related to effective delivery of oxygen and nutrients through the placenta during pregnancy (Saenger et al., 2007). The most important factors that contribute to low birthweight are maternal conditions including malnutrition, low BMI during pregnancy, low maternal weight gain, giving birth at less

than 16 years or older than 35 years, low socioeconomic status and drug use (Bryan & Hindmarsh, 2006). A number of themes relating to maternal conditions emerged from the qualitative study. These included access to healthcare services which tended to occur end of the first to middle of the second trimester. Therefore, opportunities to influence maternal conditions were often missed. Delays in accessing healthcare services by women related to their need to confirm pregnancy. Therefore, they waited and once they missed their second period they would often come to the clinic for a pregnancy test. The first trimester is important for establishing the placenta when implantation occurs, this is crucial for subsequent growth of the foetus in the last two trimesters (Langley-Evans, 2015). Healthcare workers negative attitudes towards HIV positive women may also be negatively reinforcing these women's access to healthcare services. A study conducted in Nigeria found that a significant number of healthcare workers held negative attitudes towards HIV/AIDS patients, resulting in reluctance by these patients to access services (Reis et al., 2005).

Antenatal care services are relatively well established in Botswana, for example there is rigorous testing of HIV, monitoring of iron deficiency and maternal weight and macro- and micro- nutrient supplementation to promote successful pregnancy. Therefore, if caregivers accessed antenatal services early they can achieve optimal maternal nutrition and health status. This should include equipping caregivers with skills and knowledge on what to expect especially in regards to implementing successful and longer breastfeeding. This is especially relevant in this study because, there is still room for improvement, caregivers reported challenges in implementing breastfeeding. Therefore, by educating caregivers on what to expect and how to solve these problems can help in establishing breastfeeding and thus prolong breastfeeding duration in these caregivers. In addition, this antenatal education should be extended to

older family figures and fathers because these individuals influences mothers decision on a number of issues including infant and young child feeding (Aubel et al., 2012: Bilal et al., 2016: Thet et al., 2016). Our study, due to its cross-sectional design, did not study maternal characteristics during pregnancy. Further studies are needed in this area in Botswana, in order to understand the nutritional and health status of these mothers and also to understand their perceptions relating to ensuring successful pregnancy outcomes.

Choice of feeding practices and contribution to nutritional status of infants and young children

HEU and HUU infants and young children' feeding practices differed because HEU infants and young children tended to formula feed and HUU infants and young children tended to breastfeed in the first 12 months. This finding was expected. However, factors influencing feeding choices for these infants and young children were not apparent from the quantitative data. Qualitative data indicated that infant feeding advice routes were different for HIV positive and HIV negative women, whereby an HIV test was used as a pivotal moment, which then influenced infant and young child feeding counselling by healthcare workers. This was consistent with findings from a qualitative study that studied factors that determined mother's choice of infant feeding (Chintalapudi et al., 2017). In the quantitative study it was argued that high levels of formula feeding in HEU infants and young children, may have been due the Government of Botswana's infant and young child feeding policy because it provided free formula (Chopra & Rollins, 2008). This did not emerge in the themes generated from the qualitative data. Fear of MTCT of HIV through breastfeeding, had a major influence on HIV positive mothers decision to formula feed. Other studies have found that this an important consideration for HIV positive mothers when making decisions regarding feeding their

infants and young children (Chintalapudi et al., 2017: Ndubuka et al., 2013: Ilwelunmor et al., 2014). However, other studies have indicated that mothers' decisions on infant and young child are also affected by external factors such as interrelationships with other members of family, access to healthcare and community factors (McLeroy et al., 1988: Chintalapudi et al., 2017). Healthcare workers in our study did not focus on these external factors but rather emphasized the choice of infant feeding as a mother's choice, thus provided balanced facts on feeding options. Healthcare workers' stance, though impartial, tended to ignore these external factors. In addition, most healthcare workers did not apply AFASS principles to each caregiver, when advising them on the advantages and disadvantages of formula feeding. It is important that healthcare workers include the principles of AFASS, when providing infant and young child counselling, so that mothers can consider their unique circumstances when making infant feeding decisions (WHO, 2017).

Even though free provision of formula did not emerge as an influence on caregivers initial feeding choices, it may have acted as a support system for mother's decision to formula feed, because mothers knew they would be provided with free formula if they chose to formula feed. Interestingly, breastfeeding levels were high in studies conducted in other sub-Saharan African countries where formula was not provided freely (Anigilaje et al., 2015: Illif et al., 2005: Thakwalakwa et al., 2014). Very low levels of breastfeeding in HEU infants and young children, due to free provision of formula and other factors may have contributed to poor nutritional outcomes in infants and young children in our study. Poor nutritional outcomes have been demonstrated in HEU infants and young children who were formula feeding instead of breastfeeding (Bork et al., 2014: Anigilaje et al., 2015: Chopra et al., 2007).

The issues surrounding the use of formula versus breastfeeding tend to be argued from perspective of prevention of MTCT of HIV, whereby the main focus of policies for most governments is to lower MTCT of HIV (Sint et al., 2013). Thus the choice by some governments such as Botswana's to provide free formula for HIV positive women who choose to formula feed (MOH, 2011). However, such policies have a tendency to ignore implications for nutritional outcomes in infants and young children (Patel et al., 2010). Breastfeeding is important for survival of infants and young children in the first year irrespective of their HIV-exposure (UNAIDS, 2017). This is now reflected by new WHO recommendations in infant and young child feeding, which states that all HIV positive women can breastfeed exclusively for first 6 months, introduce complementary feeds and continue breastfeeding up to 24 months, provided the mother is on ART (WHO, 2016). Postnatal transmission of HIV is as low as <1% for mothers who exclusively breastfeed for 6 months whilst on ART (Tournoud et al., 2008). Botswana's final postnatal HIV transmission rates are higher at 2.6% (UNAIDS, 2017). Therefore, it may be time for countries such as Botswana to consider increasing breastfeeding in HIV positive mothers by using option B+ programs. Currently, Botswana is implementing option B+ program in all adults, however, the infant feeding policy which encourages formula feeding still remains the same. Transition to option B+ will be challenging, however there are already structures in place such as healthcare workers' belief in feasibility of breastfeeding in HIV positive women as shown in the qualitative study.

Issues with implementing feeding choices emerged in the qualitative study. HIV negative mothers experienced challenges in implementing breastfeeding. This adversely affected duration of breastfeeding, mainly due to the mother having to return to work or school. This is consistent with findings from a number of studies (Eldridge

et al., 2017: Fischer & Olson, 2014: Hurley et al., 2016). One solution to this barrier is for the mothers to express breastmilk and thus allow the infant to exclusively breastfeed for the first 6 months. However, this is not culturally acceptable as indicated by caregivers and older family figures. Education for caregivers, older family figures and the community is therefore required to make this practice more culturally acceptable. Caregivers and older family figures are already convinced of the benefits of breastfeeding, therefore this can be used as a starting point to influence a change in behaviour.

Complementary feeding practices and nutritional adequacy in infants and young children

HEU and HUU infants and young children were on average, each introduced to complementary feeds at 6 months of age. Therefore, there were no significant differences between the two groups of infants and young children. Analysis of the qualitative data indicated that caregivers tended to introduce complementary feeds at 6 months as advised by healthcare workers. This was consistent with findings from a study conducted in Zambian women, which found that most mothers introduced complementary foods at the right age on the advice of healthcare workers (Katepa-Bwalya et al., 2015). However, caregivers in our study did not understand the rationale behind this, therefore they trusted healthcare worker's advice.

Dietary diversity was low for both infants and young children and no significant differences were observed between the average dietary diversity scores of HEU and HUU infants and young children. Dietary diversity is associated with adequate nutrient intake and thus nutritional status (McDonald et al., 2015: Darapheak et al., 2013). A study by Arimond & Ruel (2004), found that low dietary diversity was associated with lower height-for-age scores, even after adjusting for confounders such as

socioeconomic status. The quantitative finding that indicated that dietary diversity was low, was explained by qualitative finding which indicated that caregivers mostly fed their infants and young children sorghum porridge. This food has strong cultural meanings for caregivers. In addition, older family figures encouraged caregivers to feed this as the first weaning food. The strong belief in using sorghum porridge as a first weaning and subsequent food is probably the main reason for low usage of the fortified cereals (*Tsabana and Malutu*). Moreover, caregivers also associated these fortified cereals with diarrhoea. Increased intake of sorghum porridge was due to the caregiver's belief that it provided most of the nutrients a child needed. However, as indicted by Jackson et al., (2013), sorghum lacked a number of nutrients. Therefore, they sought to enrich sorghum meal with local foods such as beans (Jackson et al., 2013). Dietary diversity can be improved by increasing caregivers and older family figures' nutrition education. A study in western Kenya demonstrated that community–based education program targeting caregivers, improved dietary diversity scores in the intervention group by 27% compared to the control group (Waswa et al., 2015). Other measures for improving dietary diversity include, homestead food production such as, growing vegetables and animals, biofortication and social safety nets such as, conditional cash transfers and in-kind household food distributions (Ruel et al., 2013). In addition, since caregivers were more accepting of adding cooking oil and/or peanut butter to cereals such as sorghum porridge perhaps there should be a focus on fortifying the locally accepted cereals and avoid having two competing cereals. This may increase nutritional intake and avoid caregivers having to choose between fortified cereals and local cereals.

Child health records as a tool for improving infant nutritional and health outcomes

Healthcare workers in our study did not fully complete child health records for some of the important variables such as, gross motor development, length and vaccinations. There were variations in the level of completion for each variable, with an average completion of 72%. Completion of child health cards promotes optimal continued care by transferring important information about the patient, between healthcare workers (Ozok et al., 2013). Lack of completion of child health records is due to a number of factors as discussed in section 2.4.6.

It is important to note that length of infants and young children in our study was completed on average of 11.3% compared to 97.6% for weight in the first 6 months. This reflects the Ministry of Health and Wellness's policy for measurement of weight and length/height for infants and young children in health facilities. According to this policy, weight is measured monthly while length is measured only twice a year. This is may result in delays in identifying stunting in these infants and young children. A shift to stunting as one of the indicators of progress in eradicating hunger as per the sustainable development goals (goal 2.2), should result in more frequent measurements of length/height in infants and young children in Botswana (UN, 2015). In the qualitative study, systematic issues such as lack of staffing emerged. These are related to completion of child health records. Healthcare workers often prioritise their tasks, for example recording information if they perceived this information to be important for reporting or for their subsequent intervention (Wright et al., 2015: Mlambo et al., 2014). Healthcare workers in our study indicated that they had to do a lot of prioritising because of lack of staff, therefore they tended to complete tasks which they deemed as crucial. They also indicated that completing duplicate set of records (electronic and paper) caused delays for the caregivers. Caregivers cited delays in the clinic as one of the negative experiences associated with accessing healthcare services.

5.0 RECOMMENDATIONS

A number of issues relating to achieving optimal nutritional and health outcomes in our sample were identified from the analysis and discussion of the two studies. This chapter presents these issues and also outlines recommendations on how these issues can be addressed. It should be noted that further research is the cornerstone of these recommendations. As shown in Table 5.1, a number of issues were identified from findings in the two studies completed in this thesis. These issues include poor nutritional outcomes in HEU compared to HUU infants and young children; low uptake and duration of breastfeeding; poor dietary diversity in all infants and young children; and poor completion of health records by healthcare workers.

Poor nutritional outcomes in HEU compared to HUU infants and young children

It was demonstrated in the quantitative study that HEU infants and young children are more likely to be stunted and underweight compared to HUU infants and young children in this population in Botswana (Chalashika et al., 2017). In addition, it was also demonstrated that HIV exposure was one of the main predictors of stunting (Chalashika et al., 2017). This is an important finding that clearly argues for the need for further prospective research that studies the health and nutrition of mothers, infants and young children. This research needs to be informed of what is currently happening in the country in terms of other events therefore an immediate priority would be to liaise with all stakeholders in Botswana including Ministry of Health and Wellness, which is responsible for management of these infants and young children. Furthermore, Ministry of Local Government which is tasked with allocating resources in local settings including social support and also responsible for implementation of the SUN program, UNICEF (Botswana) should be included. Other stakeholders such as, dietitians, nutritionists, researchers in infant nutrition and organisations focusing on infant

nutrition and health should be part of this discussion. The aim is to stimulate conversation in this topic and thus allow different stakeholders to explore how they can work with other stakeholders in order to improve the nutritional status of HEU infants and young children. This will provide a good starting point for the design of the further research which will be useful for studying comprehensively the nutritional outcomes of infants and young children. Gathering all the stake holders is an immediate priority especially since there major pending decisions on policy, such as implementation of the 2016 updated infant feeding guidelines in areas with high HIV prevalence. Therefore, allowing all the relevant stakeholders to discuss these findings in context of such pending policy decisions, will help inform policy and also explore ways to conduct research that is looking at the nutritional status of HEU and HUU infants and young children.

The main predictor of all growth outcomes (stunting, wasting, and underweight) was low birthweight (Chalashika et al., 2017). Low birthweight, was a consistently strong predictor compared to other socioeconomic predictors. Therefore, further researcher is required into the maternal nutrition health as it is an important variable that we did not investigate in this study. Therefore, there is need to look at the nutrition and health of pregnant women as they present to the ante natal clinic and preferably follow them during the duration of the pregnancy to determine how their nutrition, health and other characteristics during the ante natal phase impacts on the nutrition and health outcomes of their off springs. Moreover, these studies should also specifically compare birthweight patterns in HIV positive and HIV negative women and also look at associated sociodemographic factors of these women. This would allow identification of predictors of low birthweight thus provide an opportunity to design randomised controlled trials which paves way for interventions. These quantitative studies should

also be augmented with qualitative studies in order to identify drivers of these mothers' behaviours and other stakeholders such as older family figures, fathers and healthcare workers.

Further research is also required to disentangle feeding modalities from HIV-exposure so that the true effect of HIV-exposure can be determined. This will especially be relevant when the 2016 updated infant feeding guidelines in areas with high HIV prevalence are implemented in Botswana. It is anticipated that implementing the new feeding recommendations, will result in more HIV positive women initiating and breastfeeding for longer than 6 months. This offers a unique opportunity to study the growth and development later than 6 months in free living breastfed HEU infants and young children. Currently, it is difficult to do so because caregivers (as per the 2010 WHO infant and young child feeding) stop breastfeeding at 6 months and change to formula.

Another potential area of research is investigating the impact of the newly installed SUN program. Botswana government is one of the latest signatories to the SUN movement. The SUN movement focuses mainly on improving nutritional outcomes of infants and young children in the first 1000 days (Scaling Up Nutrition, 2017). This will be useful because it will look at the role of stakeholders of the SUN and their impact on the infants and young children' growth and development.

Further research also requires a qualitative aspect in order to address the role of older family figures, fathers and the community. Specifically these should look at what integration of programs has resulted in. Any research in this area should aim to capture the diverse cultural beliefs and taboos.

Table 5.1: Summary of issues identified in the study and recommendations to address them

1. Poor nutritional outcomes in HEU compared to HUU infants and young children.
Recommendations: ▪ Further research: longitudinal studies looking at maternal nutrition and health status in order to identify determinants of nutrition and health outcomes during the time and in relation to infant's birthweight. Also include qualitative methods in order to identify drivers of behaviours and practices. ▪ Further research: studies that disentangle feeding modalities from HIV-exposure so that the true effect of HIV-exposure can be observed. ▪ Review of the SUN (Scaling Up Nutrition) looking at its impact on nutritional outcomes of infants and young children. ▪ Researching how systematic issues related to lack of resources such as lack of staffing, transport and equipment affects quality of services. ▪ Research the role of older family figures or their equivalent to expand on their role as advocates of breastfeeding and optimal practices.
2. Low uptake and duration of breastfeeding
Recommendations: ▪ Implement option B+ program in all HIV positive women of child bearing age may improve uptake of breastfeeding in HIV positive women. ▪ Implementing the WHO (2016) recommendations on infant feeding and HIV may allow safe uptake of breastfeeding in HIV positive women. ▪ Further research on what scaling up breastfeeding promotion (thus addressing cultural beliefs which detracts from continued breastfeeding) in all mothers, older family figures, fathers and the community improves breastfeeding levels. ▪ Improve healthcare workers knowledge and skills in troubleshooting caregivers' breastfeeding problems as per the Baby Mother Friendly Hospital Initiative (BMFHI). ▪ Educate mothers, fathers and older family figures on breastfeeding in order to improve implementation of breastfeeding. ▪ Implement supportive legislation for breastfeeding mothers in order to encourage them to breastfeed for longer. ▪ If formula feeding is indicated, the mother should be supported by healthcare workers using AFASS principles.

3. Poor dietary diversity in all infants and young children.
Recommendations: ▪ Further research on impact of scaling up nutrition education to caregivers. ▪ Further research: How the nutritional content of culturally accepted foods such as sorghum can improved but still remain acceptable to caregivers. ▪ Further research: How the usage levels of fortified cereals can be improved ▪ Promote homestead food production including gardening and rearing of small livestock such as chickens.
4. Poor completion of child health records
Recommendations: ▪ Addressing systematic issues related to lack of resources such as lack of staffing. ▪ Appoint officers solely focused on performance improvement in each health facility in order to educate healthcare workers on completion of health records and also audit and thus provide feedback to healthcare workers on completion of health records. ▪ Review the child health record and remove variables that are not required and/or devise a clear protocol on when and how these variables should be completed. ▪ Streamline recording in child health record and other electronic records in order to avoid duplication.

Low uptake and duration of breastfeeding

One of the main issues identified in this study is the low uptake and duration of breastfeeding in HEU and HUU infants and young children respectively. It was found that 17.5% of HEU infants and young children were breastfed and only 30.2% of HUU infants and young children were still breastfeeding in the first 12 months. Benefits of breastfeeding are well documented (Black et al., 2013). Improving uptake of breastfeeding in HIV positive women may improve significantly when the option B+ and the WHO (2016) recommendations on infant feeding and HIV are implemented (WHO, 2016). Studies in Malawi have demonstrated that implementation of such programs can significantly improve breastfeeding levels in HIV positive women (Haas et al., 2016: Tenthani et al., 2014). Improving duration of breastfeeding

in HIV negative mothers (and eventually HIV positive mothers) requires removing barriers to continued breastfeeding (Sriraman and Kellams, 2016: Brown, 2017). HIV mothers indicated that barriers such as having to go back to work or to school and/or having problems with implementing breastfeeding, deterred them from breastfeeding for longer. From findings of our study, one of the main solution for such mothers is the use of expressed breastmilk. However, this may require a change the perceptions of older family figures and the community towards use of expressed breastmilk. This because it has been demonstrated that mothers who express breastmilk are more likely to continue breastfeeding for longer (Win et al., 2006). Moreover, caregivers, older family figures and fathers should be equipped with skills and knowledge regarding breastfeeding so that they may be able to solve breastfeeding problems when they arise. There is also need to train healthcare workers in BFHMI principles so that they are confident in dispensing breastfeeding advice and also to ensure that this advice is consistent.

The WHO (2016) recommendations on infant feeding and HIV indicate that HIV positive mothers can mix feed if there are unable to exclusively breastfeed provided they are covered adequately with ART (WHO, 2016). This recommendation should could help HEU infants and young children to receive breastmilk for the larger part of their first 1000 days.

Targeted legislation that seeks to improve uptake and duration of breastfeeding may also be useful. Currently, some legislation exist in Botswana that aims to improve uptake of breastfeeding for caregivers whereby the mother gets paid maternity leave for approximately 3 months (Botswana Government, 1996). However, this is only limited to three pregnancies (Botswana Government, 1996). Furthermore, the legislation which states that mothers upon their return to work after three months should be given an hour of feeding for at least six months also seeks to improve duration of breastfeeding (Botswana Government, 1996). These types of legislations may be important for initiating and continued breastfeeding.

It is inevitable that some mothers especially those who are HIV positive will still needs to formula feed, for example in cases where mother has breast mastitis. However, such cases should be very few and healthcare workers should be trained to ensure that such mothers implement formula safely. In addition, they may help to ensure that there is no spill over of messaging between such mothers.

Poor dietary diversity in all infants and young children

Poor dietary diversity was found in all infants and young children as shown in chapter 2. However, there were no significant differences between the HEU and HUU infants and young children' dietary diversity scores. It was also found in the qualitative study that strong cultural beliefs associated with the use of sorghum porridge is one of the main factors influencing this low dietary diversity. Improving dietary diversity is important because evidence shows that infants and young children with a higher dietary diversity score are more likely to meet their requirements from complementary feeds (Habte and Krawinkel, 2016: Mallard et al., 2016: Abizari et al., 2017).

Further research into the impact of scaling up nutrition education to caregivers, older family figures and the community regarding complementary feeding. Currently, as indicated in our qualitative study, Health education assistants are mainly suitable for this role as they are knowledgeable and passionate about providing nutrition education to caregivers. However, systematic issues such as lack of staff and lack of transport impedes their ability to provide education to caregivers. Furthermore, these healthcare workers are more effective when they work from the community where they can visit the mothers and/or older family figures at home. By having the opportunity to observe the caregiver and her home environment allows the healthcare workers to offer tailor made advice and interventions.

Further research is however, needed in order to determine how the nutritional content of culturally acceptable foods such as sorghum can be improved but still remain acceptable to caregivers. This is especially relevant because caregivers and older family figures have very strong beliefs in relation to the use of sorghum porridge as a complementary feed for their children. Therefore, seeking to replace this food with a fortified cereal as is currently done, may not be the most effective method because this pits the fortified cereal against sorghum porridge and as findings from our studies show fortified cereals lose out every single time.

This research could also look at ways of improving the use of Government issued fortified cereals (*Tsabana and Malutu*). Even though the use of fortified cereal tends to be lower compared to use of sorghum porridge, there might be opportunities to expand its usage by promoting its usage. This was demonstrated in some areas where caregivers were willing to use more of the fortified cereals if they were shown how to cook it and their concerns that it caused diarrhoea were addressed.

Promoting homestead food production including vegetable gardening and rearing of small livestock such as chickens for eggs and meat has been demonstrated to have a positive impact on nutritional outcomes of individuals (Shanta et al., 2017: Jha & Chakrabarti, 2017: Mosha, 2015). Backyard gardening has been promoted to an extent by the Government of Botswana, however, has met many challenges including politically, lack of water and poor implementation (Fehr and Moseley , 2017).

Poor completion of child health records

Child health records were poorly completed by healthcare workers. It was apparent that healthcare workers prioritised recording in child health records. This was however, problematic especially for some of the important measures such as vaccinations. In addition, some length and weight measures were not recorded in some months. This may delay diagnosing malnutrition. This will consequently delay intervention to correct any problems if such exist.

Poor completion of child health records are associated with systematic lack of resources as indicated by talk with healthcare workers especially staffing. It was found that when there was lack of staffing, healthcare workers prioritised recording in child health records, thus not recording measures such as gross motor development. An immediate priority to address this issue will be to review the child health card and determine if all the variables in the card need to be there. After determining which variables are important, there needs to be a protocol developed that will direct the recording of information for each child's health card. This should be aligned with the infant's monthly visits to the clinic. In addition, linking some of the assessments with major vaccination campaigns can improve assessment and thus recording of some of the variables in the child health card. The Ministry of Health and Wellness also needs to streamline the recording so that the manual and electronic recording (Integrated patient Management System) are seamless. This should be done in such a way that duplicate recording is avoided. There is also a need to appoint performance improvement officers in each district health management team, solely tasked with coordinating these tasks. These officers will be responsible for ensuring that the developed protocol is implemented and most importantly, support the staff in completing the child health card by providing training in order to close any gaps in healthcare workers knowledge.

6.0 SUMMARY

These studies set out to explore the nutritional outcomes in HIV-Exposed-Uninfected and HIV-Unexposed-Uninfected Botswanan infants and young children from selected districts within their first 1000 days. This study area was mainly motivated by the experiences of the PhD student, when they were practising as a clinical dietitian in Selebi Phikwe.

Findings from the quantitative study has largely confirmed that HEU infants and young children have poorer nutritional outcomes (stunting and underweight) compared to HUU infants and young children. In addition, HIV exposure remained a predictor for stunting. Low birthweight was a strong and consistent predictor of all forms of undernutrition (wasting, stunting and underweight). This implied that perhaps focusing on the birthweight as an outcome, would be beneficial in improving nutritional outcomes in all infants and young children. Feeding practices of HEU infants and young children were starkly different from those of HUU infants and young children, this was expected since the Government of Botswana has largely implemented an infant formula focused strategy to reduce MTCT of HIV for the last two decades. However, findings from the qualitative study did provide more insights into how mothers chose their infant's feeding methods. It was clear that, provision of free formula though an external factor influencing feeding choices, HIV positive women' choices were largely driven by fear of infecting their infant with HIV. Therefore, rational decisions on infant decisions were often overruled by this fear. It also emerged that this fear could not be mitigated by the healthcare workers interventions. The findings from the qualitative study further indicated that external factors, though largely not addressed by healthcare workers also played a role in the choice and implementation of feeding choices by caregivers. In addition, the role and thus influence of other stakeholders' especially older family figures was often overlooked by healthcare workers when they implemented interventions. This resulted in missed opportunities at various levels.

Improving the nutritional status of HEU and HUU infants and young children requires a more convergent approach from multiple stakeholders such as Ministry of Health and Wellness, Ministry of Local Government and other Non-Governmental organisations. The main approach should begin by reorienting all the stakeholders' thinking, so that they can view the first 1000 days as the most important period of an infant's life. Furthermore, they should also view this period as an opportunity to influence infant's future health, growth and development.

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8.0 APPENDICES

Appendix 1: Child Health Card

MH 1040/REV. 12/15

REPUBLIC OF BOTSWANA

Karata ya botsogo
jwa ngwana

Child

Welfare Clinic Card



GENERAL INFORMATION

Child's Name / Leina la ngwana ..... Child's welfare card number ..... ANC Number	Sex ..... Date of Birth ...../...../..... Birth weight ..... kg Length ..... cm Head circumference ..... cm Place of Birth ..... At home / Mo gae ☐ Facility / Kokelong ☐ Date first seen at the Health Facility ...../...../.....	Present Postal Address: ..... Physical Address: ..... Ward / Kgotla: ..... Village / Town: ..... Tel / Mogala .....
Mother's Name / Leina la ga Mmaagwe: ..... Mother's Age/Dingwaga tsa ga Mmaagwe: ..... Father's Name / Leina la ga Rraagwe: ..... Guardian / Motlhokomedi:		Permanent Address: ..... Home Village / Legae ..... Ward / Kgotla: ..... Home address / Legae .....
Birth Registration Number ..... Date of Registration ...../...../.....	**APGAR Score** / **Time** (1 min, 5 min, 10 min)	**Reasons for special care** / *mabaka a tlhokomelo e e faphegileng* Twin or more ☐ Destitute ☐ Orphan ☐ Teen mother ☐ Alcohol ☐ Disabled ☐ Underweight(<2.5kg) ☐ Disabled parent ☐ TB ☐ Others (eg: allergy) ☐

Schedule Of Immunisation / *Lenaneo la Thulaganyo ya Mekento*

Did the mother get TT	Yes ☐ No ☐ What dose:	TT1 / /	TT2 / /	TT3 / /	TT4 / /	TT5 / /
At birth/	**B.C.G** Mokento wa kgotlholo e tona	1 dose...../...../.....	BCG Scar (tick) Yes ☐ No ☐	If no, Revaccinate immediately / /		
At birth, 2 & 9 months	**Hepatatis B** Mokento wa bolwetse jwa sebete	1st dose (at birth) Date ...../...../.....	2nd dose (2 mths) Date...../...../.....	3rd dose (9 mths) Date...../...../.....		
At 2,3,4 months & booster at 18 months	**D.P.T.** Mokento wa dikodu tse di tshweu, sehuba sa monganganyego, kitlano ya ditlhaa	1st dose (2 mths) Date ...../...../.....	2nd dose (3 mths) Date...../...../.....	3rd dose (4 mths) Date...../...../.....	Booster (18 mths) Date...../...../.....	
	Polio Mokento wa go swa mhama	1st dose (2 mths) Date...../...../.....	2nd dose (3 mths) Date...../...../.....	3rd dose (4 mths) Date...../...../.....	Booster (18 mths) Date...../...../.....	
9 months	**Measles** Mokento wa mmokwane	dose (9 mths) Date...../...../.....				

Minimum interval between 1st, 2nd and 3rd DPT, Polio and Hepatitis B doses is 4 weeks (28 days)

Special Immunisation Campaigns / *Letsholo la Mekento e e Faphegileng*

Name of campaign..... Date...../...../.....	Name of campaign..... Date...../...../.....	Name of campaign..... Date...../...../.....	Name of campaign..... Date...../...../.....

Vitamin A Supplementation Schedule / *Lenaneo la Kotla ya Vitamin A*

	MOTHERS AFTER DELIVERY UP TO 6-8 WKS	CHILDREN 0 -36 MONTHS					
Vitamin A dose	*200,000 I.U.*	Below 6 mths** 50,000 i.u ...../...../.....	At 9 mths 100,000 i.u ...../...../.....	At 18 mths 200,000 i.u ...../...../.....	At 24 mths 200,000 i.u ...../...../.....	At 30 mths 200,000 i.u ...../...../.....	At 36 mths 200,000 i.u ...../...../.....
Date / Letsatsi	...../...../.....						
				At 42 mths 200,000 i.u ...../...../.....	At 48 mths 200,000 i.u ...../...../.....	At 54 mths 200,000 i.u ...../...../.....	At 60 mths 200,000 i.u ...../...../.....

Minimum interval between doses is 6 months

** BANA BA BA SA AMUSIWENG/ONLY THOSE WHO ARE NOT BREASTFED.

Screening Scheme for Developmental Delay/ *Tshekatsheko ya go gola ga ngwana*

Age (Months)	Gross motor	Fine motor	Social skills	Language
3	Supports own weight on forearms	Opens hands spontaneously	Smiles appropriately	Coos Laughs
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
6	Sits momentarily without support	Transfers objects from one hand to the other	Shows likes and dislikes	Babbles
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
9	Pulls to stand	Pincer Grasp (able to pick objects with thumb and middle finger)	Enjoys game whereby adult repeatedly shows and hides face with a cloth(peek - a boo)	Imitates sounds
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
12	Walks with support	Releases an object on demand	Comes when called	Says 1 -2 meaningful words
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
18	Climbs stairs or walks up sloping ground with support	Feeds self from a spoon	Mimics actions of other words	Says at least six words
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
24	Runs	Builds a tower of six blocks or cans	Plays with others	Says 2-3 word sentence
	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐

This table provides guidelines regarding the upper range of normal skills.

NB: Please refer any child who fails to attain any of these milestones to a doctor for further evaluation and neuro - development assessment

Weight-for-age GIRLS

Adapted from WHO Child Growth Standards 2006

Birth to 5 years (z-scores)

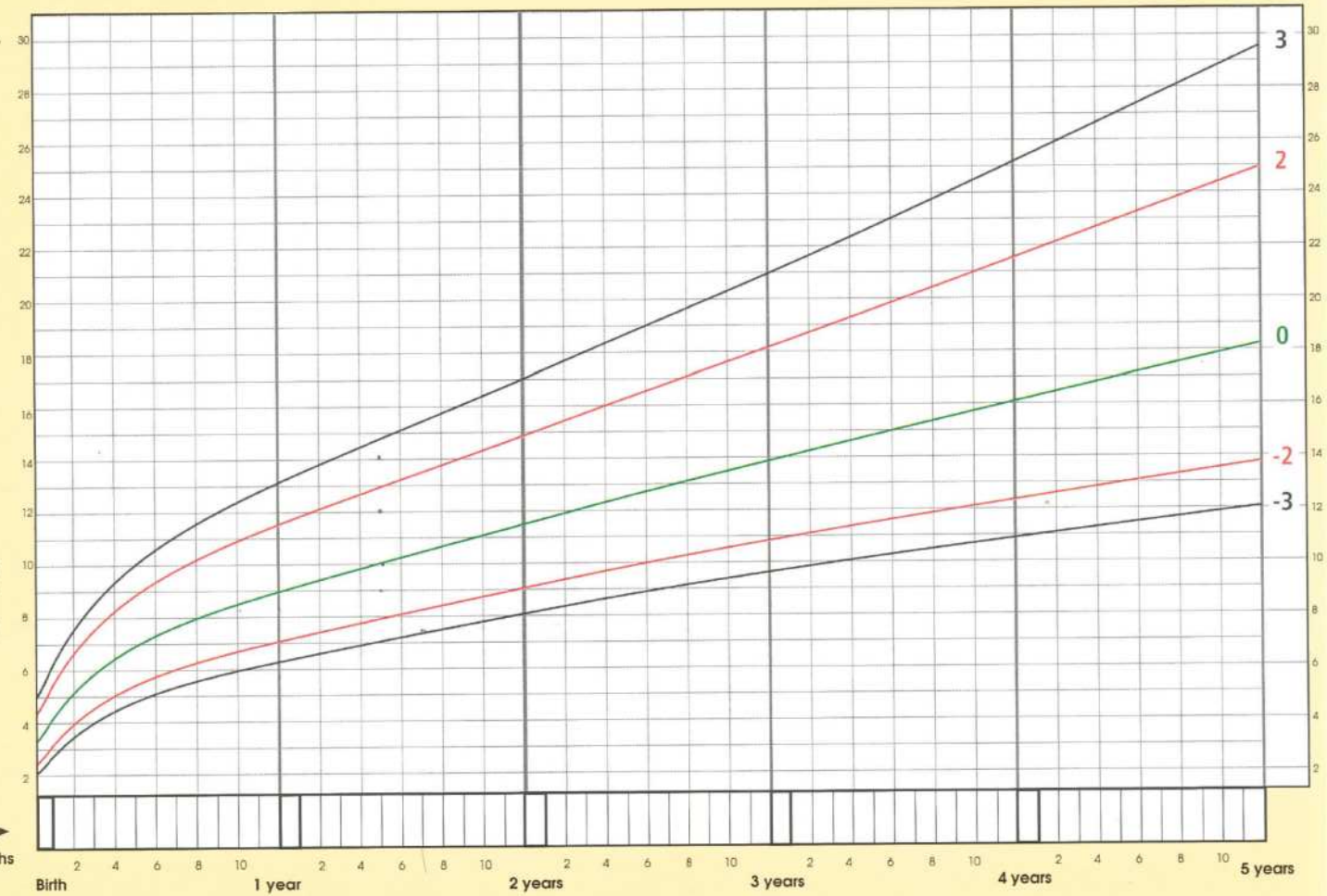
Ela tlhoko tselana ya kgolo ya ngwana

Ngwana o gola sentle

Ngwana ga a gole sentle. Tlhotlhomisa mathata a gakololo

Oa tlhotofala O tlhoka tlhokomelo e kgolo. Gakololo motsadi jaaka go tshwanetse





Weight-for-age BOYS

Adapted from WHO Child Growth Standards 2006

Birth to 5 years (z-scores)

Ela tlhoko tselana ya kgolo ya ngwana

Ngwana o gola sentle

Ngwana ga a gole sentle. Tlhotlhomisa mathata a gakololele

Oa tlhololala
O tlhoka tlhokomelo e kgolo. Gakololela motsadijaaka go tshwanetse



Weight (kg)

Write the month of birth in the heavily marked box

Months

Birth | 1 year | 2 years | 3 years | 4 years | 5 years

Age (completed months and years)

Write 'R' for ration issued for the month

Length/height-for-age GIRLS

Adapted from WHO Child Growth Standards 2006

Birth to 5 years (z-scores)

Ela tlhoko tselana ya kgolo ya ngwana

Ngwana o gola sentle

Ngwana ga a gole sentle. Tlhotlhomisa matlhata a gakolole

Oa tlhofofala O tlhoka tlhokomelo e kgolo. Gakolola motsadi jaaka go tshwanetse



Write the month of birth in the heavily marked box

length/height (cm)

125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45

3 2 0 -2 -3

Months

Birth 2 4 6 8 10 | 1 year 2 4 6 8 10 | 2 years 2 4 6 8 10 | 3 years 2 4 6 8 10 | 4 years 2 4 6 8 10 | 5 years

Write 'R' for ration issued for the month

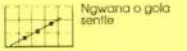
Age (completed months and years)

Length/height-for-age BOYS

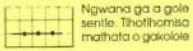
Adapted from WHO Child Growth Standards 2006

Birth to 5 years (z-scores)

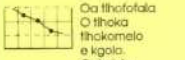
Ela tlhoko tselana ya kgolo ya ngwana



Ngwana o gola sentle

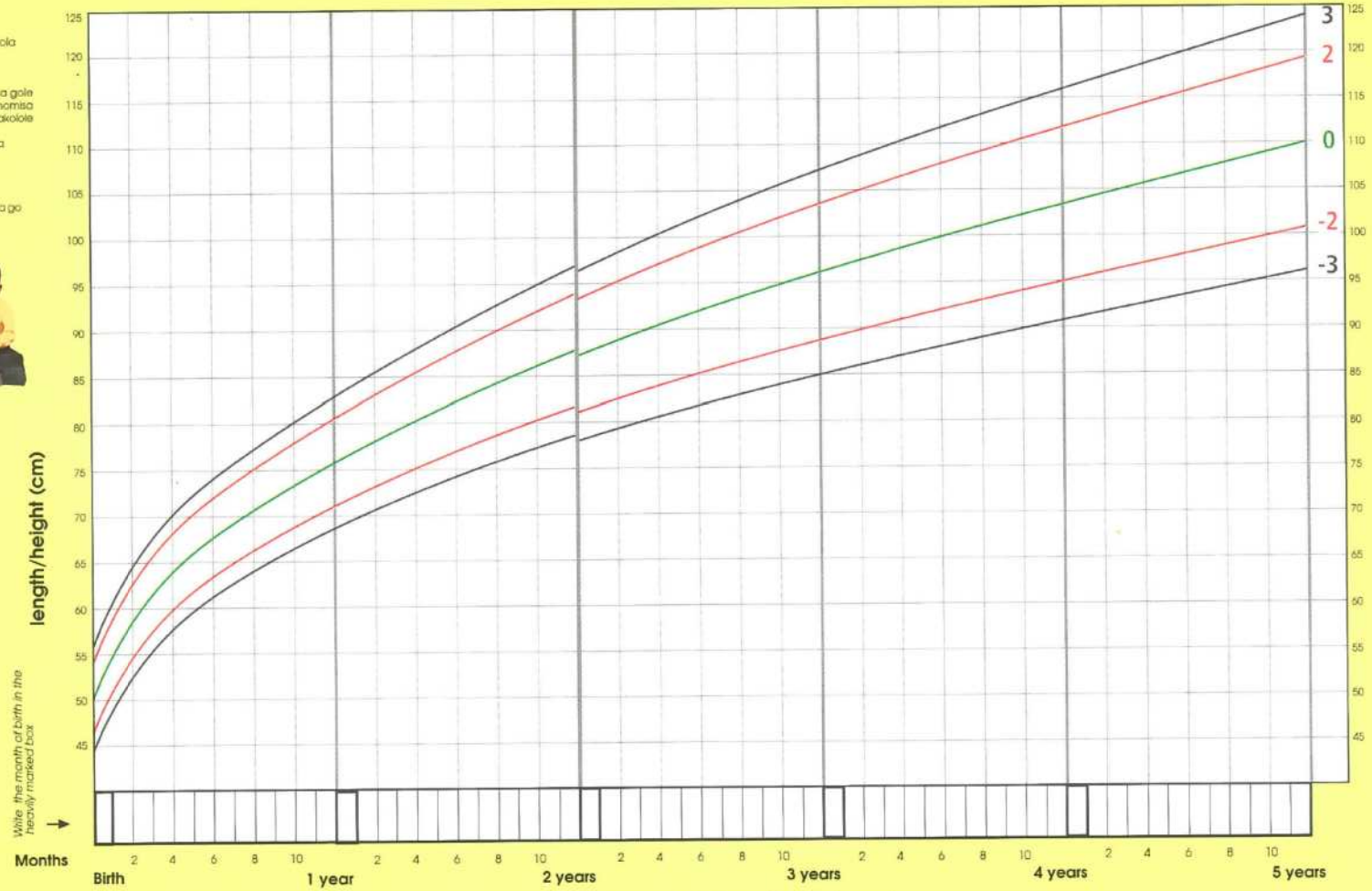


Ngwana ga a gole sentle. Tlhotlhomisa mathata o gakolole



Oa tlhotofala O tlhoka tlhokomelo e kgolo. Gakolola motsadi jaaka go tshwanetse





Write 'R' for ration issued for the month

Age (completed months and years)

Welfare clinic card karata ya botsogo

LIST OF FINAL DIAGNOSIS (INTERCURRENT ILLNESS)

Date	Treatment Centre	Diagnosis, Impression	Full Name

PMTCT FOLLOW-UP RECORD

PMTCT No. ...../..... ...../...../...../...../...../.....

District *Facility Type* *Facility Number* *Mother's No. in ANC Logbook* *Year* *Multiple births*

Mother*		**Infant**	
When did the mother have HIV Test 1) Before pregnancy ☐ 2) During pregnancy ☐ 3) At delivery ☐ 4) Post delivery ☐		ZDV start date ../../.. Was ZDV Given within 48 hrs of birth Yes ☐ No ☐	
Results of HIV Test: Negative ☐ Positive ☐		Was NVP given the first 72hrs of birth	Yes ☐ No ☐
ZDV start date ../../..		Cotrimoxazole start date	../../..
Duration of ZDV given (in weeks)			
Was the mother given NVP during labour? Yes ☐ No ☐			
Duration of HAART (3- drug ARV therapy)			
Did mother recieve infant feeding counselling? Yes ☐ No ☐			

* OBTAIN THE INFORMATION FROM THE MOTHER'S OBSTETRIC RECORD

Laboratory Testing

Test	Date due *	Date done	Results
PCR	../../..	../../..	Positive ☐ Negative ☐
Repeat PCR (Breastfed infants should return for a repeat test 6 weeks after last breastmilk)	../../..	../../..	Positive ☐ Negative ☐
Elisa or rapid test (Circle appropriate test)	../../..	../../..	Positive ☐ Negative ☐

*** Upon discharge, the health care worker at maternity should write in the actual date (DD/MM/YY) that the infant/child should return to the clinic for the test**

ARV Referral

Date referred for ARV therapy	../../..
Place referred	
Date ARV therapy Started	../../..

Infant feeding *(evaluate every month for at least 1 year)*

Date	Age (months)	Feeding method*	Infant formula tins issued (if replacement feeding)	Problems noted	Comments / Action Taken

Please write **EBF for Exclusive breastfeeding, **EFF** for Exclusive formula feeding or **MF** for mixed feeding, and indicate when solid food was begun. HIV infected mothers who are breastfeeding are encouraged to exclusively breastfeed for up to 6 months with abrupt cessation and safe transition to formula feeding.*

Feeding bottles can be dangerous to a child's health if they are not cared for properly as they are easily contaminated. Mothers are encouraged to use a cup to feed their babies

If you decide to bottle-feed, clean feeding bottles in boiling water and soap, giving particular attention to the teat where germs are likely to collect. Use a brush to clean the teat and bottle. Both bottle and teat should be submerged (covered in boiling water) for 10 minutes before use.

OUT PATIENT VISIT

Date	Treatment Centre	Complaint, diagnosis, treatment Investigations and referral	Full Name

Appendix 2: Ethical Approval letters

Direct line/e-mail
+44 (0) 115 8232561
Louise.Sabir@nottingham.ac.uk

The University of Nottingham

Faculty of Medicine and Health Sciences

Research Ethics Committee
School of Medicine Education Centre
B Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham
NG7 2UH

24th June 2014

Paphani Chalashika
PhD Student
c/o Professor Simon Langley-Evans
Deputy Head School of Biosicences &
Professor of Human Nutrition
Nutritional Sciences-North Lab
Sutton Bonington Campus
College Road
Loughborough
LE12 5RD

Dear Mr Chalashika

Ethics Reference No: E19062014 SoBS Nutrition – **please always quote this ref**
Study Title: Investigation of feeding practices and nutritional status of HIV exposed and non-HIV exposed infants aged 6-24 months in Botswana.
Chief Investigator: Professor Simon Langley-Evans, Deputy Head, School of Biosciences (SoBS) and Professor of Human Nutrition, Faculty of Science.
Co Investigators: Dr Judy Swift, Associate Professor, Human Nutrition, Dr Duane Mellow, Lecturer Dietetics, Nutritional Sciences, SoBS.
Student: Paphani Chalashika, PhD Student, Nutritional Sciences, SoBS.
Duration of Study: 06/10/2014-05/10/2015 12mths **No of Subjects:** 440

Thank you for your recent application which was considered by the Committee at its meeting on 19th June 2014 and the following documents were received:

- FMHS Research Ethics Application form, 19th May 2014.
- Study Protocol version 1.0 dated 19th May 2014.
- Appendix 1:Recruitment Advert (English) version 1.0, 19th May 2014
- Appendix 2: Recruitment Advert (Setswana) version 1.0, 19th May 2014
- Appendix 3: Consent Form (English) version 1.0, 19th May 2014
- Appendix 4: Consent Form (Setswana) version 1.0 19th May 2014
- Appendix 5: Study Information Sheet (English) version 1.0, 19th May 2014
- Appendix 6: Study Information Sheet (Setswana) version 1.0, 19th May 2014
- Appendix 7: Questionnaire BINU Study version 1.0, 19th May 2014
- Appendix 8: 5 Step multiple Pass 24 Hour Food Recall Process
- Appendix 9: Factors for possible inclusion in the multivariate model

These have been reviewed and the study was approved subject to the following issues being addressed:

1. Please can you revise the Participant consent form using the new template with tick boxes which is attached.

2. On the Participant Information Sheet please can you revise the contact details for this Committee to: FMHS Research Ethics Committee Administrator, School of Medicine Education Centre, B Floor, Medical School, QMC Campus, Nottingham University Hospitals, Nottingham NG7 2UH, UK, e-mail: louise.sabir@nottingham.ac.uk.

3. "Under do you have to take part?" please add at the end of this paragraph. However should I withdraw then the information collected so far cannot be erased and that this information may still be used in the project analysis. This is because once your data has been made anonymous and entered into the secure university databases for analysis together with the information provided by all participants it becomes impractical to trace and extract individual data. In addition it is not permitted to tamper with the University secure systems.

Please reply to the specific comments that we make listing our comments first and then give your response underlined, this will make it much easier for us to confirm that you have indeed done what was asked and will speed the processing of your revision. You should also highlight all the changes that have been made in any documents you resubmit. You only need to resubmit one copy of everything and this can be e-mailed as attachments. Please remember to update the footers of revised documents in particular the version number and date and make sure the date is not set to automatically update each time the document is re-opened.

On receipt of clarification of the above issues the study can be approved by Chair's action. Approval is given on the understanding that the Conditions of Approval set out below are followed.

Yours sincerely



Dr Clodagh Dugdale
Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Faculty of Medicine & Health Sciences Research Ethics Committee Membership 2014/2015

*denotes attendance at 19th June 2014

Chair	Dr Clodagh Dugdale, Lecturer in Sports and Exercise Medicine, Division of Rheumatology, Orthopaedic and Dermatology, School of Medicine.*
School	**Representative**
School of Life Sciences	Dr Vince Wilson, Reader and Basic Scientist, Pharmacology* Dr Kostas Tsintzas, Associate Professor, Human Physiology.
School of Medicine	Dr David Turner, Clinical Associate Professor in Microbiology, Division of Medical Sciences and Graduate Entry Medicine*
School of Medicine	Dr Kimberly Edwards, Director of Postgraduate Courses/Epidemiologist, Division of Rheumatology Orthopaedics and Dermatology. Dr Neil S Coulson,Associate Professor in Health Psychology, Division of Rehabilitation & Ageing.
School of Medicine-Non Clinical	Dr Philip Clark, Laboratory Manager, Pre-Clinical Cancer Studies, Division of Oncology* Dr Charlotte Billington, Research Fellow, Division of Respiratory Medicine* Dr Debbie Palmer-Green, Research Fellow, Division of Rheumatology Orthopaedics and Dermatology
School of Medicine-Derby	Dr Caroline Chapman, Associate Professor, Breast Surgery, Division of Medical Sciences and Graduate Entry Medicine.* Dr Saoirse O'Sullivan, Associate Professor in Vascular Medicine, Division of Medical Sciences and Graduate Entry Medicine Derby.*
School of Medicine - Clinical	Dr Paul Maddison, Consultant Neurologist/Honorary Clinical Associate Professor, Queen's Medical Centre, NUH* Dr Daren Forward, Consultant Orthopaedic Trauma Surgeon, Honorary Consultant Lecturer
Primary Care	Dr Richard Knox, General Practitioner/ Part-time Lecturer Dr Christine Johnson, General Practitioner/Part-time Lecturer Division of Primary Care, QMC Campus
School of Health Sciences	Dr Stephen Timmons, Associate Professor/Senior Lecturer, Division of Nursing.
Lay (Out of Faculty)	Professor Nigel White, Professor of Public International Law, School of Law, University of Nottingham. Lydia Davies-Bright, PhD Student, School of Law.* Dr Andy Peters, Associate Professor, SPMMRC, School of Physics and Astronomy.* Susan Pritchard, Research Associate, SPMMRC, School of Physics and Astronomy* Mary Beirne, Retired Mental Health Nurse, Birmingham and Solihull Mental Health Foundation Trust.*
Medical Students nominated by Medical student Society	To be appointed.
Postgraduate Student Member	Jyothika Kumar, PhD Student, Division of Psychiatry and Applied Psychology.* Charlotte Buchanan, PhD Student, SPMMRC, School of Physics & Astronomy
Administrator	Mrs Louise Sabir, Division of Respiratory Medicine, School of Medicine*

TELEPHONE: 363 2766
FAX: 391 0647
TELEGRAMS: RABONGAKA
TELEX: 2818 CARE BD

Republic of Botswana

MINISTRY OF HEALTH
PRIVATE BAG 0038
GABORONE

REF NO: PPME-13/18/1 Vol IX (124) 24 November 2014

Health Research and Development Division

Notification of IRB Review: New application

Paphani Chalashika
P.O. Box 2043
Jwaneng
Botswana

Protocol Title: **FEEDING PRACTICES AND NUTRITIONAL STATUS OF HIV-EXPOSED AND NON-HIV EXPOSED INFANTS AGED 6 – 24 MONTHS IN SELECTED DISTRICTS IN BOTSWANA**

Approval Date: 14 November 2014
Expiration Date: 14 November 2015
HRDC Review Type: HRDC
Risk Determination: **Minimal risk**

Dear Mr Chalashika

Thank you for submitting a new application for the above referenced study. The study was reviewed and approved with effect from 14 November 2014

This permit does not however give you authority to collect data from the selected sites without prior approval from the management. Consent from the identified individuals should be obtained at all times.

The research should be conducted as outlined in the approved proposal. Any changes to the approved proposal must be submitted to the Health Research and Development Division in the Ministry of Health for consideration and approval.

Furthermore, you are requested to submit at least one hardcopy and an electronic copy of the report to the Health Research, Ministry of Health within 3 months of completion of the study. Copies should also be submitted to all other relevant authorities.

Continuing Review

In order to continue work on this study (including data analysis) beyond the expiry date, submit a Continuing Review Form for Approval at least three (3) months prior to the protocol's expiration date. The Continuing Review Form can be obtained from the Health Research Division Office (HRDD), Office No. 7A.7 or Ministry of Health website: www.moh.gov.bw or can be requested via e-mail from Mr. Kgomotso Motlhanka, e-mail address: kgmmotlhanka@gov.bw As a courtesy, the HRDD will send you a reminder email about eight (8) weeks before the lapse date, but failure to receive it does not affect your responsibility to submit a timely Continuing Report form.

Amendments
During the approval period, if you propose any change to the protocol such as its funding source, recruiting materials, or consent documents, you must seek HRDC approval before implementing it. Please summarize the proposed change and the rationale for it in the amendment form available from the Health Research Division Office (HRDD), Office No. 7A.7 or Ministry of Health website: www.moh.gov.bw or can be requested via e- mail from Mr. Kgomotso Motlhanka, e-mail address: kgmmotlhanka@gov.bw . In addition submit three copies of an updated version of your original protocol application showing all proposed changes in bold or "track changes".

Reporting
Other events which must be reported promptly in writing to the HRDC include:
- Suspension or termination of the protocol by you or the grantor
- Unexpected problems involving risk to subjects or others
- Adverse events, including unanticipated or anticipated but severe physical harm to subjects.

If you have any questions please do not hesitate to contact Mr. P. Khulumani at pkhulumani@gov.bw, Tel +267-3914467 or Lemphi Moremi at lamoremi@gov.bw or Tel: +267-3632754

Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours sincerely

MINISTRY OF HEALTH RESEARCH DIVISION
2014 -11- 24
P/BAG 0038
GABORONE
REPUBLIC OF BOTSWANA

P. Khulumani
For Permanent Secretary

TELEPHONE: 363 2766
FAX: 391 0647
TELEGRAMS: RABONGAKA
TELEX: 2818 CARE BD

Republic of Botswana

MINISTRY OF HEALTH
PRIVATE BAG 0038
GABORONE

REFERENCE No: HPDME: 13/18/1 Vol. X (481) **03 May 2016**

Health Research Development Committee

Principal Investigator: Paphani Chalashika
Notification of IRB Review: **Continuing Review**

Protocol Title: **FEEDING PRACTICES AND NUTRITIONAL STATUS OF HIV-EXPOSED AND NON-HIV EXPOSED INFANTS AGED 6-24 MONTHS IN SELECTED DISTRICTS IN BOTSWANA**

Review Type: Health Research Development Committee
Effective Date: 15 November 2015
Expiration Date: 14 November 2016

This certifies that the continuing review request for the protocol above was reviewed under review procedures. Approval is valid for a period of 1 year.

X The research poses minimal risk to participants.
X Study is continuing.
___ The study has not been activated.
X Open to Enrollment.
X Accrual complete with treatment intervention and /or participant interviews/ surveys continuing.
___ Open for analysis only.
___ Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior).
___ Other, Please describe:
___ Research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

If you have any questions please do not hesitate to contact Mr. P. Khulumani at pkhulumani@gov.bw, Tel +267-3914467 or Lemphi Moremi at lamoremi@gov.bw or Tel: +267-3632754. Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours sincerely

MINISTRY OF HEALTH RESEARCH DIVISION 2016 -05- 03 P/BAG 0038 GABORONE REPUBLIC OF BOTSWANA

P. Khulumani
For/Permanent Secretary

The University of Nottingham

Faculty of Medicine and Health Sciences

Research Ethics Committee
School of Medicine Education Centre
B Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham
NG7 2UH

Direct line/e-mail
+44 (0) 115 8232561
Louise.Sabir@nottingham.ac.uk

21st April 2016

Paphani Chalashika
PhD Student
c/o Professor Simon Langley-Evans
Deputy Head School of Biosicences &
Professor of Human Nutrition
Nutritional Sciences-North Lab
Sutton Bonington Campus
College Road
Loughborough
LE12 5RD

Dear Mr Chalashika

Ethics Reference No: E19062014 SoBS Nutrition – **please always quote this ref**
Study Title: Investigation of feeding practices and nutritional status of HIV exposed and non-HIV exposed infants aged 6-24 months in Botswana.
Chief Investigator: Professor Simon Langley-Evans, Deputy Head, School of Biosciences (SoBS) and Professor of Human Nutrition, Faculty of Science.
Co Investigators: Dr Judy Swift, Associate Professor, Human Nutrition, Dr Duane Mellow, Lecturer Dietetics, Nutritional Sciences, SoBS.
Student: Paphani Chalashika, PhD Student, Nutritional Sciences, SoBS.
Duration of Study: 06/10/2014-31/03/2017 29mths **No of Subjects:** 440

Thank you for your letter dated 2nd March 2016 notifying the Committee of amendment no 1: 02 March 2016 as follows:

- A time extension request in order to complete the data collection with a new end date of: 31st March 2017.

These have been reviewed and are satisfactory and the study is approved.

Approval is given on the understanding that the conditions set out below are followed:

1. A Favourable opinion is given on the understanding that all appropriate ethical and regulatory permissions are sought for each overseas project in accordance with all local laws, and that the host organisation/s involved also gives their permission where applicable.

2. Please submit a copy of letters of permission and approval from the Botswana Health Research and Development Council and the Botswana Ministry of Health (Clinical Services) when they become available for approval and our records.

3. You must follow the protocol agreed and inform the Committee of any changes using a notification of amendment form (please request a form).

4. You must notify the Chair of any serious or unexpected event.

The University of Nottingham

5. This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.

6. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely

pp Lamiaggodini

Professor Ravi Mahajan
Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Appendix 3: Quantitative Questionnaire

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

QUESTIONNAIRE

STUDY TITLE:

Investigation of Feeding Practices and Nutritional Status of HIV-exposed and non-HIV-exposed Infants Aged 6 – 24 Months in Botswana.

ETHICS REFERENCE NUMBERS: E19062014 SoBS Nutrition

(**REFERENCE TO PROTOCOL:** Final Version 1.0 May 2014)

SUBJECT NUMBER:

☐☐ *(Location)* ☐☐ *(Surveyor- Initials)* ☐☐☐☐ *(Study Group & Number)*

TODAY'S DATE:

☐☐ *(Day)* ☐☐ *(Month)* ☐☐☐☐ *(Year)*

HEALTH FACILITY:

Name: _____ Type: _____

Location: _____ Demographic: _____

☐ Checked for completion ☐ Entered into SPSS ☐ Scanned & Drop box

Completed by (Name & Signature): **Date:**

ETHICS REF NO: E19062014	SUBJECT NO: |___|___|___|___|___| ___|___|___|

DATA COLLECTION FLOW CHART

STUDY PLAN	0 - 5 MINUTES	10th MINUTE	15th MINUTE	30th MINUTE
Eligibility criteria and consent	☐			
Infant information	☐			
Weight and Length		☐		
Check for pedal oedema		☐		
Mother/care giver & Household characteristics		☐		
Schedule immunisation data		☐		
Vitamin A supplementation data		☐		
Screening for Gross motor development delay			☐	
Weight for age			☐	
Length for age			☐	
HIV exposure			☐	
Infant feeding			☐	
Morbidity			☐	
24 Hour dietary recall				☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

INFANT INFORMATION

(*Complete this section using page 1 of the CWCC, if not indicated tick next to* N/C)			
1. Date of Birth:	☐☐ Day ☐☐ Month ☐☐☐☐ Year		☐ N/C
2. Age:	☐☐ Months		
3. Gender:	☐ Male ☐ Female		
4. Mother/Caregiver's ID:	☐☐☐☐☐☐☐☐☐☐☐☐☐☐		
5. Mother's age (Years):	At child's Birth: ☐☐ Years	Current age: ☐☐ Years	N/C ☐
6. Birth weight:	Weight	☐▪☐☐ Kg	N/C ☐
7. Birth length:	Length (cm):	☐☐▪☐ cm	N/C ☐
8. APGAR score:	☐ ☐ ☐		N/C ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

WEIGHT AND LENGTH

9. WEIGHT (*Measure the weight of the child to the nearest 0.01kg. Measure the weight two separate times using the scale appropriately for the child).*	
First weight: ☐☐.☐☐ Kg	
Second weight: ☐☐.☐☐ Kg	
Tared weighing ☐	☐ Independent weighing
10. LENGTH: *Measure the child's length (<2years) while lying down on the measuring board Do this twice to the nearest 0.1cm*	
First length: ☐☐.☐ cm	
Second length: ☐☐.☐ cm	
Recumbent length ☐	☐ Standing height
DO NOT COMPLETE THIS SECTION, GO TO QUESTION 11	
Weight for Age: ☐ SD	Underweight: Yes ☐ No ☐
Weight for Length: ☐ SD	Wasted: Yes ☐ No ☐
Length for Age: ☐ SD	Stunted: Yes ☐ No ☐

CHECK FOR PEDAL OEDEMA

11. Check if the child has oedema of the feet. *(If the child has pedal oedema, complete the section on page 17 and notify team leader for referral).*
1. Yes 2. No ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

MOTHER/CARE GIVER & HOUSEHOLD CHARACTERISTICS

(Ask the mother/care giver the following questions and enter the corresponding number)		
12. How does the primary care giver relate to the child?	☐	1. Mother 2. Grandmother 3. Father 4. Aunt 5. Sibling 6. Other Relative _____ 7. Not related guardian
13. The age of the primary care giver	☐	
14. The person completing the interview is the child's?	☐	1. Mother 2. Grandmother 3. Father 4. Aunt 5. Sibling 6. Other Relative _____ 7. Not related guardian
15. If the primary care giver is not the mother, is the mother alive?	☐	1. Yes 2. No
16. How many siblings does the infant have?	☐	
17. How many siblings/relatives living with the infant are aged less than five years?	☐	
18. Does the infant have siblings who have passed away?	☐	1. Yes 2. No
19. How many years did the mother/care giver go to school for?	☐	1. 0 years 2. 1-7 years 3. ≥ 8 years
20. What is the marital status of the mother/care giver?	☐	1. Single/widowed/divorced/other 2. Married/lives with partner

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

21. What is the employment status of the mother/care giver?	☐	1. Not employed 2. Self-employed (_____) 3. Formally Employed (_____) 4. Government Program (Ipelegeng)
22. What is the mother/care giver income each month? *(Note this includes money given in kind or from pension).*	☐	1. BWP 0-199 2. BWP 200 - 399 3. BWP 400 -599 4. BWP 600 - 799 5. BWP 800 - 999 6. BWP 1000+
23. How many people live in the household that the infant lives in?	☐	
24. What is the primary water source where the infant lives?	☐	1. Piped water in homestead 2. Piped water in the neighbourhood 3. Borehole/water carrier 4. River/pond
25. What is the toilet type in the homestead where the infant lives?	☐	1. Flush 2. Pit latrine 3. None

SCHEDULE OF IMMUNISATION

(Use page 1 of CWCC for this section, if indicated tick Yes, *if not indicated tick* N/C *or* n/a *if the child is still younger than the indicated age of vaccine).*

Child's age in Months ☐

26. At birth	**BCG**	a. 1st dose (at birth) Yes ☐ N/C ☐			
27. At birth, 2 & 9 months	**Hepatitis B (HBV/ Pentavalent)**	a. 1st dose (at birth) Yes ☐ N/C ☐	b. 2nd dose (2 months) Yes ☐ N/C ☐	c. 3rd dose (3 months) Yes ☐ N/C ☐	d. 4th dose (4 months) Yes ☐ N/C ☐
28. At 2, 3,4 months & booster at 18 months	**D.P.T (Pentavalent)**	a. 1st dose (2 months) Yes ☐ N/C ☐	b. 2nd dose (3 months) Yes ☐ N/C ☐	c. 3rd dose (4 months) Yes ☐ N/C ☐	d. Booster (18 months) Yes ☐ N/C ☐ n/a ☐
29. At 2, 3,4 months & booster at 18 months	**Polio (OPV)**	a. 1st dose (2 months) Yes ☐ N/C ☐	b. 2nd dose (3 months) Yes ☐ N/C ☐	c. 3rd dose (4 months) Yes ☐ N/C ☐	d. Booster (18 months) Yes ☐ N/C ☐ n/a ☐
30. At 2 & 3 months	**Rotavirus**	a. 1st dose (2 months) Yes ☐ N/C ☐ n/a ☐	b. 2nd dose (3 months) Yes ☐ N/C ☐ n/a ☐	c. 3rd dose (4 months) Yes ☐ N/C ☐ n/a	
31. At 2, 3 & 4 months	**Pneumococcal**	a. 1st dose (2 months) Yes ☐ N/C ☐ n/a ☐	b. 2nd dose (3 months) Yes ☐ N/C ☐ n/a ☐	c. 3rd dose (4 months) Yes ☐ N/C ☐ n/a ☐	
32. 9 months	**Measles**	a. 1st Dose (9 months) Yes ☐ N/C ☐ n/a ☐	b. Booster (18 months) Yes ☐ N/C ☐ n/a ☐		

Completed by (signature):	Date:	Checked by monitor (initials):	Date:

VITAMIN A SUPPLEMENTATION

(Use the CWCC page 1 to complete this section. If indicated tick Yes *if not indicated tick* N/C *and* n/a *if the child is still younger than the indicated age of vaccine).*				
Child's age in Months ☐				
33. Vitamin A dose	Mother after delivery up to 6-8 wks	**OR**	Below 6 mths *(Complete if infant was not breastfed).*	
	200, 000 I.U		50, 000 I.U	
	Yes ☐ N/C ☐ n/a ☐		Yes ☐ N/C ☐ n/a ☐	
34. Vitamin A dose *(If infant is less than 9 months old tick n/a for all of them and then go to question 35)*	**a. At 9 mths**	**b. At 18 mths**		**c. At 24 mths**
	100,000 I.U	200,000 I.U		200,000 I.U
	Yes ☐ N/C ☐ n/a ☐	Yes ☐ N/C ☐ n/a ☐		Yes ☐ N/C ☐ n/a ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

SCREENING FOR GROSS MOTOR DEVELOPMENT DELAY

(Use page 2 of the CWCC to complete this section, if not indicated in the CWCC tick N/C. *Also ask the mother the gross motor stage at the appropriate month). Use the closest preceding months.*

Child's age in Months ☐

Age (Months)	35. Gross Motor (*use CWCC*)	36. Gross Motor *(Ask the mother/care giver)*
6	Sits momentarily without support	Sits momentarily without support
	YES ☐ NO ☐ N/C ☐	YES ☐ NO ☐
9	Pulls to stand	Pulls to stand
	YES ☐ NO ☐ N/C ☐	YES ☐ NO ☐
12	Walks with support	Walks with support
	YES ☐ NO ☐ N/C ☐	YES ☐ NO ☐
18	Climbs stairs or walks up sloping ground with support	Climbs stairs or walks up sloping ground with support
	YES ☐ NO ☐ N/C ☐	YES ☐ NO ☐
24	Runs	Runs
	YES ☐ NO ☐ N/C ☐	YES ☐ NO ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

WEIGHT FOR AGE

37. *(Use page 3 for girls or page 4 for boys, complete the details for each month. Tick N/C if weight is not indicated).*

MONTH	WEIGHT (Kg)	≥3	<3 to 2	<2 to 0	< 0 to -2	<-2 to -3	<-3	N/C
0								☐
1								☐
2								☐
3								☐
4								☐
5								☐
6								☐
7								☐
8								☐
9								☐
10								☐
11								☐
1 year								☐
0								☐
1								☐
2								☐
3								☐
4								☐
5								☐
6								☐
7								☐
8								☐
9								☐
10								☐
11								☐
2 years								☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

LENGTH FOR AGE

38. *(Use page 5 for girls or page 6 for boys, complete the details for each month. Tick* N/C *if length/height is not indicated).*

MONTH	Length/Height (cm)	≥3	<3 to 2	<2 to 0	< 0 to -2	<-2 to -3	<-3	N/C
0								☐
1								☐
2								☐
3								☐
4								☐
5								☐
6								☐
7								☐
8								☐
9								☐
10								☐
11								☐
1 year								☐
0								☐
1								☐
2								☐
3								☐
4								☐
5								☐
6								☐
7								☐
8								☐
9								☐
10								☐
11								☐
2 years								☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

HIV EXPOSURE

(Use page 8 of the CWCC to complete this section)

39. MOTHER'S HIV STATUS	Positive ☐	Negative ☐	☐ N/C

(If the mother's HIV status is positive, complete the following sections. If she is negative tick n/a for all questions and then go to question 44).

40. Duration mother given ZDV (in weeks)	☐☐ weeks	N/C ☐ n/a ☐
	If not indicated record the ZDV start date: ☐☐ Day ☐☐ Month ☐☐☐☐ Year ☐ N/C	

INFANT'S HIV STATUS *(If not completed tick* N/C *and tick* n/a *if the child is still younger than the indicated age).*

Child's age in Months ☐

41. PCR (6 weeks)	Positive ☐	Negative ☐	N/C ☐	n/a ☐
42. Repeat PCR (Breastfed infants should return for a repeat test 6 weeks after last breast milk)	Positive ☐	Negative ☐	N/C ☐	n/a ☐
43. Elisa or rapid test (at 18 months)	Positive ☐	Negative ☐	N/C ☐	n/a ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

INFANT FEEDING

Determine the infant feeding method at relevant life stages *(To complete this section use page 9 of the CWCC, tick* N/C *if not indicated. Also ask the mother/caregiver).*

Child's age in Months ☐

44. 0-6 months: Predominant feeding method

a. CWCC	Exclusive breastfeeding (EBF) ☐	Exclusive formula feeding (EFF) ☐	Mixed Feeding (MF) ☐	N/C ☐
b. Mother/ caregiver	Exclusive breastfeeding (EBF) ☐	Exclusive formula feeding (EFF) ☐	Mixed Feeding (MF) ☐	None ☐

45. If mother indicates **mixed feeding** get details on what type of milks are used?

_____

46. If infant is HIV exposed and taking formula is this provided through PMTCT?: *(Use page 9 to check if there is an updated register for provision of formula, if not indicated tick* N/C *and then ask the mother/care giver).*

a. CWCC	***b. (Ask the mother if not indicated)***
Yes ☐ No ☐ n/a ☐ N/C ☐	Yes ☐ No ☐ n/a ☐

47. 6-12 months: Predominant Feeding Method

a. CWCC	Exclusive breastfeeding (EBF) ☐	Exclusive formula feeding (EFF) ☐	Mixed Feeding (MF) ☐	N/C ☐
b. Mother/ caregiver	Exclusive breastfeeding (EBF) ☐	Exclusive formula feeding (EFF) ☐	Mixed Feeding (MF) ☐	None ☐

48. If mother indicates **mixed feeding** get details on what type of milks are used?

_____

49. If infant is HIV exposed and taking formula is this provided through PMTCT?: *(Use page 9 to check if there is an updated register for provision of formula, if not indicated tick* N/C *and then ask the mother/care giver).*

a. CWCC	***b. (Ask the mother if not indicated)***
Yes ☐ No ☐ n/a ☐ N/C ☐	Yes ☐ No ☐ n/a ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

50. *(If child is HIV exposed and is receiving formula from the clinic, ask the mother)* Has the formula been available everytime she required it at the clinic in the last 3 months?

Yes ☐ No ☐ n/a ☐

12+ months: Predominant Feeding Method *(Ask the mother/care giver, If an infant is 12 months or less go to question 52)*

51. Currently what type of feeds is the infant receiving?:

- ☐ Breast milk
- ☐ Formula
- ☐ Cow's milk
- ☐ Mixed (*Indicate type*_____)
- ☐ None

COMPLEMENTARY FOOD INTRODUCTION *(Ask the mother/care giver)*

52. At what age did you give the infant other foods except milk?

Months ☐

Not sure ☐

USE OF TSABANA *(Ask the mother/care giver)*

53. How many times per week does your child eat Tsabana?

☐

54. *(Ask if the mother/care giver gives her child Tsabana less than 4 times per week.)* What is the reason for not giving Tsabana?

_____

_____

55. *(Ask the mother/care giver)* When their child consume Tsabana how may times per day do they consume it?

☐

56. Do other family members eat Tsabana?

Yes ☐

No ☐

57. If mother/care giver indicates that other family members eat Tsabana, ask why?

_____

_____

58. Does Tsabana provided from the health facility last the whole month?

Yes ☐

No ☐

n/a ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

MORBIDITY

DIARRHOEA FREQUENCY	
CWCC (*check the CWCC under outpatient visits in the last 4 weeks).*	**59.** Number of consultations in the clinic for diarrhoea in the last 4 weeks ☐
	60. Number of hospitalisations due to diarrhoea in the last 4 weeks ☐
Mother/ caregiver	**61.** Ask the mother/care giver the number of times last month the child had three or more, *watery/more loose/liquid* stools per day. ☐ Not sure ☐
HOSPITALISATION FREQUENCY	
CWCC (*check the CWCC under outpatient visits in the last 4 weeks).*	**62.** Number of hospitalisations in the last 4 weeks ☐
	63. Reason (s) for hospitalisation: _____
Mother/ caregiver	**64.** Ask the mother/care giver the number of times last month the child has been hospitalised ☐ Not sure ☐
	65. Reason for hospitalisation: _____

24 HOUR DIETARY RECALL

66. STEP 1: QUICK LIST *Ask the mother/caregiver what foods and fluids the infant has eaten in the last 24 hours starting with the latest meal eaten.*

Time/Occasion	Food eaten	Amount	Recipes

If Formula Feeding: Name of formula:_____Water amount:_____ Scoops:_____

Frequency of feeding: (In terms of number of bottles/feeds per 24 hours):

If breastfeeding: has the infant been breastfed the previous day?

Yes ☐ No ☐

Is the child taking RTUTF Plumpy nut? Yes ☐ No ☐

If taking RTUTF, indicate number of sachets of Plumpy nut taken in the last 24 hours ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

24 HOUR DIETARY RECALL

STEP 2: FORGOTTEN FOODS

Probe for foods forgotten during the quick list prompting the mother/care giver *(Tick to show completion).* ☐

STEP 3: TIME AND OCCASION

Collect the time and eating occasion for each food. *(Tick to show completion)* ☐

STEP 4: DETAIL CYCLE

For each food, collect detailed description, amount, and additions to the food. Review 24-hour day. Use the utensils given to prompt the mother/care giver to give detailed portion sizes. *(Tick to show completion).* ☐

STEP 5: FINAL PROBE

Final probe for anything else consumed *(Tick to show completion)* ☐

DO NOT COMPLETE THIS SECTION, GO TO END OF QUESTIONNAIRE:

Tick	Food Group	Common Food Examples
☐	Grains, roots and tubers	Maize meal, Sorghum (mabele), Potato, Samp, Sweet potato, Rice, Macaroni, Millet, Breakfast cereals, Infant cereals
☐	Legumes and nuts	Beans, Lentils, Jugo beans (ditloo), nuts
☐	Dairy Products	Cow's milk, Yoghurt, Cheese, Custard, Sour milk
☐	Flesh foods	Red meat (goat, beef, pork, mutton), fish, chicken, liver, offal
☐	Eggs	Eggs
☐	Vitamin A rich veges and fruits	Green leafy vegetables (spinach, rape), carrots, red/green/yellow peppers, tomato Mango, watermelon
☐	Other fruit and vegetables	Banana, apple, orange, grapes, pear, pureed baby foods (veg/fruit based)
DIETARY DIVERSITY SCORE: ☐ /7		

END OF QUESTIONNAIRE

1. Ask the mother/care giver if they have any questions.
2. Thank the mother/care giver for their participation.

Notify the team leader if the infant needs referral. Tick if the infant is referred for further management and indicate reason for this referral:

Reason:_____ ☐

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Appendix 4: Dietary diversity measure

Dietary diversity

5. **Minimum dietary diversity:** Proportion of children 6–23 months of age who receive foods from 4 or more food groups

$$\frac{\text{Children 6–23 months of age who received foods from} \geq 4 \text{ food groups during the previous day}}{\text{Children 6–23 months of age}}$$

Notes:

- The 7 foods groups used for tabulation of this indicator are:
  - — grains, roots and tubers
  - — legumes and nuts
  - — dairy products (milk, yogurt, cheese)
  - — flesh foods (meat, fish, poultry and liver/organ meats)
  - — eggs
  - — vitamin-A rich fruits and vegetables
  - — other fruits and vegetables
- Consumption of any amount of food from each food group is sufficient to "count", i.e., there is no minimum quantity, except if an item is only used as a condiment.[1]
- The cut-off of at least 4 of the above 7 food groups above was selected because it is associated with better quality diets for both breastfed and non-breastfed children (*10*). Consumption of foods from at least 4 food groups on the previous day would mean that in most populations the child had a high likelihood of consuming at least one animal-source food and at least one fruit or vegetable that day, in addition to a staple food (grain, root or tuber).
- Results may be reported separately for breastfed and non-breastfed children. However, diversity scores for breastfed and non-breastfed children should not be directly compared, because breast milk is not 'counted' in any of the above food groups. Breast milk is not counted because the indicator is meant to reflect the quality of the complementary food diet. As a consequence, this indicator may show 'better' results for children who are not breastfed than those who are breastfed in populations where formula and/or milk are commonly given to non-breastfed children.
- For the same reason, this indicator should not be used to compare populations that differ in prevalence of continued breastfeeding. This caution applies both to comparisons between different sub-populations at one point in time (e.g. urban versus rural comparisons) and the same population at different points in time (e.g. if continued breastfeeding has declined). The composite indicator (# 7 below) captures several different dimensions of feeding and can be used for comparisons across time and between populations with different rates in continued breastfeeding.
- It is recommended that the indicator be further disaggregated and reported for the following age groups: 6–11 months, 12–17 months and 18–23 months.

[1] More guidance is provided in the operational guide that is a companion to this document.

Appendix 5: Qualitative Interview Guide





INTERVIEW GUIDE: CARE GIVERS

STUDY TITLE:

Perceptions of primary care givers, older family figures and health care workers in ensuring optimal nutritional status for infants aged 6 – 24 Months in Selected Districts in Botswana.

ETHICS REFERENCE NUMBERS: E19062014 SoBS Nutrition

(**REFERENCE TO PROTOCOL:** Final Version 1.0 March 2016)

Study Group: CGE ☐ *CGN* ☐

Subject Number: *Study Group:* ☐☐☐ *Interview Number:* ☐☐☐

Today's date:

☐☐ *(Day)* ☐☐ *(Month)* ☐☐☐☐ *(Year)*

Health facility:

Name: _____ Type: _____

Location: _____ Demographic: _____

☐ Checked for completion ☐ Scanned ☐ Transcribed ☐ Entered into NVIVO

Audio File Name: _____ Length: _____ *minutes*

Completed by (Name & Signature): Date:

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Location: _____ Subject Number: _____

INTRODUCTION

Good Morning/Afternoon. Thank you very much for being part of our study, where you will share your experiences about health and nutrition of infants. My name is Paphani Chalashika; I am a PhD student in the University of Nottingham in the UK. This research is part of my work as a PhD student where I am looking at the growth and development of infants aged 6 – 24 months old. The aim for our study is to find more about what determines growth and development in these infants in Botswana, so that we can come up with interventions aimed at improving their health and wellbeing.

As part of our interview today, I will record our conversation. This will help me to remember what we discussed today in great detail, so I can correctly capture your views and experiences. There will be no way of identifying you from this recording. In addition, after the interviews the audio will be transcribed and then audio will be later discarded.

Before we continue I would like you to sign a consent form indicating that you fully understand what the study is about and the role you will play. You are also advised that you can pull out of the interview at any point and you do not have to answer questions you feel uncomfortable with. Do you have any questions before we proceed?

Observations regarding the environment:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Location: _____ Subject Number: _____

1. GENERAL KNOWLEDGE ABOUT INFANT HEALTH

- Please tell me about your son/daughter and how he has been growing and developing.
- How old are they?

Probing questions	Covered	Notes/Observations
• What do care givers consider to be good health for infants? (Indicators for good health). *You mentioned that that there are things that show you that your son/daughter is healthy, what are some of those things?*	☐	
• What baby care practices improves or fosters good health in infants? *It seems like there are some things you are doing such as... to ensure that you child grows well.... Please tell me more about these....*	☐	
• Routine visits to health facility, vaccinations for the infant, diarrhoea prevention such as use of zinc tablets and ORS, handwashing at home, household environment. *You have indicated that you take your child to the health facility.... What are the reasons for taking him/her....*	☐	
• What sort of sickness is their infant had before and what do care givers believe to be cause of this sickness? *When you said sometimes your child is sick what kind of illness does he/she suffer from..*	☐	

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

• What do caregivers do to get infants healthy after a sickness (role of clinics/health facility or health care workers or other self-administered home remedies)? *When your child is ill, what does the care giver do?* *Do care giver uses home remedies or self-administer medications?*	☐	
• Assess care giver's understanding of the importance of maternal health in infant's health and development. (Review the cultural beliefs of Botsetsi) *Please tell me about the time when you were pregnant?* *What sort of things did you do when you discovered that you were expecting him/her?* *After you gave birth what happened, did you change some things about your health and lifestyle?* *When you were in Botsetsi, what sort of things did you have to do or not do?*	☐	

Location: _____ Subject Number: _____

2. KNOWLEDGE ABOUT BREASTFEEDING AND/OR BOTTLE FEEDING

- You have mentioned how you fed your child when he was young can you please tell me about that?
- You child is now_____ months; please tell me more about how he is feeding now.

Probing questions	Covered	Notes/Observations
• What do care givers consider to be optimal feeding for infants and reasons? *You have indicated that you child breastfeed/bottle feeds, how you chose this feeding method.....* *What do you think is the best feeding method for infants?*	☐	
• When breastfeeding was initiated and if delayed reasons for this. *You indicated that you breastfed you infant when he was young, please tell me more how you initiated breastfeeding after birth....*	☐	
• Duration for breastfeeding the infant or if still breastfeeding when the mother/care giver expects breastfeeding to last for. *How did breastfeeding continue after initiation.....for how long.....why?*	☐	
• Implementation of breastfeeding, was demand feeding is practised, exclusive or mixed feeding? *How do you decide when to breastfeed your*	☐	

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

child?....How do you know when they have had enough?		
• If bottle feeding the reason for doing so. *You have indicated that you chose bottle feeding, how did this come about.....*	☐	
• If using formula, making of formula (reconstitution) and how they learnt to do this? *And when you started using formula, how was the experience in terms of knowing what to do?*	☐	
• Practices that the care givers ensures hygienic bottle feeding. *Where you live do you have indoor plumbing.....fuel source.....how do you make formula at night?*	☐	
• How the infant's HIV exposure affected the choice of feeding method. *You mentioned that you chose bottle feeding because....* *How did you settle on this choice?.....*	☐	

Location: _____ Subject Number: _____

3. KNOWLEDGE ABOUT COMPLEMENTARY FEEDING AND NUTRITION

- You child is now ____ months and it looks like you are now feeding him other feeds beside milk. Please tell me more about what you feeding him/her now and when you started feeding him/her?

Probing questions	Covered	Notes/Observations
• The optimal age for complimentary feeding. *When did you child start feeding on solids?*	☐	
• The age the infant was introduced to solid foods and reasons for doing so if done earlier or later than 6 months. *You mentioned that you started feeding him/her at ___months, what made you start feeding at this age?*	☐	
• The type of first weaning foods provided to the infant and reasons for giving these foods. *When you started feeding him/her what sort of foods did you give him?.....why?*	☐	
• The type of feeds given currently and reasons for providing these. (To determine if the infant receives all food groups and justifications). *Now that your child is older, are the types of food he is eating changing?*	☐	

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

• If some food groups are not given, the reasons for not giving foods from these food groups. *You mentioned that you mostly give him.....have you tried other foods such as.....if not why?*	☐	
• Type of drinks given to the infant and reasons for doing so. *Besides solid food do you ever give him/her drinks?....what kind?.....Does this include water?*	☐	
• What caregivers consider being nutritious food choices and reasons for giving these? *It looks like you give your child.....do you consider these foods to be nutritious?*	☐	
• Food preparation practices for infant and reasons for doing so (including whether infant's food is prepared separately, different texture, enriched?). *The foods that your child is eating; do you and other family members eat the same foods?* *Do you change the texture or add other foods to your child's food?*	☐	
• For infants weaned what are their milk intake options and reasons for doing so? *You have mentioned that you have stopped him*	☐	

breast-feeding/formula feeding, are you giving him/her other milk drinks?		
• The frequency of meals that the infant is provided with and justification for doing so. *In a day how often do you feed him/her.....*	☐	
• What culture and traditional practices affect how infants are fed (effects of culture on feeding practices?). *I have heard from other mothers that there are some things in culture such as not to feed meat because a child will develop a taste for salt too soon...what do you think of these?* *Do you have any of these beliefs?..... what are the reasons behind these?*	☐	

Location: _____ Subject Number: _____

4. INFLUENCE OF OLDER FAMILY FIGURES

- Is this your first child?
- Who helped you after giving birth?
- In your home where you live no with your child, who else do you live with?
- Is there anyone who helps with the care and feeding of the child?

Probing questions	Covered	Notes/Observations
• The older family figures in the family (gender and if they live with the caregiver). ***If the care giver does not have older family figures, explore if she has friends/neighbours who act as older family figures.***	☐	
• The kind of advice that older family figures have given before or are giving currently. *You said that you live with your mother/aunt or you sometimes take your child to them for babysitting.....* *How have they advised on how to take care of your child, feeding or otherwise*	☐	
• Tradition and culture related to caregivers and their relationship to older family figures. *You mentioned that your mother, aunt advise you on how to take of your child, have you done what they have advised?*	☐	

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Location: _____ Subject Number: _____

What do you think is the role of the older family figures in the growth and development of your child?		

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Location: _____ Subject Number: _____

5. INFLUENCE OF HEALTH CARE WORKERS

- You have mentioned that you take your child to the clinic for monthly weight monitoring or when he/she is sick.....tell me about what services you get in your health facility?
- When you go to the health facility which health care workers do you usually receive service from?

Probing questions	Covered	Notes/Observations
• What care givers regard as the role of health care workers in terms of infant health? *You have indicated that when you take your child to the clinic you get services from nurses....what do you think is the role of these in child's health and development?*	☐	
• Challenges care givers encounter with accessing health care or nutrition services. *You have mentioned the services you get from the clinic, are these services always there?* *Are you satisfied with these services?* *Are the other challenges that you have encountered that you believe are preventing you from fully accessing health services to improve your infant's health?* *When you were pregnant what services that you received from your health facility?*	☐	
• Which services that are available from health facilities that care givers regard as useful or not useful for optimal health or nutrition status of infants? *From the services you have mentioned which ones do you see*	☐	

as crucial to the growth and development of your child?		
• The role of food provisions from the government received from the health facility and whether care givers consider these useful or not useful for optimal nutrition of the infant. *Government provides tsabana, malutu, beans and cooking oil, do you receive these? Do you think these are important for the growth of your infant?* *Some mothers have stated that they don't give tsabana to their child because of diarrhoea, what do you think of this.....* *What do you think is missing in health care services that you believe can improve the health of your child?*	☐	
• How the care giver was counselled prior to choosing the feeding method and reasons for doing so in consideration of infant's HIV exposure (to assess the role of IYCF counselling). *You have mentioned that your child was on formula because of your HIV status; please take me through the process of how you were assisted by Health care workers to choose formula feeding?* *During counselling who counselled you....what happened?* *Were you given a choice to breastfeed?*	☐	

Location: _____ Subject Number: _____

6. ACCESS TO RESOURCES

- It sounds like it takes many things to get a child to grow well, besides adequate feeding, care and access to health services……..what other things do you think has helped your child grow?

Probing questions	Covered	Notes/Observations
• Is the care giver employed or not? *What do you do?*	☐	
• Which resources do care givers consider to be important for optimal infant health and nutrition? (such as land, education, employment, income or technology?) ***Probe giving examples such as land, education and relating to child health and development.***	☐	
• If the mother/care giver is not employed what other burdens/responsibilities is she/he entrusted with? *You mentioned that you are not employed/employed, what other responsibilities do you have normally have?*	☐	
• How do these (employment/burdens/responsibilities) impact infant care and feeding practices? *You mentioned that you have many things to do such as going into the farm, looking for a job…how does these affect your child for example feeding time…*	☐	
• Assess if there is adequate funds to buy adequate food and other needs for optimal growth of the	☐	

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

infant. *Does your child get all the foods each month that you believe they should have?*		
• Who is the decision maker in the household that the infant lives in? *In your household how do you make decisions on what to buy, e.t.c.....who makes those decisions?*	☐	
• What decisions affecting infant's access to health, nutrition does that care giver/decision maker make? *Such as taking an infant to health facility* *Care required* *Foods to buy specifically for the infant*	☐	
• Who controls how much money is spent on food and does decision takes into account the nutrition or health needs of the infant. *How do you budget each month?*	☐	

Location: _____ Subject Number: _____

Reflections from the interview:

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Areas for Improvement:

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_____
_____
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_____

Issues to explore on the next interview (s):

_____
_____
_____
_____
_____
_____
_____

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

BIUST
BOTSWANA INTERNATIONAL UNIVERSITY OF SCIENCE & TECHNOLOGY

INTERVIEW GUIDE: HEALTH CARE WORKERS

STUDY TITLE:

Perceptions of primary care givers, older family figures and health care workers in ensuring optimal nutritional status for infants aged 6 – 24 Months in Selected Districts in Botswana.

ETHICS REFERENCE NUMBERS: E19062014 SoBS Nutrition

(**REFERENCE TO PROTOCOL:** Final Version 1.0 March 2016)

Study Group: CGE ☐ *CGN* ☐ *OFF* ☐ *HCW* ☐

Subject Number: Study Group: ☐☐☐ *Interview Number:* ☐☐☐

Today's date:

☐☐ *(Day)* ☐☐ *(Month)* ☐☐☐☐ *(Year)*

Health facility:

Name: _____ Type: _____

Location: _____ Demographic: _____

☐ Checked for completion ☐ Scanned ☐ Transcribed ☐ Entered into NVIVO

Audio File Name: _____ Length: _____ *minutes*

Completed by (Name & Signature): Date:

Completed by (Name & signature):	Date:	Checked by (Name & signature):	Date:

Location: _____ Subject Number: _____

INTRODUCTION

Good Morning/Afternoon. Thank you very much for being part of our study, where you will share your experiences about health and nutrition of infants. My name is Paphani Chalashika; I am a PhD student in the University of Nottingham in the UK. This research is part of my work as a PhD student where I am looking at the growth and development of infants aged 6 – 24 months old. The aim for our study is to find more about what determines growth and development in these infants in Botswana, so that we can come up with interventions aimed at improving their health and wellbeing.

As part of our interview today, I will record our conversation. This will help me to remember what we discussed today in great detail, so I can correctly capture your views and experiences. There will be no way of identifying you from this recording. In addition, after the interviews the audio will be transcribed and then audio will be later discarded.

Before we continue I would like you to sign a consent form indicating that you fully understand what the study is about and the role you will play. You are also advised that you can pull out of the interview at any point and you do not have to answer questions you feel uncomfortable with. Do you have any questions before we proceed?

Observations regarding the environment:

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1. HEALTH CARE WORKERS' PERSONAL BELIEFS

- Please tell me about yourself?
- Do you have any kids, nephews or nieces?
- How old are they?

Probing questions	Covered	Notes/Observations
• What are the health care workers' personal beliefs regarding infant feeding (i.e. breastfeeding or bottle-feeding)? *Were you children or nephews breastfed or bottle fed?* *What do you think of breastfeeding and bottle feeding?*	☐	
• What do care givers think is the most appropriate feeding options for HIV exposed infants? *For HIV exposed infants how do HCW think these infants should be fed?*	☐	
• What are the health care workers' personal beliefs regarding infant health such as cause of sickness in infants? Generally what kind of sickness do children in your area suffer from? What does health care think is causing these conditions?	☐	
• How do health care workers reconcile their beliefs with recommendations especially where there are inconsistencies? *You mentioned that you believe that mothers who are*	☐	

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Location: _____ Subject Number: _____

HIV positive should not breastfeed, what do HCW do when the mother choose to breastfeed? *Do the HCW beliefs affect their counselling style or are they able to separate the two?*		
• What are the health care workers' personal beliefs regarding infant feeding (i.e. breastfeeding or bottle-feeding)?	☐	

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2. INFANT AND YOUNG CHILD FEEDING ADVICE

- You have talked a bit about how young children coming to the clinic feed. Can we please talk more about how you advise mothers/caregivers on how to feed and care for their infants?

Probing questions	Covered	Notes/Observations
• What advice is given to care givers regarding infant and young child feeding?	☐	
• What do health care workers think of this advice? (Its appropriateness or its adequacy)?	☐	
• Do health care workers believe that the advice they are providing is making an impact in the health or nutritional status of infants? Why?	☐	
• Do health care workers have enough time to provide this advice as envisioned?	☐	
• Do health care workers teach mothers/care givers about appropriate feeding especially during weaning and complementary feeding?	☐	
• What are the barriers to support care givers' choice of optimal feeding for infants?	☐	
• For PMTCT counselling what is involved in this process and how is it different from those who are not on PMTCT.	☐	

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• According to health care workers what are challenges regarding providing feeding advice for mothers/care givers on PMTCT?	☐	
• Is there prescriptive advice for mothers/care givers on PMTCT to choose one feeding method over another?	☐	
• What do the health care workers think is the role of older family figures in ensuring optimal nutrition and health of infants?	☐	

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3. MATERNAL HEALTH

- We have focused on the nutrition and health of infants, let's now look at the health of the mother before, during and after pregnancy.
- What is in place in terms of programs or advice for women who are thinking of falling pregnant, who are pregnant and after they give birth.

Probing questions	Covered	Notes/Observations
• What type of advice do you give to mothers who have not yet fallen pregnant? *Probe looking for the advice they give women or programs that are accessible for women.*	☐	
• Do women access these programs or advice? *If women do not access these program or advice what are the barriers?*	☐	
• When a woman falls pregnant what happens? *Probe looking for things in place that are offered to women of different stages of pregnancy and rationale for these?* *Look at how low maternal weight gain, Low Hb e.t.c are addressed? E.g. Food provision* *Any challenges in accessing these by women?*	☐	
• After the mother gives birth, what resources are in place targeting her health?	☐	
• Are these resources available consistently in your health facility?	☐	

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• Do health care workers believe that care givers access and utilise these resources as recommended?	☐	

4. AVAILABILITY AND PROVISION OF RESOURCES

•

Probing questions	Covered	Notes/Observations
• What are the resources available to ensure optimal infant nutrition and health (Vaccinations, food rations, access to health services, ORS/Zinc supplements, Vitamin A supplementation, de worming)?	☐	
• Are these resources available consistently in your health facility?	☐	
• Do health care workers believe that care givers access and utilise these resources as recommended.	☐	
• Some care givers do not utilise the food rations appropriately because they believe it causes diarrhoea, what is the opinion of the health care worker?		

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• Do care givers access infant's monthly weighing and health monitoring?		
• If the health care workers believe that attendance is not optimal what do they think is causing this?		
• Do health care workers believe that care givers sometimes do self-administered treatment at home?		
• What kind of self-administered treatment are care givers practising at home?		
• Is this self-administered treatment good or not good for the infants and does it contradict or support the advice or access to resources given by health care workers?		
• What do health care worker think are the barriers to optimal nutrition and health of infants?		

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Reflections from the interview:

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Areas for Improvement:

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Issues to explore for next interview (s):

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BOTSWANA INTERNATIONAL UNIVERSITY OF SCIENCE & TECHNOLOGY

INTERVIEW GUIDE: OLDER FAMILY FIGURES

STUDY TITLE:

Perceptions of primary care givers, older family figures and health care workers in ensuring optimal nutritional status for infants aged 6 – 24 Months in Selected Districts in Botswana.

ETHICS REFERENCE NUMBERS: E19062014 SoBS Nutrition

(**REFERENCE TO PROTOCOL:** Final Version 1.0 March 2016)

Study Group: CGE ☐ *CGN* ☐ *OFF* ☐ *HCW* ☐

Subject Number: Study Group: ☐☐☐ *Interview Number:* ☐☐☐

Today's date:

☐☐ *(Day)* ☐☐ *(Month)* ☐☐☐☐ *(Year)*

Health facility:

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INTRODUCTION

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As part of our interview today, I will record our conversation. This will help me to remember what we discussed today in great detail, so I can correctly capture your views and experiences. There will be no way of identifying you from this recording. In addition, after the interviews the audio will be transcribed and then audio will be later discarded.

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1. GENERAL KNOWLEDGE ABOUT INFANT HEALTH

- Please tell me about your grandson/daughter, nephew or niece and how he/she has been growing and developing.
- How old are they?

Probing questions	Covered	Notes/Observations
• What do care givers consider to be good health for infants? (Indicators for good health). *You mentioned that that there are things that show you that your grandson/daughter is healthy, what are some of those things?*	☐	
• What baby care practices improves or fosters good health in infants? *It seems like there are some things you are doing such as... to ensure that you grandchild grows well.... Please tell me more about these....*	☐	
• What sort of sickness is their infant had before and what do care givers believe to be cause of this sickness? *When you said sometimes your grandchild is sick what kind of illness does he/she suffer from.....?* *What do you think causes these illnesses?*	☐	
• What do caregivers do to get infants healthy after a sickness (role of clinics/health facility or health care workers or other self-administered home remedies)? *When your child is ill, what does the older family figure*	☐	

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do or what advice do they give mothers/care givers? *Do older family figures advice or use home remedies or self-administer medications?*		
• Assess care giver's understanding of the importance of maternal health in infant's health and development. (Review the cultural beliefs of Botsetsi) *Please tell me about the time when your daughter was pregnant?* *What sort of things did you do when you discovered that they were expecting him/her?* *After they gave birth what happened, did you advise them change some things about their health and lifestyle?* *When they were in Botsetsi, what sort of things did you advise them to do or not to do?*	☐	

Location: _____ Subject Number: _____

2. KNOWLEDGE ABOUT BREASTFEEDING AND/OR BOTTLE FEEDING

- You have mentioned how your grandchild was fed when he/she was young can you please tell me about that?
- You grandchild is now_____ months; please tell me more about how he is feeding now.

Probing questions	Covered	Notes/Observations
• What do older family consider to be optimal feeding for infants and reasons? *You have indicated that you grandchild breastfeeds/bottle feeds, what do you think of this feeding method?* *What do you think is the best feeding method for infants?*	☐	
• Duration for breastfeeding the infant or if still breastfeeding when the mother/care giver expects breastfeeding to last for. *What does the older family figure think of the first milk (colostrum)?* *If the mother is breastfeeding how long does the older family figure think the mother should breastfeed.*	☐	
• Implementation of breastfeeding, was demand feeding is practised, exclusive or mixed feeding? *How does the older family figure support breastfeeding, especially when the mother is working.*	☐	
• If bottle feeding the reason for doing so.	☐	

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You have indicated that your grandson/daughter is bottle feeding, how did this come about..... *What do they think of this?*		
• If using formula, making of formula (reconstitution) and how they learnt to do this? *And if their grandson/daughter is breastfeeding do they know how to make the formula?*	☐	
• Practices that the care givers ensures hygienic bottle feeding. *Where you live do you have indoor plumbing.....fuel source.....how do you make formula at night?*	☐	
• How the infant's HIV exposure affected the choice of feeding method. *What do the older family figures think of breastfeeding when the mother is HIV positive?*	☐	

Location: _____ Subject Number: _____

3. KNOWLEDGE ABOUT COMPLEMENTARY FEEDING AND NUTRITION

- You child is now ____ months and it looks like you are now feeding him other feeds beside milk. Please tell me more about what you feeding him/her now and when you started feeding him/her?

Probing questions	Covered	Notes/Observations
• The optimal age for complimentary feeding. *When did you grandchild start feeding on solids?*	☐	
• The age the infant was introduced to solid foods and reasons for doing so if done earlier or later than 6 months. *You mentioned that you started feeding him/her at ___months, what made you start feeding at this age?*	☐	
• The type of first weaning foods provided to the infant and reasons for giving these foods. *When you started feeding him/her what sort of foods did you give him?.....why?*	☐	
• The type of feeds given currently and reasons for providing these. (To determine if the infant receives all food groups and justifications). *Now that your grandchild is older, are the types of food he/she is eating changing?*	☐	

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• If some food groups are not given, the reasons for not giving foods from these food groups. *You mentioned that you mostly give him/her.....have you tried other foods such as.....if not why?*	☐	
• Type of drinks given to the infant and reasons for doing so. *Besides solid foods do you ever give him/her drinks?....what kind?.....Does this include water?*	☐	
• What older family figures consider nutritious food choices and reasons for giving these? *It looks like you give your grandchild.....do you consider these foods to be nutritious?*	☐	
• Food preparation practices for infant and reasons for doing so (including whether infant's food is prepared separately, different texture, enriched?). *The foods that your grandchild is eating; do you and other family members eat the same foods?* *Do you change the texture or add other foods to your child's food?*	☐	
• For infants weaned what are their milk intake options and reasons for doing so?	☐	

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Location: _____ Subject Number: _____

You have mentioned that your grandchild has stopped breast-feeding/formula feeding, are you giving him/her other milk drinks?		
• The frequency of meals that the infant is provided with and justification for doing so. *In a day how often do you feed him/her.....*	☐	
• What culture and traditional practices affect how infants are fed (effects of culture on feeding practices?). *I have heard from other mothers that there are some things in culture such as not to feed meat because a child will develop a taste for salt too soon...what do you think of these?* *Are the foods we should give more or less of to children?* *Do you have any of these beliefs? What are the reasons behind these?*	☐	

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Location: _____ Subject Number: _____

4. INFLUENCE OF HEALTH CARE WORKERS

- Is your grandchild taken to clinic for monthly weight monitoring?

Probing questions	Covered	Notes/Observations
• What older family figures regard as the role of health care workers in terms of infant health? *You have indicated that your grandchild is taken to the clinic each month for weight monitoring.....what do you think is the role of these in child's health and development?*	☐	
• Challenges older family figures believe care givers encounter with accessing health care or nutrition services. *You have mentioned the services you get from the clinic, are these services always there?* *Are you satisfied with these services?* *Are the other challenges that you have encountered that you believe are preventing you from fully accessing health services to improve your infant's health?* *When you were pregnant what services that you received from your health facility?* *How does the older family figure encourage the mother/care giver to access and utilise health care workers' advice?*	☐	
• Which services that are available from health facilities that care givers regard as useful or not	☐	

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• The role of food provisions from the government received from the health facility and whether care givers consider these useful or not useful for optimal nutrition of the infant. *Government provides tsabana, malutu, beans and cooking oil, do you receive these? Do you think these are important for the growth of your infant?* *Some mothers have stated that they don't give tsabana to their child because of diarrhoea, what do you think of this.....* *What do you think is missing in health care services that you believe can improve the health of your child?*	☐	

Location: _____ Subject Number: _____

5. ACCESS TO RESOURCES

- It sounds like it takes many things to get a child to grow well, besides adequate feeding, care and access to health services.....what other things do you think has helped your grandchild grow?

Probing questions	Covered	Notes/Observations
• Is the older family figure employed or not? *What do you do?*	☐	
• Which resources do care givers consider to be important for optimal infant health and nutrition? (such as land, education, employment, income or technology?) ***Probe giving examples such as land, education and relating to child health and development.***	☐	
• Who controls how much money is spent on food and does decision takes into account the nutrition or health needs of the infant. *Does the older family figure help the mother financially or otherwise in order to provide optimal care for infants?*	☐	

Location: _____ Subject Number: _____

Reflections from the interview:

Areas for Improvement:

Issues to explore for next interview (s):

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Appendix 6: Journal Articles, Conference Proceedings and Posters

BDA The Association of UK Dietitians
THE OFFICIAL JOURNAL OF THE BRITISH DIETETIC ASSOCIATION
Journal of Human Nutrition and Dietetics

Journal of Human Nutrition and Dietetics

RESEARCH PAPER

Birthweight, HIV exposure and infant feeding as predictors of malnutrition in Botswanan infants

P. Chalashika,[1] C. Essex,[1] D. Mellor,[2] J. A. Swift[1] & S. Langley-Evans[1]

[1]Division of Nutritional Sciences, School of Biosciences, University of Nottingham, Loughborough, UK
[2]School of Life Sciences, Coventry University, Coventry, UK

Keywords
1000 days, Botswana, child undernutrition, HIV, infant feeding practices, malnutrition.

Correspondence
P. Chalashika, Division of Nutritional Sciences, School of Biosciences, University of Nottingham, Sutton Bonington, Loughborough LE12 5RD, UK.
Tel.: +44 (0) 115 951 6400
Fax: +44 (0) 115 951 6122
E-mail: paphani.chalashika@nottingham.ac.uk

How to cite this article
Chalashika P., Essex C., Duane M., Swift J.A. & Langley-Evans S. (2017) Birthweight, HIV exposure and infant feeding as predictors of malnutrition in Botswanan infants. *J Hum Nutr Diet*. https://doi.org/10.1111/jhn.12517

Abstract

Background: A better understanding of the nutritional status of infants who are HIV-Exposed-Uninfected (HEU) and HIV-Unexposed-Uninfected (HUU) during their first 1000 days is key to improving population health, particularly in sub-Saharan Africa.

Methods: A cross-sectional study compared the nutritional status, feeding practices and determinants of nutritional status of HEU and HUU infants residing in representative selected districts in Botswana during their first 1000 days of life. Four hundred and thirteen infants (37.3% HIV-exposed), aged 6–24 months, attending routine child health clinics, were recruited. Anthropometric, 24-h dietary intake and socio-demographic data was collected. Anthropometric *Z*-scores were calculated using 2006 World Health Organization growth standards. Modelling of the determinants of malnutrition was undertaken using logistic regression.

Results: Overall, the prevalences of stunting, wasting and being underweight were 10.4%, 11.9% and 10.2%, respectively. HEU infants were more likely to be underweight (15.6% versus 6.9%), ($P < 0.01$) and stunted (15.6% versus 7.3%), ($P < 0.05$) but not wasted ($P = 0.14$) than HUU infants. HEU infants tended to be formula fed (82.5%), whereas HUU infants tended to breastfeed (94%) for the first 6 months ($P < 0.001$). Significant predictors of nutritional status were HIV exposure, birthweight, birth length, APGAR (appearance, pulse, grimace, activity and respiration) score and mother/caregiver's education with little influence of socio-economic status.

Conclusions: HEU infants aged 6–24 months had worse nutritional status compared to HUU infants. Low birthweight was the main predictor of undernutrition in this population. Optimisation of infant nutritional status should focus on improving birthweight. In addition, specific interventions should target HEU infants aiming to eliminate growth disparity between HEU and HUU infants.

Introduction

Globally, mortality of children aged <5 years has declined from 90 to 43 deaths per 1000 live births between 1990 and 2015 [1]. However, in sub-Saharan Africa, mortality of children aged <5 years still remains higher at 86 deaths per 1000 live births [1]. Mortality in children aged <5 years is mainly attributed to undernutrition, with 45% of these deaths being preventable through optimal nutrition, especially in the first 1000 days (the period from conception to the child's second birthday) [2–4].

HIV/AIDS is still a major health challenge in Botswana [5,6]. Strategies including the prevention of mother-to-child transmission (PMTCT) of HIV have been highly successful in Botswana, reducing mother-to-child transmission rates to approximately 2.6% [7,8]. Without PMTCT strategies, HIV transmission from mother to child could be as high as 25% [8]. However, this success has resulted in the

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Author: Paphani Chalashika

Co Author: Simon Langley-Evans, Judy Swift (The University of Nottingham)

Topic: The first 1000 days, infant feeding, and early childhood development

Title: Feeding practices, HIV exposure and infant's nutritional status in the first 1000 days; a study of infants from selected districts in Botswana.

Presentation Type: Oral

Introduction: Better understanding of nutritional status of HIV exposed infants and non-HIV exposed infants, within the context of feeding practices in their first 1000 days is a matter of public health importance. This study compares the nutritional status, feeding practices of HIV exposed and non-HIV exposed infants within their first 1000 days from selected districts in Botswana.

Methods: A comparative cross-sectional study was conducted in 413 infants (37.3% HIV-exposed), aged 6-24 months attending routine child health clinics in Francistown, Kgatleng, Selebi Phikwe and Kweneng East districts. Anthropometric measures, 24 hour dietary intake and socio-demographic data were collected. Z-scores were calculated using 2006 WHO growth standards to identify stunting, wasting and underweight.

Results: The overall prevalence of stunting, wasting and underweight was 10.4%, 11.9% and 10.2% respectively. HIV-exposed infants were more likely to be underweight (15.6% vs. 6.9%), ($p=0.008$) and stunted (15.6% vs. 7.3%), ($p= 0.013$). There were no significant differences in wasting between HIV and non-HIV exposed infants. HIV-exposed infants tended to formula feed (89.4%) compared to non-HIV exposed infants who tended to breastfeed (89.6%) at 0-6 months ($p<0.001$).

Conclusion: This study demonstrated poor nutritional status in HIV exposed infants compared to non-HIV exposed infants in selected districts in Botswana. HIV exposure is an important factor that dictates feeding practices. A rethink of how infant feeding policy is implemented may be required, to ensure optimal nutrition for all infants, especially in the first 1000 days.

Proceedings of the Nutrition Society (2015), **74 (OCE5)**, E338 doi:10.1017/S0029665115003857

Summer Meeting, 6–9 July 2015, The future of animal products in the human diet: health and environmental concerns

Preliminary analysis of the Botswana Infant Feeding Study: Prevalence of wasting, stunting and underweight, and formula feeding in HIV-exposed infants

P. Chalashika, S.C. Langley-Evans, J.A. Swift and D.D. Mellor

Division of Nutritional Sciences, School of Biosciences, University of Nottingham, Sutton Bonington, Loughborough, LE12 5RD, UK

Proceedings of the Nutrition Society

Maintaining a negative HIV status in infants exposed to HIV during pregnancy and breast feeding often takes priority over maintaining optimal nutritional status (Patel, 2010). This may have dire consequences, because children who are undernourished are more likely to die, compared to those who are well-nourished (UNICEF, 2013). In Botswana, mortality in children aged five years or younger has increased from 50/1000 in 1997 to 76/1000 in 2007 (BFHS IV, 2007). It is therefore, important to understand the determinants of nutritional status of infants, and also determine if there are differences in nutritional status between HIV-exposed and non- HIV exposed infants. This may inform evidence-based practices aimed at improving nutritional status and thus reducing mortality in infants. This study, therefore aimed to investigate nutritional status, feeding practices and nutritional intake of HIV-exposed compared to non-HIV exposed infants aged 6–24 months.

A comparative cross-sectional study was conducted in HIV-exposed and non-HIV exposed infants aged 6–24 months attending routine child welfare clinics in 18 health facilities located in four districts in Botswana. Data were collected by two trained surveyors in addition to a study team leader. Weight and length were taken using calibrated Seca® Scales (385, 875) and Seca® measuring board (417) and stadiometer (Seca® 217). A USDA 5 Pass 24-hour recall was used to measure dietary intake. Socio-demographic, anthropometric, medical, and behavioural data – both current and retrospective - were collected from the mother/care giver and also from each child's clinic card. This preliminary analysis focuses on underweight, wasting and stunting defined by WHO as a Z score of $\leqslant -2$ for weight for age, weight for length and length for age respectively (UNICEF, 2013), and self-reported feeding strategies. Ethical approval was obtained from University of Nottingham's Medical School research ethics committee and also from the Health Research and Development Committee, Ministry of Health in Botswana.

A total of 413 eligible participants were recruited into the study, and this preliminary analysis has focused on a sub-sample of 75 participants. 46 (61·3 %) infants were non-HIV exposed and 29 (38·7 %) were HIV-exposed infants, recruited from a single district consisting of 3 health facilities (health post, clinic and hospital). HIV-exposed infants were significantly more likely to be underweight (17·2 %) than non-HIV exposed infants (2·2 %), ($X^2_{(1)} = 5{\cdot}487$, $p = 0{\cdot}049$). In addition, wasting was more likely to occur in HIV-exposed infants than in non-HIV exposed infants (13·8 % vs. 2·2 % respectively; $X^2_{(1)} = 3{\cdot}859$, $p = 0{\cdot}019$). There was no significant difference in stunting prevalence between the two groups. Analysis of feeding practices as reported by the care-giver showed that HIV-exposed infants were more likely to be formula fed (89·7 %) compared to non-HIV exposed infants who are likely to breastfed (78·3 %) at 0–6 months ($X^2_{(2)} = 48{\cdot}705$, $p < 0{\cdot}001$) and at 6–12 months (89·7 % and 58·7 % respectively, $X^2_{(3)} = 30{\cdot}233$, $p < 0{\cdot}001$).

The findings of this preliminary analysis of a larger dataset demonstrated that HIV-exposed infants in Botswana are significantly more likely to be wasted and/or underweight compared to non-HIV exposed infants. One explanation for this finding may lie in the observed differences in feeding practices. HIV-exposed infants are significantly more likely to be fed formula during the first year of life which may result in diarrhoea and underfeeding. Analyses of the whole dataset will extend this work to investigate potential mediators and moderators of the relationship between HIV exposure status and malnutrition in multivariate analysis.

1. BFHS IV (Botswana Family Health Survey), (2007), Central Statistics Office, Botswana.
2. Patel D, Bland R., Coovadia H, Rollins , *et al.* (2010). *AIDS*. **24**: 437–445.
3. United Nations Children's Fund, UNICEF (2013), (Publication No. E.13.XX.4). Retrieved from http://www.unicef.org/media/files/nutrition_report_2013.pdf

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BOTSWANA INTERNATIONAL UNIVERSITY OF SCIENCE & TECHNOLOGY

The University of Nottingham

HIV exposed infants from selected districts in Botswana are more likely to be stunted, underweight and formula fed.

Chalashika P, Langley-Evans S, Swift J & Mellor D. Division of Nutritional Sciences, School of Biosciences, University of Nottingham, Sutton Bonington, Loughborough, LE12 5RD

Introduction

Mortality in children aged less than five years has been increasing in Botswana over the last ten years (BFHS IV, 2007). In Botswana, 76 children per 1000 live births die before their fifth birthday (BFHS IV, 2007). Poor nutritional status is linked to high mortality in infants, with 45% of deaths attributed to malnutrition (UNICEF, 2013).

It is therefore important to understand the state of infant's nutritional status and also determine if there are differences between HIV exposed and non-HIV exposed infants.

The aim of this study was to determine the nutritional status as marked by anthropometric measures (weight for length, weight for age and length for age) in HIV exposed and non-HIV exposed infants aged 6 -24 months.

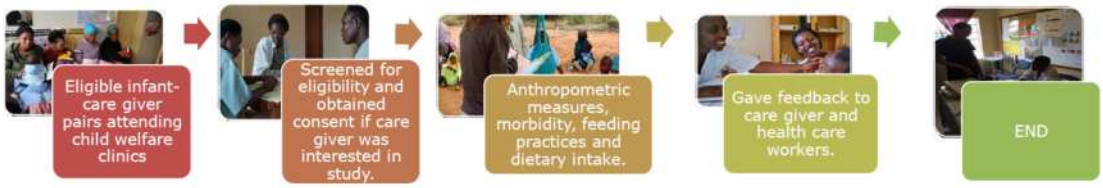
Table 1: Comparison of HIV exposed and non-HIV Exposed infants' characteristics.

Characteristic	HIV Exposed (n=154)	Non-HIV Exposed (n=259)	P-Value
Infant's age in months* [Mean ± SD]	14.3 ± 5.4	14.2 ±5.36	0.914
Infant's gender %			
• Male	49.4	50.6	0.604
• Female	46.7	53.3	
Birth Weight [Mean ± SD]	2.96 ± 0.50	3.03 ± 0.46	0.145
Birth length [Mean ± SD]	49.71 ± 3.96	50.2 ± 3.80	0.234
Apgar Score** [Mean ± SD]	9.53 ± 0.71	9.38 ± 0.90	0.08
Birth Weight Categories %			
• Low (<2.5kg)	12.3	12.1	0.93
• Normal (≥ 2.5kg)	87.7	87.9	

*Age at the time of sampling

** APGAR Score at birth: **A**ppearance (skin colour), **P**ulse (heart rate), **G**rimace response (reflexes), **A**ctivity (muscle tone), **R**espiration (breathing rate and effort)

Methods



Results

Demographics

413 eligible infant-care giver pairs were enrolled into the study, of which 259 (62.7%) were non-HIV exposed and 154 (37.3%) were HIV exposed. Characteristics of HIV exposed group and non-HIV exposed group are shown in table 1. There were no significant differences in various characteristics such as age, gender distribution, birth weight/length or APGAR score.

Prevalence of malnutrition

Stunting was found in 15.6% and 7.3%, underweight (13.6% vs. 6.9%) and wasting (14.9% vs. 10%) of HIV exposed and non-HIV exposed respectively (Figure 1). Significant differences were found for stunting and underweight.

Feeding Practices

At less than 6 months the predominant feeding method in HIV exposed infants was formula feeding (82.5% vs. 6% in non-HIV exposed, p< 0.001). In contrast non-HIV exposed infants tended to be breastfed (94% vs. 17.5% in HIV exposed, p< 0.001) during the first 6 months after birth. There were significant differences in these feeding practices.

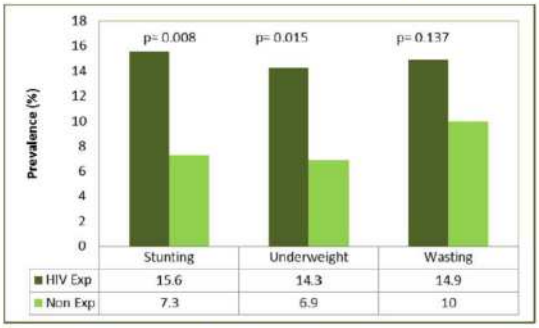


Figure 1: Prevalence of stunting, underweight and wasting in HIV exposed vs. non-HIV exposed infants.

Conclusions

HIV exposed infants were more likely to be underweight and/or stunted compared to non-HIV exposed infants. various factors may account for this difference in nutritional status. Different feeding practices may have resulted in different weight gain and thus different nutritional status in these infants. Further analysis of the data will provide more information that will further explain differences in the observed nutritional status.

References
1. BFHS IV (Botswana Family Health Survey), Central Statistics Office, UNICEF;2007
2. United Nations, (2013). *Millennium development goals and beyond 2015.* (Publication No.). Retrieved from http://www.un.org/millenniumgoals/pdf/Goal_4_fs.pdf

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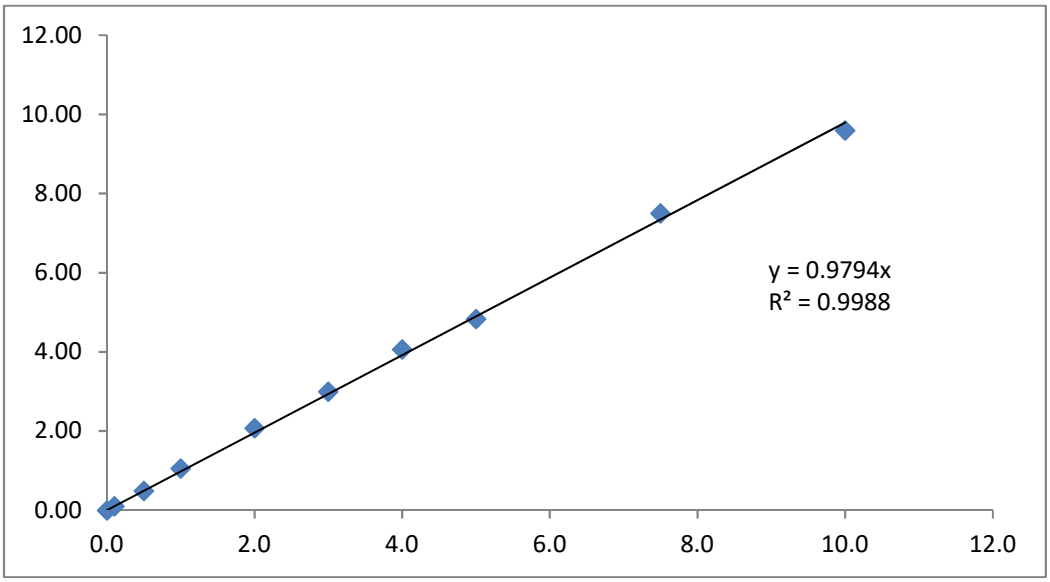
Email:stxpc11@nottingham.ac.uk

Appendix 7: Nutritional Analysis of cereals-output

Salt

Cooked product analysed

NaCl (%)	Reading			
	1	2	3	Mean
0.0	0	0	0	0.00
0.1	0.1	0.1	0.1	0.10
0.5	0.49	0.49	0.49	0.49
1.0	1.05	1.06	1.06	1.06
2.0	2.07	2.08	2.08	2.08
3.0	3.0	3.0	3.0	3.00
4.0	4.1	4.1	4.0	4.07
5.0	4.8	4.8	4.9	4.83
7.5	7.5	7.5	7.5	7.50
10.0	9.6	9.6	9.6	9.60



SAMPLE	Reading				
	1	2	3	Mean	NaCl (%)
SM	0.04	0.04	0.04	0.04	0.039
FSM	0.08	0.11	0.18	0.12	0.121

SM: Sorghum meal

FSM: Fortified Sorghum Meal

Nitrate

Cooked product analysed

Sample		Reading - Nitrate (mg/kg)		
	1	2	3	Mean
SM	20	14	20	18.00
FSM	123	132	114	123.00

SM: Sorghum meal

FSM: Fortified Sorghum Meal

Fibre

Dry meal analysed (de-fatted)

Sample	empty fibre bag		sample weight		dry bag + dry sample		empty crubicle		crucible + ash		Crude fibre		mean
	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(%)	(%)	(%)
	a	b	a	b	a	b	a	b	a	b	a	b	
SM	0.4176	0.4156	1.0009	1.0189	0.4308	0.4287	26.0384	27.8864	26.0394	27.8880	1.2201	1.1530	1.19
FSM	0.4160	0.4178	1.0169	1.0016	0.4356	0.4371	30.2925	26.1138	30.2934	26.1148	1.8715	1.8302	1.85

Fat

Sample ID	**Thimble No.**	**Sample wt** (g)	**Flask No.**	**Flask** (g)	**Flask+fat** (g)	**Fat** (g)	**Fat** (%)	**Mean** (%)
SM1	G	1.0094	7	146.5508	146.5803	0.0295	2.923	2.87
SM2	H	1.0034	8	144.4568	144.4850	0.0282	2.810	
FSM1	I	1.0089	9	145.3628	145.4339	0.0711	7.047	7.22
FSM2	J	0.9923	10	146.2406	146.3139	0.0733	7.387	

Standard

Lard 1	a	0.3007	23	138.3604	138.66	0.2996	99.634	**99.67**
Lard 2	b	0.3162	24	143.2298	143.5451	0.3153	99.715	

Lard goes up to ~99.8% fat

Fatty acids

Analysed fat from Soxhlet extraction

Sample ID		Palmitic 16-0	Stearic 18-0	Oleic 18:1n9c	Linoleic 18:2n6c	Total area	Saturated	Unsaturated	Saturated :Unsaturated
SM1	Area	35.92	6.37	51.3	6.42	100.01			
	(%)	35.92	6.37	51.29	6.42				
SM2	Area	36.35	5.64	54.91	3.1	100			
	(%)	36.35	5.64	54.91	3.10				
Mean	(%)	**36.14**	**6.01**	**53.11**	**4.76**		**42.14**	**57.87**	**1 :1.37**
FSM1	Area	18.95	5.91	38.86	31.96	95.68			
	(%)	19.81	6.18	40.61	33.40				
FSM2	Area	22.49	7.05	42.11	26.11	97.76			
	(%)	23.01	7.21	43.07	26.71				
Mean	(%)	**20.72**	**6.48**	**40.49**	**29.04**		**27.20**	**69.52**	**1 :2.56**

Protein

Dry Meal analysed

Sample	File Name	Weight (mg)	Nitrogen (%)	Nitrogen (%)	Protein (%)
Bypass	bypass		0.00		*
Sucrose	blank1		0.00	0.00	*
Sucrose	blank2		0.00		*
Aspartate	std1	47.5	10.52	10.52	*
Aspartate	std2	51.5	10.52		
Aspartate	std3 as UK	46.1	10.45	10.53	*
Aspartate	std4 as UK	50.9	10.61		
SM1	25	49.7	1.58		
SM2	26	57.4	1.74	1.71	10.67
SM3	30	50	1.80		
FSM1	27	57.1	2.93		
FSM2	28	51.9	2.78	2.87	17.97
FSM3	29	54.6	2.91		
Sucrose 5	blank 5		0.00		

Energy

Dry Meal analysed

Tray No.	**Sample ID**	**Weight** (g)	**Energy** (MJ/Kg)	**Mean** (MJ/Kg)	**Energy** (kJ/100g)	**Energy** (kcal/100g)
W1	SM1	1.0072	18.4507	18.52305	1852	443
W2	SM2	0.9540	18.5954			
W3	FSM1	1.0277	19.5954	19.59015	1959	468
W4	FSM2	1.0810	19.5849			

Standards

	(MJ/kg)	
Benzoic 1	26.5199	
Benzoic 2	26.5808	26.5471
Benzoic 3	26.5407	

(100.4% of expected value [26.434])

Appendix 8: Pictures of Tsabana and Malutu



